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Mobile Technology in Mobile Work: Contradiction and congruencies in activity systems

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Abstract

Mobile technology and the information and communication services supported by it have become increasingly embedded in, and in some cases transformed, work and social activity and created new challenges for studying information systems. This paper focuses on the experience with mobile technology in an inherently mobile and information intensive work activity - policing. Drawing upon data from this context this paper makes two key sets of contributions. Empirically, we illuminate the congruencies and contradictions between mobile technology and mobile working, and the relationship between the two, revealing a state of change based upon dialectic interaction. We highlight several ways in which mobile technology has changed the nature of mobile work activity. Theoretically we advance the use of activity theory to better understand the changes of mobile technology mediated work. We extend traditional use of activity theory by adopting congruencies as an analytical lens, in addition to the approach of examining contradictions. The findings are applicable to other areas of mobile work and contribute to the body of knowledge concerning mobile technology mediated work.

Keywords: mobile IS, mobile, activity theory, organisation change

Introduction

Mobile technology and the information and communication services supported by it have become increasingly embedded in, and in some cases transformed, work and social activity. Van der Heijden and Junglas (2006 p.249) raised the concern that research efforts had not mirrored the growth of use or

development of mobile technology; however over the last eight years there has been a mounting corpus of research focusing on the social and technical aspects and the business benefit of mobile technology.

One of the major streams of research has focused on the perception, acceptance and adoption of mobile technology. A particular theme relates to the dual function of mobile technology as both serving organisation-sanctioned and personal motives (Wiredu, 2007), with each context leading to different perceptions of user satisfaction (Scheepers et al., 2006). There is also better understanding of how users perceive their mobile devices and the utilitarian and social values patterning the decision to adopt amongst individual users (Kim & Han, 2009). It was noted that the perception of the smartphone changed noticeably over time from a coveted device, to simply a tool of habitual use (Bødker et al., 2014). Similarly, research has shown the value and user-empowerment of mobile devices going beyond the traditional deterministic paradigm (Jung, 2013). For adoption of specific activities such as banking, the perceptions of users vary with risk, opportunism, reputation and assurance being important roles (Srivastava, 2010); while for mobile commerce activities, culture in the form of trust, navigational structure and visual appeal are important influences (Vance et al., 2008). This suggests that it is important to disaggregate activities (banking, commerce, social networking etc.) and contexts (work, personal) as the issues and affordances of mobile technology are varied and each requires a specific line of inquiry. The academic research has also addressed this as an important theme in the context of work-life balance (Duxbury & Smart, 2011), where mobile technology has been shown to allow flexibility, whilst leaving employees feeling bound to work (Middleton & Cukier, 2006).

In terms of mobile workers (people who work on the move), where there is the greatest potential of synergy, there is emerging understanding of how mobile technology transforms how mobile workers communicate and coordinate their activities and the rise of self-organised mobile communities. It has been found that 'blue-collar' workers innovatively and resourcefully use mobile technologies to participate in communities of practice (Kietzmann et al., 2013). Interestingly, employee firms are often unfamiliar with the importance of community participation enabled through mobile technology. This suggests that workers are finding and creating congruencies between the affordances of mobile technology and the nature of their work (Kietzmann et al., 2013). There has also been a stream of research examining mobile technology and organisational fit, typically relying on quantitative approaches, with the findings used to suggest better ways to design mobile information systems (Gebauer et al., 2010).

An interesting development in IS research the exploration of the complex ecosystem of relationships in the development of mobile technology (Basole, 2009) and the perspective and roles of different groups in the innovation process (Kietzmann, 2008). It has been argued that developers of mobile devices and

services are looking toward exploratory, non-determinist, or user-driven development methodologies in an effort to cultivate products that consumers will consistently pay for (Wareham et al., 2009).

Outside the work context, studies of individual mobile behaviours have noted emerging patterns, whereby users turn to mobile modes of information access more frequently (Oulasvirta et al., 2012). There is mounting evidence to suggest that information searches are different on mobile devices, and different factors influence information behaviour (Ghose et al., 2013; Nicholas, 2014).

While the breadth of research on mobile technology continues to grow, we note a limitation in understanding how mobile technology leads to new patterns of work, raises new tensions in work activity (Kietzmann et al., 2013) and how it both the technology develops to resolve issues in, and compliment work activity. Furthermore, despite the level of complementarity between mobile work and mobile technology there is little research exploring how the technology supports work, changes work or creates new challenges. Research has highlighted that voice based mobile technology is harmonious with mobile workers (e.g. sales representatives, police officers) (Carlson et al., 1999; Manning, 1996), however there is less knowledge on how data services and applications enabled by mobile technology are harmonious with work activity.

In the literature review we begin by arguing that the IS field has been pre-occupied with illuminating the factors that explain technology acceptance and adoption rather than focusing on developing insights on understanding change, social action and deeper issues around the institutionalisation of technology. We suggest that the lack of appropriate theoretical lenses to frame studies, which account for both tools and the activity context, is one reason for this and present activity theory as a lens for studying the how mobile technology emerges and mediates work activity. We develop our argument by presenting the results of a study which examines the way that mobile technology provides both contradictions and congruencies in the context of work activity, in particular front-line police activity. We refer to mobile technology as handheld devices with computing capability, such as a smartphone (the terms cellular/mobile technology, PDA and smartphone have all been used in IS literature as the technology and subsequently definitions advance). The police are an appealing domain for undertaking research into mobile technology and work activity, as front-line police officers are the prototypical mobile worker and function in an information intensive and dynamic work environment. Three interrelated activities form the basis of our inquiry (1) the emergence of the mobile technology (the activity pre-mobile technology); (2) the implementation of the mobile technology activity; and (3) the mobile technology mediated activity (the activity of front-line policing after introduction of mobile technology).

This paper is structured as follows. The following section of the paper briefly reviews the literature on contemporary approaches for studying mobile technology in organisations and argues that activity theory is appealing because of its ability to conceptualise the use of technology in its social and cultural-historical context. We generate two activity theoretic research questions concerning the contradictions and congruencies of mobile technology in front-line police activity. We then outline our study methodology and the empirical data that forms the base of this paper. Our analysis focuses on the emergence, implementation and use of mobile technology in front-line police. The paper concludes with a discussion of the practical and theoretical contributions and study limitations.

