Publisher: IISI - International Institute for Socio-Informatics
ISSN 1861-4280

international reports on socio-informatics

volume 14 issue 1
2017

IT Supported Police Work: A Case Study of an Interactive Patrol Car Project in Germany

Authors:

Alexander Boden, Stefanie Giljohann

The 'international reports on socio-informatics' are an online report series of the International Institute for Socio-Informatics, Bonn, Germany. They aim to contribute to current research discourses in the fields of 'Human-Computer-Interaction' and 'Computers and Society'. The 'international reports on socio-informatics' appear at least two times per year and are exclusively published on the website of the IISI.

Impressum

IISI - International Institute for Socio-Informatics
Stiftsgasse 25
53111 Bonn
Germany

fon: +49 228 6910-43
fax: +49 228 6910-53
mail: contact@iisi.de
web: http://www.iisi.de

IT Supported Police Work: A Case Study of an Interactive Patrol Car Project in Germany

Alexander Boden[1], Stefanie Giljohann[2,3]
[1]Fraunhofer Institute for Applied Information Technology FIT,
[2]Freie Universität Berlin
[3]Fachhochschule der Polizei des Landes Brandenburg
alexander.boden@fit.fraunhofer.de, giljohann@fu-berlin.de

Abstract. This paper presents a case study on the introduction of an integrated emergency management system for the police: the Interactive Patrol Car project. In order to improve coordination of the fleet as well as increase the safety of their staff, the police in Brandenburg introduced a "multi-pc" that can be fitted into patrol cars and provides modules for task management, navigation and localization, as well as video streaming capabilities. Based on interviews with police officers from the project team, the command centre as well as officers using the system in their daily work, our study provides insights into the expectations and experiences with the new system in its interplay with practices of police operations and related change processes, as well as the various roles, perspectives and forms of expertise that come together in the implementation of such projects in a large hierarchical organisation such as the police. By doing so, the study extends our understanding of Situation Awareness and capabilities for ad-hoc collaboration within daily operations of police officers both in the command centre as well as on patrol in the field.

Introduction

Information and Communication Technologies (ICT) are increasingly entering the domain of emergency and security workers and bring new forms of transformations. For the police, one important driver of change is the introduction of technologies that support better coordination and communication between the

command centre and the personnel in the field. This paper presents insights into a technology development project of the police in Brandenburg, Germany: the Interactive Patrol Car. By equipping a patrol car with different mobile technologies such as a task management system, navigation and cameras, the police aimed at supporting and enhancing their established practices as well as to increase the safety of their staff.

Police work is a domain with rigid structures and established procedures, but requires high levels of agility and improvisation in the field (Denef, Bayerl, & Kaptein, 2013; Harrald, 2006). As malfunctioning of technology can have severe consequences in cases of emergency, this creates an interesting dynamic for the design and implementation of new technologies that are important to be taken into account when developing supportive technology in such domains. An interesting aspect of the project at hand is in this regard that it was managed and planned by the police itself, granting the possibility to study the implementation and effects of an IT change project that had not been started with a research interest, but which was grounded and governed by the practitioners themselves (of course with involving external service providers). Studying the (iterative) development and implementation of the Interactive Patrol Car thus is an interesting opportunity for practice-oriented research in Human Computer Interaction (HCI) (Kuutti & Bannon, 2014) and Computer Supported Cooperative Work (CSCW) (Rohde, Brödner, Stevens, Betz, & Wulf, 2017; Rohde, Stevens, Brödner, & Wulf, 2009; Wulf, Rohde, Pipek, & Stevens, 2011). In particular, this case study provides insights into the intricate interplay between expectations and experiences with technology, practices of police operations, related change processes and the various roles, perspectives and forms of expertise that come together in the implementation of such projects (Liegl, Boden, Büscher, Oliphant, & Kerasidou, 2016). Studying the role of the technological innovation in the context of day to day work is especially interesting since much of the work within crisis informatics has so far focused on the use of IT in emergency situations (November & Creton-Cazanave, 2016).

The remainder of this paper is structured as follows: after presenting the case study as well as our methodology in studying the Interactive Patrol Car project, we will outline related work on the study of support systems for emergency response. The paper then goes on to present different facets of the project, starting with the project planning and implementation, before we will discuss how it was appropriated by officers working in the field as well as the command centre. In doing so, we will especially investigate how the new technology affected their abilities to coordinate and communicate their daily operations, as well as some unplanned emergent issues that arose in this context. The paper closes with a discussion and concludes with a summary of the findings and an outlook on future areas of work.

Case Study

The case study that is presented in this paper has been conducted as part of the European research project COMPOSITE (Comparative Police Studies in the European Union, see www.composite-project.eu), funded by the European Commission within the program FP7. The project investigated organizational change within a consortium of police forces in ten European countries between 2010 and 2014. The overall goal was to explore the applied strategies and methods as well as the facilitating and inhibiting factors of change (Bayerl et al., 2013; Jacobs, van Witteloostuijn, & Christe-Zeyse, 2013). One important focus in that regard was the influence of IT as a driver for change in police forces in Europe.

To study IT change, the consortium conducted a number of national case studies. The aim of the case studies was to analyse how the police forces enhance their intelligence and increase their efficiency by new means of connecting systems and data sources, looking for an example that was both completed or close to completion and had an impact on a potentially high number of police officers. The case study that is presented here is focused on the work of an IT integration project of the police in Brandenburg: the Interactive Patrol Car. This change-project aimed at the integration of new technologies into the police cars, including a task management system, navigation and a security camera. Started in 2006, the project was still running in 2014, the time our case study was conducted. It started off with a phase of desk research of the overall 22 internal documents that were available on this project in 2013. Furthermore, in the same year, 10 in-depth interviews were conducted. The interviews were semi-structured and consisted of questions regarding the work experience without and with the new technologies, the advantages and disadvantages of the new technologies and on how the implementation was enrolled. Specifically for the members of the project team, there were additional questions on the challenges, experiences and lessons learned during this process. The interview partners were members of the project team (N=5), officers working in the control centre (N=3) and officers working on the interactive patrol cars (N=2).

For the analysis, we drew on methods from qualitative content analysis including thematic coding of interview transcripts as well as further collected artefacts such as technical documentation and material from the police intranet such as presentations of the capabilities of the system targeted at internal communication.

Background

Until recently, patrol cars had hardly been affected by the constant transitions and changes of police work and structures in Germany that took place over the last

decades, especially with regard to the introduction of supporting technologies. The Interactive Patrol Car was the first attempt in that direction in Brandenburg in 2005. The motivation for engaging in this change project was that the police wanted to improve the quality and the efficiency of the work as well as to enhance the safety of police officers operating in the field. Especially the latter aspect was one of the main drivers for this IT change. Since the year 2000, several attacks on police officers had revived discussions on staff safety. Consequently, the ministry of Brandenburg initiated the exploration and testing of means to address this issue, including technological innovations for improving communication between the officers in the field and the command centre. As existing solutions at that time were found to be unstable and vulnerable to interferences, the search continued for three years. However, the systematic testing and discussions with technology providers during this phase helped the police to develop a profound knowledge about technical issues with existing solutions. Consequently, the idea for a new technical solution was developed and implemented with support from the ministry.

