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Mobile Technology and Action Teams:

Assessing BlackBerry Use in Law Enforcement Units

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ABSTRACT

This research explores the effectiveness of mobile wireless information and communication technologies (ICTs) for law enforcement teams. Pilot trials of RIM BlackBerries in two U.S. law enforcement organizations provided an opportunity to assess acceptance, use, and perceived performance benefits as well as factors influencing these outcomes. Data were collected from semi-structured interviews, user surveys, and system logs. Although the work teams and tasks were similar in the two organizations, the outcomes, while generally positive, differed markedly. Results illustrate how mobile wireless ICT can meet the unique needs of action teams and the particular importance of technical factors, functionality, and implementation processes in deploying a technology to support rapid information access, communication, and coordination. We expect that these findings will generalize beyond action teams as more mobile workers in a variety of domains adopt wireless handheld technologies.

INTRODUCTION

The research reported here explores the effectiveness of mobile wireless information and communication technologies (RIM BlackBerries) for supporting the work of action teams in law enforcement. Sundstrom [35] describes action teams as teams that conduct complex "performance events" that require specialized, collective skill. They may work with adversaries or in challenging environments; their work output tends to consist of intangible events; and they often must respond to unpredictable situations that demand quick and improvised responses. Examples of action teams include cockpit crews, firefighting teams, surgery teams, investigative units, and law enforcement teams. Action teams are similar to what Jones and Hinds [15] refer to as "extreme work teams," in that members are highly interdependent and their actions can have life-or-death consequences.[1]

There is a long tradition of research establishing that different types of work groups have diverse needs for information and communication support (see Sundstrom [35] for a review). Prior work has given considerable attention to the needs of front-line production and service units (e.g., [1], [19]), along with those of product development and R&D teams (e.g., [27], [37]) and professional and managerial groups (e.g., [6], [13], [18]). With a few exceptions, such as flight crews [3], firefighters [33] and SWAT teams [15], action teams have received comparatively little attention. Moreover, whereas there are studies of mobile technologies in a variety of domains (e.g., [11], [14], [30]), there are few such studies in work organizations (for exceptions see [2], [12], [22], [24], [36]).

New generations of mobile wireless information and communication technologies (ICTs) will facilitate the widespread deployment of collaborative media to meet the needs of action teams as well as other field-based, distributed workers. It is thus appropriate to study their current deployment in order to guide future implementation and use.

Action teams have highly distinctive information and communication needs because their work is episodic; it is often field-based, event-driven, context-dependent, and self-managed [5]. Many of these episodes require real-time information access, communication, and collaboration. Further, action teams' activities alternate between tightly-coupled and loosely-coupled work [28] or between tight and loose mobility [9]. Recent research by Pinelle and Gutwin [29] proposes an operationalization of tightly- vs. loosely-coupled groups based on the stability of patterns of activity; they recognize that one pattern may predominate,

[1] Jones and Hinds also define extreme work teams as those that meet for a single event. In contrast, the action teams described by Sundstrom [35] as well as the units examined in this study.

despite intermittent shifts to the other mode of interdependence. However, previous studies of action teams as well as the research described here suggest that field-based action episodes, while perhaps not accounting for the preponderance of a unit's work, may nonetheless be its most mission-critical work and therefore merit significant support.

Finally, whereas it is important to account for the distinctive features of action teams, we have assumed that much previous research on technology acceptance, use, and perceived benefits in other work settings will help explain the uptake of mobile wireless ICTs in these work groups. In particular, the study described here makes use of prior detailed analyses of technology adoption and assimilation ([10], [23], [31], [34], [38]). Because these analyses focus on individual-use technologies rather than interdependent ones, they typically do not take into account implementation processes in organizational environments in general or interdependency and critical mass among team members in particular. Therefore, our measures also rely on prior studies that are more socially or organizationally oriented (e.g., [4], [16], [17], [20], [21], [25], [32]).

In what follows we provide an account of the organizational and technological context for the research.