Literature review

Studying the implementation, adoption and use of mobile technology

The IS field has a history of investigation into the interrelated issues of implementation, adoption and use of technology. Studies have drawn extensively on the technology acceptance model (TAM) (Davis, 1989), Unified Theory of Acceptance and Use of Technology (UTAUT) (Venkatesh et al., 2003) and Task-Technology Fit (TTF) (Goodhue & Thompson, 1995), amongst other approaches which operationalise the factors leading to the acceptance of technology. Use, validation and extension of these approaches have enhanced our understanding on the factors patterning the acceptance of mobile technology (Carlsson et al., 2006; Gebauer et al., 2010).

While these approaches have augmented understanding on the factors that explain technology acceptance and fit, it is beyond their exposition to provide insights on understanding change, social action and deeper issues around the institutionalisation of technology – that is the broader relationship between technology and human activity. Rather, IS scholars have drawn upon contemporary social theories to frame studies examining these broader issues, including: structuration theory, analytical dualism, social construction, institutional theory, actor-network theory (ANT) and activity theory; all which have a tradition in social science, organisation and IS research (Brigham & Hayes, 2012; Chae & Poole, 2005; Engeström, 2000; Walsham, 1997; Zheng et al., 2013).

In the context of the study of mobile technology however, these approaches have been applied to a lesser extent. McBride (2003) used ANT to provide insights into how mobile technology is adopted within different countries and illuminated on the geographical factors, government policy, infrastructure, culture and economic models that pattern its spread. ANT provided a framework for describing the process of

technology adoption and developing stories which explained the take-up. Donner (2007) used adaptive structuration theory to explore the use of mobile phones and meanings behind certain uses. The use of activity theory to frame studies surrounding the patterns of use of mobile technology (Wiredu, 2007; Wiredu & Sørensen, 2006) remains emergent rather than established.

Activity theoretic perspective: mobile technology mediated activity

We draw on activity theory to frame our study of mobile technology and work activity. Rather than provide an argument for activity theory in IS research (Ditsa, 2003), or explicate upon activity theory in light of other theoretical perspectives, in this section we elaborate on the contribution of activity theory in providing insights into technology mediated change, in particular mobile technology and work.

There are several ways which activity theory can help provide insights into what it refers to as mediation of an activity, the development of cultural-historical tools and social-action, offering an alternative perspective to current approaches used to study the phenomenon. We draw particularly on activity systems, which was developed by Leontiev (1978) and conceptualised as consisting of a *subject*, *tools* and *object*. The basic premise is that a subject (a person or collective) is driven by a *motivation(s)* to act upon an object (a person, collective or thing) using cultural-historical tools (technologies, mental tools, language etc.). Engeström (1987) expanded the activity system to include other elements such as *community*, the *division of labour* and *rules/norms* (see Figure 1). This follows that an activity is constantly developing and influenced by the activity community and problematised by their divergent motives (Wiredu, 2007); governed by cultural-historical rules/norms which influence the activity direction, the selection of tools and meaningful action; and, executed by a division of labour which takes place between the subject and community (and object, if applicable).

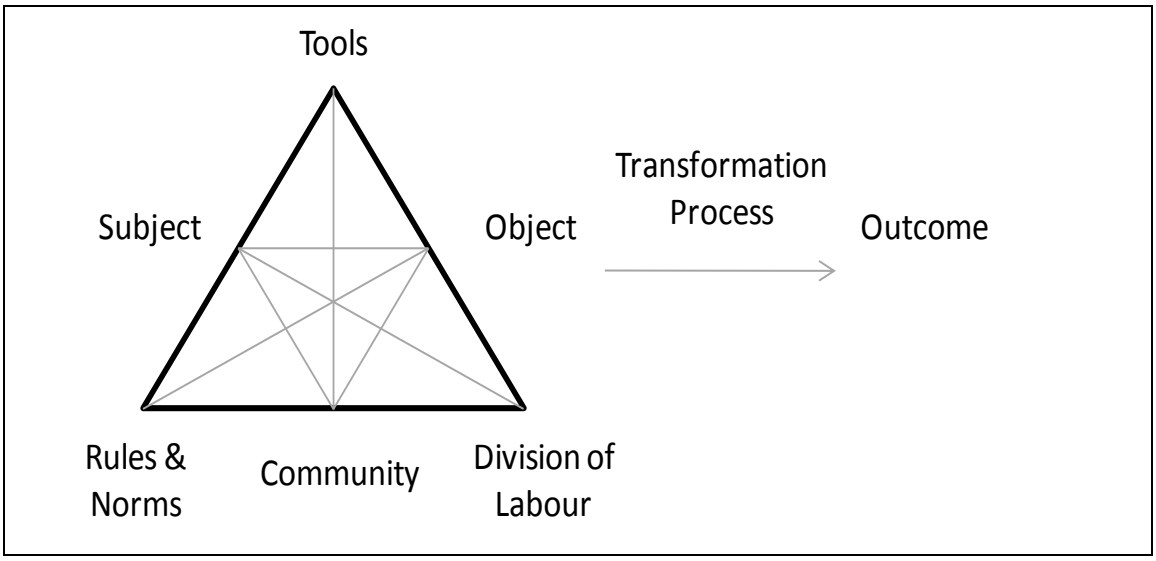

Figure 1: Engeström's Activity System

While activity theory is an expansive theoretical approach and tradition, we draw upon Engeström's (1999b) "third generation" activity theory and its related conceptual tools to understand social-action, activity, change and multiple networks of interacting activity systems, and in particular, the use of activity systems, as per our recent work (Allen et al., 2013a; Allen et al., 2013b; Karanasios & Allen 2013). Building on this we incorporate a logic of opposition, focusing on contradictions (Engeström, 1987) and congruencies (Allen et al., 2013). The frame of reference of activity theory employed in this research is set out in the following paragraphs.

The activity system is the site for analysing interaction between actors and collective structures and the use of tools, providing an analytical framework for studying the specific activity and practices at a multilevel, stratified manner, in context (Spasser, 2002). Importantly, bringing these concepts (in particular technology and the social) together into one coherent framework, counters the concern raised by scholars surrounding the absence of the role of technology in organisational life, or privileging the social over the material (Orlikowski, 2005). Rather, it brings the use of technology into the realm of specific human activity, what scholars refer to as "sociomateriality" (Orlikowski & Scott, 2008), or "intermingling" (Orlikowski, 2005). Bringing these concepts together is different from other approaches, such as Archer's analytical dualism where the analytical separation of structure and agency is required to examine their interplay; a perspective which is discordant with activity theory where they form a single unit of analysis, the activity system (Allen et al., 2013a).

