

Supporting Collaboration in Small Volunteer Groups with Socio-Technical Guidelines

Alexander Nolte^{1,2}, Isa Jahnke³, Irene-Angelica Chounta¹, Thomas Herrmann⁴

¹ University of Tartu, ² University of Pittsburgh, ³ University of Missouri, ⁴ Ruhr-University Bochum

Corresponding author: alexander.nolte@ut.ee

Abstract. In this paper, we present a study on group work in which student volunteers from different disciplines worked together to create an augmented reality expedition. The goal of the project was to develop an augmented campus tour for students. The project was successful in delivering the app but through post project interviews we found that volunteers were not satisfied with the process and expressed negative insights. In order to understand this phenomenon, we developed and applied a set of categories for detecting underlying problems in socio-technical processes of volunteer group work. Applying those categories to the aforementioned project allowed us to assess their feasibility. This led to refined categories that can potentially support other volunteer groups to create a suitable socio-technical environment.

Introduction

Volunteer groups provide a large variety of valuable contributions to local communities and society at large. They support elections (Boulus-Rødje and Bjorn, 2015) and sports events (Cuskelly et al., 2006), contribute to larger non-profit organizations (Garner and Garner, 2011), devote their time to open source software (Crowston, 2011) or support online production communities such as Wikipedia (Farzan et al., 2012). Most research investigating volunteer collaboration focuses

on large non-profit organizations or open source and online production communities (Boulus-Rødje and Bjorn, 2015; Crowston et al., 2007). Few studies so far have focused on small volunteer groups that collaborate on dedicated activities such as discussion meetings, food giveaways, social events or creating a product. Small volunteer groups face unique challenges in particular related to the way they coordinate their activities. Larger organizations are typically run by a core group of experienced volunteers that split larger efforts into manageable tasks (Cataldo and Herbsleb, 2008; Liao et al., 2016) or even employ a coordinator to take over those duties (Farrell et al., 1998; Harrison, 1995). Small volunteer groups, however, need to coordinate their activities themselves while working towards their main goal at the same time (Nolte, 2018).

In this paper we present the results of a study on a group of volunteers who collaboratively developed an augmented reality (AR) application for university tours over 11 months. During this time, the volunteers developed, tested and delivered an app prototype for a client who used it along with 130 foreign students. Although the project was successful in developing the app, the volunteers afterwards expressed their frustration about the way they collaborated. They perceived it to be chaotic and unorganized, they were not satisfied with the process and they demonstrated negative associations.

This prompted us to look deeper into the process from a socio-technical perspective. Our goal was to identify potential sources of those negative associations as well as reasons for why they still decided to finish the project together despite those negative associations. We thus aim to answer the following questions:

- Why did the volunteers continue the project?
- What were the problems as perceived by the volunteers?
- How can those problems be detected more efficiently?

The last question is of particular importance since volunteers are commonly motivated by a specific cause to which they aim to contribute (Clary et al., 1992; Cobb et al., 2014; Karr and Meijs, 2006). Activities related to analyzing the way they collaborate might thus be eventually perceived as additional work leading to frustration and eventual drop-out. To identify suitable means to detect problems efficiently we developed a set of analytic categories based on existing literature. Then, we used those categories to analyze the results of an interview study which was conducted after the project. The study focused on technical means of support and communication media, individual and group goals and the collaborative process as a socio-technical setting. Based on the analysis we refined those categories so that they can serve as a guide for volunteer groups to detect problems in the way they coordinate. We envision this to enable volunteer groups to improve collaboration

Developing Categories to Evaluate Socio-Technical Collaboration

The aim of this paper is to develop and apply a set of categories that can support small groups of volunteers to detect problems in the way they collaborate. The field of socio-technical systems seems to be a natural starting point for this since the groups we analyze need to coordinate their activities, which involves the use of technology to communicate and share artifacts. Researchers in this field have developed approaches that support collaboration through technological and organizational change since its inception in the early 1950s (Cherns, 1987; Clegg, 2000; Eason, 2005; Fischer and Herrmann, 2011; Fox, 1995; Mumford, 1995; Trist and Bamforth, 1951). There are however a number of issues when trying to apply current approaches of socio-technical design in a volunteer context:

- These approaches build on upfront planning while it is unlikely that volunteers consider planning and designing their socio-technical infrastructure before starting to work on the project they aim to complete.
- There is a difference between designing CSCW applications, e.g. in research or in an organization compared to volunteer projects, that face a high dropout rate (Kraut et al., 2010).
- Existing approaches on socio-technical design often rely on a common 'background' or 'connection' of the participants. This joint background is created by work contracts, organizational rules and norms which govern collaboration. Being part of an organization thus makes it easier for people to adopt existing work practices, while this is not so likely in the early phases of volunteer collaboration where people are more prone to opt out if they are not satisfied (Haski-Leventhal and Bargal, 2008).
- While it is generally desirable for collaborators to share common interests and values, this is not necessarily the case in an organization. Having common or at least compatible interests and values is however crucial for volunteer projects. Research has shown that maintaining a sense of community is important for sustained volunteer efforts (Cobb et al., 2014).