Figure 1: The multi-pc interface in an Interactive Patrol car.

Thus, the decision was taken in favour of a rather unusual and novel approach: instead of relying on existing technology, the police planned the development of new hardware and software in form of a “multi-pc”, specifically for integration into patrol cars. This included components such as video cameras, navigation and

task management. In addition, it was decided to integrate the mobile solution with a new task-management software in the control centres with the aim to coordinate operating sources more efficiently. In 2009, T-Systems Enterprise und Service mbH accepted the bid to act as the general contractor. One year later the first multi-pc test systems were integrated into police transporters (i.e. the bigger version of patrol cars), and by 2012, thirty transporters had been equipped with an improved version of the first prototype for a second, intensified test phase (see Figure 1). While the hardware remained stable in that phase, the software was further improved and updated continuously. After the completion of the second test phase, the fleet was continuously extended. Furthermore, a third iteration was started , trying to reduce the size of the technical components to be fit into smaller patrol cars, as well as attempts to extend the functionality towards providing mobile office workplaces for the police staff.

Management of the Project

With regard to the main actors in this change project, the first initiatives came from the ministry, which also was responsible for the financing of the project. The project team involved end users already from the very beginning of the testing of the existing technological systems. The development of the hardware and coordination of the subcontractors was outsourced to an external service provider. Further project teams of the police were responsible for the (especially IT-related) groundwork. The project was implemented step-wise, starting with four vehicles at a location that already underwent a structural change process at that time that included the renewal of the existing vehicle fleet. On top of that, the project manager had been leader at the location beforehand and was thus familiar with the staff and their tasks, existing routines, environments, and key actors. After the first experiences with the prototype at this location, the test environment was enlarged to other units who had expressed interest in participating in the change project.

According to the police, communication was one of the most important management strategies during the implementation phase. The project team ensured to communicate reasons, aims, implementation steps and successes as well as failures openly to all involved stakeholders, including the ministry, unit leaders, police officers, trainers, and even the unions. A more general approach to share the information on the most significant steps in the process was the publication of articles in the local intranet, but even more emphasis was put on personal communication. For example, the project team visited police officers in their work environment, bringing with them the new vehicles to facilitate understanding of the new systems and to foster strongly content-related discussions and constructive feedback.

Interestingly, one important strategy to gain acceptance within the organization was to enhance direct communication irrespective of the existing hierarchy. All

project team members, including the project manager, emphasized that they always had an open door for anyone coming in for questions, discussions and suggestions. However, it turned out that the officers were quite hesitant to engage in this for the police rather unusual way of communication. To mitigate this, the project team attempted to stir discussions between officers on the same level of hierarchy, with higher level officers being present during meetings but leaving "at the right time". It was then up to the other project team members, who were much closer to the relevant target group in terms of recent work experiences and the hierarchy, to continue passing on information, requesting feedback and engaging into discussions.

The reason for this approach was very much in line with Participatory Design (PD) principles (Bodker, Kensing, & Simonsen, 2004), calling for the inclusion of end-user knowledge into the development as well as dealing with the challenge of enabling them to meaningfully participate in the design of their future workspaces (Rohde, 2007; Stiemerling, Wulf, & Rohde, 1998). In order to establish a broader exchange of knowledge, the project also tried to initiate and maintain a 'multiplicator network' across the area of Brandenburg as well as across the different levels of the hierarchy. On average, there were about 10-15 multiplicators responsible at all times for passing on project related information from the project team to their colleagues and to share the experiences and opinions of their colleagues then again with the project group. The project team emphasized short feedback loops, including fast and open communication of errors, quick iterations and fixes to identified problems, and requesting timely feedback on the improved system. If fast solutions to errors could not be obtained, great care was taken to communicate that the problem was being attended. By applying this strategy, the team wanted to reduce the danger of errors being interpreted as a generalized proof for the failure of the project.

The New Technologies

The multi-pc integrates police specific technologies in one interoperable hardware module built for transporters that is connected to a coordination tool in the command centre. The system is based on open source software, can be extended with additional modules and be used free of charge by other police forces in Germany. Despite federal attempts to establish digital radio in the area, this technology was not yet sufficiently available in the countryside, so data transfer is established through UMTS. Another important feature of the new technology is that the hardware can be integrated into the patrol cars without affecting the auto body. This is important, because the vehicle fleet of the Brandenburg police is leased.

The multi-pc is positioned in the radio slot, and its screen serves as the central control unit for the peripheral equipment and software (see also figure 1). It contains the following modules (see figure 2):

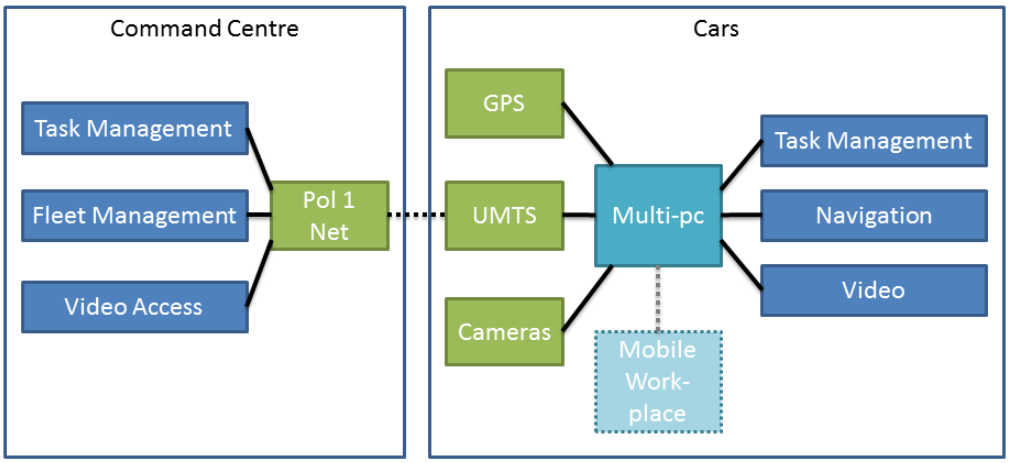

Figure 2: Components of the system in the command centre (left) and patrol cars (right).

Task Management

The cars are equipped with a management tool that is connected to the central management database in the central and displays relevant information for the current operation as well as the history of past operations. Based on a list view, officers can see current and past assignments as well as their status (see Figure 3). When sending brief information regarding the next operation to the task management tool, the officers in the control centre can also directly activate the navigation tool (see below) for the drivers on the patrol cars.

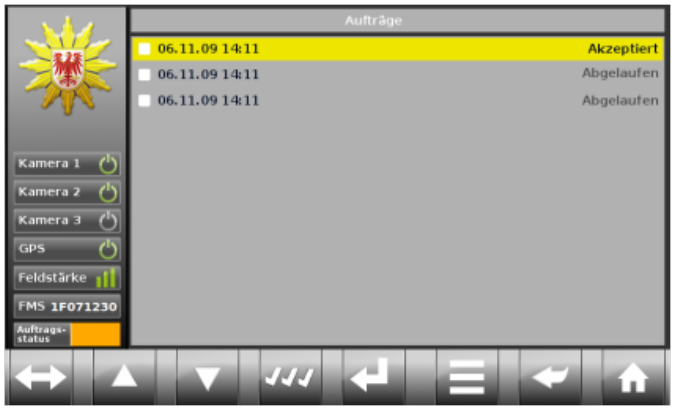

Figure 3: Task Management User Interface from the car.

