DEPLOYMENT AND USE OF MOBILE INFORMATION SYSTEMS
A case study of police work

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Abstract: The paper presents the results of the investigation of the implementation of mobile technologies in an under researched area: the police. Five key themes of investigation with relation to mobile information and communications technologies were identified in the research: changes in work procedures, changes in the organisational capability, changes in relationships, effectiveness of equipment and effectiveness of infrastructure. These themes provide a framework for analysis of the police context, and one which could perhaps be extended to other contexts in the public safety / service arena.

Keywords: Implementation of mobile technology, case study

1.   INTRODUCTION

This paper reports the initial impacts of the introduction of mobile information and communications technologies into a UK Police force. The paper aims to describe the officers' reactions and to develop a first stage model of the areas of attention in the process of introducing such technologies. Despite the growth in use of mobile information and communications technologies (MICT), the huge potential opportunities they offer and the challenges that they pose, there has been an emphasis in the literature to date on the stationary applications of computing (Kristofferson and Ljungberg, 1999a; Weilenmann, 2001). This relative neglect of the mobile technologies is not, however, unrecognised and Weilenmann comments that this lack of research into MICT is not the only gap and notes that other existing technologies for mobile working, such as the VHF radio and its use by organisations, are poorly researched. Whilst the lack has been

addressed to some extent by recent work such as that of Nulden (2003) and Pica et al (2004) which have looked at the specific police context and that of Sawyer and Tapia (2003) which has looked at the public safety context more broadly there is still a recognition within this work, and in parallel work such as Vaast and Walsham (2005) that we actually know relatively little about the changes in work practice which result from the introduction of information and communication technologies into work settings. Vaast and Walsham comment that we can posit confidently that there is an effect from the introduction of ICT into work settings but that we have little understanding of exactly how work practices change with ICT use and how the interrelationship of technological artefact and technology-in-use develop. Indeed, while mobile environments are becoming more common writers such as Pica et al (2004), Yoo and Lyytinen(2003), Bellotti and Bly (1996),and Kristofferson and Ljungberg (1999 b) have identified that such environments are qualitatively different from fixed computing and that they both pose new variants of old problems and raise new problems for those seeking to make best use of the technologies. Yoo and Lyytinen, for example, comment that mobile systems are unlikely to prove any easier to calculate returns from than fixed systems and suggest that as a result of their distributed nature and 'multiple levels in multiple contexts' they may well prove to more intractable than more traditional systems when it comes to showing a positive return on investment. Weilenmann (2003) and Green (2002) suggest that mobile information and communications technologies (MICT) can lead to a potentially detrimental blurring of boundaries between work and other activities and Kristofferson (1999 c) comments that current platforms 'do not realise the full potential of mobile computing as mobile work and IT use differ significantly from other settings' This concern is reflected in the finding that the use of the technology is currently mainly a white collar phenomenon (Brodie and Perry, 2001) and, on a linked point Nishibe and Waki (1998), dealing with MICT support for academic conferences, note that the majority of applications are small scale. They report on a range of contexts of use but note that the challenge may not be to get small scale trials to work, but to scale this up to commercially useful levels.

This research project focused on the use and deployment of MICTs in the particular context of policing in the UK. The UK Government has recently invested over four billion pounds in a mobile communications network for UK police forces. The continuing cost of this infrastructure is in excess of 200 million pounds per year of central government funds and an unspecified amount of money at local police force level. This network provides voice and limited data communication capability. In addition to this activity many local forces are heavily investing in other mobile information and communication technologies in an attempt to provide further functionality.

Despite the significant changes anticipated by the development of this technology, there has been little academic interest in this area. This paper analyses one of the earliest and largest deployments of mobile information and communication technologies within the policing environment. Until relatively recently only a few articles explicitly mentioned the application of such technologies to policing. Colton (1979) for example identifies the potential of ICT for policing and Nunn (2001) noted that Police forces tend to be major users of ICT and posited that the reasons for this are the normal business drivers of improving efficiency and effectiveness, commenting, 'At the simplest level IT is added in order to improve things'. This lack of research is despite the fact that police officers in most developed countries operate in an information rich environment (Nulden, 2000). They have access to sophisticated databases (Hauck and Chen, 2002) and the facility to call on colleagues via email, mobile phones, radio contact and in personal meetings. Recently there has been an upsurge of interest in the area of public safety as a whole (Sawyer and Tapia (2003 for example) and in the police specifically. Pica et al (2004) outlined the differences in police roles and the issues of passive vs. active and structured vs. unstructured information use in police work. Nulden (2003) has addressed the difference between police and policing and has suggested a framework to determine whether mobile technologies provide advantage for officers. A common theme in all of this work is a recognition that the devices themselves are not the focus of analysis – it is the use of the devices in context which is both more valuable and more complex. This has been neatly summed up by Sorensen (2003) who commented that technology use is about more than technology and clearly stated the need to 'take account of the actualities of human interaction' In evaluating the effectiveness of the ICT investment Yoo and Lyytinen (2003) highlight the problems of measuring impact in ubiquitous computing environments and Nunn (2001) suggests that 'the jury is still very much out' on the value of ICT. He identifies specifically that the cost associated with ICT can mean that there are fewer officers to deliver on the ground services and higher average costs for technical personnel. This may well be seen to conflict with current UK political commitments to high visibility policing with 'more officers on the beat'.

The rest of this paper is in four sections, the next section of this paper briefly discusses the nature of mobile work and mobility. This is followed by a section briefly describing the research methodology and methods. The findings from the research are presented in the next section and the final section provides some conclusions and areas for future consideration.