To create an initial set of categories that can serve as a basis to analyze collaborative practice of volunteers on the fly, we conducted a literature study that focuses on approaches in the context of socio-technical systems (STS), groupware and volunteer collaboration. We also included literature around usability since technology usage will most likely be part of the volunteer's coordination activities. The categories were inspired by the work of Nielsen around usability heuristics since they provide an easy to use set of guidelines to assess complex situations and identify crucial problems (Nielsen, 1994). The literature we studied is spread among but not limited to the following five major clusters:

- socio-technical design (Cherns, 1987; Clegg, 2000; Eason, 2005; Fischer and Herrmann, 2011; Fox, 1995; Mumford, 1995),

- principles of job design (Hackman and Oldham, 1975; Mumford, 1995),
- usability heuristics (Nielsen, 1994),
- principles for the design of computer supported cooperative work and collaboration (Grudin, 1994; Herrmann et al., 1996) and
- volunteer collaboration (Cataldo and Herbsleb, 2008; Chevrier et al., 1994; Cobb et al., 2014; Crowston et al., 2007; Hibbert et al., 2003; Liao et al., 2016).

Category 1 – Reality Check

Category 1 (Cat 1) examines whether the process conducted by volunteers is compatible with the reality of their environment or not. This has been derived from Nielsen's "Match between system and the real world" (Nielsen, 1994).

Suggested questions for detecting problems:

- Is there a sufficient compatibility between pursued goals and what can be achieved in reality based on the available resources?
- Are the terms, information and data being used during the socio-technical process compatible with the language and the information base used by the users of the socio-technical product?
- Are conflicts within the process identified and reported - for example by knowing clients, relevant stakeholders and their interests? This fit with personal interests is related to Mumford's criteria of 'psychological fit' (Mumford, 1995).

Category 2 – Suitability of Task Allocation

Category 2 (Cat 2) is about suitability of task allocation and explores whether tasks are compatible to the competencies and capabilities of volunteers. Clegg refers to the necessity for multiple task allocation (Clegg, 2000); Mumford emphasizes the necessity for a task structure fit (Mumford, 1995).

Suggested questions to detect suitability-related issues:

- Is the distribution of tasks between volunteers and the allocation of tasks understandable and related to volunteer needs, competencies and interests?
- Is there the possibility to assign different arrangements to different volunteers in accordance with their competences, physiological and psychological preconditions and their needs?
- Is coordination communicated to the volunteers and do all volunteers understand it? For example, do volunteers understand how to execute a task, what the available resources are and how the tasks can be carried out efficiently?
- Are volunteers in control of their work (Baker et al., 2001; Herrmann et al., 1996)?

Category 3 – Social Dynamics

Category 3 (Cat 3) explores the role of social dynamics and whether the group accepts and deals with them. Eason claims that socio-technical design has to consider the characteristics of a social system that enables participants in work roles to co-operate effectively (Eason, 2005). In addition, Cataldo and Herbsleb emphasize the necessity for participants to understand their role and how to deal with inevitable fluctuation of volunteers (Cataldo and Herbsleb, 2008).

Suggested questions for identifying problems related to social dynamics:

- Is the relationship clear (described/defined) between the volunteers and the roles they take (e.g. power relations)?
- Is it clear how to deal with ongoing, partially non-anticipatable changes of these relations?
- Is it clear how a volunteer group is prepared to include new volunteers or roles - even if they contribute only informally - or how to deal with changing volunteers?

Category 4 – Proper Information Exchange and Communication Tools

Category 4 (Cat 4) discusses sufficient support and control of information exchange. Cherns includes the necessity for proper information flows (Cherns, 1987); Herrmann et al. require 'suitability of information' (Herrmann et al., 1996); Baker et al. propose principles aiming at proper communication support (Baker et al., 2001). Furthermore, Cat 4 explores the effective integration and efficient use of technology to scaffold communication.

Suggested questions to discover information exchange and communication problems:

- Can volunteers decide - or at least negotiate - which tools they want to use?
- Can volunteers identify what information they need and what information they should provide to the group?
- Are people/roles, who work together, sufficiently connected through spatial conditions, artifacts and communication channels?
- Is sufficient support of communication and information exchange provided and maintained - is this support clearly identifiable?

Category 5 – Balance Between Effort and Benefit, Lack of Motivation

Category 5 (Cat 5) explores the trade-off between the participants' effort and perceived benefits. Grudin mentions related problems in groupware (Grudin, 1994). Values and interests of individuals determine their motivation and willingness of engaging in work (c.f. Cobb et al., 2014; Liao et al., 2016; Mumford, 1995). Similarly, Hibbert et al. (2003) found increased volunteer retention if they perceive their contribution to be worthwhile.

