Chapter II

Integrating Handheld Computer Technology into HR Research and Practice

Scott A. Davies, Hogan Assessment Systems, USA

Robert F. Calderón, Caliber Associates, Inc., USA

Abstract

Current theory, applications, and future opportunities for the utilization of handheld computer technology in HR research and practice are presented in this chapter. Empirical research findings on the use of handheld computers for passive collection of workplace data and as a platform for electronic diaries are presented. Potential applications of handheld computers for HR practice are also presented. Finally, current issues and opportunities concerning integration of handheld computer technology into HR research and practice are discussed.

Introduction

The integration of handheld computer technology with human resource (HR) research and application is an area that has not received a great deal of attention from HR researchers or practitioners. However, as the efficiencies and economies associated with handheld computers have continued to increase over the past five years, with meaningful advancements in hardware (e.g., 400 MHz processor speeds, transflective color screens), storage (e.g., 1GB+ memory cards), software (e.g., MS Pocket PC 2003), and wireless connectivity options (e.g., Bluetooth, Wi-Fi, Sprint PCS 153 Kbps service), their utility to human resource research and practice is greater than ever. Based on our research, we believe that full utilization of handheld computers in HR will be most fully realized through the collaborative efforts of HR researchers, practitioners, and IT specialists.

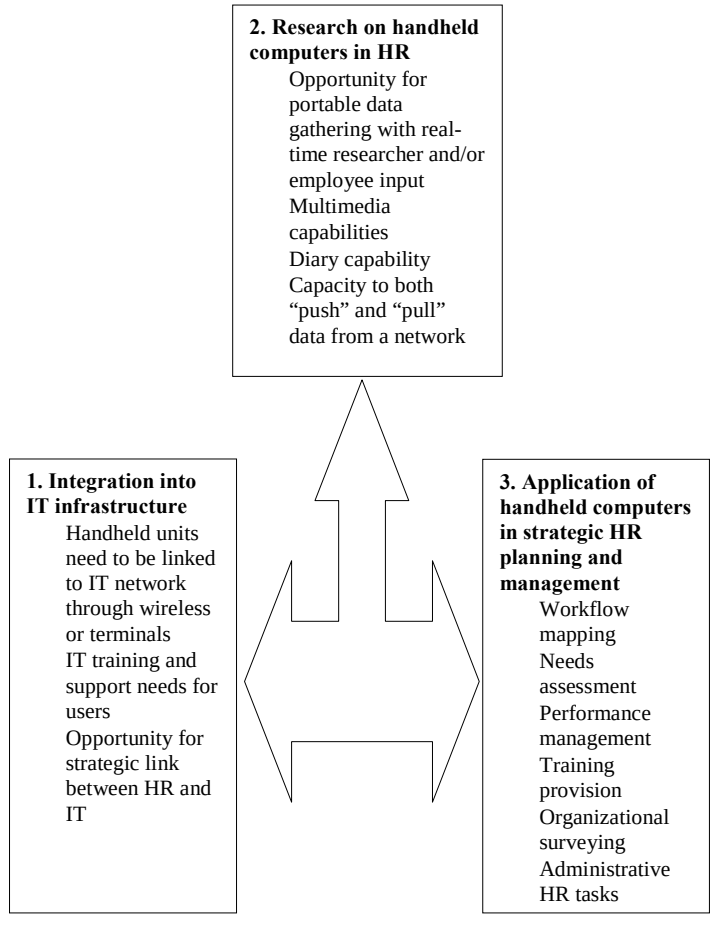
In this chapter we bring together empirical research and practical knowledge on the integration of handheld computer technology with strategic human resource planning, management, and research theory into a working model that may serve as a foundation for future work in this area. We begin with an overview of how handheld computer technology fits into a model with HR research, HR practice, and IT infrastructure. We then review the role of handheld computers in strategic human resource practice and research, including the use of handheld computers to: (a) gather data for business process engineering, workflow mapping, and job analysis; (b) conduct organizational needs assessments; (c) gather and manage performance data, and provide employee feedback in performance management systems; (d) provide training to employees and gather training evaluation data; (e) conduct organizational surveying; and (f) enhance administrative tasks, such as scheduling, messaging, and provision of HR forms. Finally, we present our view of future research opportunities and challenges associated with the integration of handheld computer technology into strategic human resource planning, management, and research.