Navigation & Fleet Management

The cars are equipped with GPS sensors and a navigation tool (see Figure 4-1, left) that was implemented based on the open-source software OpenStreetMap. It includes local access to street maps, specific police maps and the possibility to update these constantly. The navigation software also provides additional police specific information called ‘points of interest’: Certain areas or buildings relevant for operations can be marked on the display and linked to additional information.

A project team of the police is responsible to keep this information up to date at all times.

In the control centre, the order management software was extended by a component to localize the operating sources for better fleet management (see Figure 4-2, right, and Figure 6). For quick orientation, the vehicles' colour on the displays identifies them as 'available' or 'in operation', based on information from the task management system.

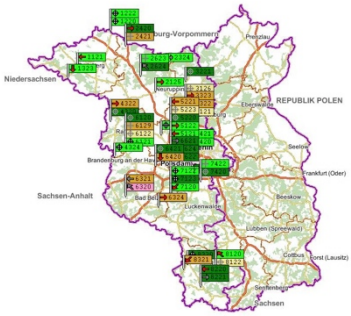

Figure 4-1 und 4-2: Map and navigation in the car (left) and control centre view (right).

Video Streaming and Access

The vehicles are equipped with two IP-rated cameras, one in the front and one in the rear end. This enables patrol officers to watch and record the vehicle's environment through the cameras and to transmit the streams to their colleagues in the control centre (see Figure 5). Streamed video recordings can be viewed on the displays of the computers in the control centre, but the videos are stored only in the vehicles. However, the command centre can switch on the video cameras remotely in case of emergencies (for instance if a car is not answering the radio).

Figure 5: Video stream as seen in the car.

Mobile Workplace

Another aspect of the Interactive Patrol Car was the possibility to equip the patrol cars with a mobile office workplace in form of a laptop that would be connected

to the central IT system in the command centre via the multi-pc link. This function was not yet implemented at the time we conducted the study. However, our interviewees anticipated further functionalities which were therefore discussed as part of the interviews.

Figure 6: Control centre workplace.

Related Work

A diversity of roles, perspectives and forms of expertise needs to come together in emergency management. The precise details of performing tasks, roles, perspectives and expertise may change with the introduction of new technologies. This implies that the details of evolving work practices and workflows must be considered when creating and evaluating IT systems for emergency response. (Flentge, Weber, Behring, & Ziegert, 2008) summarize key aspects that emergency systems should support based on the following points:

- Reduce complexity by supporting an overview of the situation
- Focus on tasks and devices in the User Interface design depending on the roles and needs
- The system needs to be usable by novice and experts
- Flexible design depending on the environment and devices
- Security and privacy issues (depending on roles and needs)

These are generally relevant design principles for many applications, but they are very important to consider in safety-critical systems such as emergency management systems. Arguably, usefulness hinges on people's ability to integrate such systems into highly pressured, distributed and complex work practices (Ley, Pipek, Reuter, & Wiedenhoefer, 2012).

CSCW has a long-standing tradition of studying control room environments with regard to informing the design of information systems (Berndtsson & Normark, 1999; Heath & Luff, 1992). Aspects such as the role of awareness or design approaches such as media spaces and common information spaces have played a paramount role in research in a variety of domains (Boden, Rosswog, Stevens, & Wulf, 2014; Fields, Amaldi, & Tassi, 2005; Harrison, 2009) and have also been discussed in the context of emergency management (Ley et al., 2014; Reuter, Marx, & Pipek, 2012). With the advent of ubiquitous computing, such capabilities have also been extended to the mobile world, i.e. the question how emergency personnel in the field can be supported in complex tasks such as navigating dangerous environments (Al Akkad, Ramirez, Boden, Randall, & Zimmermann, 2014; Johansson, Hellgren, Oskarsson, & Svensson, 2013) or providing ad-hoc decision support in time-critical situations (Bergstrand & Landgren, 2009).

In the following, we will discuss two aspects that are especially important in the context of our case study, because they were key expectations in the development of the Interactive Patrol Car project: the ability to support Situation Awareness by providing a better overview on the position and tasks of the forces in the field, and supporting collaborative response in an agile way by providing better and direct access to IT resources and communication as well as coordination tools.

Supporting Situation Awareness

Situation Awareness refers to how well individuals and teams know and understand what is going on around them (Endsley, 2016). In effect, good Situation Awareness provides a better foundation (though not a guarantee) for effective decision making. Within emergency response, this need is closely related to the wish to maintain a "common operational picture" in terms maintaining an overview of the unfolding situation, both for the emergency management in the command centre as well as for the ad-hoc coordination of resources operating in the field (Ley et al., 2012). It is no longer a lack of data that constrains emergency responders' capability to develop and maintain timely Situation Awareness amongst large, diverse and distributed groups of actors (Johansson et al., 2013). The challenge is to support people in finding and integrating relevant information from heterogeneous sources and to make the integrated information available and intelligible for other agencies—visually and

in other multi-modal modes of representation (Ludwig, Reuter, Siebigteroth, & Pipek, 2015; Reuter et al., 2012).

In small local teams, coordination can often be upheld without much effort in the course of the daily social interaction (Olson & Olson, 2000). Analytically, awareness (Heath & Luff, 1992) describes an implicit form of coordination based on "an understanding of the activities of others, which provides a context" for their own activities (Dourish & Bellotti, 1992). Awareness is often divided into different categories like informal awareness, social awareness or workplace awareness (Gross & Koch, 2007). It can reduce the need for explicit articulation work, as actors monitor each other's work progress subconsciously and react to changing states of the project without the need for explicit discussions. Furthermore, many day to day issues can be handled informally, as upcoming questions can be worked out in ad-hoc discussions and plans can be re-adjusted easily. However, there are often situations where these implicit forms of coordination are not sufficient anymore. Especially in cases of emergency, articulation work can become more complex as needs for higher communication frequency and awareness clash with urgent operational needs.

Emergency Systems often aim at making an abundance of data available. Some also develop ideas for supporting people in making information meaningful and configuring awareness in diverse and distributed teams (Ley et al., 2014). This is a critical issue, since Situation Awareness in such teams needs to be produced and negotiated. Sense-making, not just 'access' to 'more' information, is critical and the collaborative practices that are necessary for sense-making need to be supported.

Collaborative Agile Response

Responders and communities must be able to collaboratively solve problems by preparing plans, providing situation reports, managing resources, assigning orders and documenting progress. Organizational routines and procedures play an important role in police operations (Denef et al., 2013), but there is a need to be able to respond to unforeseen contingencies and dangers in an agile manner, requiring ad-hoc coordination and awareness between the field personnel and the operation centre (Büscher, Liegl, & Thomas, 2014).