Questions to discover problems:

- Are pursued benefits, goals and the effort how to achieve them clearly described?
- Is it clear how each task will contribute to pursued goals and to values and interests of the volunteers? Are the possible sequences of tasks and workflows clearly directed towards achieving solicited goals/benefits without detours?
- If others are the beneficiaries of one's work: Are the underlying conditions of this exchange clear and transparent?
- Do pursued goals fit motivations and interests of volunteers (Hibbert et al., 2003; Mumford, 1995)?

Category 6 – Feedback and Visibility

Category 6 (Cat 6) deals with providing feedback about outcomes, progress of task completion and options for action. Usability principles in particular emphasize that users must be able to recognize the status of the system, the degree of goal achievement, and have to be guided and supported (Nielsen, 1994). Feedback also is an important aspect of job redesign (Hackman and Oldham, 1975). While visibility in Nielsen's heuristics is an item for evaluating web interfaces, visibility in STS can mean that volunteers show visible motivation to stay in the project or to conduct work. Positive feedback has also been found to increase volunteer retention (Chevrier et al., 1994).

We created following questions:

- Is feedback provided about volunteers' achievements and how well they are acknowledged?
- Is this feedback provided by the coordinator on a substantial basis and at deliberately chosen points in time?
- Do volunteers get guidance according to their needs?

Empirical Method

We analyzed a volunteer group at a mid-western university that jointly developed an AR app over the span of 11 months (09/2015 to 08/2016). Volunteers were from different domains and they were marginally familiar with software and app development. Volunteers did not receive any monetary compensation for their work in the project. A professor, who was interested in augmented reality technology, initiated and continuously supervised the project. This professor sent out a call for participation and ten volunteers responded. None of the volunteers had previous ties with her/him or the department. Out of the ten volunteers who started the project, eight stayed until the end. Two participants dropped out after 6

months (Figure 3). The professor and three researchers (who were not part of the project) conducted the research presented in this paper.



Figure 1. Map view guiding users to points of interest.

Context Information

The goal of the project was to develop an AR app to complement university tours for new students and their families. The idea was to guide users around campus by presenting location-based stories about points of interest (Figure 1). When users arrive at a point of interest, they can use the app to trigger the story (Figure 2). Depending on the spot, users can use different types of media ranging from text to images and video. The app was used during an event to introduce 130 foreign students to the campus.

Project Process

We studied this volunteer project as a socio-technical process in which social settings and technology intertwine (c.f. Figure 3 for an overview of the process of the project). The project started with conceptual meetings (Figure 4 top) during the first month. The volunteers agreed on a preliminary timeline and a meeting schedule, including weekly informal meetings and monthly mandatory meetings between volunteers and the project initiator (Figure 4 bottom). The goal was to set up an initial frame for the project without enforcing a strict project management plan with milestones and deliverables. The group agreed on an initial goal of creating a prototype within eight months (Figure 3). Progress would be discussed during meetings and timelines would be adjusted accordingly.



But what is the Tiger Walk? Explore it now. The Tiger Walk means...

We go through the columns toward Jesse Hall... >

We go from Jesse Hall through the columns... >

Figure 2. Game interface at a point of interest on campus.

The volunteers initially aimed at developing the app using GoogleGlass as the main technology. During the first four months, the efforts focused on identifying tools to develop a GoogleGlass app as part of an augmented university tour. It turned out that this would not be possible without major development efforts and monetary funds.

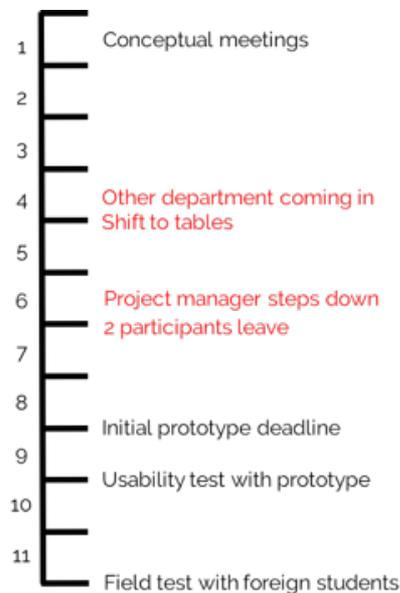


Figure 3. Process of the project over 11 months.

After this investigation, the project took an abrupt change towards using tablets instead of GoogleGlass. This decision was taken as the project initiator was

approached by a university department that was interested in the project. The new stakeholder set a deadline for a field test. This led the volunteers to disband the original plan due to time and resources restrictions and to start working towards a solution based on tablets. At the same time, one volunteer was appointed as project manager.

The volunteers proceeded to search for suitable software and to develop usage scenarios. The scenarios were mainly focused on points of interest around campus. Potential spots were discussed before each volunteer picked a spot and started developing a scenario for it. The scenarios were discussed and refined in follow-up meetings. Around this time, two volunteers dropped out of the project and the project manager stepped down. One month after the initial eight-month deadline, an app was in place and tested with two student groups. Afterwards, changes were made before the app was formally presented and used by a group of 130 foreign students. Results from a study on this large-scale test were mainly positive. The project was thus successful in that the participants developed an app that was perceived as usable and useful by a larger user group.

