A Method for Formative Multi-Context Boundary Profiling

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The ubiquitous availability of mobile communication technology has significantly extended the time during which people are available for communication requests by others. The traditional boundaries between contexts such as work and family life have become blurred. Incoming communication requests always have the potential to disrupt one's current activities and thus require active boundary management. Existing research in this field has mainly examined the phenomenon of boundary management and used a fixed set of pre-specified contexts to identify generic boundary profiles. We argue for a more flexible approach to building upon an individual set of contexts grounded in research on context-aware computing and mental model theory. Consequently, we propose using structure elaboration techniques to allow for the individual specification of contexts and elicit the information necessary to create a boundary profile. The proposed method is deployed in an exploratory study, which demonstrates its feasibility. Building upon these results, we introduce a technical support tool for boundary profiling and discuss the potential use of the created profiles in daily communication practice.

Interaction Science Key Words: Boundary Management, Mobile Communication Technology Use, Interpersonal Communication Management, Method Design

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1 INTRODUCTION

Today's ubiquitous availability of networked information technology and the rapid advent of mobile communication devices has significantly extended people's potential availability for interpersonal communication [32] as well as changed the ways in which people communicate [26]. Permanent availability allows contacting people anytime, independently of their current location. In particular, it may interrupt a person's activities in his or her current context (e.g., at work or spending time with family and friends).

Those experiencing such interruptions might perceive them as annoying or problematic. In general, however, studies [7, 21, 46] have shown that many people deliberately manage their availability for communication with others to avoid distractions. Such acts of considering and eventually deciding whether to accept an incoming communication request are referred to as "boundary management" [23]. The frequency with which boundary management activities occur has risen with the advent of mobile communication technologies [46]. The time and cognitive resources spent on such activities consequently impacts people's activities in their current context. Avoiding boundary management is not an option, as consequently any incoming communication attempt would be accepted. Such behavior would massively decrease the performance of one's current activities [47] and has been shown to create stress [25] and eventually negatively impact one's wellbeing [27].

Boundary management in the age of ubiquitous availability should thus be actively supported by the devices used for communication. In particular, these devices should be aware of a person's current context and change the availability settings accordingly. While much research has been conducted to identify a person's current context technically [5], less focus has been placed on identifying the cognitive availability of a person in a particular context and the acceptability of incoming communication requests. Research in this area is mostly based on Clark's boundary theory

[8], which relies on a binary distinction between a work domain and a family domain. Research on the context-aware adaptability of systems [16] and role-specific behavior [2], however, has shown that the number of contexts into which people distinguish in their lives is usually more diverse and dynamic. The dynamic nature of individually perceived contexts requires a flexible approach to boundary management that can capture the individual mental models upon which a person builds. Existing methods in this field (e.g., [20, 22, 46]), however, adopt summative approaches to boundary profiling using quantitative methods that can help identify boundary management strategies at large but hardly allow for deriving individualized support measures. The research presented in this article sets out to bridge this gap and introduces a qualitative method for formative boundary profiling (i.e., a method that enables informed socio-technical support for boundary management activities).

The working hypothesis guiding our research is that boundary management needs to be based on a conscious distinction between an individually specified set of contexts. Furthermore, we hypothesize that both the willingness and the necessity to accept interruptions depend on an individual's perceptions of the source and target contexts as well as the used communication channels. In the forthcoming sections, we justify these hypotheses on the basis of the results of existing research.

Based on these working hypotheses, the present paper proposes a method that allows us to identify these contexts, the interruptions that occur among them and the acceptability of those interruptions. The contribution of the paper is twofold. First, we propose an elicitation method that gathers qualitative data on boundary management behavior in technology-mediated communication. These data can be used for the individualization of socio-technical communication support systems and – more generically – allow us to examine individual attitudes toward situated technology-mediated communication via different channels. Second, in applying the method in a case study setup, we demonstrate the relevancy of fine-grain context identification in boundary management and identify its potential value for designing support systems for technology-mediated communication.

The research presented here has been discussed at a workshop on subject-centric community support instruments1 and summarized as a workshop paper [38]. The present article has, however, been significantly extended to include the scientific justification of the proposed intervention and introduce a novel approach to the situated capturing of boundary profiling information on mobile devices.

The remainder of this paper is structured as follows. In the next section, we introduce the concept of boundary management as conceived by Clark [8] and discuss studies that outline its relevance in the topic of the present article. We then argue for a more flexible conceptualization of people's life contexts based on them being non-static, evolving mental models [39]. Next, we discuss state-of-the-art methods for boundary profiling, namely for identifying interruptions between contexts and their acceptability for a person approached by a communication request. Section 5 describes the design of our method, which builds upon structure elaboration techniques [17]. Section 6 presents the results of a study conducted to examine the validity of our method design and underlying hypothesis. Based on the proposed method, we develop a tool for the situated capturing of boundary profiling information on mobile devices, which we briefly present in section 7. We close with a discussion of the potential usage scenarios of the profiling results in section 8 and review future research in the conclusion section.

[1] http://ceur-ws.org/Vol-2074/.

2 BOUNDARY MANAGEMENT

This section briefly reviews the work/family border theory introduced by Clark [8]. The theory and its fundamental concepts (e.g., domains, borders between them and interruptions) are explained below to provide context for the following sections. The main idea of work/family border theory is that there are two primary contexts in a person's life, namely work and family (referred to as "domains" by Clark [8]). These two domains influence each other and usually cannot be easily separated. A domain has unique properties such as rules, thinking patterns, roles and behaviors that a person deploys when perceiving to be engaged in that particular domain. Clark introduces the concept of borders that separate the domains from each other and provide the fundamental information necessary to decide which domain is considered to be active. Borders can be physical (e.g., workplace), temporal (e.g., work time) or psychological (i.e., a domain property expression-like behavior).

Furthermore, the type(s) of border(s) between domains, their flexibility (e.g., when working flexible hours) and their blending (e.g., when working from a home office) can affect the border strength, which subsequently determines how likely "interruptions" are to occur and influences how they are perceived. The concept of "interruption" refers to the phenomenon that expressions of domain properties appear in a domain to which they do not originally belong (see Figure 1).

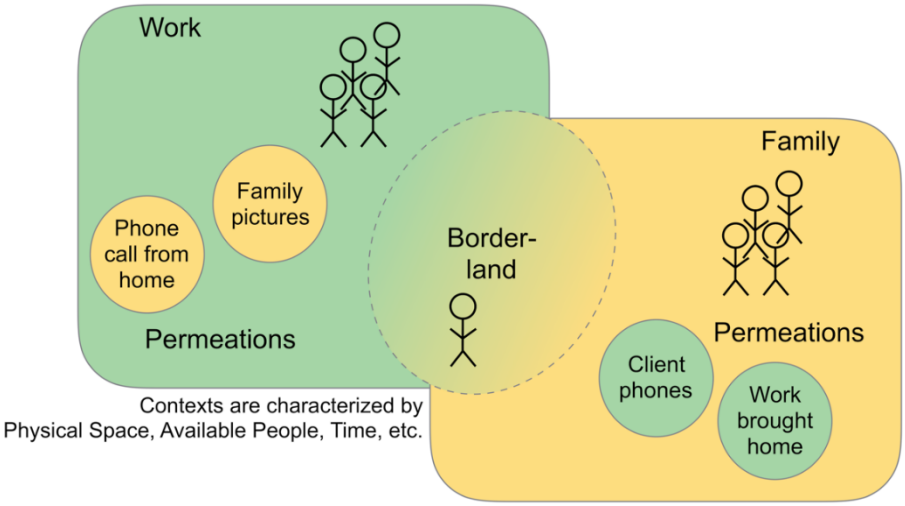

Fig. 1. Boundary Management Behavior.

Such domain properties can manifest in a person's behavior but can also be members of a particular domain. Hence, encountering a communication request by a member of a domain different from the one currently considered to be active would be an interruption. An example of such an interruption would be a phone call from a member of the family domain when the person is in the work domain. Interruptions are not necessarily dynamic phenomena but can also manifest themselves (semi-)permanently in a particular domain. Putting up family pictures at one's workplace would be an example of such a permanent interruption. Its perceived intrusiveness also determines the quality of an interruption. Some interruptions might be perceived only peripherally and hardly influence one's current activities. Others, however, can be highly intrusive and require one's full attention. Boundary management refers to how people deal with such perceived interruptions, both

in situ and ex-ante. For example, do they proactively strive to create settings that avoid or facilitate interruptions?

In the context of the original work/family border theory [8], boundary management is situated in the area in which the work domain and family domain overlap. This area is referred to as the "borderland," and its size is dependent on a person's preferences and proactive or in-situ strategies for dealing with interruptions. People who do not strictly separate the domains are referred to as "border-crossers." These border-crossers usually engage in active boundary management (i.e., consciously decide how to act in the case of interruptions in different domains).

Interruptions originating from work contexts have often been connected to issues related with work/life balance [6], meaning the desire to perceive one's time and effort devoted to work-related activities to be sufficiently contrasted with opportunities for non-work-related activities. While the extent to which people perceive a "balanced" setup is highly individual [20], studies have repeatedly confirmed that the advent of modern mobile communication technologies may impact the perceived work/life balance negatively [13, 25, 46]. This negative impact is attributed to the constant reachability enabled through these technologies, making them a constant source of potential interruptions. Research addressing these issues has proposed deploying technical [15] or organizational [36] measures with a focus on avoiding interruptions. Support for active boundary management, however, has hardly been discussed to our best knowledge. Empirical studies in this field show that the strategies to deal with interruptions are highly individual [22] and dependent on one's perceived current context [20], where people usually not only distinguish between work and non-work but also adopt a more fine-grain conceptualization of their lives. These results indicate that support approaches should build upon an individual context model containing the information necessary to describe the boundary management strategy of a person.

How people manage their boundaries and which information they require to do so have been active subjects of research [20, 23, 46] and are usually described in boundary management profiles. Before we review the methods developed to elicit such profiles in section 4, we further elaborate on the concept of fine-grain individual work/life contexts, as this fundamentally determines the approaches that can be adopted for boundary profiling.