2.   THE NATURE OF MOBILITY

In discussing mobile work and the technology available to support it there tends to be an assumption that we know what is meant by 'mobility'. Where attention has been paid to this issue it has tended to concentrate on geographic mobility to the exclusion of other areas. An embryonic literature is, however, emerging which has started to examine the nature of mobility and the impacts on the way we work more broadly. The following review of the literature identifies and briefly reviews three core areas. The first reviews the core analytical frameworks that have been put forward as analytical frameworks for understanding mobility. The second group of literatures relates to the use of mobile technologies within the context of the workplace. The third literature relates to the organisational benefits that are related to the deployment of the mobile information and communication technologies within the workplace.

Kakihara and Sorensen (2001, 2002a, 2002b, 2002c) Green (2002) and Kristofferson and Ljungberg (1996), in particular, have started to extend the notion of mobility. Kakihara and Sorensen have written extensively on the nature of mobility and argue that we need to examine more than the location where people transact work if we are to get a true picture of the nature of the work and the impact and utility of technology in that situation. Kakihara and Sorensen (2001, 2002 a) presented an initial framework which has been extended by their later work in a number of areas. They argue that people can be mobile in different senses. The first is geographic or spatial mobility which is much discussed in the literature but only really in terms of the movement of people. Kakihara and Sorensen (2001) argue that this is a restricted view and that we need to look at a number of additional facets of this physical movement of people including, the mobility of objects, symbols and space as a result of symbolic travel on the Web. The second facet of mobility is temporal and it has been argued that the availability of mobile technologies has altered the nature of temporal constraints on work. At the crudest level a mobile telephone allows you to call a colleague on the other side of the world and leave a message for them in the middle of their night and your day. On a slightly more complex level they also argue that this is in some senses a commodification of time and lead in to a discussion of monochronicity and polychronicity; polychronicity being the divergent use of time rather than adherence to a pre planned order – monochronicity - and they note that MICT can increase both. This apparently contradictory position is reconcilable; MICT promotes polychronicity in that it can allow us to work on a number of tasks at the same time or outside of the normal time frame within which we would deal with them, such as taking a work call during a social event; it also allows us to summon up information or resources to allow us to continue with a task which, without MICT, would

have had to be shelved until we returned to the office, or a fixed terminal. This notion of time flexibility and the compression of activity into shorter 'soundbites' is a facet of mobility which is also noted by Green (2002). The third facet of mobility which Kakihara and Sorensen (2001) discuss is that of contextuality. ICT allows people to be free of many contextual constraints; so, for example, it is possible to make a social call from a business context or check a stock price on a PDA at a birthday party, but it also imposes the risk that others will not be sensitive to the context that you are in when they try to interact with you (Fitzmaurice, 2000). Kakihara and Sorensen (2002 b) identify that while devices do allow some limited declaration of context to others there are dimensions of the use of MICT which can be detrimental.

In order to understand the nature of mobile interaction Kakihara and Sorensen (2001, 2002 b) suggest that it can be considered in terms of regions, networks and fluids. Regions, with fixed boundaries and a sense of enclosure are a metaphor for the pre ICT organisation, networks are a metaphor which work well for physically connected ICT and the fluid metaphor is the one they use to discuss and analyse MICT. In discussing this Kakihara and Sorensen, (2002 b) give an example of a delivery firm using a range of mobile technologies to manage a complex environment and act proactively to meet the constantly changing needs of their customers and (2002 a) of consultants working in a fluid way across a range of organisations balancing a range of tasks, locations and demands; a way of working which they characterise as 'post modern professionals'. They argue the need for an organising paradigm for mobile working and the use of technology within this mobile working environment to combat the dangers of detachment from reality and the increasing blurring of the boundaries between work and social life.

Kristofferson and Ljungberg (1996, 1999 c) identify three key modes of mobility which they argue can be used to start to understand the way in which people use mobile technologies. These three modes are 'travelling, visiting and wandering' and are illustrated with examples of the types of activities which are undertaken in these ways and the technologies which are needed to support them; so the traveller requires the ability to move information but does not need to be able to manipulate that data en route, the visitor needs to be able to gain access to information from a range of fixed locations, and the wanderer needs to be able to access the information on the move probably without fixed connections. An illustration of the wanderer is provided by Gallis (2000) in a medical context where staff cannot guarantee to be able to access fixed technology and so need to be able to make full use of the potentials of MICT.

In a more recent article Pica and Kakihara (2003) suggest that the existing concept of mobility is a somewhat impoverished one in many discussions and they suggest that concepts of a dualism of views of mobility

centred around views of stability and of fluidity separately need to be replaced by a duality 'studying both fluidity and stability in contemporary society and work organizations and understanding their mutual influences' This paper highlights the need for further investigative work producing 'rich and contextualised data' which integrates a micro (interactional) viewpoint with a macro (organizational) viewpoint. Sorensen (2003) also highlights the need for a richer definition of mobility and comments that for many professionals and knowledge workers MICT means that they have 'everywhere to go and nowhere to hide'.

 The police context is one where the officers have been mobile workers for a long time and have had the support of communication tools and management tools to allow them to undertake a role that is often reactive, highly mobile and dependent on good information for the effective and defensible performance of the role. MICT has changed the landscape of the police organisations by changing the nature of the mobility of police officers, by allowing them to relate to peers, managers and the public in different ways and by providing ways to both automate and increase the efficiency of existing processes as well as adding the ability in some areas to police their communities in ways which were previously not available to them.