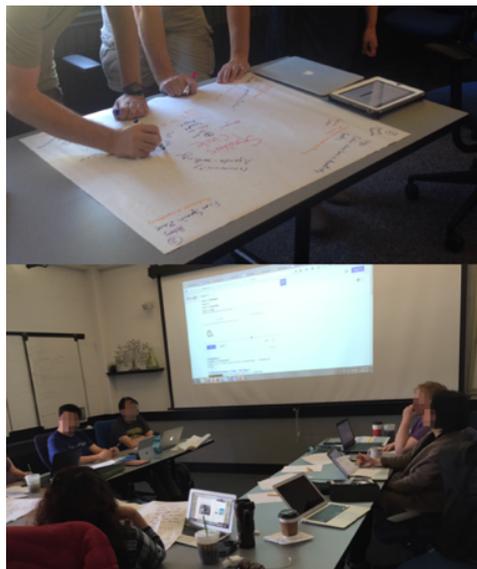


Figure 4. Initial conceptual meetings (top) and monthly project meetings (bottom).

Data Collection and Analysis

Five out of eight volunteers agreed to be interviewed. The others did not respond or they replied they had no time. The interviews lasted between 27 and 57 minutes each. The volunteers covered different career levels (undergraduate, graduate and PhD students, post-docs and faculty), gender (2 female, 3 male), relation to university (no affiliation at all to 25 years of service) and background (information science and education). The interviews were conducted using a semi structured

interview protocol (Denzin, 2008) focusing on collaboration.

To answer the questions stated in the introduction we applied the developed categories to the interviews. Interviews were recorded, transcribed and analyzed using qualitative content analysis (Mayring, 2014). We also had access to documentation from meetings and in between, as well as app versions which served as context during analysis.

Findings

By applying the categories to our empirical case, we identified different episodes during the volunteer group work alongside limitations and ways for improving the categories.

From the interviews, we found multiple indications for discrepancies between project goals and the volunteers perception (**Reality Check (Cat 1)**). The main motive for people to volunteer was an interest to work with GoogleGlass. This is evident by multiple statements such as *“using wearable devices [...] attracted me at the very beginning”* (I1) or *“the technology [...] was innovative and I am highly interested in mixed reality technology”* (I5). Volunteers were also interested in the conceptual idea of the project, to create an augmented learning experience: *“It sounds like this exciting idea conceptually [...] I want to be a part of that”* (I2). Even after it became evident that using GoogleGlass was not feasible (*“without significant funds where we put hundreds of thousands of dollars [...] to try to make it happen”* (I2)), the volunteers were not willing to give up on GoogleGlass until the initiator of the project made *“an arrangement with another department”* (I2). That arrangement required to change to iPads instead of GoogleGlass. The decision that was not unanimously supported: *“I am not so interested in iPad research”* (I4). Our analysis revealed a misalignment between volunteer visions and actual resources for the project. Furthermore, there was a discrepancy between the stories that the volunteers created for campus locations, the length of words and language they used with what would be appealing for future users. This resulted in multiple rounds of *“discussing things over”* (I2) around *“changing the sentences, changing the content, adding more colorful pictures, backgrounds something like that”* (I1).

Volunteers brought diverse skills to the group work. They had backgrounds in *“usability testing”* (I1), *“project management”* (I2) and *“ed[ucation]”* (I5) but they partly over-estimated themselves and their capabilities particularly with respect to their required software development skills. Also tasks were not distributed based on individual skills but based on willingness (**Non-Suitable Tasks (Cat 2)**). This is evident by the statement of a volunteer when asked if s/he could take over a specific task: *“Yeah I can do that”* (I1). Tasks were also rarely coordinated and the volunteers *“failed a lot when tracing [their] activities”* (I3). Realizing that a lack of coordination might become an issue, the group chose one volunteer as a project manager who stepped down after four weeks commenting

that “*this is not a project for project management success*” (I2) and “*it is a very informal group of people who were volunteering*” (I2). During the time where there was no project manager, the group was driven by “*five core members*” (I1). This group, however, did not perceive itself as in charge of coordinating the group but picked up tasks from each other when necessary: “*Some of us ended up redoing [things]*” (I5).