We hope readers find what we present in this chapter useful to their own HR research and practice. As in all applications of technology, the field is bursting with activity and constantly changing, but we believe that the material presented here will remain a relevant foundation for work in this area for the foreseeable future. It is our goal not only to inform the reader, but to increase interest in pursuing additional research in this area.

A Model of Handheld Computer Technology Integrated into HR

Currently, handheld computers are often used as stand-alone devices in the workplace to supplement individuals' computing resources. This situation neglects the potential for use of the technology in a systematic manner. In our conceptual model (Figure 1), the boxes represent what we see are the three key elements in the relationship between handheld computer technology and HR. As shown by the arrows, this is not a linear relationship, but one of conver-

Figure 1. Working model of handheld computer technology integrated into HR practice, research, and IT infrastructure



gence, with each element both contributing to and drawing from the other elements. The key to optimizing the use of the handheld in HR research and practice is attendance to all three factors in the model simultaneously.

Factor #1: Integration into IT Infrastructure

As with any organizational technology solution, handheld computers need to be a part of the larger IT system. According to our model, IT integration is linked to both the HR research and HR application factors. Some aspects of these linkages are supported by empirical work in this area. For example, we have found that optimal use of handheld technology in HR research requires integration into the organization's IT system as an enterprise solution (Davies, Rodbard, Brandes, & Poropatich, 2004; Lyons, Davies, Rodbard, Brandes, & Poropatich, 2004; Rodbard, Brandes, Davies, & Lyons, 2002). Furthermore, our research has shown that a lack of integration will be an insurmountable roadblock to successful handheld use. We have also found that successful integration of handhelds as research or applied HR tools is dependent on strategic links to the organizational IT infrastructure through HotSynching terminals or wireless methods. Successful applications also require adequate, ongoing IT-related training and support to handheld users. Finally, collaboration between HR and IT staff is a critical factor in making integration of handheld technology a part of an organization's strategic business plan.

Factor #2: Research on Handheld Computers in HR

While integration into the IT system will make handheld technology available to HR, it is up to the HR researchers to identify opportunities for a wide variety of data-collection activities in the workplace, such as diary studies, multimedia interventions, survey work, and real-time assessments/evaluations. Organizational researchers have begun to utilize handhelds in their research to a limited extent, but the full potential of having entire organizations of respondents voluntarily carrying computers around with them every day has not yet been capitalized on for research purposes. We have identified four research functions in our model that would be accentuated through handheld use, but the published work in this area is scarce. As a notable exception, Miner, Glomb, and Hulin (2001) gathered employee mood data in an experience sampling

design using the diary feature of handheld computers. From feedback we received from others in the field, other programs of HR research using handhelds exist, but are being conducted by organizations internally; as is too often the case in applied settings, the results are not available for publication. In our research, we utilized the real-time evaluation and diary function of the handheld, but have not had the opportunity to explore multimedia and wireless capabilities (Lyons et al., 2004; Rodbard et al., 2002). These conceptual factors in our model provide an impetus for future empirical research.

Factor #3: Application of Handheld Computers in Strategic HR Planning and Management

In our research, we have found that introducing handheld technology as a platform for HR applications provides a means of conducting HR-related research on a variety of issues (Lyons et al., 2004; Rodbard et al., 2002). This is the basis for the relationship in our model between Factor #1, HR Research, and Factor #2, HR Application. Our findings support the concept that the research capacity of handhelds can be captured as a byproduct of the implementation of HR functions on the same device. For example, in occupations that rely heavily on forms to complete work activities (e.g., nurses use forms to chart patients, lawyers use forms to bill time, teachers use forms to track students, warehouse workers use forms to maintain inventory), by placing the forms on handhelds and passively gathering form use data from the devices, research on workflow mapping, job analysis, and job design can be conducted with little to no extra data collection. We expand on these findings in the following sections on handheld applications and research.