3.   RESEARCH METHODOLOGY

The approach taken in this research was interpretive and qualitative. The analytical frame used was Grounded Theory. This approach has been extensively used within the Information Systems Research Community (Howcroft and Hughes, 1999). Grounded theory requires a researcher to examine the data collected and build up 'theories of process, sequence and change pertaining to organisations, positions and social interaction' (Glaser and Strauss, 1967) and is inductive, contextual and processual (Orlikowski 1993) requiring an iterative approach to the collection and analysis of data and constant comparison across evidence to control the conceptual level and scope of the analysis. A hermeneutic approach is implicit in the analysis of data collected in an interpretive paradigm and elaborated using grounded theory, it is also applied as a specific analytical technique in this research project and this was facilitated by the use of Atlas ti, which is discussed below. The hermeneutic circle is predicated on a movement 'from the whole to the part and back to the whole' (Gadamer, 1976) which is intended to 'try to make sense of the whole, and the relationship between people, the organisation and the information technology' (Myers, 1997).

Two groups of mobile users were interviewed, the first are a group of Criminal Investigation Department (CID) officers who have had laptops and

mobile Global System for Mobiles (GSM) connections giving them remote access to all network facilities on a laptop Personal Computer (PC) for about eighteen months. The second group of staff are Scene Of Crime Officers (SOCO) who have been provided with similar equipment together with the specialist software and hardware required to operate a specialist role. This specialist software package was not operational at the time of the interviews with these officers and they were only just getting used to having mobile access to the main applications discussed in the introduction. The sample provided access, therefore, to users with experience and to novice users. It also provided a coverage of two quite different roles – CID officers are often quite heavily office based and SOCOs spend much of their time out of the office in what they describe as a nomadic life moving from crime scene to crime scene; their demands of technology are also quite different – CID officers need access to office type facilities and to information sources such as databases while SOCOs need to be able to access specialist software. Fourteen interviews were conducted with individual officers. Interviews lasted 60-90 minutes. The interviews were guided by the use of a semi-structured questionnaire which was refined after each theory generating iteration.

Across this period observations were also undertaken, in the incident handling centre (IHC), in the CID offices and on site with SOCOs. Interviews were also conducted with two key senior staff – the officer managing the Mobile Technology and Knowledge Programme and the Senior Management sponsor. These observations and interviews were scene setting and were used to enable the writer to have a better understanding of the context in which officers and the technology operated.

Interview data was transcribed verbatim from the tapes made at the time of the interview. This was done using a voice recognition package to dictate the interviews into a word processor and the files were then sense-checked and compared to the original tapes for accuracy. This data was analysed using the computer programme, Atlas ti. The package makes use of the techniques and approaches of grounded theory and takes a 'hermeneutic unit' of text or graphic resources as its base. In this study all resources used were in the form of .txt files transcribed from the interviews with police officers. The process is, therefore one where the 'two analytical techniques of theoretical sampling and constant comparison … are the means by which Grounded Theory proceeds' (Hughes and Howcroft, 2000). In this study the coding process was started after the first round of interviews and built up as further interviews were conducted. In all, interviews were conducted in three rounds across a period of six weeks. Codes were iteratively built up, and quotations attached to these codes. These codes were grouped within the package and memos developed to provide the basis for areas of analysis and investigation within the text data. These codes and attached quotations were

then organised into five categories and a total of fourteen sub-categories within which to examine the use of MICT.

4.   DISCUSSION AND RESULTS

The analysis of the interviews with officers produced five main categories under which their comments on MICT could be grouped. Two of these categories – equipment and infrastructure – are in the nature of 'hygiene factors' in that a failure to ensure that they support effective use will reduce the level of use to a point where it is not useful to observe changes in the other three categories. Each of these categories has a number of sub categories associated with it and these have been used to build up an initial framework for examining the impact of MICT on officers and on the organisations within which they work. Table one below summarises the categories and sub categories derived from analysis of interview data.

Table 1: Categories and sub categories derived from analysis of interview data

Category	Sub categories
Changes to work procedures	Changes to officers ways of working Changes to boundaries and controls on working
New capabilities as a result of the adoption of MICT	Working faster or better at a level above that of incremental or evolutionary improvement Working in new or radically different ways
Relationships	With colleagues With supervisors With others With the public
Equipment	Concerns about loss or fragility of equipment Issues relating to ease of use Issues relating to connectivity
Infrastructure	Ways of working Support issues Future potential

In this section of the paper each of these categories are discussed in turn. The final part of this section briefly discusses a framework which provides a mechanism for understanding the relationships between the different categories.

4.1   Changes to Work Procedures

This category is concerned with the way in which the work is done and the ability of the users to use the technology to achieve their work goals. The analysis provided two sub-categories; changes to the officers own ways of working, and changes to boundaries and controls on working.

Within the sub category of 'changes to officers own ways of working' officers identified that the use of MICT allowed greater control over their own time, including the use of slow time (this referred to time which wasn't spent responding to an incident or dealing with a member of the public) , to complete work. Officers identified that the technology allowed them to reschedule tasks as well as not having to wait for information to be relayed via an information intermediary, as one officer commented;

'I definitely multi-task but it makes it a lot easier when you have access directly to information – you can look at your workload and work more jobs and give them a decent amount of time whereas before you would be waiting for something and then forget what you had been working on before' .

The feedback from officers in this sub category officers picked up on a strong theme in the literature (Kakihara and Sorensen, 2001, 2002a, 2002,b; Green, 2002; Lindroth et al., 2001, Edvardsson and Bergqvist, 2002, Juhlin, 2001) which identifies that the use of MICT can allow users to control and manage time in new and potentially more effective ways, and specific reference was made to the use of the technology in ways such that both monochronicity and polychronicity can be supported (Kakihara and Sorensen, 2002a) giving officers the choice of multitasking where appropriate and also allowing them to follow a job through where this is appropriate. The ability to spend more time in the operational situation was also noted as a positive benefit by many officers and reflects the findings of studies in sales forces (Krogstie, 2003; Watad and DiSanzo,2000) and in maintenance settings (Pakanen, 2001; Nielsen, 2002, Wiberg, 2002).