The organization of the project was unanimously described as “*pretty organic*” (I2) and “*self-emerging*” (I3) (**Social Dynamics - Changing Conditions of Organizing the Process (Cat 3)**). There was “*no [explicit] hierarchy*” (I1) and decisions were taken during meetings (“*if we have a meeting, we take a decision*” (I1)). The atmosphere in the project was described as “*very positive*” (I2). The project organization was perceived well by most volunteers, “*the way it happened is probably the way it needed to happen*” (I5). However, there were concerns about the “*lack of structure*” (I5) especially with respect to meetings which were perceived as being inefficient “*that entire situation has made me become very stringent about what meetings I want to attend*” (I2). The same volunteer described the culture of the project as “*meeting happy*” (I2) with “*not much really happen[ing] in these meetings*” (I2). Other volunteers thought that decisions took too long and that the project was “*too slow*” (I4). While most decisions were taken by the group as a whole, few decisions were taken by the project initiator alone. One of these decisions was “*making an arrangement with another department*” (I2) to test the system which led to an abrupt change of plans. Some volunteers also expressed their frustration about the commitment of their peers: “*Not really really interested and motivated*” (I3) which meant that “*some of the [assignments] fell through so some of us ended up kind of redoing those*” (I5). Others perceived their peers as “*driven*” (I2) and “*hard working*” (I2). Not all volunteers appreciated each other in the same way (internal role dynamics). In the beginning of the project, roles were clear and distinct. This changed when personal bonds became stronger. For example, the volunteers referred to the coordinator as a “*kind of friend*” (I1). Other volunteers mentioned that “*it created kind of a friendship*” (I1) or “*there was a camaraderie built because people liked each other*” (I2). Furthermore, the appearance of a new client with new requirements changed the orientation of the project: the project became more formal and less exploratory with a clear goal and delivery deadline (external role dynamics). During the course of the project two volunteers dropped out. One was “*really busy and did not want to develop*” (I3) and the other “*opted out*” (I3). However, despite those two volunteers dropping out we did not find any evidence for a change of dynamics based on those drop-outs.

The volunteers used various ways to communicate, coordinate and distribute content (**Proper Information Exchange, Media (Cat 4)**). The decision for using certain technologies was mainly based on previous experiences and preferences of volunteers, “*s/he is a Box person*” (I2), “*[My colleague] had heard about it*” (I5). This led to tools like GoogleDrive, Box and Samepage all being used at different

points in time for different purposes: from sharing “*notes and schedules*” (I3) to “*storyboards*” (I5) for the app and “*documents*” (I4). None of these tools was used for the entire duration of the project. The usage of different tools at different points in time led to materials being scattered and hard to retrieve. Consequently, volunteers often resorted to using email to communicate: “[*to keep track of what other people are doing*] we usually would send emails to ask” (I4). Email was the only tool used consistently during the whole course of the project: “*email would be number one*”. Nonetheless, email was also criticized for being inefficient (“*too slow*” (I4)). Our analysis thus indicates that control of information exchange, flexibility and autonomy, for volunteers was not sufficiently supported.

As aforementioned, the perception of the effort of other volunteers was not unanimous (**Balance Between Effort and Benefit, Lack of Motivation (Cat 5)**). For example, while one volunteer perceived the others to be “*driven*” (I2) and “*hard working*” (I2), another volunteer stated that people were “*not really really interested and motivated to do this project*” (I3). This may indicate that the core team of project members was motivated and willing to contribute but that was not the case for all volunteers, particularly members who were peripherally associated with the project (“*I am a little on the edge of the project*” (I5)). This assumption is backed up by another project member who states that there were “*core members, like five core members*” (I1). All volunteers described the leadership during the project as very positive: the project initiator was described as being “*great*” (I2), “*extremely hard working*” (I4) and taking “*a lot of effort*” (I1). This motivated some volunteers as evident by the following statement: “*When I saw the project leader is doing great [...] I continued volunteering*” (I1). Some volunteers also described the project as being “*too slow*” (I4) and “*inefficient*” (I4) which led to “*people loose[ing] interest*” (I2). Our analysis indicates different levels of engagement and effort. A difference in effort itself is not problematic. However, it is problematic that this issue had not been addressed during the project. The group did not discuss about different expectations, perceptions and effort. Volunteers may engage differently at different points in time which results in constantly changing conditions of group work compared to non-volunteer project teams. There was an imbalance between what they wanted to achieve, how they expected the others to perform, and the success of the group as whole. The group did not 'see' an appropriate balance between effort and pursued benefits. Still volunteers stayed engaged during the entire project. As a reason for that one member stated that s/he has “*a high work ethic for myself*” (I5). Another person mentioned her/his cultural background as a reason to continue participating in the project: “*if I came in at first and I leave without any good reason [...] it will be considered kind of lazy, not diligent, not hard working, not serious*” (I4). Another reason for people to continuously participate is that people were trying to leave a good impression in order to support their career plans. This becomes evident by one volunteer stating

that “when you are a student and when you are involved in a research project your reputation is on the line” (I5).

During the course of the project, there were many opportunities for direct feedback especially due to the fact that there were “meeting[s] every week” (I2) which lasted “for one hour” (I1) (**Feedback and Visibility (Cat 6)**). The main focus of the meetings however was on “discussions” (I1) and “decisions” (I3). There was little to no coordination between the members during or in between meetings. In addition, meetings were mainly perceived in a negative way as described under Cat 3. The question thus remains how volunteers stayed motivated. Although feedback was rare, people continued volunteering their time. One reason was that bonds were created between project members (c.f. Cat 3). The results show volunteers' perceived difficulties while conducting the group work. It raises the questions and show problems with respect to visibility, continuous preparation, guidance and an overall supportive environment. The interviews indicate that volunteers did not receive sufficient and explicit feedback about their performance, outcomes, progress of task completion and options for action. Although implicit feedback was provided during regular meetings, the interviews revealed that volunteers did not recognize this as feedback. Nonetheless, it seems that these regular meetings served as a communications channel that contributed to volunteers sticking together and maintaining a common ground, even though this was not the main purpose of the meetings.