Importantly, activities are woven, combining, merging, interpenetrating, dividing and become more complex over time (Spinuzzi, 2008). The notion of connected, interwoven activities or "weaving" is different to the "spliced" network perspective, which is the understanding used by ANT and concerns

political-rhetorical alliances and negotiations (Spinuzzi, 2008) (see Miettinnen [1999] and Spinuzzi [2008]) for comparison with ANT). However, Spinuzzi (2008) acknowledges, as do we, that there is considerable overlap between the two perspectives. This woven understanding suggests that improvements or deterioration of an activity caused by mobile technology will have consequences for other activities. Mobile technology for instance is the result of a social process and previous network of activities, embody cultural characteristics and have become a norm and a means of labour in other activities.

In technology and work studies, difficulties and conflict around the development, use and change of technology typically manifest (Orlikowski & Gash, 1994). A major contribution of activity theory is that it emphasizes contradictions which emerge within an activity as a means of understanding change and action (Engeström, 2001; Ilyenkov, 1974); a concept which is not explicitly available in other contemporary social theories. Contradictions shape an activity and reveal inefficiencies and importantly, opportunities for change (Engeström, 1987), providing important ways for researchers to approach change and problematise mobile technology. We have contended that the resolution of contradictions through technology mediated change may result in several levels of symmetry or congruency, which shape success, normalization and agreement between the use of tools and work activity. These can be immediate areas where things work better in some way (which may in fact be contradictions at a later stage, acting as a form of feedback) or potential areas of longer-term congruencies as the system changes to adapt to the new tool and ways of working which it necessitates (Allen et al., 2013a). This helps to identify areas in which mobile technology has created efficiencies, new ways of working and tensions by becoming the central information tool, and also to identify opportunities for future development and change. Importantly, it does so while considering the work context in which it is employed. In other words, it does not overly emphasize technology or separate it from the work activity.

In line with this, Robey and Boudreau (1999) suggested that in order to theorise organisational change it is necessary to incorporate a logic of opposition into the initial conception of the research and appropriate methods to analyse opposing forces. In a practical sense, in the context of mobile working and mobile technology where the monetised benefits are often contested and equivocal, the identification of patterns of contradictions-congruencies provides an alternative approach to articulating how technology leads to positive change and explaining the evolution in the work activity.

Research questions

The lens of contradictions and congruencies within the activity theoretic perspective allows us to generate relevant research questions in the context of mobile technology and mobile working. Two interlinked research questions form the basis of our inquiry (1) *What are the major contradictions in the emergence,*

implementation and use of mobile technology? And (2) *What are the major congruencies in the emergence, implementation and use of mobile technology?* We blend the three interrelated activities in order to illuminate upon the experience with mobile technology in the police. More importantly answering the research questions generates insight into how mobile technology introduced new ways of working, in one of the quintessential mobile occupations, and how it has led to new efficiencies and challenges. While the research setting is one UK police force the research has broader theoretical implications as it provides a lens which may explicate upon how mobile technology has rapidly grown as an information and communication medium in different settings. In the next section we present some discussion on the literature concerning mobile technology and its implications for police work activity.

Research setting: Mobilising the police

It has been argued that mobile technology has the potential to significantly support front-line police, allowing for greater extension of the police institution to the streets (Sørensen & Pica, 2005), as it is an information intensive (Nunn, 2001) and geographically distributed activity. While the police have not traditionally been the focus of a body of research into technology mediated change there has been academic interest in the use of the mobile technology in the police, largely in Europe and North America. These studies have focused on its early use as a 'low-tech' innovation in the 1990's (Manning, 1996), the acceptance of mobile technology (Bouwman & van de Wijngaert, 2009) and the rhythms of interaction between mobile technology mediated work and physical work (Sørensen & Pica, 2005). One theme extracted from these studies is that the mobility characteristic inscribed in the technology is harmonious in many ways with the activity of front-line police. Despite this level of interest, it is important to note however that the use of mobile devices, of various distinctions such as smartphones and laptops, to access information services is by no means universal and remains fragmented even within police forces.

In the UK, the setting for this paper, the police have been the focus of large-scale investment into mobile technology. The potential to access information on the move directly, transforming the information ecology, aligns well with the issue of "police force visibility" (the amount of time police officers are on the "beat", as opposed to in the police station), a major public concern in the UK (House of Commons., 2008), and making better use of resources in the context of budget restraints (HMIC, 2011). However, technological change in the police is problematised as it is a highly politicised entity, not amenable to radical change and particularly failure (Ackroyd et al., 1992). Technological solutions that do emerge is often mandated and influenced heavily by political influences and public opinion (Newburn, 2008). This has become evident by the high-profile negative assessments from government concerning the investment into mobile technology in the police over the last five years and the lack of clearly articulated financial impacts (NAO, 2012; PAC, 2012), which have been more pronounced in light of budget cuts to police

forces (HMIC, 2011). This is problematised by the elusive and difficult to measure notion of the benefit of "mobility" and "information on the move". This study therefore presents a lens to study the relationship between technology and mobile-working, by highlighting the areas of problematisation and agreement in the emergence, implementation and use of mobile technology.

Methodology

Study case

The empirical data centres on a case-study of one UK police force. It was selected for several key reasons. First, it was one of the earliest police forces to undergo a mobile technology project (Allen & Karanasios, 2011; Karanasios et al., 2009); providing the potential to identify lessons applicable in subsequent implementations. Second, the technology under investigation was sufficiently technologically and institutionally embedded, allowing investigation from implementation to actual use. Thirdly, access to the necessary actors, a major difficulty in such research settings, was readily available. This included subjects within the police force, as well as external organisations, trade associations and government bodies.

The police force under investigation has approximately 1,500 front-line officers and 2,500 employees in total. It services a wide semi-rural and urban geographical and demographic base. At the time of study the implementation of the mobile solution resulted in 1,200 devices rolled out to police officers (which was to be followed by a larger rollout).