Within CSCW, an important concept in this regard has been Articulation Work. It has been initially introduced by the sociologist Anselm Strauss in the late 1980s (Strauss, 1985, 1988, 1993). Strauss has introduced articulation work as a form of meta- or supra-work that is needed to handle these inherent aspects of cooperative work. He characterizes articulation work as "the coordination of lines of work. This is accomplished by means of the interactional processes of working out and carrying through of work-related arrangements. Articulation varies in degree and duration, depending upon the degree to which arrangements are in place and operative" (Strauss, 1993). Articulation is needed mainly to

coordinate the distribution of tasks amongst the actors: who does what, when, how, where, in which quality, until when etc. However, articulation work is more than just "coordination" in the sense that it also includes the negotiation of the inherent distribution of work. Apart from a top-down allocation of resources and responsibilities, articulation work includes the mediation of the different, individual activities with regard to their related arcs of work, for example corresponding individual interpretations and perspectives on work (Schmidt & Simone, 1996).

Coordination systems usually attempt to reduce the need for articulation work by optimizing the division of labor and the corresponding workflows. From an articulation work perspective, they thus make use of formal constructs like plans or workflow models to reduce complexity and make articulation work easier. While they can reduce the need for constant coordination, one characteristic of articulation work is that it can never be fully substituted (Star, 1991). As it is not possible to anticipate all possible eventualities and contingencies, formal constructs can never be complete. Hence, their use in practice always requires articulation work itself (Gerson & Star, 1986), and while plans can be seen as resources for cooperative work, they can never predefine it fully and will always require articulation work in practice—an understanding which Lucy Suchman has labelled as "situated action" (Suchman, 1987).

Especially in the context of emergency management, this does not mean that plans don't play a role or that every action is done in an improvised, spontaneous manner. As Schmidt (Schmidt, 2011) recently pointed out, situated action is rather a concept that opposes a basic assumption from cognitive science: that rational action would be *determined* by plans. When studying emergency support systems, it is hence important to keep in mind that those can be designed based on this assumption, and that it can be fruitful and important to investigate how actions are planned and enacted in practice. In that regard, it is important to study what function support systems play in the *normative* sense of serving as rules and guidelines for legitimate, correct or incorrect action, and how actors can choose to alter, abandon or ignore them in certain situations on the basis of ad-hoc articulation work.

For the police, this means that it is important to study the appropriation of IT systems in their interplay with practices of operation and collaboration, especially in the context of agile response, but also in the context of daily procedures (Draxler, Stevens, Stein, Boden, & Randall, 2012; Orlikowski, 1995). In the following, we will look into how the wish to maintain awareness and the ability to react to unforeseen situations were affected by the introduction of the new technologies outlined in the previous chapter, and what unforeseen appropriation effects became visible in this context.

Findings

> The three selling points of the interactive [patrol cars] are obvious to the colleagues: The enhanced staff security, for the police itself the fleet management, and as a third aspect especially the intervention times (member of the project team).

The quote at the top of this section hints at the most important advantages of the project from the perspective of the police. In the following, we will illustrate findings with regard to experiences, attitudes and expectations of the police along the different functional aspects of the Interactive Patrol Car. In doing so, we will highlight emerging themes and topics that will serve as a basis for the following discussion section.

Task Management & Navigation: Awareness and Overview

The introduction of the task management and navigation/fleet management system allowed the police to reduce the need for frequent radio communication.

> It helps a lot to reduce the workload, both of the command centre as well as the officers receiving the tasks. The display shows a lot of information that we don't need to communicate via radio anymore (officer working in the car).

Before the change, the officers in the field received all information from the control centre via radio calls. Frequent status and location updates from the cars to the command centre and the necessity to receive information about new tasks and locations as well as what kind of assistance was needed in a certain location required a lot of communication via the radios. This had often been cumbersome because of quality problems with the analogue radios. Also, Brandenburg is a large federal state, and it was quite common for police officers to operate in areas they were not very familiar with. Getting rid of the frequent radio exchanges that were needed to maintain an overview on the positions of the units in the area was especially regarded as positive by both the command centre as well as the field personnel.

All information that is relevant for an assignment can now be received as text and be displayed on the multi-pc on the patrol car. This data transfer does not even cause extra work for the personnel in the control centre as all tasks were documented anyways in a local database; being able to forward this information without needing radio communication thus helped to make the information flow more efficient, freeing resources for using the radio to discuss the assignment details, or to make colleagues aware of updates or changes to the assignment. At the same time, the police officers in the car do not need to write down all the information themselves anymore as reference during the operations. Furthermore, the history of the task management can help to relate new assignments to previous

ones in the area, further reducing the need for constant requests to the command centre.

From the perspective of the police officers in the cars and the command centre, the task management goes hand in hand with the navigation functionality that allows them to get the quickest route to a destination of a task as well as related points of interest nearby and other cars operating in the area. This was redeemed as especially important as the previously used navigation systems were not always good in finding the best route. From the perspective of the command centre, on the other hand, the better overview the system provided about the status and tasks of police officers in the field was especially important:

> If I receive an emergency call, I open the entry mask, register the location, with one click on the symbol on the map the location appears and only several seconds later also the patrol cars appear. I choose an available one that is closest to that location, insert it into the operation and give the order (control centre officer).

Before the introduction of the new system, the command centre only had an incomplete operational picture and awareness about how the fleet was distributed in the region.

> In the case of an emergency it is most important for us in the control centre to immediately reach the patrol car which is closest to the location, where it is needed. (...) The actual workflow has hardly been changed. (...) But because we do not need to inquire about the locations of the patrol cars any more, the task can at once be assigned. As it happens, the localization decreases the intervention times (control centre officer).

Having this complete operational overview is especially advantageous in urgent situations, because it allows the centre to quickly identify the patrol car that is best suited to take over the assignment, even when this means it has to leave its usual area of operation. Hence, the localization reduced the time needed for dispatching drastically.

Overall, the officers reported that “the cooperation with the command centre was much more efficient using the new system” (FW2), which can be also illustrated with the following incident:

> An alarm was reported to the command centre. It was caused by a trap in a metal construction company. A patrol car was dispatched instantly, and sent to [the address]. However, the colleagues only were aware of one metal construction company at this address, which looked ok, so they assumed the alarm was a failure and reported everything was ok. However, based on the information on the map, the control centre could see that the car stood at the wrong building. After informing the police officers, they were able to find the right building and stopped the ongoing burglary (intranet report written by the project team).

Apart from the better communication and quicker localization, the officers in our study also reported improved safety as one of the advantages of the system; especially being able to locate colleagues on a map was seen as important, because it could happen that officers in danger were not able to use the radio to call for help. The control aspect, however, was also seen critically by some:

> "Now you know, where we are, now you can see, what our position is right now. […] Surely there are colleagues out there who don't like to be seen" (control centre officer).

While such fears still played a role after the introduction of the system, in practice they seemed to be often unfounded. In fact,

> In practice there is a tendency that the assumption that something could have happened is normally not pursued. The assumption [if a car does not move] is rather that the colleagues are taking a break (member of the project team).

Video: Security, Control & Evidence

The installation of video cameras, too, was related to the wish to improve the safety of the police officers operating in the field. Their introduction was related to a series of attacks against police officers in the late 1990s, which led to several changes to operational procedures (e.g. that officers no longer were sent on patrols alone) and the introduction of video cameras for documenting standard operations such as controlling vehicles.