BACKGROUND

In 2004, large law enforcement organizations in two major metropolitan areas in the US decided, within months of one another, to introduce mobile wireless information and communication technologies (RIM BlackBerries) on a pilot basis. The devices were intended for use among units whose work often involves significant time spent on field tasks such as surveillance, criminal investigation, apprehension, and emergency responding. Both organizations initially envisioned a 6-month trial period, providing a rare opportunity to conduct replicated, multi-method assessments of the acceptance, use and perceived benefits of these technologies for supporting action teams. This paper reports on outcomes of a larger longitudinal study of the introduction of mobile ICTs in law enforcement.

Work Setting

In both organizations, work is divided among divisions based on general orientation (e.g., criminal investigation vs. surveillance). Divisions, in turn, are subdivided into more cohesive units, here called "teams." (Whereas the two organizations studied here did not have exactly the same division/subdivision break-down, they relied on similar partitioning approaches.) The units chosen to take part in the pilot were those expected by the organizations to benefit most from access to mobile wireless ICTs because of the proportion of their time spent in the field and the degree of interdependence among team members.

Teams range in size from approximately 5-25 members in these organizations. Team members may work alone, in sub-teams, or with the entire team (if small), and the composition of sub-teams changes for different tasks. Teams or subsets of team members assigned to field tasks may be away from their offices for hours or even days at a time. While in the field, they are typically mobile and distributed--in unmarked cars, on foot, and/or on public transportation. They do not wear uniforms. The need to get or share timely tactical information is especially acute when a team leader or member perceives a situation that demands a change in plans or suggests that a coordinated action should be initiated immediately as well as when a hand-off is to occur between a sub-team going off duty and another that is taking over the task.

Examples of these units' activities illustrate some information and communication needs that perhaps are unique to action teams. For instance, an investigator may be on surveillance for several hours, during which targets come together for a 5-minute interaction. This gives the investigator only a short window to identify the targets (e.g., via their license plates) and coordinate action among his or her team members (e.g., pursuing the targets after they depart). In a rolling surveillance, an investigator follows a target for some period time (e.g., in a car, on foot, or on public transportation) and then hands off the surveillance to a team member in a different location – activities that require rapid and discrete methods of team communication. In order to maintain situational awareness and coordinate action in emergency response situations, (e.g., riots; hostage-taking; natural disasters), a team leader must be able to determine where team members are located, what threats they have identified, and what actions they are taking. They also may need to communicate with first responders from other organizations. In a subsequent section of this paper, we describe how features of the BlackBerry can support these activities in ways that other mobile technologies, such as cell phones, can not.

Supporting Technology

The RIM BlackBerry is a handheld device with a small keyboard and display that provides wireless data and voice services. Specifically, it supports cell phone functions such as regular calling; "push-to-talk" or "Direct Connect" and "Group Connect," which allows immediate one-to-one or one-to-many voice communication, respectively; and address books. It also equips users with email and Internet access; via web-browsing, users can access databases used in law enforcement such as National Crime Information Center (NCIC) or ChoicePoint as well as MapQuest and other sources. A commercial carrier provides basic voice and data transmission services, while the host organizations

are responsible for operating the email systems and internal databases that reside on the BlackBerry servers, such as user directories. The BlackBerry offers encrypted email, deemed by the two adopting organizations to be adequate for sensitive but unclassified information exchange. As a security feature, the BlackBerry requires re-authentication every 30 minutes, even when the device is in use; this demands entry of a lengthy password involving several types of symbols.

The BlackBerry joins a suite of other tools. Team members also typically carry into the field regular cell phones, pagers, mobile radios, and, of course, guns. Some also use digital cameras and laptops in the field. When at their desks, they have access to networked personal computers as well.

The Research

An interdisciplinary team comprising social scientists and computer scientists undertook a multi-method evaluation of these pilot trials aimed at assessing the acceptance, use, and perceived performance benefits of the BlackBerries as well as factors influencing these outcomes.