As one of the earliest and most advanced police forces developing mobile technology in the UK it was not constrained by existing solutions. The technology was deployed to response, traffic and community police officers. While the notion of Bring Your Own Device (BYOD) has gained much interest recently, such devices are not amenable to the strict security nature of policing. Police officers were issued with a device and would typically pick up their device at the start of a shift and dock devices at the end of a shift, although offices could take the device home. A 3G network by one of the large commercial providers in the UK supported data communication; like most commercial networks coverage was not universal.

The mobile technology consisted of a device with the capability to perform person and vehicle checks, record crime reports, view data on a crime/incident/situation in-progress whilst *en-route*, e-mail, access intelligence and issue tickets (using small wireless printers by traffic officers), amongst other key tasks and types of information access/capture that was typically performed over the radio by interacting with control-room staff, on paper or in the police station. Radio remained the voice-communication tool.

Windows was selected as the operating system and input was made using a stylus or by finger on the touch screen keyboard. The cameras were initially disabled. However, some 'common sense guidelines' were developed so that they could be used. Typically, they were used in instances where for example a

vehicle was obstructing an area or vandals had been observed; however the captured images were not evidence that was admissible in court. Mapping functions were enabled, but this was used as a standalone feature and was not integrated with crime intelligence, or other applications, at the time. Beyond mapping, broader internet access such as web browsing was limited. As part of the study we also looked at future areas of development.

Conceptual framework, data collection and analysis

The study employed a qualitative research emphasis, using activity theory as a conceptual framework. In particular we used the notion of activity systems to study and analyse the cultural-historical emergence of mobile technology, the interplay between the subject, the technology and the community, their motivations and the contradictions and congruencies that patterned the emergence, implementation and use of the technology in the police force. We focus on three interrelated activity systems (1) the emergence of the mobile technology; (2) the implementation activity; and (3) the mobile technology mediated activity. In examining the emergence and implementation of the mobile technology we concentrate on the aspects that are relevant to the use of the technology and connect to latter congruencies (in the mobile technology mediated activity) and the relationship between them.

We employed several forms of data collection, namely interviews with the project team, high-ranking officials, users and IT suppliers; observations of meetings and of the use of the technology *in-situ*; and, reviewed documentary and archival material. Such a pluralistic approach has been encouraged in IS research (Trauth & O'Connor, 1991) and used in similar studies (Sørensen & Pica, 2005). Access was made possible through previous engagement with the police force and support from the National Police Improvement Agency (NPIA). The study commenced in 2008 and was completed in 2009. The researchers interacted with members of the police force, the NPIA and external entities using telephone, email and through formal and informal meetings.

Interviewees were identified through initial contacts and then through the snowball sampling technique and included a range of rank, experience and job-focus (e.g. traffic/front-line policing). In our experience this is the most effective method of obtaining deep access in a "closed" organisational setting. Interviews ranged from 45 minutes to two hours. An interview protocol was developed using the concepts available in activity theory (for instance, motivation, tools, rules and norms etc.) within the frame of reference of the emergence of the three activities we focus on. This allowed us to draw on contradictions within and between activity systems and observe congruencies as resolutions of the contradictions or (un)expected ways in which aspects of the activity worked better as the activity changes to adapt to the new tool (or adapt the tool) and ways of working. The line of questioning focused on the development, the

implementation and the use of the mobile technology. Interviews took place in the police station or in some cases during observations of police officers in action.

Observations involved embedded fieldwork with police officers using the technology, where researchers would shadow police officers, often for the duration of the shift (roughly eight hours). This involved observing the use and non-use of the mobile technology in vehicles, at crimes scenes and during interactions with the public and often lasted the duration of the shift. This illuminated directly on scenarios where the police officers would use or wouldn't use the mobile technology, a perspective that was not possible from interviews, and provided data triangulation by allowing us to confirm what was derived from interviews with what was observed. The embedded nature of this part of our data collection suggests our approach has some connection with an ethnographic research approach which can provide "*insights into human, social and organisational aspects of information systems development and application*" (Harvey & Myers, 2002 p.169). The perspective of individual citizens who were the "recipient" or "beneficiary" of the technology was captured through second-hand account of police officers or direct observations, rather than through individual questioning of citizens.

All interviews were digitally recorded and transcribed verbatim. In the case of the observations, comprehensive notes and memos were taken and reconstructed shortly after. The data was entered into Nvivo qualitative analysis software and analysed by two members of the research team individually and then compared to verify the analysis (Weber, 1985). Using content analysis we systematically worked through each transcript and assigned codes to the text at the thematic level (Dawson, 2002; Ezzy, 2002), particularly looking for contradictions, which involved examining "*tension, contrast, denial, or opposition between two propositions*" (2008 p.1063), rather than a general assertion of asymmetric power relations (Engeström, 1999a). In our case it also involved the resolution of these or new and (un)expected ways that the activity worked better as result of the introduction of the tool. While these are coded during the data analysis they were often identified during data collection (Ezzy, 2002).

Given the hierarchical nature of police organisations, it was expected that there would be some bias in the primary data collection (for instance, where the interviewees would give answers they believed the people who may gain access to the data would like to hear). Likewise, the field observations may have suffered bias, whereby the police officers used the mobile device because they were being observed. To combat this, secondary data (Jarvenpaa, 1991) was used as a mechanism of validation and further triangulation (in addition to the observations), allowing us to check inferences drawn from one set of data with other sources (Trauth & O'Connor, 1991) offering a more holistic perspective and mitigating the limitations of relying a narrow source of data (Eisenhardt, 1989). Analysis of documentation involved examining material related to the evaluation of the mobile technology, which helped piece together its emergence, who was involved, the issues that patterned its development and verify statements made by study

subjects. In analysing the data we identified a number of congruencies and contradictions, however, prioritised and judge the significance of issues according to the weight of the data. Where necessary in order to clarify the data gathered and confirm findings, subjects were contacted. Table 1 summarises the data collected.

Table 1: Summary of data collection

Interviews with key actors /police officers (users)	**Meeting observations**	**Field observations**	**Documentary: archival and other**
Semi-structured interviews with Deputy Chief Constable, Program Manager, Head of Tech-Services, NPIA, Project Manager, Project team members (3) and IT supplier. 25 semi-structured interviews with police officers.	National mobile data user group meetings. Police mobile-data conferences.	Ten observations of officers using mobile devices *in-situ* and interacting with citizens (up to eighty hours in total).	Documentation/reports concerning pilots, evaluation etc.