3 INDIVIDUAL MENTAL MODELS OF CONTEXTS AND BOUNDARIES

How people distinguish their life contexts and how they respond to interruptions can be conceptualized in mental models. Mental models are cognitive constructs used by people to make plausible and assess their perceptions of phenomena in the real world [39] (see Figure 2). Individuals create mental models to explain their perceptions and derive adequate reactions. Mental models might be incomplete or even inherently contradictory. In a given situation, individuals develop ad-hoc mental models only to a point, enabling them to react to the stimulus in a way they consider to be adequate. Mental models consequently evolve through experience in real-world situations. Whenever a person encounters a situation that cannot be explained by current mental models, these models evolve and accommodate the new perceptions.

Mental models, however, do not only evolve through external stimuli [39]. External representations can be used to reflect on and communicate mental models and – during the process of articulation – make them more complete and consistent (ibid.). Diagrammatic representations of mental models in the form of conceptual models, in particular, have been shown to aid the articulation process [19] and not only affect individual mental models but also – through their potential processing of supportive information technology – have an immediate impact on handling interruptions in the real world (referred to as "activation" [24] in Figure 2).

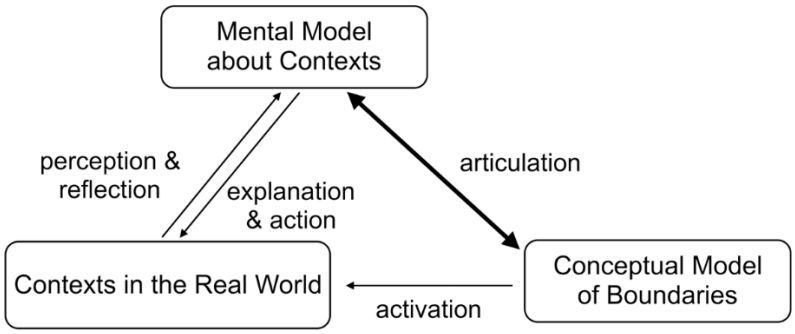

Fig. 2. Mental Models of Contexts and Boundaries.

In boundary management, individual mental models determine which situations are perceived to belong to a particular context, which contexts are distinguished at all and how one reacts to a perceived interruption. Articulating and capturing this information allow us to design individualized socio-technical support measures for boundary management. Before we elaborate further on how to support this articulation process, we briefly examine the state of research on how the different contexts in one's life are distinguished and conceptualized.

Much research on boundary management is performed from a sociological or behavioral science perspective. There, the binary distinction between "work" and "non-work" (also referred to as "family" or "life") appears to be prevalent [6, 8, 21, 22]. More recent research, however, has started to question the binary nature of contexts in people's lives [4, 20]. In particular, Boyd and Crask [4] report on a qualitative study that shows a more differentiated picture of the contexts distinguished by people in their lives. They attribute these distinctions to the different roles people take in their lives and the domains (i.e., contexts) in which these roles are anchored.

The concept of people taking different roles in their lives and these roles being connected to different properties of the current environment (e.g., space, people) is also examined in organizational and managerial science [1, 2, 34]. Works referring to the role concept, in general, appear to take a more flexible view of how people manage their boundaries and not follow the dual domain approach used by Clark [8]. In particular, Ashforth et al. [2] describe that people establish "mental fences […] around geographical areas, […], people, ideas, and so on that appear to be contiguous, similar, functionally related, or otherwise associated" to simplify and order their environment. This description is operationally similar to what we have specified above as being the purpose of mental models. The "slices of reality" created by these fences "have particular meaning for the individual(s) creating and maintaining the boundaries" (ibid.). In other words, they are individual phenomena that cannot be generalized, but are only "real in the sense that the individual perceives them as such and acts as though they are real."

Using this individual-centric approach to context specification requires not only accepting different contexts in the non-work domain (as proposed by Keeney et al. [20]) but also distinguishing between an arbitrary number of roles and connected contexts. Consequently, boundaries not only emerge at the interface between work and non-work contexts, but may also occur between all the contexts people distinguish in their lives (see Figure 3). Interruptions can thus originate from different source contexts and might be more or less acceptable or demanding to deal with. The occurring interruptions and how people handle them are another constituent of a boundary profile (aside from the distinguished context). The information necessary to characterize them, however, is not evident. We therefore examine related work on boundary profiling in the next section to identify the relevant aspects to be covered in an articulation support instrument.

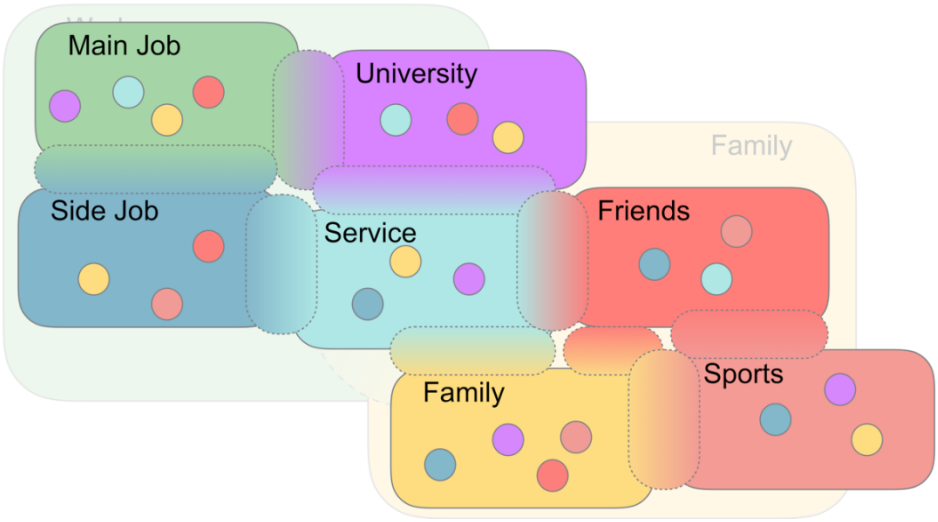

Fig. 3. Multi-Context Boundaries.

4 APPROACHES FOR BOUNDARY PROFILING

This section discusses approaches to creating boundary management profiles. The approaches proposed by Kossek et al. [23] and White and Thatcher [46] are based on the dual domain concept originally devised by Clark [8], whereas Keeney et al. [20] extend the number of non-work contexts, but still propose using a fixed set of contexts. Kossek et al. [23] propose using a questionnaire to collect the required data for creating a boundary management profile that describes a person's behavior when encountering interruptions. Methodologically, 17 items are developed to elicit information about a person's "non-work-interrupting work behaviors" and "work-interrupting non-work behaviors" as well as their "boundary control," "work identity" and "family identity." The items are formulated as statements with which one can agree or disagree on a five-point Likert scale. The answers are aggregated to values for each of the areas mentioned above, which form the basis for the boundary management profiles defined in a further step. When applying their method in a validation study with 591 participants, Kossek et al. [23] find six general patterns of how people deal with interruptions. These patterns are characterized by distinct features, namely the perceived importance assigned to each of the contexts, the acceptability of interruptions from one context to the other and the probability of interrupting one's activities in the current context to accept an interruption from another.

White and Thatcher [46] also build their work on the dual domain concept introduced by Clark [8]. Their approach focuses on boundary management in the context of mobile communication, whereas Kossek et al. [23] do not focus on any particular area of application. Methodologically, the authors propose using questionnaires to collect demographic data and then interviews to elicit boundary management behavior in an open-ended way. The interviews are semi-structured and domain-specific, covering the areas of the general usage of mobile phones, times and effects of communication, the domain in which the communications occur more frequently, facilitation or disruption in the domains and whether external entities regulate mobile phone usage. The results were transcribed and analyzed using thematic content analysis. In a validation study, 27 people participated in such interviews. The results were again used to identify generic boundary management profiles. One notable finding for boundary profiling was that participants handle

interruptions differently depending on the role of the interruption initiator. Participants seem to decide on acceptance not solely based on the context from which the interruption originates; they also use a more fine-grain approach focusing on the distinct members of this context.

Unlike the approaches of Kossek et al. [23] and White and Thatcher [46], Keeney et al. [20] use a multi-context model as the conceptual foundation of their study. Based on a literature review, the authors identify eight non-work contexts, namely health, family, household, friendships, education, romance, community and leisure. Methodologically, Keeney et al. [20] propose a questionnaire consisting of 48 items to collect data on the perceptions of how much interference one observes from the work context to any of the non-work contexts and whether these interferences are considered to be problematic (i.e., whether they are sources of stress). This set is augmented with items assessing the perceived importance of each context and a person's involvement. The items are formulated as statements with which one can agree or disagree on a five-point Likert scale. In a validation study, 1811 people used the developed instrument [20]. The results show that six of the eight proposed non-work contexts are considered to be relevant by 88% to 99% of participants. These results indicate that people usually distinguish between two or more non-work contexts. Furthermore, the indicators of perceived interference and whether they are considered to be sources of stress vary across the non-work contexts, which indicates their diversity and suggests that they should be explicitly distinguished when supporting boundary management activities.

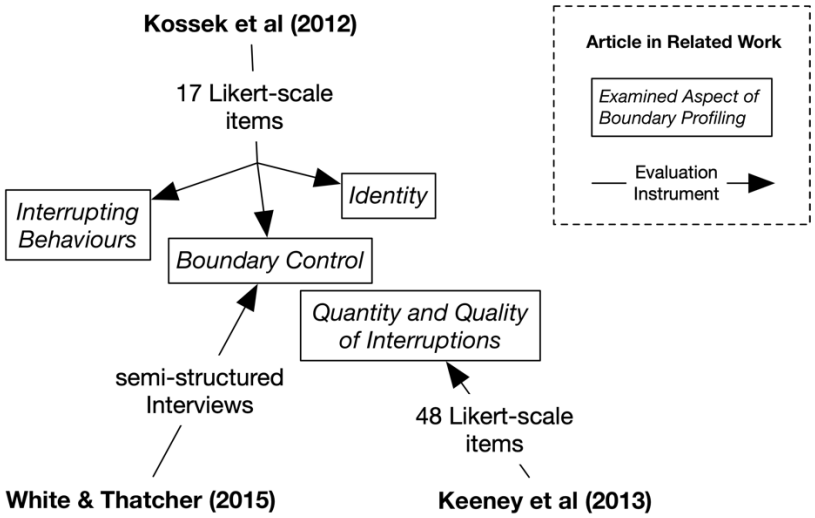

Fig. 4. Aspects of Boundary Profiling Covered in Related Work.