Apart of gathering material for evidence and training purposes, the motivation for this practice is that officers can stream their operations to the command centre, which can monitor the operation and send help in case of emerging dangers; thus, the command centre can take supportive action without any active request on behalf of the police officers who might be too busy with reacting to some unforeseen situation or danger and thus lose valuable time. Also, there could be situations where police officers are hurt or immobilized and thus unable to request assistance, and having the command centre watching what is happening would be the only means for sending immediate assistance to the exact location of the car. For that reason, the command centre has the additional possibility to switch on the system externally without any interaction by the field officers, for instance if a car does not answer the radio.

The use of cameras is tied to a strong operational protocol that the officers in the control centre may only watch the recording if asked to do so or else if there has been no response from the patrol officers after a repeated radio call and when it must thus be assumed that they are endangered. Also, citizens have to be informed that they are recorded, and recordings are automatically deleted after 24 hours if they are not marked as evidence. Nevertheless, the introduction of the cameras led to a strong controversy among police officers and unions, as there

were fears that the cameras would be used to control the work of the officers. Here, their interest of the command centre being aware of unforeseen dangers clashed with the fear of being controlled and spied upon. Even though the protocol forbids the central switching on the camera without asking permission first, this would be technically possible, and officers feared that this might become the norm when cars would not be moved for a while. Similar to the location information, the safety aspects were stronger than the privacy concerns from the perspective of the command centre:

> The officers in the command centre are not interested in the "customs" of the colleagues in their area of operation. For us, it is important to have access to the position of the car in case of an emergency. Until then, no one here sits at the computer and follows the patrol cars (intranet document, written by the project team).

This statement was also related to the fact that, in practice, the time to check video streams was very limited:

> In extreme situations this technology is helpful, because it makes it easier to gain an overview and allows reducing radio communication. Time to watch the videos is usually not available, […] for the command centre it would not be practical to use the camera more often (control centre officer).

As a consequence, video streaming and recording was rather used in special situations where officers expected a direct advantage, such as confronting citizens directly with video evidence ("Here the tendency to dispute trends against zero". (FW4)), as well as in situations where they felt unsafe and actively requested monitoring by the command centre. Another aspect in this regard was that in order to use the cameras effectively, officers had to take care to position the car in a way that allowed the command centre to see what was happening on the video feed—a prerequisite that required active attention and "tactical" (FW4) planning on behalf of the police officers.

Mobile Workplace: More time on the street

Even though the mobile workspaces had not been implemented at the time we conducted our study, the officers we interviewed saw a very high potential in this expected feature:

> The task management system should support all steps up to the signature on a demand for a penalty in the Interactive Patrol Car. This would allow officers a quicker execution of tasks on the spot, and they would not need to go back to the office all the time (intranet document, written by the project team).

Apart from the advantage of spending more time on the street instead of at the desk, the mobile workplace would also allow to further reduce the communication needed between the command centre and the patrol car:

> Requests that I have outside, such as identifying a vehicle owner […] could in principle be made with the laptop, without needing to ask […] the command centre. That would make us a bit more independent (officer working in the car).

The importance of such functionality was supported by the fact that officers spend approximately three quarters of their time in the car, shifting office work to the end of their shifts. Especially on busy days this sometimes requires officers to return early to the command centre, reducing police presence in the field and potentially increasing intervention times in emergencies At the same time, some office tasks were already done in the car, indicating a potential for further technical enhancements in that area.

> You […] don't always need to go to the office, you can stay in the area […], prepare things outside (officer working in the car).

Issues that were mentioned with regard to implementing these changes where security aspects of allowing external write access to task and office information systems, leading to some functions being limited in the beginning.

> You can create and edit data, but this happens locally, and is only synchronized when you connect the laptop with the docking station in the local police network (officer working in the car).

Other issues that were mentioned were related to the bad ergonomics of working in a car (especially when the system would be ported to "normal" patrol cars instead of transporters), resulting from the limited space and different requirements for mobile equipment such as being sturdy and resistant to moisture and dirt.

Discussion

Our study showed the different perspectives that officers in the command centre and in the field had on the usage of the shared IT system. While all police officers in our study redeemed the change project to be successful in terms of providing better awareness and coordination between the command centre and the fleet, it was especially the aspect of control that had made the field officers initially sceptical—on the first glance maybe a surprising finding in the context of a hierarchal and strictly governed organization such as the police. One of the end

users of the patrol cars explained that after lots of changes that had taken place before, and not always for the best, there had been further scepticism in the beginning, especially as to the functionality of the new technologies. The attitude had been to wait and see if it worked, but became more positive after the first contacts with the technology. “By now, we like driving this car. Because it is easier.” Also some officers had feared that the intention of implementing new technologies was to reduce staff, requiring additional information management by the project team.

It was of advantage that the officers needed hardly any acclimatization or training, as the work procedures remained the same. On the other hand, the functionality of the technologies was convincing. Most certainly, in such a stressful work environment, an important factor is how stress can be reduced (Boden et al., 2016). The officers stated that the new technologies work reliably and that the new navigation system facilitates the orientation. The intervention times are not only shorter, but also more predictable. The exchange of case relevant information depends no longer only on the sometimes quite bad quality of radio communication. And furthermore, the officers appreciate that their colleagues in the control centre can on the one hand monitor their actions if they sense this may be needed and that they have on the other hand their exact geographic coordinates in case they need support.

In the following, we will revisit the findings from the previous section along these aspects, and also discuss the influence of the approach of the project, i.e. being planned and managed by the police itself.

Situation Awareness and Common Operational Picture

With regard to the role of Situation Awareness, the task management and navigation / localization functionalities turned out to be an important driver for reducing the need for frequent radio communication; “information overload” has been extensively discussed in the context of supportive IT systems (Hiltz & Turoff, 1985), and is a well-known phenomenon in emergency management especially in the case of ad-hoc operations (Al Akkad et al., 2014).

In the context of this project, the possibility to reduce radio communication was seen as univocally positive, allowing field personnel and command centre staff to reduce annoying and time intensive tasks such as the frequent location and status requests. By shifting important information to a new, text based channel in the task management systems as well as by visualizing the status and location of the fleets on a map, it was possible for the police to focus the radio communication to important additional information and requests, freeing sparse resources and reducing times where field personnel would need to wait for information before being able to take action. Instead of reducing the *implicit* awareness about the fleet status that officers would acquire by listening to the radio, the change hence allowed the police to replace *frequent* communication

with *better* communication (Ackerman, Pipek, & Wulf, 2003). In this case, it allowed to focus the radio communication on important issues and ad-hoc requests, and also to share some of this information to the rest of the fleet by means of adding points of interest to the map—thus providing a better operational picture not only for the command centre, but also for the police officers in the field.