Semi-structured interviews were used to understand the nature of the teams' tasks and use of the technology in field contexts as well as the decision making and implementation processes that led to the deployment of BlackBerries. We also relied on these qualitative data to help interpret what we learned from analyses of quantitative data. We sought quantitative survey data to get a broader picture of the technology's acceptance, use, and benefits along with factors influencing these outcomes, relying heavily on scales widely employed and validated in previous research. Finally, to get an objective account of level of use, we acquired system logs of instances of BlackBerry-enabled email sent and received by users at the end of the 6-month trial period. These data also provided a way to help judge the validity of self-reported use levels. Below we describe the research method in more detail.

METHOD

Procedures

Data were collected over a six-month period beginning three months post-adoption. Table 1 shows the sample sizes and response rates, where applicable, for these data sources in each site.

Site	Interviews	Surveys	Email Logs
A	22	191 (52%)	402
B	23[a]	132 (53%)	251

Table 1. Number of Participants and Response Rates

[a]Five of these participants were from a group of 20-25 very early adopters who had the technology prior to the pilot trials. There were no early adopters in Site A.

Interviews

At three months post-implementation, we conducted semi-structured interviews of users in each organization (n=45). Two teams of two researchers conducted each interview, which lasted approximately 45 minutes. One or both researchers on each team conducted interviews at both sites. The interviews addressed topics such as users' experiences with the device, how they use it, effects on their communications and job performance, barriers and facilitators to use, and recommendations for improvement.

Surveys

Six months after the trial began, we administered a web-based survey (n=323) that measured users' perceptions of how the technology affects their work and communication effectiveness, other attitudes toward the technology, and individual differences such as division in the organization, team characteristics, and demographic information. Many of the items in the survey were adapted from Venkatesh et al. [38]. Survey responses were de-identified, and project-generated ID codes were used to link survey data to email log data (see below).

Email Usage Logs

The email logs (n=653 users) were gathered from approximately months six through nine post-adoption. They consisted of sender, receiver, date, and time information from message headers, as well as a message identifier. Sender and receiver names were replaced with project-generated ID codes. The data indicated whether correspondents were from within the same law enforcement organization, and if not, top level domain designators (e.g., .com, .net, .gov, .org, and so forth) were preserved as a coarse indicator of the correspondents' type of organization. Message subject and content were not included.

Participants

Responses to demographic questions in the survey showed that the majority of participants were team members (71%) or team leaders (12%); a small proportion were senior managers (10%) or other staff (7%). The two sites were similar in the distribution of participants by role in the organization. About 75% of participants in Site A were male, compared with 91% in Site B. Most participants in both sites were between the ages of 25 and 44. There were some differences in the distribution of experience in the organization, with a greater percentage of participants with low tenure (less than 2 years) in Site A than in Site B, $\chi^2(4) = 23.83$, $p < .0001$. The distribution of participants with higher levels of experience was similar across sites.

RESULTS

Outcomes

Technology Acceptance

The first question in the survey asked respondents to report their BlackBerry status. Options included: (1) I turned my BlackBerry in; (2) I have a BlackBerry but don't use it; (3) I use it occasionally; and (4) I use it frequently. This item directed respondents to different sets of questions; for example, respondents who turned in their devices were asked why they made this decision, whereas ongoing users were asked about how the device affects their work. Responses revealed some interesting differences in acceptance of the technology across sites. As shown in Table 2, the distribution of responses shows much greater acceptance in Site B, $\chi^2(3) = 29.29$, $p < .0001$. Of particular note is that nearly 15% of the users in Site A reported that they turned in their BlackBerries voluntarily, and an additional 4% reported that they have a BlackBerry but don't use it. In contrast, all users in Site B report using the device occasionally or frequently. The proportion of frequent users also is higher in Site B than in Site A.

Site	Turned in Device[a]	Don't Use	Use Occasionally	Use Frequently
A	15%	4%	11%	70%
B	0	0	10%	90%

Table 2. Status of BlackBerry Acceptance and Use

[a]Indicates voluntary relinquishment as opposed to turning in the device due to job transfer, termination, or device malfunction.

A second measure of acceptance presented a list of communication media and asked users to indicate which option they would choose if they had to rely on only one mode of communication for their jobs. Results are presented in Table 3.