Overall, we propose that the research and application of handheld technology to HR functions would be well served to follow a conceptual model, not occur in an unsystematic manner with post hoc evaluation, as is often the case. Evidence that this may already be the state of the science in this area is the lack of published research on handheld technology and HR (Cascio, 2003). There is much to be gained in this potentially fruitful area of HR practice and research by working from a common understanding and publishing results both supportive and unsupportive of that understanding.

In our model, we acknowledge the importance of relating IT infrastructure to HR practice and research on handhelds, but we do not further develop the IT issue in this chapter. We urge the reader to examine resources and to

collaborate with IT experts in this area. In the following sections, we expand on the research supporting Factors #2 and #3 of our model (Figure 1).

HR Applications on Handhelds

HR-related applications on handhelds are being developed at an ever-increasing pace. The most popular of these falls into the realm of personal information management (PIM) functions, such as a calendar, contact list, to-do list, and e-mail. In our model, these functions on individual employee's handhelds become important parts of a strategic HR practice and, if managed properly, become a system of organizational information management (OIM) functions.

Applications are available for time management, for example, that have advanced capabilities for applying complex work rules (e.g., managing overtime accruals and employee leave periods), processing time billing, providing sophisticated scheduling, and allocation capabilities; they further include the ability to equalize overtime in schedules, match skills to jobs, and provide a platform for resource substitution and alternatives. Physicians in some medical facilities are using a handheld device to manage a variety of workflow functions, including accessing real-time patient scheduling information, capturing charges, and dictating point-of-care patient notes. These professionals use their handheld devices to review medical reference libraries, current diagnostic and procedure coding, and coding compliance rules. These applications are applicable to other occupations as well.

Organizational-level contact management can be accomplished by enabling multiple handheld users to synchronize with a master list of contacts, update the contact list, then resynchronize the changes to the master database. For example, using a .NET Compact Framework solution on Pocket PCs provides a SQL Server CE database on each device that contains a replica of the master database. The handheld database is synchronized with the master database programmatically to build the organizational contact list.

Most directly related to HR practice are applications that make various organizational forms and documents available to employees on the handheld—either downloadable from a PC or via distance connection through land-based or wireless connection. Forms may be "pushed" out to employees as required, or "pulled" as needed, completed, and returned electronically. Other applica-

tions enhance record keeping for traveling employees, including programs for time management, project management, sales tracking, and expense accounts.

Handhelds are also capable of holding quick reference material that can be accessed immediately in a non-cumbersome fashion. In some organizations, individuals are able to reference journals/databases with the push of a button and provide critical information in real time. For example, Hayes (2003) examined the benefits of using handheld computers for a population of psychiatrists and found that these devices were extremely useful in storing and retrieving information and applications that could be accessed anyplace at anytime. Basically, the handheld computers can provide the same basic benefits that are available via an individual's personal computer (e.g., reference materials, Web searches), with the added bonus of being with the individual at all times.

There are also many handheld applications with implications for potential HR use. For example, organizations with workers in the field are finding rugged-use handhelds useful for land surveying, mapping, civil engineering and construction, forestry, utility, facilities and asset management, machine control, law enforcement, and military applications. The technology is also being used to assist employment of people with disabilities. For example, networked job training and coaching applications can be provided on handhelds with audio- or graphics-based step-by-step instruction on how to complete a job, check progress to completion, and as a means for family and coach to communicate with workers (MobileVillage, 2003).

In summary, handheld technology is being utilized as a means to provide a wide range of HR-related applications. In many cases, the opportunity exists for provision of the HR function to be improved through the use of the handheld. In our model, we conceptualize the relationship of HR functions on the handheld to the IT infrastructure and increasing capacity for HR research. In the next section, we describe how HR research and handheld research can be accomplished as a byproduct of handheld use.

Researching HR Functions on Handhelds

In preparing this chapter, we discovered that the dearth of published research on integration of HR functions and handheld technology continues. When we

first started work in this area in 2001, the lack of existing research was not entirely surprising given the age of the technology. However, now — three years later — the technology has matured and the body of research appears to have grown very little. Much of the work that *has been* accomplished in this area appears to be proprietary and therefore not available for our review. In this section we present reviews of the few published studies we have identified, along with a description of our own research program in this area.