Results

In this section we use an activity theoretic perspective to examine the three key interrelated activities (1) the emergence of mobile technology; (2) the implementation activity; and (3) the mobile technology mediated activity. While there is significant overlap between these phases we use the lens of contradictions and congruencies to move between them and illustrate how the notion of providing information services to police officers through mobile technology emerged from cultural-historical contradictions and came to present several levels of congruency.

The emergence of mobile technology

The initial motivation behind the mobile technology was traced to 1993 when the idea existed amongst certain staff (the project members), who explained that they recognised there was some need for mobile working, but acknowledged that technology had not reached an adequate level of functionality.

> *"As early as 1993-4 (three chief constables ago) it was looked at briefly, however there were so many changes both organisationally and technologically…it was felt that technology was not ready to achieve the results they desired and provide a good return on the investment – we would have struggled to provide operational benefits"* (Project Officer; interview)

The concept re-manifested itself at the beginning of the decade as the technological capacity advanced and the police force moved forward with the idea of running applications on mobile devices and progressively built the technology, relying on experimentation and piece-meal development. Alongside advances in technology the issue of police returning to the police station rather than remaining visible to the public was a major contradiction that existed in the activity norms. The dominant existing work norms supported behaviours which were drawn from earlier activity systems predicated on working from a police station and completing information tasks in the station. In contrast the emerging political discourse provided an alternative set of norms and values predicated on the need for police to spend more time 'on the beat' and to be visible to the public and to undertake more work out of the station. At the time, "police force visibility" was a major public concern in the UK (House of Commons., 2008). As this contradiction between the existing and new norms emerged over time this primary contradiction became a source of ambiguity and uncertainty about the acceptability of use of mobile technology in police services (Allen & Wilson 2004). There was, however, an expectation that this contradiction could be resolved using mobile technology. Indeed, in the case described in this paper as this contradiction was resolved (with the norms related to police force visibility becoming dominant) we observed an emerging congruency between the new norms, the non-material tools (language) and technology. This provided the project team with a rationale and legitimization for their innovation. This was underscored in official documentation and by the statements by the project team, which revealed that from a cultural-historical perspective the police force was an innovator of the technology rather than just an appropriator of tools.

> *"The reason we started working in this area of the business was that when you actually look at the amount of time the police officers spend in a police station or is invisible to the public, its roundabout in excess of 50% of their time. Now if the public get reassurance from seeing a policeman out and about, therefore my job is to try and create the capacity where we increase that visibility to some 70% or 80%"* (Project Manager; interview)

Implementation activity

Congruencies in aligning the shared object

Figure 2 illustrates the implementation activity system from the perspective of the police force and captures the multiple-voices of the community and subject in the activity. It was derived from a synthesis of the data collection. In the community we include other independent police forces who were involved in the broader UK landscape of mobile technology; citizens who had a role in accepting or rejecting the technology and are beneficiaries; the NPIA who supported the change; and, IT suppliers who actively

contributed to the development of the technology. As we are particularly interested in the police it places the implementation activity at the centre. The Figure shows the motivation for the activity and the tools used in undertaking the activity in order to achieve the object, and shows that IT supplier and the NPIA activities interconnect by contributing towards the same object. The roles are described briefly here. The major congruency in the implementation activity was the alignment between the community and the subject in developing a functioning mobile technology solution. This is represented in Figure 2 by indicating that the three activities shared the same object. Several issues are described as they show that the tool developed as the result of a dialectical social process, embodying multiple motivations and cultural characteristics. This is important as the technology was intended to act as a norm and a tool of labour in the police activity.

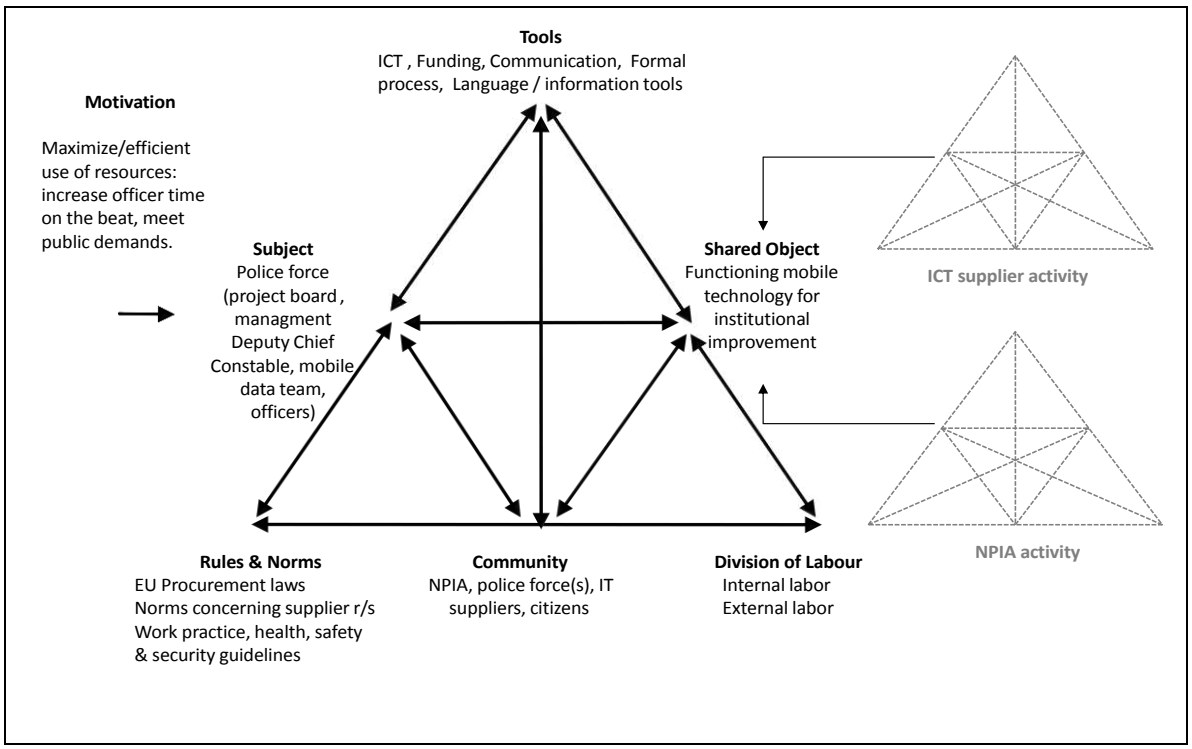

Figure 2: Implementation activity system

Suppliers included mobile technology providers, network bearers and firms that developed mobile applications and can be classified as passive (supplying off-the shelf software/hardware) and those that were more instrumental and used the force as a R&D test-bed (technology of this type, in this setting, was still in its infancy). Whilst the motivations of the police force (to improve efficiency) and commercial suppliers (to establish a position in the burgeoning market space) were divergent the common and shared object (of delivering a working mobile technology solution) proved a major congruency.