Figure 4 summarizes the review of the validation studies reported on in related work to identify the main characteristics of boundary management profiles that need to be considered when engaging in elicitation activities. Kossek et al. [23] and White and Thatcher [46] identify the actual probability of accepting an interruption to be a constitutive element of boundary profiles. White and Thatcher [46] and Keeney et al. [20] focus on interruptions originating from the work context, whereas Kossek et al. [23] examine interruptions in both directions (i.e., non-work-interrupting work and work-interrupting non-work). Keeney et al. [20] also provide evidence that the non-work domain should be elaborated on in more detail and can be split into distinct contexts in which people show different boundary management behaviors.

Furthermore, White and Thatcher [46] find that the role of the interruption's trigger is crucial to boundary management behavior. Consequently, boundary management must not only consider the source contexts of interruptions but also explicitly distinguish different members of the source context triggering such interruptions. Results showing that the invasiveness of an interruption is perceived differently depending on the source and target context (see "facilitation vs. disruption" [46] and "time-based and strain-based interference" [20]) indicate that the acceptability of an interruption can and should be assessed as well. Finally, the results on the importance of different non-work contexts and a person's involvement therein, as described by Keeney et al. [20], show that different people might perceive having different contexts and should be able to name them explicitly.

5 METHOD ENGINEERING

The review of the methodological considerations present in related work has shown that boundary management can be supported by articulation activities, which elicit a person's acceptance of interruptions among contexts and their way of dealing with such interruptions. All existing methods, however, are based on a fixed set of examined contexts. While Keeney et al. [20] show that a binary work/family distinction appears to be insufficient, they still develop their instrument based on a set of eight pre-specified contexts identified to be generically suitable from a literature review. Based on our considerations of mental models (as described in section 3) and backed by research on context-sensitive adaptive systems [16], we hypothesize that contexts are individually constructed concepts that cannot be generalized. Prescribing a set of contexts to be assessed might thus either oversimplify or over-structure a person's perception of her or his communication contexts. We thus take a different approach based on structure elaboration techniques, which have been proven to be suitable for identifying such individual constructs without any a priori assumptions [11].

5.1 Methodological Approach: Structure Elaboration Techniques

Structure elaboration techniques are useful for the elicitation of mental models. Mental models are cognitive constructs used by people to make plausible and assess their perceptions of phenomena in the real world [39]. An individual's conceptualization of a perceived situation as a particular communication context is an instance of such a mental model. Assessing whether an incoming communication request is regarded as an interruption of this context and whether the request is still acceptable or must be accepted puts this mental model to use. Reflecting on and making explicit this mental model supports boundary management (see Figure 2).

Structure elaboration techniques are an effective means of creating physical representations of mental models [11] to make them explicit. In a process moderated by a facilitator (referred to as the "dialogue-hermeneutic method" [17]), an articulating person creates a graphical representation of his or her mental models by placing labeled cards on a modeling surface. Subsequently, the articulating person and facilitator put those cards into mutual relationships. Dann [11] stresses the importance of the immediacy of representation in the structuring process. The physical creation of the model attains this immediacy. Both participants can immediately refer to a physical representation rather than generic items. They create and modify the model in a dialogue-based way until agreeing on what is represented. Mental models of individuals are thus externalized, questioned and modified at the same time. This concurrency is necessary, as a mental model might be incomplete or even inherently contradictory. Such a dialogue-oriented process enables them to reflect on and resolve these potential issues. The articulation procedure ends once the articulating person feels confident that the result matches his or her mental model.

Structure elaboration techniques have a highly sophisticated specification in terms of both the methodology and the instruments to be used. However, their suitability for the externalization of mental models has already been evaluated empirically [17, 19]. Some researchers [11] have suggested that structure elaboration techniques should always be adapted to the case at hand (e.g., in terms of prescribing model elements or a modeling procedure). In the following, we thus introduce a structure elaboration technique adapted to allow the elicitation and representation of the information required for boundary management in combination with the dialogue-hermeneutic method. Which information needs to be articulated can be derived from related work and is summarized in the next section.

5.2 Articulation Requirements

A structure elaboration technique that supports boundary profiling needs to represent different information categories, which can be derived from the study of related work on boundary management and boundary profiling as described above. The four fundamental requirements we identify are outlined in Figure 5 and briefly described in the following.

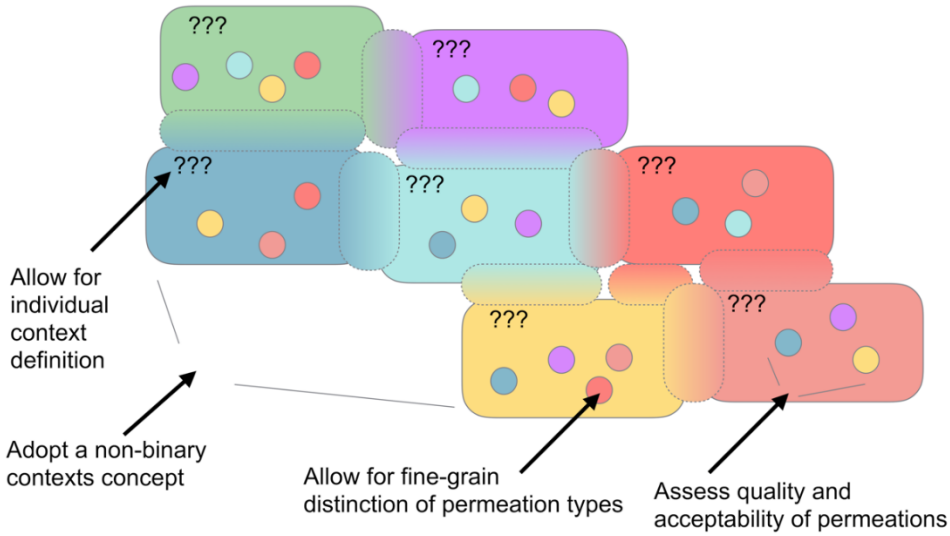

Fig. 5. Requirements of the Method.

Two requirements can be derived from our line of argumentation connecting boundary management to mental model theory and thus requiring a non-normative way of context specification. First, a method meeting this requirement needs to **adopt a non-binary context concept** (i.e., it must be able to scale the articulation support process to more than two contexts). Second, it must **allow for an individual definition of the contexts** (i.e., it cannot rely on a set of pre-specified contexts but must be flexible not only in the number of contexts to be addressed but also in their specification). In relation to structure elaboration techniques, these two requirements demand a two-step process, where the structures to be elaborated on (i.e., the contexts) need to be specified in a first step before their relationships (i.e., the interruptions occurring between them and their perceived qualities) can be reflected on and eventually articulated.

The other two requirements are derived from existing methods on boundary profiling and describe the types of information that need to be representable in an instrument supporting boundary

profile articulation. They both focus on potential interruptions. First, interruptions may be perceived differently depending not only on their source context but also on the delivery channel used and trigger of the interruption within the source context. Articulation support thus needs to **allow for a fine-grain distinction of interruption types**. Related work points in the delivery channel and triggers are relevant aspects here. This is not necessarily an exhaustive list; rather, it provides a starting point for the first version of the instrument and needs to be explored further in future research. Second, dynamic interruptions (i.e., interruptions that occur at a specific, potentially unforeseen point in time) are the focus of the present study. Such dynamic interruptions usually request some reaction, which again may depend on the trigger of an interruption. For active boundary management support, the acceptability of the interruption and probability of its acceptance (independently of the perceived acceptability) are crucial pieces of information. An articulation support method thus has to support the **assessment of the quality and acceptability of the potential interruptions**.

As already outlined above, the nature of structure elaboration techniques requires us to address these requirements in a two-step process, during which the relevant structures are first specified and then elaborated on. Finally, the forms of representation used in structure elaboration techniques focus on supporting the articulation process but are not necessarily suitable for reviewing the results. The conceptual models created in the articulation process thus need to be condensed to allow for reflection and further analysis. In the next sections, we describe each of these three stages in the structure elaboration process.

5.3 Identification of Contexts and Trigger Roles

In a first elaboration step, the articulating person specifies the different context he or she perceived to be relevant in daily life. These contexts form the foundation of the following elaboration steps. Initial tests of the method showed that the concept of "context" is abstract and not self-explanatory. To provide a first anchor for orientation, we thus introduce a context named "work." This can be rejected as irrelevant (e.g., for non-working people) or refined to become more fine-grain (e.g., for people active in more than one job). The number of contexts is not constrained. All contexts are named and written on cards of distinct colors (one color per context).

Following the findings of White and Thatcher [46], we not only assess the interruptions of one context into another but also provide the possibility of differentiating the acceptability of interruptions per trigger role in a particular context. As an example, one might not generically reject interruptions from a work context to a family context; however, we might want to differentiate between close co-workers (i.e., those permitted to cross this particular border) and other members of the context whose communication requests might be rejected. In addition to specifying a context, the articulating person can specify distinct roles that are to be handled differently (positively or negatively) to the way in which members are handled in the overall context. Those roles are again named and written on cards matching the color of the context to which they belong (using a differently shaped card to distinguish contexts and roles).

Figure 6 shows an example result of this first elaboration step. Here, two contexts, namely "work" and "family," are specified. Each context has two distinct roles that are to be considered separately when assessing the potential of interruptions and their acceptability in the next step.