Discussion

Applying the categories, we derived from literature to a case of volunteer group work allowed us to develop an understanding of why the volunteers stayed on board and allowed us to detect problems of socio-technical constellations in volunteer group work. Table I provides an overview of issues that could be detected using our six categories.

Table I. Issues discovered from the application of the categories.

Category	Issues detected
Reality Check (Cat 1)	<ul style="list-style-type: none"> • No sufficient compatibility between pursued goals (goals set by the volunteers) and what could be achieved in reality (the AR Campus tour app). • The language used by volunteers was not always compatible with the language and information requirements of the future users of the system. • Discrepancies between vision and reality during the project were not identified and reported.

Non-Suitable Tasks (Cat 2)	<ul style="list-style-type: none"> • Tasks did not relate to volunteer competencies. • No possibility to re-assign tasks based on volunteers' competences. • Volunteers understood the coordination of the group even though the process of coordination was not communicated to volunteers. • Guidance was informal and did not meet volunteer's expectations. • The core team did not perceive themselves as in charge of taking decisions.
Social Dynamics (Cat 3)	<ul style="list-style-type: none"> • No clear role definition for each volunteer and no definition of the relationship between volunteers. • No strategy to deal with ongoing, partially non-anticipative changes of relations between volunteers. • No strategy to deal with changing volunteers roles.
Proper Information Exchange, Media (Cat 4)	<ul style="list-style-type: none"> • Volunteers had certain preferences for tools based on their previous experiences. These individual preferences were not necessarily compatible. • Volunteers could not decide or negotiate on tool usage. • Volunteers could not identify necessary information and ways to share it with the group. • We assumed that volunteers who worked together, were sufficiently connected to each other by spatial conditions, artifacts and communication channels but the volunteers themselves perceived it differently. • No sufficient support for communication and information exchange was provided.
Balance Between Effort and Benefit, Lack of Motivation (Cat 5)	<ul style="list-style-type: none"> • The volunteers put a lot of effort, but the perceived benefit was rather low. • Volunteers conducted tasks they did not sign up for. This led to frustration. • There was a gap in the perceived effort between different volunteers. • Volunteers were mainly driven by their intrinsic values. There was little perceived effort for external motivation.
Feedback and Visibility (Cat 6)	<ul style="list-style-type: none"> • Despite many opportunities, feedback was not provided in a way that it related the volunteer's achievements.

	<ul style="list-style-type: none"> • Feedback was provided by the coordinator on a substantial basis and at deliberately chosen points in time but not labeled as explicit feedback. • Volunteers mainly worked in solitude on their tasks with little to no feedback.
--	--

The categories were thus feasible to detect problems in volunteer collaboration. Nonetheless, they do not directly point towards solutions for them. It can, however, be assumed from the analysis that applying the categories during the course of this project by the volunteers themselves would have supported them in dealing with their problems and it would have probably led to a smoother project process. Volunteer work is a specific context, so it may be that for other kinds of projects additional categories are required or the categories we developed do not apply.

Our analysis helped us understand why people continued volunteering their time despite the unsatisfactory process. The motivation aspect and its relation to personal values is of high relevance and led the volunteers to stick together despite problems they faced during the group work, e.g., organizational issues, unsteady clients and a radical change of technology. From our analysis, we found the following aspects to be the main issues:

- First, for people to get interested initially they need an idea that excites them. In this case, it was the idea of using augmented reality technology (Cat 1).
- Second, the initial motivation may not persist during the course of the entire project. It is thus important to be aware of motivational shifts to not lose volunteers (Cat 2, Cat 6).
- Third, in order to keep people on board for the long run it is necessary to forge relationships among volunteers as well as between volunteers and project leaders. It is necessary to keep track of the social dynamics and remain aware of changes in them (Cat 3).
- Fourth, an important motive for people to stay on board is to further benefit or expand their career potential within an organization. Volunteers should thus have the opportunity to form bonds and create a perspective within the hosting organization (Cat 5).
- Finally, tools can become an additional distraction if they are not well aligned with individual practices or with the organization of the project. They can thus be a source of frustration rather than motivation (Cat 4).

Our analysis also points towards potentials for refining the respective categories so that they are a better fit for volunteer projects:

- **Reality Check (Cat 1):** While the aspects of this category remain unchanged, it seems necessary for a group to conduct the proposed reality check multiple times throughout a project. Goals and motivations change throughout a project and volunteer groups have to ensure that individuals stick to achievable and interesting goals to retain a high level of commitment.