The rules and norms that governed the implementation activity differed from traditional rules and norms of technology development in the police. For instance, the force-supplier relationship was based on a

trade-off of cost and benefit and shifted towards an open-innovation mode (Chesbrough, 2003) of development. The reason for this was that the police force initially had limited funds to deliver a mobile solution and used its position (as a gateway to other police forces and a platform for successful mobile technology) to entice partnerships and develop relationships which would maximise benefit. This relationship breaks the traditional structure of the relationship between the buyers and sellers of technology.

> *"I think we have saved an awful lot of money because the approach we have taken is that we will take all the pain of the development, but the benefit for us is the licence...the benefit for you (the supplier) is you get a product that you can market and....we get reduced prices"* (Project Manager; interview)

Where there are different motivations, especially commercial vs. public sector, contradictions are likely to exist. One instructive example was the contradiction between the supplier and police force vision of mobile technology, which as resolved influenced the direction of the technology, as noted in the statement below:

> *"We (the police force) started off with 3.5 inch screens and all of a sudden they (suppliers) start making 3.2 inch screens, then it's down to 3 inch screens… and you are now talking about going down to 2.8, you just can't fit that information on there...We have to say, we want a larger screen, we want more power or more processing power or more memory. So it's all these things that you actually say to them"* (Project Manager; interview)

The quote shows that the supplier was moving towards smaller screen sizes, which was problematic for the usability of the device in the policing context. While this is an example of a supplier-buyer contradiction, it was resolved by the attractive position of the force to suppliers and the overarching congruent shared-object leading to some agreement on the physical aspects of the technology, which is important in its later use.

There was some alignment between the police force and the NPIA in achieving the shared object. The NPIA viewed mobile technology as a way of rreducing the need for police officers to return to the station, in-turn increasing police visibility and helping to make citizens feel safer and reducing bureaucracy; this is in many ways in line with the police force motivation. This is evident from the initial funding allocated in 2006 by the NPIA for a pilot phase of the technology, enabling the force to establish a formal project

and by the then Prime Minister, who in 2007 announced funding for mobile technology (part of £80 million to rollout 10,000 devices to 30,000 officers) in the UK.

The change was supported by high-ranking representatives within the police force who agreed with the vision of using the technology to overcome the contradiction of police officers returning to the police station. That is, the change was aligned with management objectives. Therefore, within the subject (in Figure 2) there was congruency in developing and implementing functional mobile technology. Management support was described as instrumental in persuading the various actors during the implementation activity that the investment was worthwhile. The legitimisation process was important in the context of the public sector, where misused and wasted funding is viewed critically. From the stage of early design or conception the technology needed to be legitimised in order for the police force to progress at minimum to the position of testing.

The legitimisation process involved negotiating for initial funding within the police force. Each progression of the technology was used to legitimise the technology and obtain funding for further development. For instance, after demonstrating that PNC functioned (the ability to check the identity of an individual/vehicle), internal funding was sourced to develop the technology further with more sophisticated applications and information services (e.g. crime reporting). In addition to high-level support the perceptions and sense making of the police officers was understood to be important by management, and was illustrated by the number of pilots, surveys, training sessions, and various avenues for feedback and bonuses for competence. The level of congruency in the development and implementation of the technology helps to explain the level of congruency in the use of the technology described next.

Mobile technology mediated activity

Disruption to work practice

The interviews revealed several pertinent contradictions and congruencies between the mobile technology and police activity. Experienced officers initially interpreted the technology as disrupting their established work norms and patterns, as did those who were less competent with new technologies (a tension between the subject and tool), although this was not always the case. Instances were observed where officers would often leave the vehicle without the mobile device, before quickly realising that they needed it and returned to the vehicle to retrieve it. Ultimately, however given the hierarchical nature of police (a bottom-heavy hierarchy), officers had little choice but to adopt the technology (creating an institutional norm). In order to oblige use of the technology, management removed paper notepads as an operational

tool from the front-line officers. It was observed that as a result of this, on some occasions officers would write notes on the back of their hands as it was quicker than using the mobile device. Therefore, there were several ways in which the technology led to disruption and contradictions, however as we will note below these were short-lived. An important distinction to make is that the mobile device also acts as a method for officer oversight and management as every transaction between the officer and the public or the officer and police IS is recorded.

Functional issue example

There were several ways in which functional contradictions in the use of the mobile technology disrupted work activity and acted as feedback into developing a more effective system. A serious functional issue for police officers (the users) surrounded the limitations of the technology during a pilot, which showed that police officers became frustrated with the mobile technology in areas where there was poor telecommunications signal:

> *"Our first trial, one of the biggest complaints we had from the officers was that they were using mobile data and they were starting to accrue crime report and then half way through it they would lose the signal and then they would lose all the information they had started…we had to find some software whereby what it allows you to write all the information...and once it found the signal it would automatically update all the information..."* (Project team staff; interview)

In this example, management understood that the technology would not be used if it did not meet the work demands of the officers. Furthermore, they understood that it needed to work every time:

> *"If it doesn't work, the first thing a police officer will do is put it down and walk away from it because they lose confidence in it"* (Head of IT; interview)

This is important because while users may not have had the choice to adopt the technology, they nonetheless played some direct and overt role in how it was improved according to their work behaviour, leading to general acceptance. The functional contradiction was resolved technically, and while simple in its solution, led to more harmonious use of the technology. In other words, the contradiction between the tool (mobile technology) and the subject (user) fed back into the technology resulting in a congruency between the two – a better functioning mobile device which fit with the mobile work expectations and work behaviours of the users by allowing them to work seamlessly and not dependent on wireless connectivity (similar to using the traditional paper and pen approach). Other studies have found that in the public safety context connection reliability is more important than data download speed (Sawyer et al., 2004).