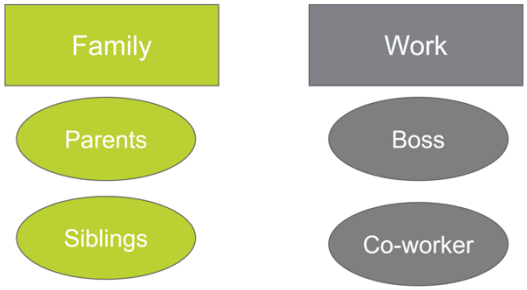

Fig. 6. Two Contexts, Each with Two Distinguished Roles.

5.4 Boundary Profiling

Based on the set of contexts and trigger roles identified in the first step, the second step elaborates on the boundary profile of the articulating person. The boundary profile describes which interruptions can happen from any context, or role therein, to any other context via different communication channels. It furthermore represents the acceptability of each potential interruption (or, expressed inversely, whether the interruption is considered to be intrusive) and the probability of the acceptance of the interruption. Distinguishing between acceptability and the probability of acceptance is also rooted in the findings of White and Thatcher [46]. They describe that although an incoming communication request might be considered to be a potential source of heavy irritation, it is still accepted, for example, because of the perceived importance of the role from which the request originates.

For the second step, another set of cards is introduced into the elaboration process to express potential communication channels that could create interruptions, their acceptability and their probability of acceptance. Each type of card represents one communication channel used by the articulating person. The structure elaboration technique itself is not restricted to any particular set of channels. Still, as we focus on mobile communication settings, we provide participants with the three most common pre-specified channels on mobile devices [12, 26, 46]: phone, email and messenger. As for contexts, this list of channels is not prescriptive; participants can opt to skip channels they do not use or add extra channels.

The articulating person now selects the first context for which to examine the boundary profile. This first target context (i.e., the context in which the person is when experiencing an incoming communication request) is the starting point for examining potential interruptions. Each other context and each role therein as specified in the first step are now potential sources of communication requests, which can be made by any of the available channels. Given the usually large number of potential sources, the contexts are reviewed pairwise to reduce the complexity of the initial elaboration setting. For each source context including the specified roles, the articulating person describes how he or she experiences incoming communication requests using the different channels. For each channel, its acceptability is assessed and indicated by differently colored channel cards: green indicates low perceived intrusiveness, yellow indicates medium perceived intrusiveness and red indicates high perceived intrusiveness. Additionally, the probability of acceptance is assessed separately and indicated by marking the respective channel card: a tick mark indicates almost certain acceptance, an “x” indicates almost certain rejection and a “~” indicates situation-dependent acceptance, (i.e., dynamic in-situ assessment of acceptance).

Figure 7 shows an example of such an assessment. “Family” is considered to be the target context here, while “Work” is considered to be the source context. The work context has two distinct roles, whose potential communication requests causing interruptions in the family domain have already

been assessed. In this setting, co-workers would usually only use the phone for communication requests (as messenger and email are omitted as potential channels). Such requests are not considered to be intrusive and are their acceptance is usually judged based on the perceived situation. Communication requests by the boss using the phone are considered to be highly intrusive but are usually still accepted. Communication requests via email or messenger are perceived to be less intrusive and are usually ignored or deferred to a later point.

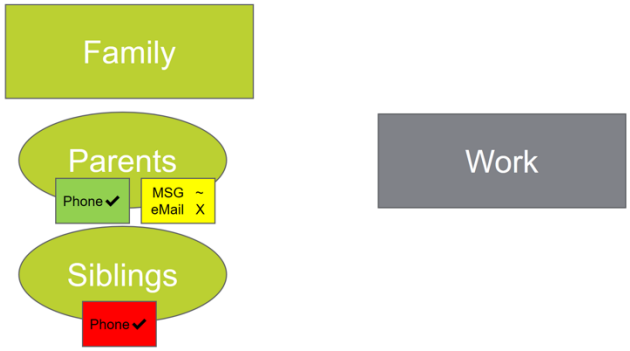

Fig. 7. Boundary Profiling for a Source Context "Work" Causing Potential Interruptions in a Target Context "Family."

This pairwise review of contexts is repeated until each combination has been assessed. Each created structure is then documented (e.g., via pictures) and the cards are reused for the next combination of contexts. Some contexts might not be relevant as source contexts (i.e., the contexts from which communication requests originate) but are only possible target contexts. An example of such a context would be "Workout," which designates a person's physical training activities. While this would be a regular current context of a person, it would hardly be the source of communication requests. After the assessment of all relevant combinations, the documented raw data are condensed in a final step to be revisited and reflected on by the articulating person.

5.5 Representation of the Condensed Boundary Profiles

The collected data are tabulated to provide a condensed overview of the boundary profile. The table rows indicate the source contexts and roles (i.e., the sources of communication requests) and the columns indicate the target context (i.e., the context in which a communication request is experienced). Each cell is then colored to indicate the acceptability of the communication request and the mark indicating the probability of acceptance.

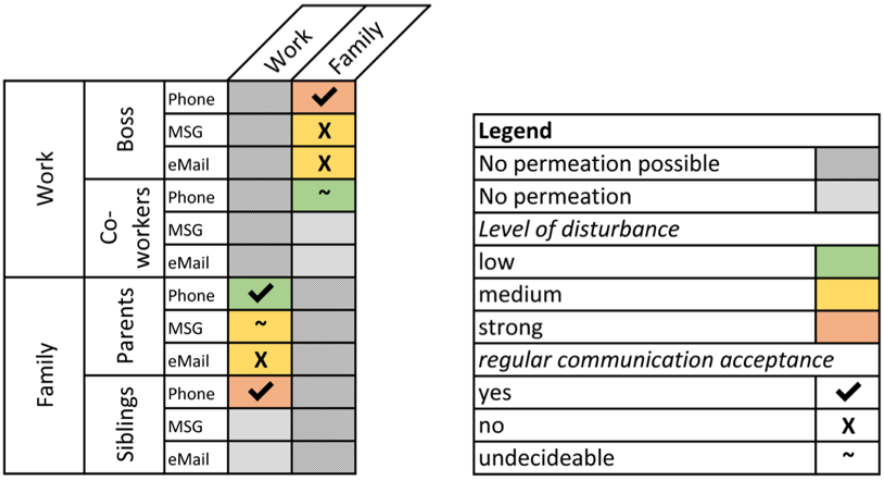

Fig. 8. Condensed Boundary Profile with Two Contexts.

Figure 8 shows an example of such a table with two contexts that each have two distinct roles. The table cells with a gray background indicate non-occurring interruptions. Requests from a context in which a person currently is are not considered to be interruptions by definition (i.e., the cells where the source and target contexts are identical are always grayed out). Further, the communication channels that are not used by a particular role are also grayed out, as they cannot create interruptions.

5.6 Summary and Example

In this section, we introduce a structure elaboration technique tailored for boundary profiling. As shown by the description of the method above, the number of pairwise interruption assessments between contexts rises with the square of the number of specified contexts. Consequently, a full assessment of mutual interruptions between all contexts causes considerable effort and requires both the articulating person and the facilitator to stay on task for some time.

Owing to the number of potential interruptions, constructing a single visualization of the full boundary profile during articulation is unfeasible. The evolving complexity of the mutual connections between contexts and space required to construct such a model would draw cognitive capacity away from articulation toward maintaining the model state [42]. This problem is avoided by focusing on only two contexts at a time, as proposed above. This approach, however, causes a potential loss of overview about the overall state of articulation and might lead to inconsistencies. Furthermore, the need for the permanent documentation of intermediate results might cause frequent interruptions, again leading to a non-optimal articulation process. One way to mitigate these frequent interruptions and maintain a more comprehensive overview of the profile would be to create one model for each target context covering the potential source contexts.

Figure 9 shows an example of such a model, where the reviewed target context is placed at the center ("Uni," representing university) and all the potential source contexts including the involved roles are placed around it (contexts from left to right and top to bottom: "own start-up," "work," "family," "friends," "sport" and "cooking"). The contexts "sport" and "cooking" are notable, as they cannot act as source contexts for the articulating person. As described above, such contexts do not contain any members that could create interruptions and usually refer to situations in which the person is engaged individually (i.e., without any interactions with others).

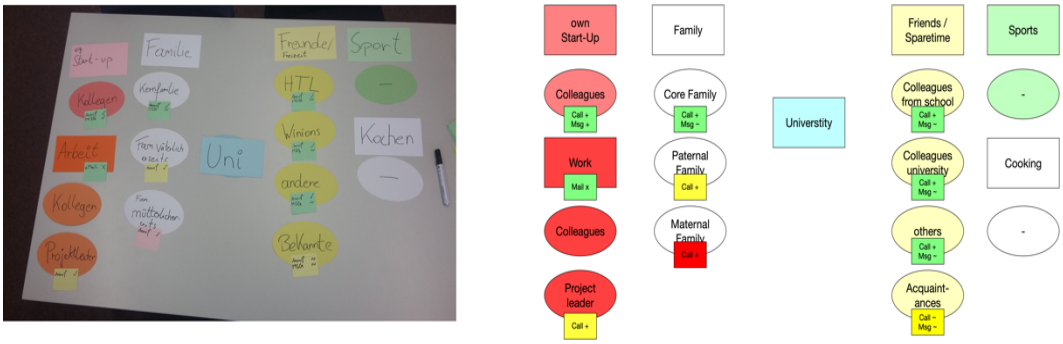

Fig. 9. Elaborated Boundary Profile for One Target Context and Six Source Contexts.

6 VALIDATION OF THE METHOD

This section describes the exploratory study we conducted to examine the applicability of the developed method and assess the working hypotheses on which this work is grounded. The fundamental hypothesis informing our method engineering process is that boundary management in a mobile communication setting is based on consciously distinguishing between a set of perceived contexts that are more fine grain than the distinction between work and family proposed by Clark [8] (H1). This hypothesis would be confirmed if our study showed that people tend to ground their boundary management on more than these two fundamental contexts. Such behavior has already been observed in related work [2, 4, 20] and will be verified in our study.

Building on H1 and again drawing from existing research [2, 16], we further hypothesize that those multiple contexts are distinct for every individual and cannot be determined generically (H2). This hypothesis would be confirmed if we could show that different articulating people create various sets of contexts on which to base their boundary management.