This is an interesting finding with regard to systems that aim at supporting awareness and which provide a common operational picture in emergency management, because those systems often suffer from the mismatches between the need for frequent communication and the interest of reduce that information in order to reduce information overload (Boden et al., 2016; Johansson et al., 2013); in our case, the police found a valid way by providing the field personnel with their own augmented map view, and by keeping the existing radio communication in place. It hence helps to illustrate that in terms of providing awareness and information for emergency workers, the key is to understand the needs and perspectives of the practitioners as well as the ones of the command centre (November & Creton-Cazanave, 2016; Reuter et al., 2012)—especially as in this case of everyday activities the police units patrolling the area are semi-autonomous, which resulted in the observed struggles between trust and control—another critical issue of awareness providing IT systems (Boden, Nett, & Wulf, 2009).

Shifting the previously common *pull-based* status requests via radio to a *push-based* model where positions and status information would be transferred automatically from the cars to the command centre hence also led to some concerns about privacy and the feeling of being controlled. Even though there was a strict protocol in place, the police officers had to give up some of their agency in terms of the ability of *not* being available for communication (Boden et al., 2016). Here, two different perspectives clashed against each other: on the one hand the need for the command centre for situation awareness about the status and location of all officers in the fleet at all times, for instance to be able to send help in times of danger or simply to plan new assignments, and on the other hand the freedom of the police officers to conduct their work independently from frequent monitoring, leading to the next aspect: the ways in which the system helped to support collaborative agile forms of response.

Collaborative Agile Response

For the aspect of ad-hoc agile collaboration, the system also turned out to be beneficial. On the one hand, this related to the better planning that was facilitated by the more efficient task and fleet management. On the other hand, it was especially the video component that turned out to be important for supporting ad-hoc collaboration between the officers in the field and the command centre.

This form of collaboration, like the task management, turned out to have two different aspects: the wish for security vs. the feeling of being controlled. The main driver that led to the implementation of the change was the security aspect, that allowed police officers to show parts of their activities to the control centre officers in order to provide them with a quicker way to assess unfolding situations, send assistance and help in situations of unforeseen dangers (such as an attack on a police officer). This aspect has been much discussed within emergency management, especially with regard to emergency personnel carrying mobile cameras on their bodies (Bergstrand & Landgren, 2009). However, again this new system was also connected to the privacy vs. control aspects of our study. Here, it turned out that making efficient use of this form of technology required active participation by the police officers in the field, for instance in terms of positioning the camera in a way that provided a useful view for the control centre. This introduced a new level of agency to the police officers in the field, which also helped to reduce the scepticism towards this new perceived form of control to some extent.

Looking at our findings from the perspective of Articulation Work (Strauss, 1993) and situated coordination (Schmidt, 2011) thus reveals another interesting layer that is closely connected to the *normative side* of the new system as a way for governing daily procedures and increasing the safety of police officers. At the same time, it showed the implicit need of using the system in a way that makes it actionable in the highly situated context of collaborative agile response in emergencies, and that could not be guaranteed by technical and / or hierarchical means alone.

In this regard, our study connects the existing discourse of the advantages and disadvantages of equipping police officers with security cameras for reasons of increased safety, better training, and evidence collection with another dimension (Bergstrand & Landgren, 2009; Hellgren & Johansson, 2012): the aspect that the ultimate control of this tool still remains with the police officers operating in the field, despite any tendencies to put this equipment into the control of the command centre (which, due to the legal need of informing citizens about video recordings, would not have been fully possible anyways).

Interestingly, the possibility of equipping the cars with mobile workplaces can also be seen in this context, because it would reduce the need for field personnel to frequently return to the command centre, again increasing the agency of the police personnel for acting independently and quickly. In the next section, we will now revisit the organizational aspects of the project, which were especially interesting in this case, and highlight their connection to the success of the project.

Project Management

Our study also highlighted some important aspects of IT-project management within the context of police forces, especially the question on how to deal with the rigid structures and hierarchies in this domain (Bayerl et al., 2013; Betz & Wulf, 2014). During the implementation of the new technologies, direct communication seemed to be the most effective method to gain this acceptance. Applying a (new) communication strategy that was able to bridge over different layers of hierarchy was hence an important key to the success of the project. The project team admitted that initially they must have missed out on the chance to well communicate the project goals as they became aware of serious misunderstandings regarding these.

For the project team, it was a bit of a surprise that there had been critical voices against the change even from younger officers, who were expected to be open for new technologies. But especially these were disappointed, because the "new" technologies appeared to them quite out-dated compared to the technologies available on the market, for instance in the context of consumer devices. "The enthusiasm for innovation should be balanced by the consideration of the gain and consequences", stated one of the project group leaders. The specific needs and limitations of technologies being used by police forces had to be thoroughly explained to the colleagues, in order to be accepted.

Of course, some sort of critical acclaim had been expected from officers preferring their routines without technical improvement. However, apart from the reported scepticism towards the capabilities of the system to control the work of the police officers, the Interactive Patrol Car was further associated with personnel cuts as it was introduced while police stations were being closed due to a large structural reform, resulting in a relatively strong opposition that the project team had to address. According to them, the success was mainly the result of the large multiplicator network—without which the project might have even failed in the very beginning.

What further helped with the acceptance was that the team avoided changing the core tasks for the officers in the control centre as well as on the patrol cars. The focus was rather in providing additional functionalities, adding new opportunities, and addressing issues that had been identified in the daily work: With the new technologies there is more information available, the new tools facilitate the work and reduce the intervention times. Additionally, the officers' safety is enhanced. As a consequence of these improvements, the change has received a widespread acceptance.

However, the project nevertheless revealed the need for long term changes of the police culture in the specific context of the development and implementation of new technologies. In the development and testing process of new technologies honest feedback is critical for revealing failures, analysing these and trying out new ways of optimization. But the officers are not used to participate in such

processes and the police do not have a feedback culture except for top-down communication. Hence, it was difficult to receive the necessary feedback bottom-up. Reducing the distances in the hierarchy to facilitate such a feedback was, as also mentioned before, a challenge. Top-down communication is, after all, a core characteristic of the police and is unlikely to change.

Despite this, the multiplicator approach used proved to be successful. By collecting feedback on the same hierarchical level and channelling it from there up to the next level by the well-informed and trained multiplicators, bottom-up feedback could be established without interfering with police culture and its established norms. In future developments officers will further have to develop an even deeper understanding of the responsibilities that come with such a new feedback culture, especially that feedback requires a constructive approach of communication. By establishing multiplicator networks during IT changes such an understanding can be fostered, as well as an understanding of the concept that in this context their expertise is irreplaceable when deciding what changes are functional for their future healthy workplace—always keeping in mind the numerous police specific limitations to IT change, especially with regard to data security, which make implementations in this area especially hard.

Conclusion and Outlook

The case study of the Interactive Patrol Car has provided insights into the design of an integrated emergency management system and its use in the daily operations of police forces in Brandenburg, Germany. The main motivation for the police to implement the technologies in this project was to create ways of collaborative police work by better coordination of resources and increased situation awareness between police units. The emergency management system can hence be seen as an attempt of improving the efficiency of organizational processes and staff security. The most important features where the order management tool with its brief information relevant to the next operation and the order history, the navigation tool with its police-specific maps and information on points of interest and the video streaming component.