Congruencies in work activity

After the initial period of adoption, we observed that police officers, including technophobes, on the whole, viewing the technology positively and described several early benefits. These were largely broad brushed benefits such as "*checking (work) email*" and other ways in which the mobile technology could be used. There was however also clearly articulated ways where there were levels of congruence emerging between the technology and the police activity, which are suggestive of benefit areas:

Efficiency in data entry: The use of mobile technology reduced bureaucracy, paper and especially duplication of data. For instance, there was no need to capture information on a paper-notepad and then re-enter it once at the police station, leading to changes in the activity rules/norms and tools. In one example technical support staff explained changes in norms surrounding the case of domestic abuse, where police officers previously would return to the police station and update the system then key in the same data on a public protection system. Whereas, on the mobile device officers simply entered the data once, which could be done on the street or in the police vehicle, illustrating how the tool had changed the rules/norms and the labour surrounding it.

Improving communications: The use of the mobile devices to access information reduced the radio traffic-load between the control-room and officers, which meant that police officers were able to reach the control-room quicker when necessary, especially during peak times. It was explained that previously to reach the control-room during peak times could take up-to 15 minutes to do a person check, as opposed to seconds on a mobile device. This meant that prior to the mobile technology in some instances police officers went without information, whereas mobile technology facilitated faster access to information in some situations. The direct access to information also reduced the effect of "Chinese whispers" between dispatchers and officers, which often led to incorrect locations/addresses being visited in error.

This is an interesting congruency as it shows how congruency in one activity system (front-line police) can have significant impact on other related activities (control-room dispatch and call answering), demonstrating how activities are interwoven.

Efficient policing: Police officers were found to perform up to ten times more person checks increasing the chance of arrests and spending anecdotally between 10 and 20 percent more time on the beat, as reported by some respondents. This works towards resolving the cultural-historical contradiction and is in line with the initial motivation for the mobile technology. This is an example of how the tool changed the relationship between the subject (police officer) and the object (individual) and evolved the rules and norms surrounding the activity. Even in the context of the office environment it was commented that there

were rarely enough computers to update systems and therefore often police officers would use the mobile technology to update systems in whilst at the police station.

Officer safety: The information made available through mobile technology offered a safer working environment to front-line police officers. For instance, a police officer could pull information *en-route* to an incident informing him/her of 'warning markers' such as individuals at the location that are known to be aggressive. For instance, an individual had a warning marker next to his name which could be viewed on the mobile technology indicating that he had once commented to a dispatcher "*if you send cops you better send an army*" meaning that the police officers could take extra precaution. During observations it was observed that one of the double-crewed team (the passenger) could pull information about an incident on the device while verbally communicating the information to the driver. At the same time, a contradiction raised was that the mobile device created new concerns around police officer safety. It was argued by some police officers that the use of a mobile device can put them in danger by changing their working norms i.e. looking down at the device rather than up at a person or monitoring the surrounding environment, particularly when working single-crewed. In other words, in this case it led to emergent and unexpected contradictions in the form of mal-adaptive behaviours.

Engaging citizens with mobile technology

One of the important realisations in the implementation of the mobile technology was the role of citizens in accepting/rejecting the technology. It merits mentioning that this type of technology was implemented before the common use of smartphones. Some police officers explained that they were initially uncomfortable using the device in view of citizens as they were unfamiliar with its use and commonly received remarks such as *"did you miss the training session on this one?"* or encountered the perception that they were playing a "*gameboy"* from members of the public. While this often caused tension between police officers and the citizen, it was overcome as officers became more confident and its use became less obtrusive and seamless and people in general became more familiar with the technology. This can be described as a weak-temporal contradiction, which was based on the expectations of the citizens to be efficient in their work and competent with technology. In the latter stages of the roll-out, where police officers had become mature users, members of the public displayed what was described and observed as a *blasé* sentiment towards the use of mobile technology. During one incident, where the mobile device was used to record a crime, a police constable commented "*(the citizen) wouldn't have noticed if I was writing on the back of a cigarette packet"* (Police officer; observation). Police officers also explained that citizens indicated that they expected police officers to be using the latest available technology and appreciated that the technology would allow officers to be more efficient, offering tacit approval. Some individuals, on the other hand, tended to view the technology as obtrusive, as it limited their scope to escape identification or

evade potential arrest as all the information immediately accessible and verifiable. It was observed that individuals trying to evade identification had less scope to do so when confronted with an officer using the technology, particularly those with outstanding warrants. It is possible that they were concerned about privacy issues or were uncertain how information may be used against them; this was not explored.

Discussion

We examined the ways in which congruencies and contradictions materialised in the emergence, implementation and use of mobile technology. In addressing the research questions we showed that the mobile technology was implemented in order to overcome the major contradiction of police officers returning to the police station. The emergence, implementation and use of mobile technology to resolve this contradiction was a relatively diffused and scattered process of contradiction resolution, cumulating in the development of a tool (mobile technology) for use in front-line police activity in order to improve the amount of time officers are on the beat.

The number of congruencies suggests a "fit" and better understanding of the relationship between mobility, mobile technology solutions and police activity. Congruencies in the use of the technology were varied and included several levels of suggested improved operational efficiencies in the nature of police work. However, the argument isn't that the number of congruencies outweighs the contradictions, but rather that congruencies show resolution of contradictions and the dialectical interaction between the congruencies-contradictions is important in explaining the evolution in the activity and the tools used to mediate the activity. We observed this in our study, through the process of contradiction recognition, to resolution of the contradiction through to experiencing intended and unintended congruencies and new contradictions (feedback). Further, actively addressing and resolving contradictions in the implementation activity suggests greater congruencies in the use of the tool during the work activity.