Finally, our method is based on the hypothesis that the acceptability and probability of the acceptance of interruptions are dependent on the respective source and target contexts (H3a) as well as being influenced by identifiable groups of people within the source context triggering the interruption (H3b). H3 thus goes beyond H2 by claiming that people not only distinguish between multiple contexts, but also adapt their boundary management behavior according to them. These hypotheses would be confirmed if we could show differences in the acceptability and probability of the acceptance of interruptions from a particular source context depending on the target context (H3a) and that those differences are not consistent for a particular source context but rather differ depending on the role triggering the interruption (H3b).

If all these hypotheses could be confirmed, the proposed method should fundamentally be suitable for creating individual boundary profiles. The study aims to confirm that the method allows us to elicit the information necessary for formative multi-context boundary profiling (H4) and thus design socio-technical boundary management support.

6.1 Study Design

Our hypotheses require us to apply the developed method to a real-world setting. Specifically, we conduct structure elaboration sessions with people to create their boundary profiles based on their perceptions of the real world. The data required to assess the hypotheses formulated above can be derived from the structure elaboration results (i.e., the created models). In addition, observations from the articulation and elaboration processes may inform the assessment of H4. Therefore, one of

the authors acted as a facilitator in the sessions to gather observations on the feasibility of the method. The elaboration results were documented using a digital camera and then transcribed asynchronously into the table form described above. These tables are considered to be the raw data used for our analysis.

H1 is assessed by counting the number of contexts specified by the articulating person. If any of the target contexts show identical results for all the other profiles, the distinction between those contexts is validated with the articulating person. If no arguments for keeping them separate are put forward, this would eventually lead us to consider these identical contexts only once in the metric for H1. H1 can thus be confirmed if the number of contexts exceeds two.

H2 is assessed by assessing the names of the contexts specified by participants. The names provided by different people that seemingly refer to the same concepts (e.g., firm or company) are validated with the affected people and considered to be equal if there is no disagreement. The number of occurrences for each name is counted and related to the overall number of structure elaboration sessions conducted. A high number of distinct names with a low number of occurrences lends support to H2.

H3a and H3b are assessed by examining the heterogeneity of the data provided for acceptability and the probability of acceptance for interruptions. We assess the patterns of acceptability/probability of acceptance values for interruptions occurring in each source/target context combination. For H3a, we count the number of identical patterns occurring for each target context in any source context (see Figure 10, left) and normalize the resulting value with the number of potential source/target context combinations. Lower values for this metric (i.e., different patterns across contexts) indicate that H3a can be accepted. For H3b, we more closely examine the patterns of the source roles and count the number of identical patterns occurring for each source role across all the target contexts for each source context (see Figure 10, right), and then normalize the resulting value with the overall number of specified roles. Lower values for this metric (i.e., different patterns across roles) indicate that H3b can be accepted.

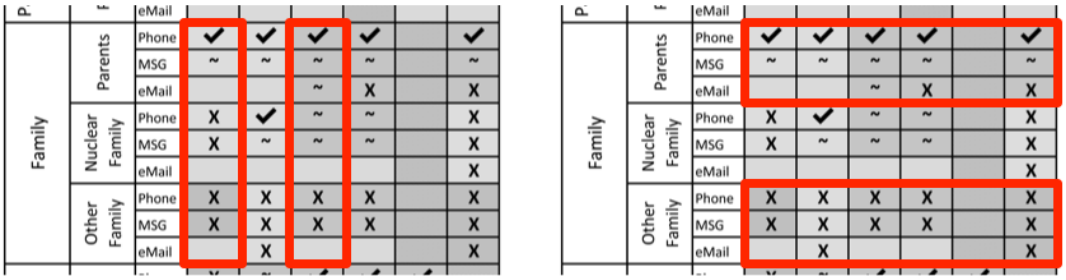

Fig. 10. Scope of Pairwise Comparisons for Calculating the Metrics in H3 – left: per target context for H3a, right: per role for H3b.

For H4, we take a bird's eye view of the resulting data and qualify whether the required data are sufficient to support boundary management. Furthermore, we augment these results with our observations of the elaboration process and discuss potential usage scenarios of the obtained data in section 8.

6.2 Results

The study was conducted with a sample of 12 people (10 men). All participants were working students of business informatics at an Austrian University, with varying numbers of hours per week

ranging from six to 40 hours with a mean of 16.25 hours. They were aged between 21 and 36 years with a median of 26 years. Three were in a relationship and nine considered themselves to be single.

The structure elaboration sessions were conducted over two weeks and one of the authors acted as a facilitator. The duration of the sessions, starting with a brief introduction and ending with the finalization of the structure elaboration (excluding condensing the data in a table) lasted between 47 and 123 minutes, with an average duration of 80 minutes. We first summarize the metrics required to assess the hypotheses for all participants. Afterward, we provide examples of the results, selecting two profiles that show complementary features for further discussion.

6.2.1 Profile Metrics

Table 1 summarizes the metrics described above for the assessment of H1, H3a, and H3b. The number of overall contexts is necessary to assess H1. The relative number of identical patterns identified at the context level is the metric used to assess H3a. H3b is assessed using the relative number of identical patterns identified at the role level.

Table 1: Profile metrics used to assess the hypotheses

Participant	overall contexts	target-only contexts	overall roles	identical patterns (scope: source/target context)		identical patterns (scope: source role)	
				absolute	relative	absolute	relative
1	6	0	14	0	0%	2	14%
2	6	0	11	7	19%	0	0%
3	5	0	10	5	20%	2	20%
4	5	0	16	7	28%	4	25%
5	6	0	16	9	25%	2	13%
6	7	0	14	24	49%	4	29%
7	6	0	9	3	8%	2	22%
8	7	2	12	5	10%	4	33%
9	6	0	11	3	8%	0	0%
10	8	0	18	20	31%	2	11%
11	5	1	10	2	8%	0	0%
12	5	0	12	0	0%	0	0%

Table 2 provides an overview of the identified contexts and their occurrences for all participants, as required to assess H2. Names referring to identical concepts are merged. The single occurrence of “spare time” is a conceptual merge of “family” and “friends,” which were considered by the articulating person to be different roles in the same context.

Table 2: Number of occurrences per concept

Context name	Occurrences	
	absolute	relative
Work	12	100%
University	12	100%
Family	11	92%
Friends	10	83%
Sports	5	42%
Partnership	4	33%
Student Union	3	25%
Shared Flat	2	17%
University Tutor (side job)	2	17%
Spare Time	1	8%
Ambulance Service	1	8%
Music Band	1	8%
Playing Computer Games	1	8%
Club	1	8%
Fitness Club	1	8%
Soccer	1	8%
Cooking	1	8%
Own Start-Up (side job)	1	8%
Hobby	1	8%
Crackerbarrel	1	18%

The boundary profiles allow us to calculate additional metrics for assessing the heterogeneity of the profile concerning acceptability and the probability of acceptance for interruptions between different contexts and via different communication channels. Such metrics are not relevant for the hypotheses examined in the present paper and are thus omitted for reasons of space. We, however, show their potential by calculating and describing them for the selected example profiles.

6.2.2 Example 1

Figure 11 shows the boundary profile for participant 2 (see the metrics in Table 1) with six contexts and 14 explicitly specified roles.

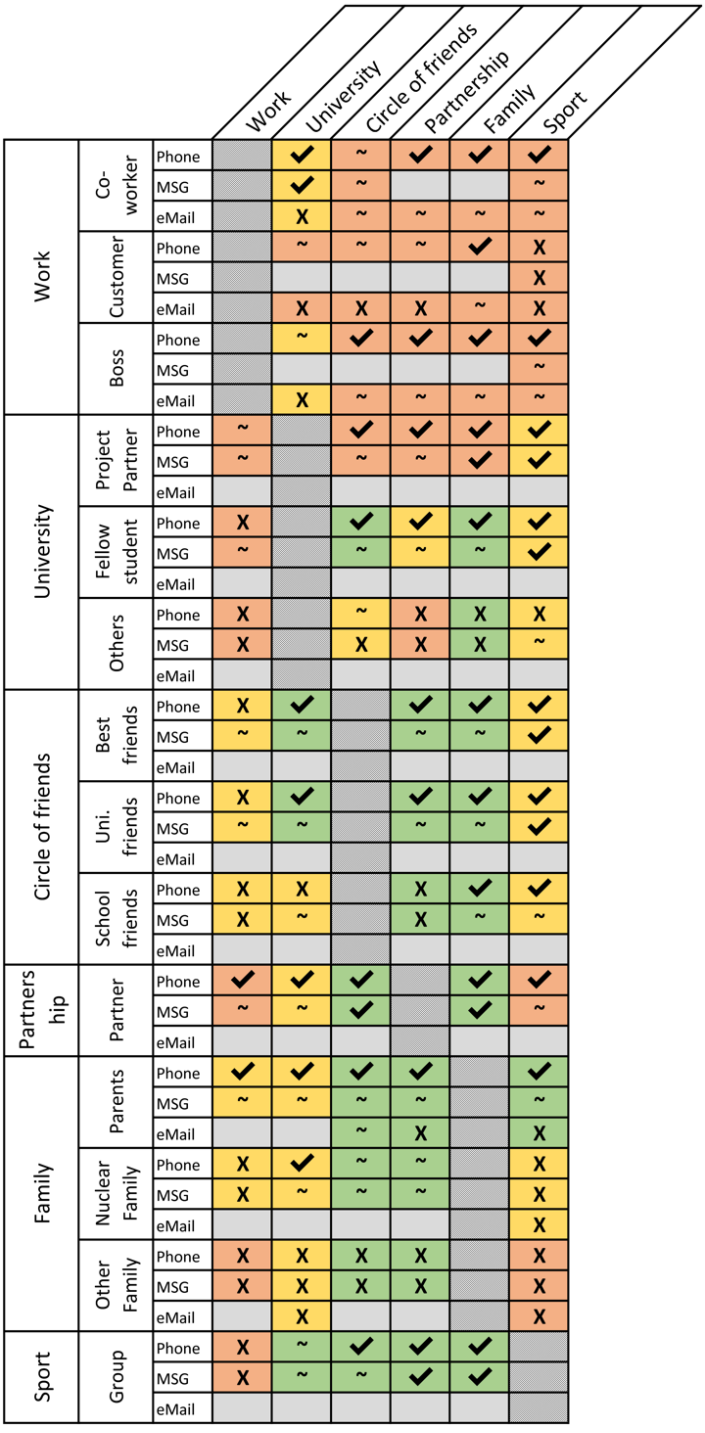

Fig. 11. Example of a Boundary Profile with Six Contexts.