Officers also noted the potential to make use of the technology in the form of more efficient scheduling of their tasks; this is especially important for officers like SOCOs who can criss-cross an area visiting scenes of crime, rather than being able to plan an efficient schedule, due to lack of information. SOCOs see this as a key advantage of mobile technology and one summed this up 'so in many cases the kit allows access to better scheduling and maybe allows you to pick up something which has not come over the PR'.   Again this is a theme which recurs in the broader literature with scheduling efficiencies being identified in a number of studies (Pica et al, 2003; Juhlin 2000; Jipping et al, 2001)

MICT was seen as a complement to existing communication channels rather than a replacement for them. This provides officers with the chance to take transactions off the air and onto the mobile technology, freeing up

airtime and also allowing them to be more thorough. One officer said 'for us I think it's going to be that the information is going to be there quicker and we can do more delving than we would dare to do over the radio'. All of the officers who commented on this issue saw this as being a positive development. The use of the equipment to take communication off existing communication channels also reflects an identifiable theme in the literature (Kakihara and Sorensen, 2001; Abowd and Mynatt, 1997).

MICT was also seen as being a key way to access decision support materials, allowing officers to make better decisions without having to make reference to printed materials or to colleagues. This was seen as a way to be more certain in dealings with unfamiliar situations and one patrol officer commented;

> *'normally we would just crash ahead and do things – or hold off and think that we would come back in here [the police station] and look them up. Perhaps we could just go ahead and do them on the street without having to lug a couple of big fat books around.'*

Other effects identified included the issue of reduction of equipment, analogous to the 'reduction of the backpack' identified by users in educational settings (Soloway et al., 1999). This was reinforced by other officers who commented that they took a bulk of material with them on patrols (of which they used very little on an average patrol) which could be reduced by placing reference materials onto mobile technology. The comment was made by officers, with some force, that the equipment is useful only when it provides business benefit and Nulden (2003) identified resistance to the use of MICT in a police setting as the device per se was not seen to be advantageous to the officers concerned – in addition he suggested a framework of functionality, properties, modalities of use and mandate for examining the use of the technology-in-use. In addition, one potential for the future identified here was that the mobile technology could eventually replace the pocketbook, an illustration of the potential of such a replacement is the use, identified by five officers, of MICT to allow officers to update CIS files with intelligence updates at the time that the information comes to the attention of the officer rather than having to wait until the officer has access to a shared terminal at the police station. This is linked to the ability of the technology to update information from the field which is a theme in the literature (Guerlain et al., 1999; Watad and DiSanzo, 2000).

The risk of losing the nuances of personal communication has been identified at a macro level (Green, 2002) and at a micro level (Luff and Heath, 1998) and Green (2002) also notes the issue of resentment at being 'kept tabs on' remotely as does Weilenmann (2001). The 'blurring of the boundaries between social and work life' noted by Green is also reflected by

the officers in these interviews and this is an issue discussed extensively by Kakihara and Sorensen (2001, 2002b, 2002c).

In the sub category of ' changes to boundaries and controls on working' the main issue was the existence of comprehensive log files allowing the use of MICT to be audited. Officers perceived that this provided them with reassurance that there are external logs to confirm the probity and accuracy of their actions. Others, however, were concerned that the existence of such files would be used in order to observe productivity and working patterns and some police officers interviewed expressed the concern that the technology could be used as a 'big brother' form of control of officers working time. This concern was vague in content but attracted comment from a number of officers, one of whom said '[I] would be concerned that we were being looked at or monitored, and I think that is bound to happen, but I wonder in what form it will be and what exactly they will be looking at?'.

There were also areas which were raised by the officers which are either ephemerally reflected in the literature or are not reflected at all. Most of these issues could be regarded as police-specific. There was a strongly expressed concern that the nature of the technology could expose officers to a range of risks to health and safety – this is not an area dealt with to any extent in the literature beyond the issues related to the problems of using small interfaces to get information into and out of mobile devices and yet was of major concern to officers in the operational situation who identified the problems of portability (or lack of it with laptops), inattention or distraction and the failure to call in location endangering officer safety. Officers also noted the dangers of using the devices in quicktime (response incidents as discussed above) incidents when attention needs to be paid to the unfolding events rather than the information, which would be more appropriately handled by information intermediaries.

4.2 Changes in Capability

This category is concerned with the speed, thoroughness and accuracy of work done by officers. In the analysis two main sub-categories emerged within the overall category. The first is concerned with the extent to which work would be affected by being able to do things faster or better than they are done without the use of MICT – to the extent that they add a significant new capability to the manner in which an officer can work. An example could be the use of MICT to check a selection of car registrations at 2.00 am on Sunday morning, something which would not be possible over the radio at that time of the night. The second is concerned with the extent to which MICT could enable new or different work practices to those currently in place and an example in this area could be the ability of the mobile

application of the Home Office Large Major Enquiry System (HOLMES 2) to integrate information into a database at the point of entry rather than having to wait for up to two weeks for this information to be dealt with in the current 'normal course of events'

With regard to being able to do the job 'faster or better' officers identified a number of strengths / potential strengths. Overwhelmingly officers felt that the availability of information via MICT would allow them to do their jobs better. This positive attitude was based on the expectation that the MICT facility would provide them with access to data faster and this is reflected in studies by Lindgren and Wiberg (2000), Lindroth, (2000) and Nielsen (2001). Timeliness is an issue of importance to the policing context and this is discussed both by Nielsen (2001) and by Guerlain et al. (1999) who identify the role of MICT in placing information where it is needed, when it is needed and in the form that it is needed.