- **Suitability of Task Allocation (Cat 2):** There should be a differentiation with respect to the nature of the tasks. Leadership and coordination tasks should be considered as separate tasks that complement practical project work. This became obvious since volunteers seemed to be comfortable to conduct practical tasks. Practical tasks were not well coordinated though because no one did take charge.
- **Social Dynamics (Cat 3):** This category, similarly to Cat 1, fits the context well. It did however become clear from our analysis that there is a strong inter dependency between tasks (Cat 2) and roles (Cat 3) which should be considered when exploring the social dynamics within a group.
- **Information Exchange and Communication Tools (Cat 4):** Our analysis indicates that each volunteer brings a set of preferred tools and practices to the group. While different tools can become an issue, it also became clear that the focus should be on the application of tools. Therefore, the focus should be not on the specific tool but on the combination: which tools are used for what and by whom.
- **Balance Between Effort and Benefit, Lack of Motivation (Cat 5):** The analysis suggested that effort and effectiveness are only parts of a larger picture. It is important that volunteers can decide which tasks they want to take over since they have to perceive them as worthwhile. This requires a certain level of autonomy and control on part of the volunteers which should be taken into account when studying volunteer groups.
- **Feedback and Visibility (Cat 6):** Bonds between volunteers turned out to be a major factor for their willingness to continue working on the project. This category should thus explicitly include feedback among volunteers in addition to feedback given by the coordinator.

Not all categories were equally important to make sense of the project, its conflicts and problems. The main categories in the studied context of a volunteer group seemed to be those ones that are related to personal interests such as Cat 2 and Cat 5. The categories also pointed towards - sometimes major - problems related to task and collaboration (support), yet the group still stuck together. When there is a clear benefit perceived by the volunteers they stay on the project despite the chaos of the process. It thus seems that not all categories were equally important for this particular project, a point that should be a future subject of study.

Contribution and Limitations

The contribution of this paper is twofold. We propose a set of socio-technical categories based on literature and present results from applying them in a practical context. The application of the categories provides in-depth insights into the socio-technical practice of a small volunteer group that is not part of a larger non-profit organization. This is a subject which has not been studied extensively so far. We

also identified means to improve the categories and discussed their potential application in volunteer group work in general.

Nonetheless, the exploratory nature of this study poses some limitations. First, we drew our initial categories from an analysis of relevant literature. While exhaustive, it is possible that the literature did not cover all aspects that can be found in real world projects. Applying the categories in a project led to deeper insights on their application but it is certainly necessary to confirm their usefulness in further studies. Also, the application of the categories on self-reported data in one project poses a threat to the generalizability of our results. However, our work is meant to be an initial application of newly developed socio-technical categories and thus rather informative than generalizable.

Conclusion and Outlook

This work provides insights into how socio-technical categories can be used to facilitate and to reflect on the collaboration of small volunteer groups outside the context of non-profit or other organizations. The categories can be used by them to evaluate their current practices and identify problems thus leading to a better understanding of volunteer collaboration and improved practices.

In the future we aim to refine the developed categories based on our findings and reflect them on relevant work in the field of co-design (Bratteteig and Wagner, 2014) thus including aspects of power and potential inner-group politics. We then aim to evaluate the refined categories in a larger scale mixed-method study which includes volunteer groups from different domains and analyzes interviews as well as behavioral data and documentation created by the volunteer groups.

Acknowledgments

Dr. Nolte's contributions to this research were partially funded by Deutsche Forschungsgemeinschaft (DFG) under grant no. NO 1302/1-1.

References

- Baker, K., S. Greenberg, and C. Gutwin (2001): 'Heuristic evaluation of groupware based on the mechanics of collaboration'. In: *Engineering for human-computer interaction*. Springer, pp. 123–139.
- Boulus-Rødje, N. and P. Bjorn (2015): 'Design Challenges in Supporting Distributed Knowledge: An Examination of Organizing Elections'. In: *Proceedings of the 33rd Annual ACM Conference on Human Factors in Computing Systems*. pp. 3137–3146, ACM.
- Bratteteig, T. and I. Wagner (2014): *Disentangling participation: power and decision-making in participatory design*. Springer.