Here, we provide an overview of the results to interpret the table. From a bird's eye view, the overall pattern represents a more or less binary diversity profile despite the rather fine-grain elaboration of the contexts. Concerning the acceptability of interruptions, there is a clear distinction between the "work" context and other contexts largely oriented toward the participant's private life. Interruptions by members of the work context (as visualized in the top nine rows) to the other contexts are mostly considered to be not acceptable (i.e., colored red). Similarly, interruptions from the other contexts into the work domain (as visualized in the first column) are also considered not or only somewhat acceptable. By contrast, interruptions from and to the other domains are largely considered to be acceptable. The context "university" blurs the distinction between work and private life and shows a more heterogeneous picture of the interruptions originating from this context (see the rows under the label "university") or entering this context (see the column labeled "university").

The probability of the acceptance of an interruption seems to be not only determined by its perceived acceptability. For only 41.2% of the interruptions considered to be acceptable (marked green), the articulating person states a high probability of acceptance (marked with a tick). In 19.6% of the cases, an interruption is likely to be rejected (marked with an "x") despite being considered to be acceptable. Interruptions not considered to be acceptable (marked red) show a similarly mixed picture. In this case, only 33.3% of the interruptions are highly likely to be rejected and 25.9% are still likely to be accepted.

Looking at the source and target contexts concerning the probability of acceptance also provides a mixed picture. A more consistent picture only evolves when considering the different roles. At this level of detail, we can identify clear tendencies on whether an interruption is likely to be accepted. Interruptions triggered by "other family" members, for example, are very likely to be rejected in any other context, whereas interruptions triggered by a "partner" are very likely to be accepted in any other context (although acceptability varies).

Concerning the used communication channels, there are indications that the articulating person hardly uses email as a means for communicating with others, as the rows labeled "email" mostly show gray cells (indicating that an interruption is not possible via this channel). This pattern is only different for the work context, where email seems to be used as a means for contact by all the identified roles. Aside from that, no clear preference for any communication channel can be found overall or in any context. Hence, the acceptability and probability of acceptance mostly seem to be dependent on the involved contexts and roles rather than the communication channels used.

6.2.3 Example 2

Figure 12 shows the boundary profile for participant 8 (see the metrics in Table 1) with seven contexts and 12 explicitly specified roles. It has been selected to complement Example 1 concerning the identifiable patterns in the profile.

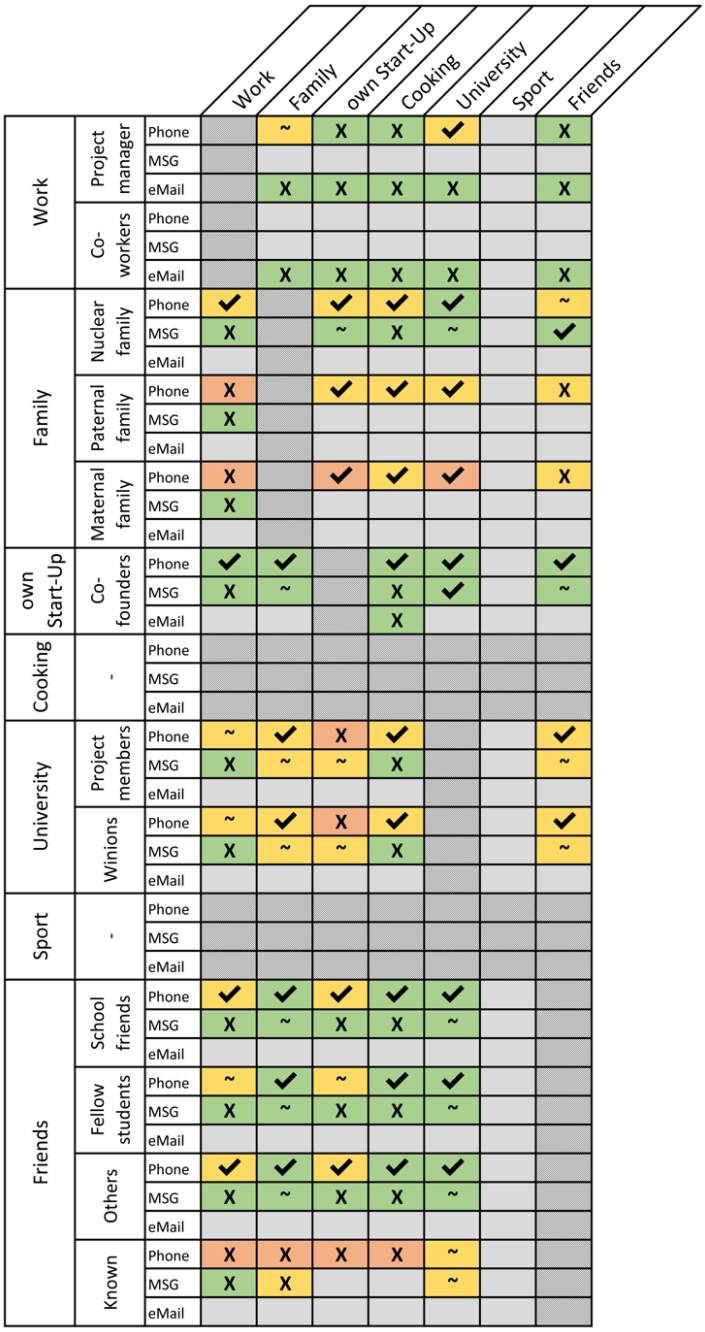

Fig. 12. Example of a Boundary Profile with Seven Contexts.

From a bird's eye view, the most distinct feature of the profile is its frugal use of different communication channels, as indicated by the large number of gray cells. Furthermore, the profile contains two target-only contexts ("cooking" and "sport"), which cannot trigger any interruptions.

Such target-only contexts are indicated by the fully grayed-out rows for all communication channels. Further, one of these contexts, "sport," cannot be used as a target context (indicated by the fully grayed-out column including this label). One might question the need to specify in a boundary profile such a context where no communication can happen. The articulating person, however, considered it to be necessary to state that they are not available for communication during a specific situation (namely sports), likely because the mobile communication device is not carried with them. This information in turn can be useful for boundary management (e.g., to direct incoming interruptions to a mailbox).

In terms of the acceptability of interruptions, the articulating person appears to be somewhat open to accept interruptions in any context, except for particular roles and communication channels (e.g., phone calls from maternal family members). The probability of acceptance does not seem to be mainly tied to particular roles or contexts, but rather to different communication channels. All potentially occurring interruptions, which account for 54.5%, are likely to be accepted when the used communication channel is a phone call. By contrast, only 5% of communication requests via a messenger application and 0% of potential interruptions via email are likely to be accepted.

In combination with the first example, the patterns and metrics described above provide an overview of the information that can be extracted from the elicitation of boundary profiles using the introduced method. These results thus provide the foundation to discuss the validity of H4 in the next section.

6.3 Discussion

The results described above provide evidence of the validity of our hypotheses. Concerning H1, we confirmed the results of Keeney et al. [20] that a binary distinction of contexts, namely the "work" and "non-work" (or "family") domains, is insufficient to describe a person's boundary management strategies. The minimum number of contexts specified during structure elaboration and actively used to distinguish acceptability and the probability of the acceptance of interruptions was five, clearly indicating the need for a non-binary context concept in boundary management.

Concerning H2, the results confirmed that communication contexts should be considered to be individual constructs and cannot be pre-specified when capturing a person's boundary management behavior. While Keeney et al. [20] only consider a more fine-grain structure of the non-work domain, our results suggest that people also tend to identify distinct contexts in their work domain (e.g., when having side jobs, see Table 2). In general, the participants in the present study seem to have refrained from a binary assignment of contexts (i.e., either a work or a non-work domain). This result, however, might be biased by participant selection (all being working students). Still, the results show that generically considering the work domain to be an atomic context without any sub-contexts is an invalid assumption.

For H3a, we found evidence that boundary management strategies are dependent on both the source context of the interruption and the target context of a person. The number of identical patterns for both acceptability and the probability of acceptance varies across the examined sessions. Larger numbers of distinguished contexts tend to lead to higher numbers of identical patterns (see Table 1, participants 6 and 10), suggesting an upper limit for the number of contexts a person can distinguish. This limit, however, seems to differ by person and cannot be determined in advance. This phenomenon instead indicates the need to reconsolidate the articulation results to allow redundant contexts to be merged.

The results for the metrics calculated to examine H3b also show that distinguishing roles within contexts triggering interruptions is a necessary part of a boundary management profile, as suggested by Keeney et al. [20]. The relative number of redundant patterns does not seem to be connected to the absolute number of roles or the ratio between the number of roles and contexts. The observed

redundancies thus might again indicate the need to consolidate the results after the initial articulation phase; however, they do not fundamentally question the need to distinguish roles within contexts when creating a boundary profile.