Almost all the comments made about quality of information supported the view that mobile technology would mean that there was more use of information and that officers could be more thorough in the performance of their duties. This was primarily due to the availability of more information – and this was seen in part as a function of being able to do more checks than would be the case when working via the IHC. As one officer commented there is a value judgement to be made as to whether it is 'worth' doing a check and this value judgement is different depending on the demands on the IHC at the time; this officer said that 'there are a lot of people who we stop who we know will probably come back alright, so we don't bother to do the check. With this we could take a minute and so we would just do it.' Another officer felt that the technology (a laptop in this case) 'allows us to do more checks before we walk in the door, and that increases the chances of having insights to share with other people'. Many positive comments were concerned with increasing the speed with which information could be supplied to officers in the field, although one officer noted that there was a potential for overload in the availability of information 'I can do more and faster; so in some respects it is wearing me out because I'm actually doing a massive amount more'. Officers also noted that MICT should speed up information supplied via the radio systems as a result of the reduction in airtime congestion. At present the 'airtime does get really busy at times' so transferring information requests to MICT would allow those officers needing to use broadcast systems to be able to do so with less delay and this freeing of the radio for urgent jobs was a specific strength noted by seven officers. In conjunction with this increase in speed was a suggestion, by over three quarters of officers interviewed, that the accuracy of information received would be higher over MICT than via the IHC. This was expected to be a result of officers entering data queries themselves rather than via

information intermediaries who may mishear or misspell a name or reference and chasing things further. A typical comment was that;

> *' If you have used CIS you know there are ways of searching and the search engines on the system; you know you can search in so many ways but if you go via control they are just too busy and they often come back with "No results here." And you do your checks yourself when you get back and you think "Christ, this has come up, that has come up"- and that would have affected the way you dealt with the job.'*

It was also recognized by officers that the IHC staff would welcome the reduction in traffic, allowing them to concentrate on dealing with major or 'quicktime' incidents and this was an aspect of general ' reducing the call on others' which officers saw as a strength of MICT. The use of the equipment to take communication off existing communication channels has already been noted above (Kakihara and Sorensen, 2001; Abowd and Mynatt, 1997).

The quality of information retrieved was also seen as being likely to improve and this is an issue highlighted in the literature by Wiberg (2000) although it has not been investigated in any depth. In the case of the police context the increase in accuracy was expected to come from the ability of the officers on the ground to delve further using MICT than they would using the current PR systems and from the fact that they were inputting information and removing a link from the current supply chain for information and, with this link removing a source of error (poor sound quality, mis-spelling and lack of time to deal with queries being cited). Officers perceived the technology as making them more independent and this is again, a theme which has been identified in the literature to date in studies such as those by Juhlin and Normark (2000), Laurier and Philo (1998) and Watad and DiSanzo (2000) although fears were also expressed that this could lead to isolation as identified by Pakanen (2001).

The ability to access forms and documents remotely was identified as a strength by many officers, especially when taken with the ability to use slow time. One officer commented 'you can just park up, especially on nights when it is a bit quiet, and bang it out [routine paperwork] and it is done'. The use of efficiency enhancing applications, and specifically spreadsheets, was mentioned in comments from five officers as being a strength of MICT. One officer commented that the efficiency gains meant that she would tackle jobs which would not have been attempted before and she depended heavily on the facility, saying 'I use the spreadsheet for everything and it is fantastic for that – so, whereas in the old days I would have had to write up 800 exhibits onto a witness statement now I just copy and paste off the sheet and it is done.'. A potentially important issue was also raised under this sub-

category with regard to the general quality of presentation of work with officers commenting that the use of IT allowed them to present work more professionally and improved the access to information, one officer noted that this was linked to facility with keyboards more generally 'their [new entrants] typing skills are phenomenal...so whereas before you would get a handover package and it was scribbled and you couldn't read it, if you get a tight and clear, legible document that sets out everything you need'.

There were, however, also some significant concerns relating to this sub-category of changes in capability. Concerns with relation to speed were expressed by officers interviewed in three main areas. The first was that officers would not update information at the time when the information came to their notice but might rely on imperfect recollection to update intelligence files at a later stage; a typical comment from an officer was that 'we might have an awful lot of knowledge in our head, but we are thinking about the next job and we just want to move on and do it. And that could come back to bite us later if something goes wrong for any reason whatsoever'. The second issue, although a minority view, was still significant and was a concern that the availability of e-mail via MICT would be a starting point for information overload for the officers concerned. A third concern was around the potentially slow speed of supply of information using mobile browsers and wireless connection and three officers expressed fears that the connections would be too slow for meaningful work. One senior officer commented on this topic that 'I currently use my mobile with my laptop for mobile data, but the bandwidth is so small that apart from very quickly looking at ICAD it is hardly worth using at all'. Officers also noted that the ability of the technology is currently limited by the lack of pervasive connections allowing databases and information to move seamlessly across networks and devices, and this is an area that officers saw as being aspirational for the use of MICT. The literature on pervasive (Fails and Olsen, 2002) or 'everyday' computing (Abowd and Mynatt, 2000) identifies this but offers no immediate solutions.

A final concern is that there will be a level of loss of incidental knowledge as a result of the transfer to a more personal information environment. Currently much police information is either available to all as a result of being on the force networks or is explicitly given to all members of a team in a briefing or by virtue of coming over the voice radio system. Officers have a clear idea of what their team are doing and this situational awareness is cited as a strength of the current systems by some officers. MICT allows information to be sent to an individual officer in accordance with their role or their availability and so a lot of information which was formerly public as it was passed to the individual(s) for who it was meant, will now go directly to them. This area was not a concern for all officers but was one of the expressed fears that the police put forward at the start of the

study and is reflected in the literature by Wiberg (2000). A significant minority of officers interviewed also raised the issue that their skills in inputting information to MICT were such that the accuracy of the information retrieved could be compromised as a result of their lack of IT skills.