Site	Black-Berry	In-person	Desk-top Email	Land-line	Cell Phone	Mobile Radio
A	39%	40%	5%	5%	9%	2%
B	46%	28%	2%	5%	15%	5%

Table 3. Preferred Mode of Communication by Site[a]

[a]Options that were endorsed by less than 5% of respondents in both sites were omitted from the analysis.

The responses indicate that the BlackBerry was reasonably well-accepted in both sites. However, there was a marginally significant effect of site, with somewhat greater endorsement of BlackBerries in Site B, $\chi^2(5) = 10.73$, $p < .06$. Differences in the distributions are more extreme when including nonusers' responses $\chi^2(5) = 12.8$, $p < .05$. Most nonusers selected in-person or cell phone communication (their response options excluded BlackBerry).

Technology Use

Use of the BlackBerry was measured in two ways. Usage logs provided objective measures of the frequency of email communication.[2] The number of messages sent versus received varied widely across users, ranging from 0 to 2022 messages sent and 0 to 3256 messages received. We used a log transformation of number of messages to correct for non-normality. Multivariate analysis of variance, excluding nonusers,[3] shows that substantially more email was sent, $F(1,615) = 15.85$, $p < .0001$ and received, $F(1,615) = 39.16$, $p < .0001$ in Site B, with more messages received than sent. Because received messages are a passive measure of use (we don't know if the messages were read), we focus on analyses of sent messages.

These data were supplemented by survey items measuring frequency of using six different features of the BlackBerry: email, cell phone, Direct Connect, Internet, internal databases, and data management tools. Items were rated on five-point scales (coefficient $\alpha = .70$). There was a high level of agreement between self-reported email use and the actual number of messages sent, $r = .64$, $p < .0001$, $n = 267$. Unlike the objective measures, however, there were no differences between sites in self-reported use of the BlackBerry device overall, $t(285) < 1$, $M = 3.4$ in both sites. The sites differed only in reported use of Direct Connect, $t(285) = -3.49$, $p < .001$, with higher usage in Site B, $M = 4.23$ (SD=1.13) than in Site A, $M = 3.72$ (SD=1.36).

Vision for the Technology

Next, in our interviews with users, it became apparent that there was substantial variation in views of the purpose of the BlackBerry. These differences are clearly reflected in responses to a survey question in which we asked participants to select a response that best matched their vision of the potential of the BlackBerry for the organization: (1) The BlackBerry is a replacement for old cell phones. Although it has additional functions, they are not very useful in performing my job; (2) The BlackBerry provides communication functions, such as remote email and Internet access, in addition to a cell phone. It will become one of several communication devices to carry at all times; and (3) The BlackBerry provides phone, remote email and Internet access, and other data acquisition and

[2] Due to space constraints, we present only usage data in this paper. Analyses of network properties, including communication with outside organizations, will be presented elsewhere.

[3] Most of the nonusers appeared as having sent zero messages. Participants who did not retain or use their devices still had valid user IDs, so they appeared in the usage logs even if they did not use the device to send a message.

management features all in a single, portable device. Team members will no longer carry a separate cell phone, pager, or mobile radio because the BlackBerry provides all of these functions. Results show that participants in Site B were much more likely to have a shared vision of the technology, and one that is more forward-looking, than users in Site A, $\chi(2) = 15.09$, $p < .001$ (see Table 4).

Site	Cell Phone Replacement	One of Several Devices to Carry	Integrated Device / All I Need
A	14%	40%	46%
B	5%	28%	67%

Table 4. Vision for the Technology

These differences in vision were corroborated by comments from interviewees. A representative quote from Site A was, "I find that the BlackBerry is little more than a glorified cell phone." In contrast, a participant from Site B stated, "A [team member] should have a gun, a badge, and a BlackBerry."