Several functional, use and subject-community contradictions were also identified in the analysis. Some of the contradictions recognized, such as the early perceptions of the public towards the technology, were organically overcome, as socio-cultural perceptions and norms around mobile technology evolved. Only a few years later there is perhaps even greater expectation amongst the public that police adopt more advanced use of mobile computing. There was clear evidence of new contradictions. For instance, the use/non-use of the technology in certain situations because of safety concerns is not resolved, and unlikely to be so through this iteration of technology. The non-use of the technology in certain problematic scenarios is an example of Orlikowski's (2005) "situated entanglement" or Sørensen and Pica's (2005) "rhythms" of use and non-use of technology. Further contradictions are likely to arise as the individual police officer's personal device is likely to be more intuitive, easier to use and powerful than the work device described in this paper. The resolution of this is likely to see more advanced types of

mobile technology being developed and employed in this context. However, this points to possible future issues as the level of (re)investment into the technology needs to be sustained in order to maintain currency. At present government assessments argue that there are unresolved issues surrounding the cost-effectiveness of mobile solutions (NAO, 2012), suggesting the process of contradiction-congruency continues. At the same time this also shows a pattern in technology adoption, in which changes in the activity tools do not lead to permanent stabilisation or some end point of efficiency and effectiveness, but rather leads to new ways of mediating an activity and new contradictions (and hence need for change often enabled by advances in technology).

This paper extends theory in several ways. It builds upon the extant use of activity theory to examine the process of development to institutionalisation of IS (Miettinen, 1999) and on the notion of congruency of technology with organisational activity, and is the first to do so in the context of police activity and mobile technology. An understated strength of activity theory is that it provides a lens to understand the context and emergence of technology in a particular setting and allows researchers to consider the cultural-historical influences, providing critical reflection on its emergence and use, rather than a narrow focus on the effects of technology. Such lenses are necessary when dealing with the messiness that is embodied in the change involving the mobile technology described. As argued, bringing technology and actors into one coherent framework overcomes the concern raised by some scholars (Orlikowski, 2005) of the absence of the role of technology in organizational life, or emphasizing the social over the material, or indeed, privileging the technology over its cultural-historical context in which it is being used.

By examining the three interrelated activities we see dialectically how contradictions were resolved and congruency formed. Through the examination of the three activities we have created a different narrative of mobile technology change compared to other scholars who have examined the dialectics of large scale systems implementation (Lyytinen & Newman, 2008; Reimers et al., 2013; Robey et al., 2002). As noted, the lens of congruency-contradiction is useful in understanding the emergence and use of mobile technology in the police, showing how mobile technology can support change of activity, and provides a more complex narrative of the emergence and use of mobile technology in the police. Such a logic of opposition, as noted by Robey and Bourdeau (1999), offers an alternative and unexpected account of the ways in which technology introduces and overcomes contradictions. The blending of contradictions-congruencies gives practical examples of the logic of opposition, as well as the internal dynamics within an activity. It goes further, in that, it suggests the resolution of contradictions is not straight-forward and that technology is likely to introduce new contradictions.

Contradictions act as a source of tension and change leading to a more advanced form of the activity (Engeström, 2001), similar to the notion of feedback in systems thinking (Levins, 1998). Manning (1996) refers to a similar notion. Using a dramaturgic framework he suggests that following the introduction of a

technology a period follows characterised by negotiations over meanings among relevant parties and foreshadows potential changes in power relations "*In due course, a reconstitution or redefinition of technology occurs and a new integration of work and authority, now embedding the technology, follows*" (Manning, 1996, p. 54). Our argument, builds on this by suggesting that the new technology will lead to temporary congruency and further contradictions. This also overlaps, with Vaast and Walsham's (2005) notion of consonance and dissonance, which focused on specifics of how practices change at the micro level of inter-individual relation. When agents experience dissonance between actions, practices and representations they adapt their practices and representations to re-establish consonance.

Complex activities have an increasing number of contradictions causing events to be the cause of more events, thus generating snowballs and arbitrary and unpredictable and positive as well as mal-adaptive changes. This is likely to be true as the digital-information ecology grows, enabled by wireless broadband, growing familiarity with technology and unexpected challenges such as the ability to harness information from social-media and use it to interact with citizens in real-time on the beat, combining to afford a type of real-time intelligence. Recent research points to the convergence of wireless, social, cloud and mobile technology and paints a picture of evolving expectations and use of mobile technology in the police (cf. AIMTech Consulting., 2013).

The study also extends important works on mobile technology in the police, which are relevant to the evolving nature of mobile work. In the 1990's Manning (1996) outlined several ways in which mobile technology could lead to organisational transformation based on largely voice communication; our study builds on this by providing a more progressive prospective, demonstrating the evolution of data services (rather than voice) and how it has transformed the policing activity Over time, both studies show that the mobile artifact occupies central position, displacing other material objects in the work environment. Alongside technological changes more importantly the cultural-historical context has evolved with growing expectations by the public and police officers on the use of the latest mobile technology to be used for public safety.

Limitations

There are several limitations to this research. While our investigation lasted over one year and examined the cultural-historical emergence of the mobile technology, it is inherently time bound. Therefore, congruencies may in-fact transform and other contradictions are likely to arise due to internal or external pressures. In addition, contradictions are not straightforward notions (Peim, 2009) and in the context of the politicised entity such as the police may be difficult surface and may not be acknowledged. Another important point is that an over emphasis on contradictions neglects other reasons for change.

Further, it was beyond the scope of our research to examine extra-organisational contextual influences (Scheepers et al., 2006). For instance, the role of mobile technology in the police officers' personal life may have been more sophisticated than in the work activity, meaning that the congruency with work activity may in fact be driven by congruency with the use of the technology in their personal context. This presents an interesting direction for future research, and one that is important when considering mobile technology which has blurred the boundaries between work and non-work (Scheepers et al., 2006).

Conclusion

In this paper we focused on the emergence, implementation and use of mobile technology in an inherently mobile and information intensive work activity. We explicated upon two key sets of contributions. The methodological contribution lies in the utilization of activity theory to understand the phenomena of mobile technology. Activity theory allowed us to illuminate congruencies and contradictions between mobile technology and mobile working, and the relationship between the two revealing a state of change based upon dialectic interaction between emergent contradictions and congruencies.

The identification of contradictions and congruencies in the context of an activity may not satisfy directly policy-maker needs for monetised outputs in today's economic climate. However, it does present individual concrete areas which can be investigated further. While some of the areas identified lend themselves to monetisation (e.g. safety, in terms of reduced injuries), others remain difficult to monetise (e.g. improved visibility from the citizen perspective, efficiency). It also forces recognition that the introduction of mobile solutions is not the resolution, and that, in fact, it is likely to initiate subsequent disruption and change. In this way, the approach employed cautions against overstated early and often "rosy" benefits of technology. Nonetheless, the findings and discussion in this paper add to the body of knowledge concerning the nature of mobile technology mediated work.

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