The appropriation study showed that the multi-pc of the Interactive Patrol Car complemented the beforehand necessary radio communication with the integration of text as well as audio-visual information. The communication between the control centre and the officers happened in a rather self-organized form of peer-to-peer communication, and the system helped freeing resources for using available communication channels more efficiently. Especially with regard to the staff safety, the usage of the system was also connected to a field of tension between the wish to give and/or receive ad-hoc assistance in dangerous situations, and the wish to work semi-autonomous without constant monitoring. As the usage especially of the video component requires active collaboration, this was used by

the police officers in the field for managing the related control-related aspects, mitigating fears and unintended side-effects of the technology to some extent.

In particular, the study has extended our understanding of the role of Situation Awareness and capabilities for ad-hoc collaboration against the background of daily operations of police officers both in the command centre as well as on patrol in the field. This study contributes to recent discussions within CSCW about the possibilities of providing support for coordination and organizational processes in emergency management (Ley et al., 2014; Ludwig et al., 2015; Reuter et al., 2012). Furthermore, it extends our understanding of the role of technology in day to day operations as opposed to the more prominent focus on exceptional situations in the context of emergencies that has been identified recently (November & Creton-Cazanave, 2016).

Our study also highlighted some of the context specific difficulties that police forces face when implementing change projects due to their rigid hierarchical organisation and strongly governed organisational culture. Analysing a technology project that was strongly pushed by the police and organized in a way resembling user-oriented design methods was hence an interesting case for studying end user development, human computer interaction and sustainability of change projects in such contexts, which is especially relevant for conducting further design case studies in such environments (Wulf et al., 2011). In particular, the case study provided insights into emerging possibilities for change projects in complex environments, such as the introduction of mobile workspaces for police officers—though this remains a topic for future work.

References

Ackerman, M. S., Pipek, V., & Wulf, V. (2003). *Sharing expertise: beyond knowledge management*. Cambridge, Mass.: MIT Press.

Al Akkad, A., Ramirez, L., Boden, A., Randall, D., & Zimmermann, A. (2014). Help Beacons: Design and Evaluation of an Ad-Hoc Lightweight S.O.S. System for Smartphones. In *Proceedings of the 2014 ACM annual conference on Human Factors in Computing Systems (CHI)* (p. accepted for publication). Toronto.

Bayerl, S., Jacobs, G., Denef, S, van den Berg, R. J., Kaptein, N., Birdi, K., … Vonas, G.. (2013). The role of macro context for the link between technological and organizational change. *Journal of Organizational Change Management*, *26*(5), 793–810. https://doi.org/10.1108/JOCM-05-2013-0076

Bergstrand, F., & Landgren, J. (2009). Information sharing using live video in emergency response work. In S. J. J. Landgren & 6th International ISCRAM Conference on Information Systems for Crisis Response and Management (Eds.), *ISCRAM 2009 – 6th International Conference on Information Systems for Crisis Response and Management: Boundary Spanning Initiatives and New Perspectives*. Gothenburg: Information Systems for Crisis Response and Management, ISCRAM. Retrieved from http://idl.iscram.org/files/bergstrand/2009/312_Bergstrand+Landgren2009.pdf

Berndtsson, J., & Normark, M. (1999). The Coordinative Functions of Flight Strips: Air Traffic Control Work Revisited. In *GROUP* (pp. 101–110).

Betz, M., & Wulf, V. (2014). EmergencyMessenger: A Text Based Communication Concept for Indoor Firefighting. In *Proceedings of the 32Nd Annual ACM Conference on Human Factors in Computing Systems* (pp. 1515–1524). New York, NY, USA: ACM. https://doi.org/10.1145/2556288.2557188

Boden, A., Al-Akkad, A., Liegl, M., Buscher, M., Stein, M., Randall, D., & Wulf, V. (2016). Managing Visibility and Validity of Distress Calls with an Ad-Hoc SOS System. *ACM Transactions on Computer-Human Interaction (TOCHI)*, *23/6*.

Boden, A., Nett, B., & Wulf, V. (2009). Trust and Social Capital: Revisiting an Offshoring Failure Story of a Small German Software Company. In *Proceedings of the Eleventh Europaean Conference on Computer Supported Cooperative Work (ECSCW 2009)* (pp. 123–142). London: Springer.

Boden, A., Rosswog, F., Stevens, G., & Wulf, V. (2014). Articulation Spaces: Bridging the Gap Between Formal and Informal Coordination. In *Proceedings of the 17th ACM Conference on Computer Supported Cooperative Work & Social Computing* (pp. 1120–1130). New York, NY, USA: ACM. https://doi.org/10.1145/2531602.2531621

Bodker, K., Kensing, F., & Simonsen, J. (2004). *Participatory IT design: designing for business and workplace realities*. MIT Press. Retrieved from http://books.google.com/books?id=Oncc6OEn9rMC&pgis=1

Büscher, M., Liegl, M., & Thomas, V. (2014). Collective Intelligence in Crises. In D. Miorandi, V. Maltese, M. Rovatsos, A. Nijholt, & J. Stewart (Eds.), *Social Collective Intelligence* (pp. 243–265). Springer International Publishing. Retrieved from http://link.springer.com/chapter/10.1007/978-3-319-08681-1_12

Denef, S., Bayerl, P. S., & Kaptein, N. A. (2013). Social Media and the Police: Tweeting Practices of British Police Forces During the August 2011 Riots. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 3471–3480). New York, NY, USA: ACM. https://doi.org/10.1145/2470654.2466477

Dourish, P., & Bellotti, V. (1992). Awareness and coordination in shared workspaces. In *Proceedings of the 1992 ACM Conference on Computer Supported Cooperative Work* (pp. 107–114). New York, New York, USA: ACM Press. https://doi.org/10.1145/143457.143468

Draxler, S., Stevens, G., Stein, M., Boden, A., & Randall, D. (2012). Supporting the social context of technology appropriation: on a synthesis of sharing tools and tool knowledge. In *Proceedings of the 2012 ACM annual conference on Human Factors in Computing Systems* (pp. 2835–2844). New York, NY, USA: ACM. https://doi.org/10.1145/2207676.2208687

Endsley, M. R. (2016). *Designing for Situation Awareness: An Approach to User-Centered Design, Second Edition*. CRC Press.

Fields, B., Amaldi, P., & Tassi, A. (2005). Representing collaborative work: the airport as common information space. *Cognition, Technology & Work*, *7*(2), 119–133. https://doi.org/10.1007/s10111-005-0177-3

Flentge, F., Weber, S. G., Behring, A., & Ziegert, T. (2008). Designing Context-Aware HCI for Collaborative Emergency Management. In *Int'l Workshop on HCI for Emergencies in conjunction with CHI 2008 (electronic proceedings)*.

Gabriele Jacobs, Arjen van Witteloostuijn, & Jochen Christe-Zeyse. (2013). A theoretical framework of organizational change. *Journal of Organizational Change Management*, *26*(5), 772–792. https://doi.org/10.1108/JOCM-09-2012-0137

Gerson, E. M., & Star, S. L. (1986). Analyzing due process in the workplace. *ACM Transactions on Office Information Systems*, *4*(3), 257–270.