Perceived Performance Gains

The survey included two main measures of users' perceptions of how the BlackBerry affects their work: Work Effectiveness and Communication Effectiveness. Each measure comprised 5 items rated on 5-point scales (Coefficient α = 94 and .77, respectively). Results for work effectiveness show that users in both sites reported modest performance gains, $M = 3.52$ (1.0) in Site A and 3.5 (1.1) in Site B, $t(285) < 1$. Similar results were obtained for communication effectiveness. In sum, there were no differences between sites in perceived performance gains due to the BlackBerry in spite of differences obtained from measures of acceptance and use. It is possible that six months of use may not be sufficient for performance gains to emerge or to become apparent to users.

Understanding the Outcomes

Our interviews and surveys explored three sets of variables that we believed would affect outcomes of the BlackBerry trials. (1) Technical characteristics, which refer to features of the device hardware and software. For example, these include ergonomic/hardware factors such as the size of the screen and keys, screen backlighting, and sturdiness of the device, and features of the operating system such as the need for system re-authentication. (2) Functionality, which refers to the device's applications, or what the device allows users to do. Examples include telephone service, email, database access, and data management tools. (3) Implementation processes, which refer to how the device was deployed in the organizations. Implementation includes topics such as management emphasis, training and technical support, technology diffusion (who and how many people receive the device), and policies for use. These distinctions are heuristic, not absolute, in that each class of variables may have some influence on the other. Unless otherwise noted, survey responses were measured on 5-point scales, where higher numbers represent more positive perceptions

Technical Characteristics

Users in both sites identified similar advantages of the BlackBerry. Frequently mentioned advantages included device portability, unobtrusiveness, and multi-functionality. Likewise, users identified a common set of limitations. First, virtually all participants mentioned the system lockout.[4] Survey participants in both sites reported that the lockout was a major impediment to use of the BlackBerry ($M = 1.78$, $SD = .98$). In the interviews, participants reported that the need for frequent re-authentication jeopardized operations by impeding communication in time-critical situations and compromised personal and public safety (e.g., inputting their password while driving). Second, users at both sites reported that integration of systems was poor ($M = 2.43$, $SD = 1.16$); they could not exchange email with users on the organization's intranet, which is the primary system used by most on-site employees.[5] Third, numerous participants commented that the device ergonomics do not meet the needs of law enforcement action teams. Examples of design problems included key size, placement, and function (e.g., placement of the Direct Connect key results in accidental alerts; backlighting key is difficult to find in the dark, and backlighting shuts off quickly), and insufficient ruggedness of the device. Survey data showed that users in Site B were generally less satisfied with the ability of the device to withstand the physical stresses of the job, $t(285) = 2.62$, $p < .01$, $M = 3.28$ (.94) in Site A and $M = 3.0$ (1.0) in Site B. However, users in Site A had more concerns about the security of information transmitted via BlackBerry, $t(285) = -2.64$, $p < .01$, $M = 3.28$ (.78) in Site A and 3.54 (.91) in Site B.

Preliminary regression analyses show that technical features, including perceptions of information security, risks due to device lockout, and device ruggedness, were related to use in Site A. However, rather than technical

[4] A newer version of the operating system segments password protection for voice and text, such that users do not need to re-authenticate every 30 minutes to use the phone or Direct Connect. The 30-minute lockout applies to text-based functions, such as email and access to internal databases and the Internet.

[5] Paradoxically, the lack of internal system integration makes it easier for BlackBerry users to communicate via email with people outside of their organizations than with others in their own organizations who do not have BlackBerries.

factors predicting use, the direction of the coefficients for device ruggedness (β = -.23, p < .01) and lockout (β = -.12, p < .10) indicate that the participants who used the device more became more frustrated with these technical features. In Site B, there was no association of technical features and email use.

Although users in Site B were faced with the same technical limitations of the device and were more critical of device ruggedness, they sent substantially more email and showed greater acceptance of the technology. We examine device functionality and implementation processes as possible explanations for these site differences.