- Cataldo, M. and J. D. Herbsleb (2008): 'Communication networks in geographically distributed software development'. In: *Proceedings of the 2008 ACM conference on Computer supported cooperative work*. pp. 579–588, ACM.
- Cherns, A. (1987): 'Principles of Sociotechnical Design Revisted'. *Human Relations*, vol. 40, no. 3, pp. 153–162.
- Chevrier, F., R. Steuer, and J. MacKenzie (1994): 'Factors affecting satisfaction among community-based hospice volunteer visitors'. *American Journal of Hospice and Palliative Medicine*, vol. 11, no. 4, pp. 30–37.
- Clary, E. G., M. Snyder, and R. Ridge (1992): 'Volunteers' motivations: A functional strategy for the recruitment, placement, and retention of volunteers'. *Nonprofit Management and Leadership*, vol. 2, no. 4, pp. 333–350.
- Clegg, C. W. (2000): 'Sociotechnical principles for system design'. *Applied ergonomics*, vol. 31, no. 5, pp. 463–477.
- Cobb, C., T. McCarthy, A. Perkins, A. Bharadwaj, J. Comis, B. Do, and K. Starbird (2014): 'Designing for the deluge: understanding & supporting the distributed, collaborative work of crisis volunteers'. In: *Proceedings of the 17th ACM conference on Computer supported cooperative work & social computing*. pp. 888–899, ACM.
- Crowston, K. (2011): 'Lessons from volunteering and free/libre open source software development for the future of work'. In: *Researching the Future in Information Systems*. Springer, pp. 215–229.
- Crowston, K., Q. Li, K. Wei, U. Y. Eseryel, and J. Howison (2007): 'Self-organization of teams for free/libre open source software development'. *Information and software technology*, vol. 49, no. 6, pp. 564–575.
- Cuskelly, G., T. Taylor, R. Hoye, and S. Darcy (2006): 'Volunteer management practices and volunteer retention: A human resource management approach'. *Sport Management Review*, vol. 9, no. 2, pp. 141–163.
- Denzin, N. K. (2008): *Collecting and interpreting qualitative materials*, Vol. 3. Sage.
- Eason, K. D. (2005): *Information technology and organisational change*. CRC Press.
- Farrell, J. M., M. E. Johnston, and G. D. Twynam (1998): 'Volunteer motivation, satisfaction, and management at an elite sporting competition'. *Journal of sport Management*, vol. 12, no. 4, pp. 288–300.
- Farzan, R., R. Kraut, A. Pal, and J. Konstan (2012): 'Socializing volunteers in an online community: a field experiment'. In: *Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work*. pp. 325–334, ACM.
- Fischer, G. and T. Herrmann (2011): 'Socio-technical systems: a meta-design perspective'. *International Journal of Sociotechnology and Knowledge Development (IJSKD)*, vol. 3, no. 1, pp. 1–33.
- Fox, W. M. (1995): 'Sociotechnical system principles and guidelines: past and present'. *The Journal of Applied Behavioral Science*, vol. 31, no. 1, pp. 91–105.
- Garner, J. T. and L. T. Garner (2011): 'Volunteering an opinion: Organizational voice and volunteer retention in nonprofit organizations'. *Nonprofit and Voluntary Sector Quarterly*, vol. 40, no. 5, pp. 813–828.
- Grudin, J. (1994): 'Computer-supported cooperative work: history and focus'. *IEEE Computer*, vol. 27, no. 5, pp. 19–26.
- Hackman, J. R. and G. R. Oldham (1975): 'Development of the job diagnostic survey.'. *Journal of Applied psychology*, vol. 60, no. 2, pp. 159–170.

- Harrison, D. A. (1995): 'Volunteer motivation and attendance decisions: Competitive theory testing in multiple samples from a homeless shelter.' *Journal of applied psychology*, vol. 80, no. 3, pp. 371–385.
- Haski-Leventhal, D. and D. Bargal (2008): 'The volunteer stages and transitions model: Organizational socialization of volunteers'. *Human Relations*, vol. 61, no. 1, pp. 67–102.
- Herrmann, T., V. Wulf, and A. Hartmann (1996): 'Requirements for the human centred design of groupware'. *Human Factors in Information Technology*, vol. 12, pp. 77–100.
- Hibbert, S., M. Piacentini, and H. Al Dajani (2003): 'Understanding volunteer motivation for participation in a community-based food cooperative'. *International Journal of Nonprofit and Voluntary Sector Marketing*, vol. 8, no. 1, pp. 30–42.
- Karr, L. B. and L. C. Meijjs (2006): 'Sustaining the motivation to volunteer in organizations'. In: *Solidarity and prosocial behavior*. Springer, pp. 157–172.
- Kraut, R., M. Burke, J. Riedl, and P. Resnick (2010): 'Dealing with newcomers'. *Evidencebased Social Design Mining the Social Sciences to Build Online Communities*, vol. 1, pp. 42.
- Liao, Q. V., V. Bellotti, and M. Youngblood (2016): 'Improvising Harmony: Opportunities for Technologies to Support Crowd Orchestration'. *Urbana*, vol. 51, pp. 159–169.
- Mayring, P. (2014): *Qualitative content analysis: theoretical foundation, basic procedures and software solution*.
- Mumford, E. (1995): *Effective systems design and requirements analysis: the ETHICS approach*. Macmillan.
- Nielsen, J. (1994): 'Enhancing the explanatory power of usability heuristics'. In: *CHI '94: Proceedings of the SIGCHI conference on Human factors in computing systems*. pp. 152–158, ACM.
- Nolte, A. (2018): 'Exploring Potentials of Process Reflection to Support Communities of Small Volunteer Groups'. In: *Workshops and Work-in-Progress Contributions at S-BPM ONE 2018, Vol. 2074*. CEUR-WS.
- Trist, E. and K. Bamforth (1951): 'Some Social and Psychological Consequences of the Longwall Method'. *Human relations*, vol. 4, pp. 3–3