Gross, T., & Koch, M. (2007). *Computer-Supported Cooperative Work*. Oldenbourg Wissenschaftsverlag. Retrieved from http://books.google.com/books?id=5aAvlGlQJlEC&pgis=1

Harrald, J. R. (2006). Agility and Discipline: Critical Success Factors for Disaster Response. *The ANNALS of the American Academy of Political and Social Science*, *604*(1), 256–272. https://doi.org/10.1177/0002716205285404

Harrison, S. (Ed.). (2009). *Media Space 20+ Years of Mediated Life*. Springer.

Heath, C., & Luff, P. (1992). Collaboration and Control. Crisis Management and Multimedia Technology in London Underground Line Control Rooms. *Computer Supported Cooperative Work*, *1*, 69–94.

Hellgren, C., & Johansson, B. J. E. (2012). Reducing workload by navigational support in dynamic situations. In J. R. L. Rothkrantz & 9th International ISCRAM Conference on Information Systems for Crisis Response and Management (Eds.), *ISCRAM 2012 Conference Proceedings – 9th International Conference on Information Systems for Crisis Response and Management*. Vancouver, BC: Simon Fraser University. Retrieved from http://idl.iscram.org/files/hellgren/2012/127_Hellgren+Johansson2012.pdf

Hiltz, S. R., & Turoff, M. (1985). Structuring computer-mediated communication systems to avoid information overload. *Communications of the ACM*, *28*, 680–689. https://doi.org/10.1145/3894.3895

Johansson, B., Hellgren, C., Oskarsson, P.-A., & Svensson, J. (2013). Supporting situation awareness on the move - the role of technology for spatial orientation in the field (pp. 442–451). Presented at the ISCRAM. Retrieved from http://www.diva-portal.org/smash/record.jsf?pid=diva2:810643

Kuutti, K., & Bannon, L. J. (2014). The turn to practice in HCI: Towards a research agenda. In *Proceedings of the 32nd annual ACM conference on Human factors in computing systems* (pp. 3543–3552). ACM.

Ley, B., Ludwig, T., Pipek, V., Randall, D., Reuter, C., & Wiedenhoefer, T. (2014). Information and Expertise Sharing in Inter-Organizational Crisis Management. *Computer Supported Cooperative Work (CSCW)*, 1–41. https://doi.org/10.1007/s10606-014-9205-2

Ley, B., Pipek, V., Reuter, C., & Wiedenhoefer, T. (2012). Supporting improvisation work in inter-organizational crisis management. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems* (pp. 1529–1538). ACM.

Liegl, M., Boden, A., Büscher, M., Oliphant, R., & Kerasidou, X. (2016). Designing for ethical innovation: A case study on ELSI co-design in emergency. *International Journal of Human-Computer Studies*, *95*, 80–95. https://doi.org/http://dx.doi.org/10.1016/j.ijhcs.2016.04.003

Ludwig, T., Reuter, C., Siebigteroth, T., & Pipek, V. (2015). Crowdmonitor: mobile crowd sensing for assessing physical and digital activities of citizens during emergencies. In *Proceedings of the Conference on Human Factors in Computing Systems (CHI). ACM Press, Seoul*.

November, V., & Creton-Cazanave, L. (2016). Inquiry in control rooms – an analysis through the lenses of space, time and practices. In A. Tapia, P. Antunes, V.A. Bañuls, K. Moore, J. Porto, & 13th International Conference on Information Systems for Crisis Response and Management (Eds.), *ISCRAM 2016 Conference Proceedings – 13th International Conference on Information Systems for Crisis Response and Management*. Rio de Janeiro, Brasil: Federal University of Rio de Janeiro. Retrieved from http://idl.iscram.org/files/valerienovember/2016/1381_ValerieNovember+LaurenceCreton-Cazanave2016.pdf

Olson, G., & Olson, J. (2000). Distance Matters. *Human-Computer Interaction*, *15*, 139–178.

Orlikowski, W. J. (1995). Evolving with Notes: Organizational change around groupware technology. *MIT Working Paper Series*, *186*. Retrieved from http://mit.dspace.org/bitstream/handle/1721.1/2577/SWP-3823-32948044-CCS-186.pdf?sequence=1

Reuter, C., Marx, A., & Pipek, V. (2012). Crisis Management 2.0: Towards a Systematization of Social Software Use in Crisis Situations. *International Journal of Information Systems for Crisis Response and Management (IJISCRAM)*, *4*(1), 1–16. https://doi.org/10.4018/jiscrm.2012010101

Rohde, M. (2007). Integrated organization and technology development (OTD) and the impact of socio-cultural concepts: a CSCW perspective. Retrieved from http://rudar.ruc.dk/handle/1800/3112

Rohde, M., Brödner, P., Stevens, G., Betz, M., & Wulf, V. (2017). Grounded Design – a praxeological IS research perspective. *Journal of Information Technology*, *32*(2), 163–179. https://doi.org/10.1057/jit.2016.5

Rohde, M., Stevens, G., Brödner, P., & Wulf, V. (2009). Towards a paradigmatic shift in IS: designing for social practice. In *Proc. of DESRIST'09* (p. 15).

Schmidt, K. (2011). *Cooperative Work and Coordinative Practices: Contributions to the Conceptual Foundations of Computer-Supported Cooperative Work (CSCW)*. Springer.

Schmidt, K., & Simone, C. (1996). Coordinaton Mechanisms: Towards a Conceptual Foundation of CSCW Systems Design. *Computer Supported Cooperative Work*, *5*, 155–200.

Star, S. L. (1991). The Sociology of the Invisible: The Primacy of Work in the Writings of Anselm Strauss. In D. Maines (Ed.), *Social Organization and Social Process: Essays in Honor of Anselm Strauss* (pp. 265–283). Hawthorne: Aldine de Gruyter.

Stiemerling, O., Wulf, V., & Rohde, M.. (1998). Integrated Organization and Technology Development – The Case of the OrgTech-Project. In *Proceedings of Concurrent Engineering (CE 98)* (pp. 181–187). Tokyo.

Strauss, A. L. (1985). *Social organization of medical work*. Chicago: University of Chicago Press.

Strauss, A. L. (1988). The Articulation of Project Work: An Organizational Process. *The Sociological Quarterly*, *29*(2), 163–178.

Strauss, A. L. (1993). *Continual permutations of action*. New York: Aldine de Gruyter.

Suchman, L. A. (1987). *Plans and situated actions: the problem of human-machine communication*. Cambridge, New York, Port Chester, Melbourne, Sidney: Cambridge University Press.

Wulf, V., Rohde, M., Pipek, V., & Stevens, G. (2011). Engaging with practices: design case studies as a research framework in CSCW. In *Proceedings of the ACM 2011 conference on Computer supported cooperative work* (pp. 505–512). New York, NY, USA: ACM. https://doi.org/10.1145/1958824.1958902

Acknowledgments

Our sincere thanks go to our interview participants from the project team, the end users of the patrol cars and in the control centre Potsdam, who shared their experiences and opinions with us. Further, we highly acknowledge the support of the project team, which presented us the technology in the patrol cars and in the control centre and who furthermore enriched our knowledge with valuable information and great discussions. Last but not least, we thank ZDPol for the friendly permission to use their figures and graphics for this article.