Functionality

Both Sites A and B configured the BlackBerries with email, Internet access, data management tools, and Direct Connect. They also had access to internal databases on the BlackBerry server. Email access in the field, in particular, is a new type of functionality for these investigators that can influence the work of action teams. Although the log data indicate that team members are not heavy users of email, usage was higher in Site B, and these users noted numerous benefits of mobile email. Interview respondents reported that mobile email enables team members to communicate when and where needed, unobtrusively, and to an entire group simultaneously; coordinate multi-person tasks efficiently; compose longer messages than permitted by text messaging on phones or pagers; efficiently and accurately transmit complex information such as numbers, timing, or detailed directions; and conduct efficient transfers of operations to other teams. With regard to the unit tasks discussed earlier, some users described how, in a rolling surveillance, they could use email to communicate a target's whereabouts discreetly and unobtrusively in public settings – compared to, for instance, using a cell phone. In an emergency response situation, a team leader reported that he sent an email message to his team members and was able to account for all of their whereabouts within two minutes.

There also were some marked differences between sites in device configuration. Site B deployed the devices with Group Connect, which supports instant one-to-many communication. More important, the 20-25 early adopters in Site B had access on their devices to subscription databases for law enforcement such as NCIC, ChoicePoint, and Department of Motor Vehicles records. Without such access, team members who need information from these databases while in the field submit a search request to helpdesk staff. Because these calls may involve the exchange of sensitive information, communications occur via mobile radio, typically from the team member's car. In addition, team members often must wait – anywhere from minutes to hours – for a response. In contrast, users cited numerous advantages of access to these databases via BlackBerry, including getting information when and where needed; faster information access (minutes versus hours) with fewer steps involved (and therefore fewer opportunities for error); more sophisticated searching; increased accuracy and scope of information obtained; acquisition of supplemental data (e.g., outstanding warrants); and the ability to get information without losing touch with ongoing operations. Many interview participants characterized database access in the field as the "killer app."[6]

For instance, in the example of the surveillance described earlier in which targets met for a brief interaction, a BlackBerry user could search on the targets' license plates within the 5-minute window – an opportunity that would have been lost if he or she had to call in a search request to the helpdesk. Moreover, the user could send the plate numbers to other team members immediately and coordinate action before losing sight of the targets. Thus, database functionality became a shared resource, and even users without direct access could benefit. In short, it is not database access per se that drives the value of the device, but the combination of information access and mechanisms for group communication. As one interviewee stated, "The key advantage is that the [device] is a complete package."

Responses to open-ended survey questions regarding improvements to the BlackBerry confirmed the importance of database access. Of 862 comments contributed by 284 participants, device functionality was the second-most frequently mentioned topic (following technical issues). There were 233 recommendations to provide additional functionality. Of these, 113 (49%) recommended adding subscription databases.[7] In response to another question on the survey, 80% of users in Site A and 90% of users in Site B reported that they would use these databases via the BlackBerry if the services were available.

Although survey participants in Sites A and B did not differ in perceptions of the impact of the device on their jobs, the interview and open-ended survey data suggest that database access by even a small percentage of users in Site B helped account for greater acceptance of the technology and more favorable views of its potential.

Implementation Processes

We identified several factors that affected the success of the deployment in each site. Two facilitating factors distinguished Sites A and B. First, in Site B, there was an influential user-champion for the technology who

[6] "Killer app" refers to a highly desirable or useful computer program or application.

[7] Examples of other applications users requested include GPS and the ability to take and transmit photographs.

generated enthusiasm, encouraged a shared, forward-looking view of the technology, and provided resources to support the implementation. Second, all managers in Site B clearly expected team members to use the BlackBerry in place of their old cell phones and pagers. In contrast, in Site A, no mid-level champions emerged, and there was more variation in management emphasis. In fact, some managers and team leaders in Site A took a "wait and see" stance and accepted teams members' continued use of their old cell phones and pagers, which decreased members' motivation to adopt the BlackBerry.

End-user involvement was a second aspect of the implementation that distinguished the two sites. Although the senior manager in each site was supportive of the program, the early, limited trial in Site B illustrated the value and desirability of the device throughout the organization. These very early adopters also helped guide the choice of applications and served as resources for new users in the broader site deployment. In fact, a survey participant from Site A astutely noted, "The way this project was rolled out to the [organization] was detrimental to its success…A *smaller* pilot group of eager users could have helped …come up with a better way to market this device to the [rest of the] population."