4.3   Relationships

This category is concerned with the impact that the use of MICT will or may have on the relationships which officers have as a part of their working lives. The category attracted significant comment and most of these comments were positive about the use of MICT, identifying strengths or potential strengths and, where there are concerns about weaknesses or potential weaknesses, they tended to be expressed less forcefully than in other categories with only a few codes showing solely concerns. In the analysis three key sub-categories emerged; these were, (1) relationships with colleagues, (2) relationships with supervisors, and (3) relationships with others.

Taking the sub-category of relationship with colleagues first, it was noted that IT and MICT in particular has the potential to make people more independent, able to do the job 'without relying on someone else in another room' as one officer put it. The ability of users to act more independently with greater control of time and their manner of working is one which is reflected in a number of studies including Wiberg (2000) and Watad and DiSanzo (2000). It was also noted that this is not far from making someone more isolated. The analysis revealed that there were a significant number of comments praising potential independence and an equal number expressing fears of potential isolation. There were also areas of weakness or potential weakness which have been identified in the literature and which were also of concern to the officers interviewed. One of the main issues was the potential isolation which some officers could experience. Many officers, especially SOCOs and Community officers work independently and there was an expressed fear that their 'road warrior' lifestyle would be made even more lonely by the use of MICT. This risk of isolation has also been identified by a number of writers in a range of settings (Krogstie, 2003; Weilenmann, 2003; Green, 2002; Wiberg, 2000). One of the issues which had been identified at the initial stage of investigation was that potentially the use of MICT could reduce camaraderie and team ethos. This does not seem to be a concern at a significant level for the officers interviewed and all of the fourteen comments on this code said that they did not foresee this as a problem, a typical comment being ' in the office we will still chat amongst ourselves and there is a good camaraderie. We still have briefings and we still chat'. Officers felt that camaraderie came from team activities and

briefings far more than it did from the open information environment currently in place. The use of MICT is not expected to damage team ethos and camaraderie (although this was a fear for the managers at the start of the study) and both Okoli et al. (2002) and Gaines and Shaw (1994) note that a positive effect on camaraderie has been a benefit of the use of MICT in their respective studies

All of the comments dealing with the topic noted that the ability to reduce their call on others for information could significantly improve their working relationship with those others, and this has been noted under other categories above. Generally officers have a positive view both of MICT and of the effect they believe it will have on their relationship with their peers, although some noted that there was a danger of being perceived as a 'nerd' either by colleagues or by the public (akin to the perception of the equipment as a Gadget – Lindroth et al. (2000)).

As far as the relationship with supervisors is concerned most officers felt that the introduction of MICT was unlikely to change their relationship with supervisors and only about a few of the comments on this topic expressed fears about the role of the supervisor. This had been a concern expressed by management at the initial stage of discussions with the police force but, overwhelmingly, officers felt that a good supervisor would be aware of the needs and strengths of their team through whatever communication channels were available. As one officer commented *'A good supervisor is a good supervisor – this is just another tool. The difference is between those who understand that "supervise" is a verb and means you do something, and others who believe it is a title and things happen round you'.*

The relationship with the public was felt to be one which would benefit most from the introduction of MICT with officers overwhelmingly seeing this as something which can present a positive image to the public. This positive image is based in part on the efficiency gains, as one officer commented 'I phoned up a witness in relation to a job, phoned them up and that job was in 2000, and she was amazed. I had all the dates, all the names and what have you at the touch of a button' but also on the actual image of police officers with technology; the same officer continued 'they are quite surprised at the level of our technology and they are pleased to see we are using that. That's the feedback I get from them [public].' A comment from a recent user was that the use of the MICT 'looks good to the public – but can take away a part of the social dimension of the role in terms of helping people with crime prevention issues and being prepared to listen. Not so easy to do that with your head stuck in a computer'. The creation of a positive image has been identified by the officers interviewed and is addressed in the literature reviewed, although the publics in the academic studies to date tend to be specific audiences rather than the police officers

'Joe Public'. These include the sales staff examined by Watad and DiSanzo (2000) and Okoli's work looking at academic conferences.

4.4   Equipment

This category is concerned with the ability of the equipment issued to meet the needs of the officers using it in the situations in which they use it. The category attracted relatively low numbers of comments but these were grouped into relatively few areas. This was the only category where the concerns about weaknesses or potential weaknesses strongly outweighed the expected strengths or potential strengths. Nearly three quarters of the comments made in this area were concerned with weaknesses or potential weaknesses and only one area attracted a positive set of comments – this was, however, concerned with the future abilities of the equipment rather than current.

The major area of concern for many officers centred on the issues of fragility and loss with many comments identifying fears of damage loss or theft of equipment. This was felt by one user to be an evolutionary issue in that 'ruggedized' versions of equipment would be developed and this user noted clearly that the technology per se was fine, it is the environment which is specific and renders it too fragile 'when you look at the successful stuff, kit that worked in that [police] environment, stuff from Husky, Psion which has been ruggedized – the degree to which it has been made operator proof and environment proof is quite high'. Some of this concern was based on the cost of the equipment but most on the potential security breach if confidential information was stored on the device, although the extent to which that could be protected was realized by many officers, as one commented 'I think the protection they have on the machines that they [informant handlers] have is too good for me to worry about that [theft of the equipment and loss of information]'. It is also useful to note that a minority concern was that damage or loss could be the result of user abuse of the equipment rather than genuine theft, or accidental or loss or damage. These concerns are reflected in other studies in public service environments such as education (Valiquette, 2000; Jipping et al., 2001; Soloway et al., 1999) as well as noting the limitations on input and output from the devices as identified by numerous writers in the field (Nielsen, 2002; Adam et al., 1997; Marcus, 2002). The issues of signal coverage and connections (Varshney 1999; Satyanaryanan et al., 1996; Ebling et al., 2002) are a major concern for users in this study with current users reporting significant problems both with via dial in and via GSM cards, partly as a function of signal strength and coverage. Overall officers felt that the connection technology was not as advanced as the hardware, and was not user-friendly.