Taking a bird's eye view of the deployment of the method concerning the collected results and the process of articulation through structure elaboration allows us to collect evidence to assess H4. Overall, the method has allowed us to collect most of the information types already identified by related work to be constituents of boundary profiles. The method currently lacks a way to express the perceived importance and perceived involvement in a particular context, as noted by Keeney et al. [20]. While relevant in boundary profiles (i.e., for describing a person's behavior), its value for supporting boundary management activities is limited, as support needs to be available independently of the importance of one's current context. The importance of a source context is implicitly encoded in the information on the probability of the acceptance of interruptions and thus does not need to be specified separately. Concerning the articulation process, the approach of conducting elaborations in multiple steps (i.e., focusing on one target context at a time and elaborating on interruptions from all potential source contexts) seems to be feasible. However, the time required to conduct a full structure elaboration session is a major obstacle for practical deployment. Depending on the number of contexts, sessions can last between one and two hours, which usually exceeds the amount of time people are willing to spend on configuring a boundary management support system. As such, the method proposed here is mostly of academic value, and to improve its applicability in real-world settings, we have developed technical support that allows for the situated capturing of the relevant information. This support enables us to circumvent or at least bootstrap the time-consuming collaborative structure elaboration setting, reducing the overall effort necessary to deploy boundary profiles operationally.

7 DIGITAL CAPTURING SUPPORT FOR BOUNDARY PROFILING

The major obstacle to deploying the boundary profiling method in daily practice is the effort required to conduct the structure elaboration sessions necessary to collect the relevant data. While the collaborative dialogue-based setting contributes to triggering the reflection processes, which are desirable for high-quality articulation results [11], it still requires a significant investment of time and human resources, which may not be feasible in all settings. We have thus implemented a tool that can be used on mobile devices to pre-capture the information necessary to conduct the boundary profiling process or even support the implementation of the process itself [33].

The structure elaboration setting presented above is inherently collaborative and always includes a facilitator experienced in deploying the boundary profiling method who can guide the articulation process to ensure that the captured information is complete and sufficiently reflected on. This guidance is not available when using a digital tool on a personal mobile device and needs to be replaced with the appropriate supportive measures. We therefore explore the use of dynamic and static scaffolds [43] for providing contextualized support to users in the boundary profiling process. Such a strategy cannot only mitigate the potential lack of guidance through a facilitator, but also provide added value in the profiling process, as it can use information on the potential contexts of a user that might be available on the mobile phone (e.g., contact groups, calendar data, and location information).

In the following, we outline the functionality of the developed tool and show how the scaffolds must be implemented. We close with a first account of the adequacy of the app for supporting the proposed methodology.

7.1 Functionality and Architecture

The tool was developed as an application for the Android mobile operating system. From a functional point of view, it supports all stages of the proposed methodology (identification of contexts and trigger roles as well as the boundary profiling process itself). Owing to its modular nature, it can be combined flexibly with the presence-based setting described above (e.g., to pre-capture contexts and trigger roles), thus potentially reducing the amount of time necessary for the articulation of the boundary profile.

The application adopts standard Android user interface elements and interaction flow structures to meet users' expectations. The user interface is structured along the profiling process as described in the method and allows for different entry points in the capturing process. Figure 13 shows the basic structure of the app and flow of potential user interactions. The screen in the center of the figure shows the generic navigation elements and main content area, which is filled with task-specific information for the different stages of the method.

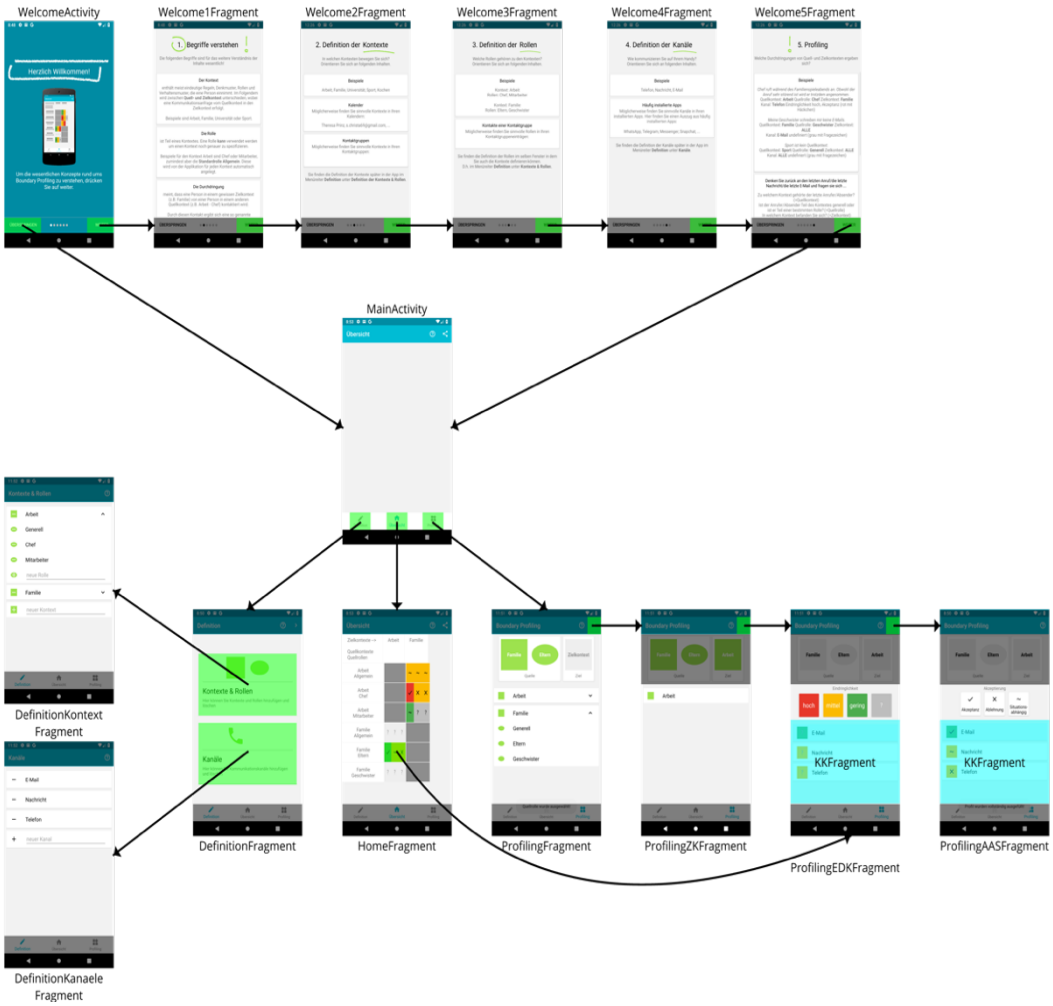

Fig. 13. Interaction Flow of the Application.

The screens in the upper part of Figure 13 show the onboarding support steps that introduce the method. These steps use the dynamic information derived from the information available on the mobile device (e.g., contact groups and calendar names; see the next subsection), thus contextualizing the app and providing a more familiar entry point to users than using generic examples that might not fit their perceived reality. The lower part of Figure 13 visualizes the screens that guide the boundary profiling through the different stages of the method. The definition screens on the left allow us to specify the contexts and trigger roles, whereas the profiling screens on the right support the boundary profiling process. The center screen provides an overview of the profiling progress using the table-based visualization introduced above.

7.2 Scaffolding the Boundary Profiling Process

The method was initially designed to be implemented in a collaborative setting with a facilitator to guide the articulation process and ensure that all the required information is captured. The absence of such a facilitator during self-directed boundary profiling on mobile devices needs to be mitigated by an appropriate means of support. We here use the pedagogical concept of scaffolding [43], especially conceptual and procedural scaffolds [28] to support users as required. Scaffolds should be deployed dynamically, only providing the support required to keep users operative and prevent cognitive overload or handling mistakes [43]. Furthermore, scaffolds are most effective when they are personalized (i.e., refer to the existing knowledge of users) and related to the current context [35].

In the present app, we address these requirements by providing different types of scaffolds. To motivate the use of the application, we have developed a personalized onboarding assistant as a conceptual scaffold, which introduces the rationale of the application and required articulation steps in a step-by-step guide (see the screens in the upper part of Figure 13) using the information available on the mobile device. In particular, during our explorations, we found that calendar or contact group names often reflect the contexts that people use to structure their lives. Consequently, we use this information to hint at the possible contexts one could identify. Furthermore, contact names in conjunction with appointment data from calendars could be used to uncover potential trigger roles.

We not only use this information to scaffold the initial familiarization with the application (see Figure 14, left), but also use it as a conceptual scaffold during the specification of the contexts and trigger roles (see Figure 14, right). The onboarding assistant is automatically triggered during the initial startup of the application and can be accessed on demand at any time during usage thereafter. In the context specification process, personalized information items are always provided to trigger reflection processes, just as a facilitator would repeatedly query potential further contexts.

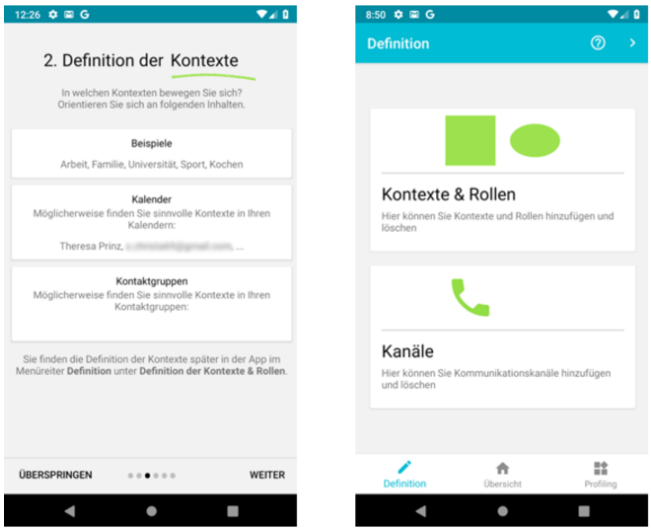

Fig. 14. Preparing Profiling with Situated Scaffolds.

The profiling process itself is guided via a procedural scaffold, which serializes the steps necessary to specify the required information and aims to reduce the perceived complexity of the information structures (see the next subsection). This allows us to focus on a specific interruption setting at a time and reflect on a user's specific reactions to that particular type of interruption. As users become more accustomed to the articulation setting, they might no longer require such strict guidance. They can then use the table visualization (see the bottom center screen in Figure 14) for random access to different interruption settings and the direct specification of their reactions. In this way, the procedural scaffold can be circumvented, meaning that it only needs to be used when required by the user.