We also identified a number of factors that inhibited success in both sites. First, the deployment pace was rushed. Consequently, there wasn't enough time to pre-configure devices with users' individual address books, create team distribution lists, or populate a global directory of users' contact information. Moreover, the training did not instruct users how to perform these functions themselves. These limitations, while seemingly trivial for seasoned IT users, are particularly serious here given the need for rapid team communication in the field. Similarly, there was not enough time for users to practice and integrate BlackBerries into their work routines [39]. Thus, the BlackBerries were not as useful as they could have been and led some users to believe that the device's limitations outweighed its advantages.

Other aspects of the training also inhibited the success of the BlackBerry program. Although team members perceived the training to be adequate ($M = 3.9$, $SD = .81$), it was not well adapted to law enforcement use or to users with diverse expertise. Training also did not cover organizational policies and procedures for BlackBerry use. For example, only 18% of survey participants reported backing up their device, and the most common reasons cited indicated a lack of knowledge (e.g., I don't know how; I didn't know I could; I didn't know I should; I don't understand the question).

IT policies were a third barrier to implementation in both sites. As noted earlier, inconsistent policies about the use of auxiliary devices, such as cell phones and pagers, discouraged adoption in some teams. There also were no spare units available to replace lost or damaged devices or to outfit new members who joined a team. Multiplier effects also were inhibited when devices were not distributed to all members of a team or to all teams across the organization. In the preliminary regression analyses of predictors of use discussed earlier, diffusion of BlackBerries, in terms of the percentage of squad members that received a device, predicted email use (number of messages sent) in Site A ($\beta = .11$, $p < .06$). Although diffusion did not predict email use in Site B, interviews of the early adopters revealed increased value of the BlackBerry after the devices were deployed more broadly. The importance of broad diffusion to a critical mass was clear to a number of users, who said:

> "The value of the device is likely to increase as more people get it."
>
> "The group gets value because they all use the device."
>
> "If the device was distributed [site]-wide, the benefit would be immeasurable because you can communicate instantly across [the organization]. Once organization-wide, there is no limit to how this device will improve our ability to do our job."

Finally, in both sites, a lack of articulated policies for BlackBerry use created uncertainty in key domains, including: (1) penalties for lost or stolen devices; (2) modernization and refresh plans for equipment and applications; and (3) long-term financial responsibility for the program. This uncertainty further discouraged BlackBerry adoption. For example, some interviewees reported reluctance to invest a lot of effort into learning how to use the BlackBerry because they were under the impression that penalties for lost or stolen devices were excessively harsh, there was no clear plan for hardware and software updates, or they were unsure of whether the technology would remain in use (which is a hazard of any pilot trial). This uncertainty was due to a combination of policies that did not exist or existed but were not communicated clearly to users.

DISCUSSION

Conclusions about Technical Characteristics

BlackBerries have a number of technical limitations as currently configured in these organizations. Although numerous other studies of technology implementation have found that organizational factors often outweigh technical issues in facilitating adoption, the technical characteristics of the device should not be neglected. The need for attention to the device's technical features is particularly acute in action teams. A white collar worker may be inconvenienced if he or she needs to input a password to access the device or has trouble finding the backlighting key in the dark, but these problems can have dire

consequences for members of action teams. Thus, even a small number of users who experience a serious negative outcome should be sufficient to prompt reassessment of the technical features of a technology.

The law enforcement community, as a whole, would benefit by negotiating with providers of mobile, wireless technologies to design devices that meet the needs of this very large market. For example, the devices need to be ruggedized and must be easily accessible in urgent situations – a goal that was impeded by the frequent lockout and current method of authentication. Technical solutions such as biometric identification could resolve this problem. In addition, whereas a poor user interface may not have life-or-death consequences in other contexts, users in a variety of domains will likely value these enhancements. These improvements will become increasingly important as more mobile workers adopt wireless handheld technologies.