The fear was expressed that the use of MICT would result in yet more cables and wires and it was also noted that the input for handheld devices is poor ('I'm not sure I could do that [stylus use] in gloves on a dark night in February') and that even laptop devices have keyboards which are less user-friendly than a full-size desktop device. The fear was expressed that handheld technology particularly could become a gadget or status symbol issued as a result of rank or functional specialisation rather than as a tool provided to meet a genuine job need and one officer noted the predilection of the police for such items 'if you take something small, black and shiny and you give it a three letter acronym then police officers will buy it' .The literature has charted the weaknesses and potential weaknesses of the equipment used in MICT quite fully (Satyaryanan, 1996, Varshney, 1999) and officers reflected many of these concerns. Portability was addressed by all users and there was a clear division between the perception of handheld devices and laptop equipment. The laptops were perceived as 'luggable' rather than portable and many comments identified the size and weight of the laptops as being a barrier to their routine use as mobile equipment. Almost all of the comments on PDAs were positive with relation to portability with the 'pocketable' nature of the devices being stressed – although it was also recognised that they are not just pocketable by the officers concerned – raising issues of loss of data and data security more generally. It should also be noted, however, that smaller is not always better – a point made by Krogstie (2003) in an analysis of the myths surrounding MICT use where he points out that there is a drive to smaller equipment where sometimes larger devices are more appropriate.

4.5   Infrastructure

This category is concerned with the support structures which underpin the use of the technology.

A high proportion the officers interviewed or observed expressed a concern that they have either not had, or are unlikely to get, adequate training to allow them to make the most the of the potentials of the technology with which they have been supplied. Officers felt that they needed variable levels of training with some identifying that they have good existing levels of facility with PCs and with equipment generally. One user commented that 'everyone is independent and individual and they will all use different things. It is a shame that some people don't use some of the things because of they knew how to do them it would make their jobs easier and it is only when you start to use them that you start to think "Yes, this is good" '. Officers also identified that they needed ongoing support and that a mobile user required qualitatively different support from that required by a desktop user – often needing the answer to a query instantly to allow an in-

progress task to be progressed. Communities of practice are seen as a solution to this and there are also informal solutions which have built up with current users where an individual or individuals are seen as 'super-users' ('I'm the IT helpdesk in here'). Other solutions include getting advice and support from friends and family as well as, in one example, from the victim of a crime. This issue of training is also supported in the literature and was a particular issue in the Watad and DiSanzo (2000) study. Watad and DiSanzo (2000) note that the implementation he described required 'several days of general PC training and specific software training' to start with and that after this formal training users started to carry out their own informal training. This training was sourced not just from inside the company but also outside from people such as friends and relatives. Watad and DiSanzo (2000) note that this may be an issue for security, as is also identified by Badamas (1999) and Lee and Lee (2002) who comment on the inherent risks of mobility and the role of user habits. A failure to train will, according to Juhlin (2000) lead to people being 'intimidated by the technology' and this is sometimes best addressed by being able to get support from colleagues.

5.   AN INTEGRATIVE MODEL

This study has sought to examine the changes in work and working practices for police officers which have been produced as a result of the process of introduction of MICT into their working environment and routines. The study was based on a single force and did not seek to address the manner in which these changes occurred but, in the process of speaking with managers and with officers and of observing practice in this and in other forces we have started to develop an initial understanding of the process that is taking place and have included a statement of this below. This is an area where further work is needed and this paper is not in a position to address this although it is an area that the authors are keen to develop further.

In most police forces there is an initial planning stage for the introduction of mobile data – this may be a result of either top down pressure by senior managers or ICT departments or it may be a result of pressure from officers who have either seen technology deployed in other forces or have experience of the technology in other contexts and want to deploy a similar technology. Such pressure will lead the organization into some form of planning period during which they are likely to make an initial identification of business gain at a broad level, scope the technology and cost issues and then use this information to build a business case for a proof of concept or pilot. Such business cases vary dramatically from being argued and reasoned cases

based on force strategy and incorporating mapping of existing and proposed process to identify cost time and other gains through to being rough delivery plans aimed at scoping the issues involved and more at an experimentation level. From this stage forces will tend to move into a stage in which they concentrate on getting the chosen equipment and infrastructure to work – this may be done by an ICT department alone or by an ICT department working with a single supplier or a supplier consortium. At this stage forces will have identified some desired outcomes from the project – and these are usually in the form of incremental changes – improvements to existing ways of working, savings in travel or officer time and reduction in load on existing systems. This process is illustrated in Figure 1 below.
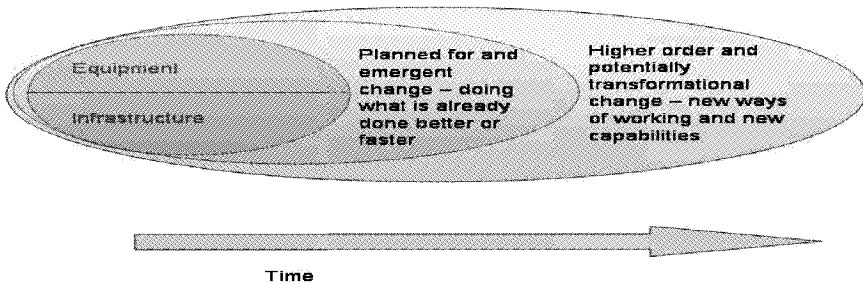

Figure 1. Stages of development and implementation of MICT in police forces

Figure 2 shows the process against a time line. This is not intended to provide a timescale but to indicate a sequence of events. The figure takes the process described above on a stage from the initial explanation above in that, as officers and other stakeholders implement their project and seek to manage the gains they have targeted and avoid the risks they have identified they may, and usually will, start to see ways in which this, or allied technologies can be used to transform the manner in which they work. This ties in with the original model proposed above to explain where effects can be seen in the work of officers and this is replicated in a similar format to figure 1 above.