Figure 15 shows the serialized version of the boundary profiling process along the required user interaction (from the top left to bottom right). The top area initially shows the placeholders to be filled by user-selected contexts and trigger roles, which are provided as a collapsible list below. After the selection of the source context and trigger role (left placeholders) as well as the target context (right placeholder), users are asked to specify how intrusive they would consider an interruption by the trigger role from the source context when in the target context. Such interruptions can be perceived differently via different communication channels and accordingly treated separately in profiling, just as would be possible in a structure elaboration session. Hence, the probability of the acceptance of an interruption is specified in the final step of the specific interruption setting, completing the necessary information.

Fig. 15. Guidance during Boundary Profiling.

As an alternative to the first three steps of profiling (i.e., selecting the source context, trigger role, and target context, as depicted in the upper row in Figure 15), users can directly access a specific setting via the condensed table view, as described above. The table view is also used to identify information still missing from the boundary profile (i.e., interruption settings that have not yet been specified). These are displayed as light gray fields containing a question mark and again allow users direct access to the specification screens of that setting.

7.3 Usage Scenarios

Overall, the application replicates all the stages of the method described above. Owing to the modular navigation concept, it can be used as a stand-alone boundary profiling tool or a supplement to presence-based structure elaboration techniques, replacing either the context and trigger role specification stage or the boundary profiling stage itself. This leads to four scenarios for implementing boundary profiling using the introduced method:

Fully synchronous presence-based setting: This setting corresponds to the method implementation described in section 5. It usually benefits from the collaborative articulation setting, where a facilitator can provide situated guidance, but is rather time-consuming.

Fully asynchronous setting on mobile devices: This setting uses the mobile application for implementing the whole method. It benefits from the potential to contextualize the profiling process (using data from the mobile device) and allows us to conduct profiling whenever appropriate for the user without losing information. It, however, lacks the individualized guidance a facilitator can provide and needs to compensate for this using scaffolding.

Asynchronous context and trigger role specification, synchronous presence-based boundary profiling: This setting uses the data available on the mobile device to support the specification of contexts and trigger roles. It can be used to prepare for the presence-based profiling phase, thus reducing the time required to conduct the overall profiling process. The identification of contexts and roles can be spread over a longer period and conducted in situ, which allows the set of contexts and roles to evolve over time and thus might create a more comprehensive picture of the articulating person's actual contexts. The set of contexts and roles can then be used to bootstrap the presence-based boundary profiling stage, where it still would be possible to start with an initial reflection on the asynchronously collected data and potentially extend or modify it.

Synchronous, presence-based context and trigger role specification, asynchronous boundary profiling: This setting uses a brief presence-based phase to bootstrap the profiling process by supporting the articulating person through a facilitator in the initial stage of the method. Such support might be beneficial, as the correct and comprehensive identification of the contexts and trigger roles is crucial for the profiling process. The asynchronous profiling process on the mobile device then allows us to reflect on interruption settings whenever a user considers it to be relevant and appropriate. The data representation format used in the application also enables us to extend the set of contexts and roles dynamically in situ whenever new interruption settings are encountered that require distinct reactions.

Scenario 2 implements the most comprehensive use case for the application and thus was used for the user tests to examine the fundamental usability and usefulness of the tool.

To improve the application, we adopted a formative testing approach using the qualitative "thinking aloud" method [3]. In contrast to summative usability testing (e.g., using technology acceptance models [45]), such approaches provide rich data on how people interpret and interact with an application and allow for adaptations to avoid misconceptions and handling issues. In an initial round of evaluations, the application was tested based subjects' age, gender, and affinity to technology use in general. Each subject received a set of tasks to complete using the application. Subject were observed while solving the tasks and continuously asked to verbalize their thoughts and assumptions about how to interact with the application. In this way, we could resolve common misconceptions in application handling as well as identify potential areas of improvement for user support via scaffolding. In particular, the data automatically extracted from on-device calendars and contact groups do not always provide sufficient guidance to identify the relevant contexts or trigger roles. This can lead to confusion, as users cannot necessarily abstract from actual people and identify generic trigger roles.

In light of these findings, the applications appear to be the most useful in Scenario 4, where the contexts and trigger roles are identified in a presence-based setting guided by a facilitator. These contexts and roles then provide a frame for asynchronous boundary profiling, during which further contexts and roles can be added dynamically as they emerge. Further user tests in real-world settings adopting this scenario will be implemented in the next step to examine the application's practical applicability and identify further areas of improvement to be addressed in the next iteration of the design cycle [31].

8 USAGE OF PROFILING RESULTS

The introduced method aims to support "formative boundary profiling," which can be understood in the tradition of formative evaluation techniques [18]. Formative boundary profiling not only aims to describe a person's boundary management behavior, but also enables informed socio-technical interventions that can support a person's boundary management activities. The need to address boundary management support at a socio-technical level arises from the pervasive nature of communication technology use in and across different contexts in people's lives [10] that calls for interventions on both social and technical aspects influencing one's boundary management.

Such interventions can target different aspects of a socio-technical system. A common conceptualization is to review such a system's potential impact on the involved people (individual level), the use of technology (technical level) and the implications on collective structures and behavior (organizational level) [40].

At an individual level, the deployment of the proposed method poses an intervention, as it requires the reflection of one's own perceived contexts in life and the interruptions that occur. This reflection refines the underlying mental models [39] and can lead to a behavioral change in future situations that trigger boundary management situations. The results of the profiling process (see the table with the condensed articulation results) make visible patterns and structures that are not immediately obvious during the articulation process. Recognizing behavioral patterns (e.g., evolving from different uses of communication channels for interruptions in different contexts) enables proactive boundary management by consciously changing one's availability on a channel when active in a particular context, as also suggested by Fleck et al. [15] for using different devices to manage work/life balance.

At an organizational (i.e., collective) level, the boundary profiles of the involved individuals can serve as boundary objects [14] that enable a shared understanding of the social space in which communication practices evolve [9]. The boundary profiles can act as anchors that enable the articulation of individual needs and expectations and can be used to support the negotiation processes to agree on mutually acceptable communication practices [41]. Boundary profiles may contain information that individuals might not want to share with others, or which should not be made a subject of the negotiation. The parts of the boundary profiles that should be made visible and can be altered while developing a shared understanding thus need to be specified individually ex-ante [28]. While these considerations are beyond the scope of the present article, they provide promising starting points for future research.

At a technical level, boundary profiles can be used to design behavioral support instruments to be embedded in communication devices such as smartphones. This would allow for individual dynamic availability management (e.g., as outlined by Schneider et al. [37]), as it would provide the meta-information necessary to interpret the data that characterize the different properties of the environment. Such information can be obtained via these devices (e.g., location, calendar information, incoming communication requests and their sources). This interpretation enables users to modify their availability for incoming communication requests from different contexts and various triggering roles, thereby helping people avoid being confronted by unacceptable or unwanted interruptions and thus reducing the strain connected with such communication requests [20]. Technically, a boundary profile could reside on the communication device itself and could be enriched over time with further information influencing one's boundary management (e.g., additional trigger roles to be distinguished in a particular context). In this way, the profiling approach presented above would add bootstrap boundary management support to the device, which would then iteratively refine the profile when used. Methods such as experience sampling [44] could also be used to support this refinement process.

9 CONCLUSION

In the present paper, we introduced a method of creating multi-context boundary profiles for managing communication requests based on individual perceptions of the structure of one's social environment. Such boundary profiles allow users to reflecting on their strategy of dealing with interruptions between different communication contexts. They eventually provide the foundation to create technical support instruments that reduce the cognitive load and stress emerging from dealing with permanent availability caused by today's ubiquitous communication infrastructures. We identified the constituents of boundary profiles from related work and argued for considering communication contexts not to be stable, generically identifiable categories, but rather individual constructs dependent on one's mental models of how to deal with communication. Based on this assumption, we proposed a method using a structure elaboration technique to elicit the necessary information in a dialogue-based way. We furthermore conducted an exploratory study that showed the feasibility of the method and confirmed the validity of our underlying hypotheses.

Summarizing these findings, the proposed method goes beyond the state-of-the-art of elicitation methods available in the field of examining technology-mediated communication behavior, as it explicitly considers individually constructed contexts and their interdependencies when examining how communication requests via different media are perceived and eventually handled. From a scientific point of view, it thus allows us to collect rich qualitative data on individual communication behavior, which can be represented in a structured, aggregated way. This is a first step toward examining and comparing boundary management strategies without ex-ante assumptions about individual mental models or interpersonal relationships. In its qualitative approach and examination focus, the method appears to be a suitable instrument for formative evaluation in design science projects [31] concerned with supporting interpersonal communication via technology-mediated channels, as the data it allows us to elicit can be directly mapped to the properties of such systems. Practitioners in the field of socio-technical system design can use the method as an instrument to reflect on communication behavior, which can inform changes to individual boundary management as well as provide the foundation for agreement on communication policies in group settings, as indicated in section 8. Furthermore, the method can be incorporated into technical systems providing (semi-)automated boundary management support, as indicated in section 7.

The research presented in this article has several limitations. First, the external validity of our study suffers from the limited heterogeneity of the study participants, whom all were working students with a rather technology-proficient background. Future work will need to broaden the scope of method applications to show its feasibility in a generalizable way. Second, we found the potential to extend the method's scope to non-social interruptions, such as exploring the acceptability of notifications from non-human actors (e.g., from apps on a smartphone). Such sources of interruptions were not considered in the present study but could easily be included in the structure elaboration technique. Furthermore, handling the complexity of the evolving elaboration structures could be simplified by technically supporting the articulation and elicitation process by using mobile boundary profiling support, as outlined in section 7, capturing intermediate results [30] or using an interactive surface to guide the articulation process [29].

Our future research will address these limitations and initially focus on further exploring alternative options to capture the necessary information for boundary profiling. Furthermore, we will also aim to put the profiles to practical use by creating technical instruments that actively support boundary management activities such as, for example, those outlined by Schneider et al. [37] and exploring the implications of the deployment of such tools.

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