In addition to the device lockout, a frequent complaint among users was the lack of integration among the organizations' systems. Our findings suggest that in addition to ruggedizing the device, a key technical issue is to "ruggedize" the information environment to enable information exchange between the BlackBerry server and the organizations' intranets. System interoperability is a growing concern in law enforcement, national security, healthcare, and other domains (e.g., [7], [26]). Technology integration issues will become increasingly important for mobile workers who use handheld devices, as this will not be the only device or system in their toolkits. The ability to integrate systems will be necessary to access users' full range of work applications (thereby boosting functionality).

Conclusions about Functionality

Our findings suggest that users were more tolerant of many of the BlackBerry's technical limitations when the devices were equipped with applications to support the needs of action teams. Likewise, Davis [10] reported that users were willing to put up with complicated software if they could see the benefits of use.

Although some users in Site B were able to benefit even if only one member of their team had access to law enforcement databases in the field, the majority of users expressed a need for access. The lack of access at both sites is a major source of unmet potential of the device for these users. This is largely of an issue of management devoting resources to add the applications that will maximize the value of these devices.

Conclusions about Implementation Processes

The implementation process is a driver of both technical issues and device functionality. For instance, decisions made in the implementation process determine some of the technical characteristics of the device and what applications the device will run. Just as device functionality can offset some of the technology's technical limitations, effective implementation processes can compensate for sub-optimal device functionality. Members of some teams in Site A, which did not have access to subscription databases via Blackberry, still became enthusiastic users. This was most likely to occur in teams in which supervisors encouraged use of the device (or prohibited use of auxiliary devices) and when technically savvy users took the initiative to provide training and support to other members of their teams.

Moreover, aspects of the implementation process such as end user involvement, clear policies, and management emphasis – particularly an influential champion – will determine whether team members will buy in to the technology and embrace it or whether they will be apathetic or skeptical and unwilling to invest the time and effort needed to exploit the technology. Whereas these findings are not new to research on technology adoption, we believe that they are particularly critical for ICT compared to individual-use hardware or software (e.g., [10], [23], [38]). Exploiting the multi-functionality of the BlackBerry, particularly email, will not be fully successful without policies and practices that encourage adoption and create critical mass.

Strengths and Limitations of the Research

This paper provides one of only a few studies of mobile wireless ICT in work settings in general and in action teams specifically. The use of multiple methods and the longitudinal design paint a rich picture of the influences on and outcomes of the deployment of this technology. The results add to previous findings of individual-use technologies by highlighting the effect of organizational factors, which will become increasingly important for mobile workers who use a range of ICTs in the field.

The study has several limitations. Because it was field research, there were several study design parameters that we could not control. For example, the distribution of BlackBerry devices across divisions and teams was not random, and participation in the interviews and surveys was subject to selection biases typically encountered in field studies. There also may have been pre-implementation differences (e.g., in organizational culture) between sites that affected outcomes. The opportunity to observe the influence of predictors of technology use may have been limited by floor effects on email usage in both sites. Nonetheless, we believe that this deployment of Blackberry devices presented a unique opportunity to study the adoption of wireless mobile technologies and action teams, and results contribute to our understanding of how to implement mobile technologies in a variety of domains.

Summary and Conclusions

In conclusion, at the end of a six month trial period, users in one of two comparable organizations achieved markedly positive levels of acceptance of a mobile ICT for its action teams. Although the vast majority of users in Site B did not have the "killer app," and study participants did not report major gains in performance, they experienced the advantages of real-time coordination among people, information and ongoing events. The implementation process in Site B also involved end-user participation and a champion who provided both charismatic and instrumental leadership [25], promoting a future vision among users of becoming "wireless investigators of the 21st century" who can "direct all aspects of an [operation] from the field." These findings support Brynin and Kraut's [8] thesis that ICT can have substantial effects on individuals and groups "resulting from an aggregation of small and seemingly inconsequential changes." The results of this study suggest that even stronger effects might be found for mobile wireless technologies supporting action teams when there is better planning, increased diffusion, and a longer trial period to allow more time for the development of shared social norms and incorporation of the technology into work repertoires.

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