As stated above, this is an initial and tentative explanation of the stages that an MICT implementation can go through in a police setting and is not fully developed. It is provided to offer some background and perspective to the main findings of the study as discussed in the paper, and to provide a basis for further discussion and research.
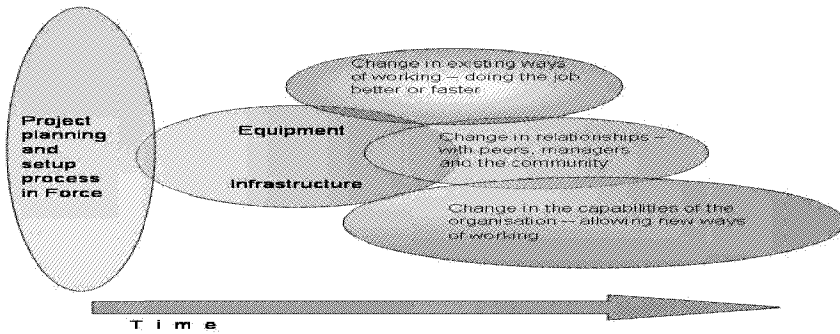
Figure 2. Areas of influence of MICT on police practice set against a broad timeline

6. CONCLUSIONS AND AREA FOR FUTURE RESEARCH

The conclusions for research are discussed below but it may be useful at this stage of the paper to signal the key areas that we feel to be of note for practitioners. The current study supports the idea that the police context can benefit from the use of MICT as others can and the study has highlighted some significant commonalities between the expectations that the police have of MICT and the effects experienced to date by the officers involved in their pilots of the technology. The police context is a major one in the UK and worldwide and the delivery of a public service of this type is a priority for this Government and others worldwide (Adderley and Musgrove, 2001). It also has parallels with other emergency services and contexts in the public and private sectors. In examining conclusions for practice there are two main areas of note and impact. The key point is that while the process of introduction of MICT into the police environment is one which has the potential to produce benefits for the officers, forces and communities involved these benefits will not be gained as a direct result of simply introducing MICT but will come from a process of introduction which will require planning and organisational adjustment as well as training and change for individual officers and teams. This is neither a simple process nor one which has any formulaic 'answer' which can be imposed. In examining the nature of this process the work done to date suggests that there are two 'hygiene factors' which need to be addressed before a

technology has any chance of being used – these are the areas of equipment and infrastructure (in the broader sense). If either of these have significant problems (poor connectivity, screens too small, input methods unsuitable, lack of training, poor technical support) then the technologies stand little chance of being used and moving into the mainstream of practice. Once these hygiene factors have been addressed there are three broad areas where the effects and impacts of the introduction of the technologies can be seen – in the relationships which users have with others, in the way that they carry out their work and in the addition of new capabilities to the way that the organisation works and the way that individual users work.

The study has highlighted a number of areas where further research may prove fruitful - ethnographic studies would help to provide fuller data on the nature of use and on the issues surrounding micro-mobility (Luff and Heath, 1998) and further real-life studies of this nature would allow the issues identified here to be extended and further explored. The matching of users to equipment and facilities is currently a quite broad process and it would be useful for further studies to examine the nature of the match between users and equipment or facilities. Luff and Heath (1998) have looked in detail at contexts and identified that there is a role for the evaluation of transactions at the level that they characterise as 'micro-mobility'. Such evaluations could lead to an examination of the factors which affect the use of the technology by individual users and the implications that this has both for the equipment provided and the manner of management of the change process generally.

Perhaps the largest single area for future work may be in the area of user involvement and the ISD methodologies which facilitate and incorporate this. The role of user involvement in the design of systems could usefully be clarified. Nandakhumar & Jones (2002) state that the 'literature on information systems almost unanimously recommends that users should be involved in the process of (IS) development', yet this does not appear to be a major feature of the design of systems using MICT according to the literature to date. This is, perhaps, part of a broader area for investigation which is the potential of information systems development methodologies to explicitly support the development of mobile information systems. The use of such systems is widely assumed to improve the quality of the systems produced; Walters, Broady and Hartley (1994) for example, comment that the use of a methodology 'helps to facilitate...the effective and efficient management of such (information) systems' but the literature identifies that relatively few organisation have such a methodology in place, and that even fewer report using it consistently; Fitzgerald (2000) notes that while many companies pay lip service to the idea of a methodology directing their development efforts close to 60% do not actually use one in the development they do. This study has shown that the police context in particular is a complex one and it may be that a broad approach such as Multiview (Avison

and Wood-Harper, 1990) or Soft Systems Methodologies (Checkland and Scholes, 1990) could support the development of more effective systems for the provision of information via MICT. User involvement is often promoted as a panacea for the development of systems which suit users and this is also suggested for MICT. However, as is always the case with user involvement this is a process which requires some care and precision and Fussell and Benimoff (1995) comment, '[we] have to involve users in the design of applications but also have to be aware that just asking' is unlikely to get all of the necessary detail''. There are also arguments that we need to get the views of non-users on the design of systems (Lindroth et al., 2000) in recognition of the fact that the use of MICT does have an impact on those around the users (Ling, 1999; Brodie and Perry, 2002).

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