A group of researchers at Carnegie-Mellon have conducted handheld research since 1997 in the PEBBLES project (PDAs for Entry of Both Bytes and Locations from External Sources). Although not explicitly focused on HR functions, the work of the team is of importance to this area. For example, the PEBBLES team has researched multi-machine user interfaces (MMUIs), which are of importance in our conceptualization of handheld integration with the larger IT system. In their research, the PEBBLES team has examined how handhelds and PCs can be used together (Myers, 2001; Myers, Steil, & Gargiulo, 1998).

In one study, the team found that in a meeting setting, handhelds could be used to make a PC-based slide presentation more effective by providing additional details of the presentation to handheld meeting attendees wirelessly, on demand. The details included additional data, graphs, and other information that were not included on the more macro slide presentation, but were of interest to some of the attendees during the slide show (Myers, Steil, & Gargiulo, 1998).

In another study, the team found that real-time classroom assessment via handhelds linked wirelessly to the instructor's PC was more effective from both the student and instructor perspectives. Finally, the PEBBLES team is examining the effectiveness of handheld use by multiple meeting participants when annotating large, shared electronic displays, such as military maps (Myers, 2001).

The bulk of the research on the use of handheld computers in organizational settings has been conducted in medical facilities. Many resources have been devoted to developing medical programs for handhelds, and evaluating both their use and effectiveness in the work of medical professionals. For example, Rosenbloom (2003) reported on the use of handhelds to reduce medical errors in a number of ways across the medical professions. Primarily, Rosenbloom identifies the need for medical providers to have the correct information in a usable format at *the point of care* and recognizes the handheld as the best portable platform for fulfilling this need.

Lanway and Graham (2003) reported a study on handheld implementation in a medical facility, with results that generalize beyond the medical field. The study involved nurses who performed primarily administrative functions in evaluating quality of patient care. This role required a great deal of documentation, usually at the site of patient service. The nurses were using a paper-based system to meet the portability requirements and then transcribing the handwritten notes onto their desktop computers as the opportunity arose. This situation resulted in an unmanageable amount of lag time between evaluation and feedback to the medical providers, and unnecessary costs for double documentation. Finding that laptop computers were too bulky for the job, the organization moved the nurses to wireless handheld computers. The nurses could document the evaluations once and transmit the information immediately to the organization's mainframe for use. The use of handhelds saved the nurses two to three hours each — per day — in the double documentation process. Also, the immediate delivery of information back to the medical facility often results in patient discharge a day earlier than under the old system — an outcome that has shown in the decreasing average length of stay since the handhelds were put into use. Finally, the researchers report that the nurses' job satisfaction has increased since the handheld technology has been implemented. It is unlikely that these results would be specific to the medical field; they would more likely generalize to administrative applications in other professions.

The impact of handheld use in the medical profession has been noticed not only by medical professions, but by corporations paying for healthcare as well. In order to reduce healthcare costs due to prescription inaccuracies, insurance billing errors, and other problems created by poor penmanship, General Motors Corporation has distributed handhelds to over 5,000 physicians who attend to the company's employees (Konrad, 2001). Generalizing this technology effort to the corporate HR program would probably have similar effects.

In our own research program (e.g., Rodbard et al., 2002), we are exploring the use of handheld computers in both laboratory and field settings. Current laboratory research is focusing on the human factors of the user-machine interface and how those factors are impacted by various software solutions. This basic research is primarily of importance to the IT domain for effective hardware and software design; therefore, we do not describe that line of research in this chapter. We will instead focus on the research we have conducted on handheld computers in the field and present findings primarily of importance to HR researchers and practitioners.

Description of the Rodbard Study

The goal of the Rodbard et al. (2002) study was to provide medical professionals with handheld computers, train the professionals to use the handhelds in their work, and then gather data regarding when, how, and why the handhelds were used. This study was unique in its inductive, "bottom-up" approach to understanding how professionals would use handhelds in their work, how work-related functions could be provided on the handhelds, and how handhelds would perform as data-gathering devices for organizational research.

Overall, the study employed both qualitative and quantitative methods, with measurement of actual use from objective data captured from the handheld computers, measurement of user preparation through survey methodology, measurement of real-time user reactions through the use of an electronic diary on the handhelds, and qualitative user input through focus groups and Delphi methods. Use of multiple methods provided more valid measurement of the complex phenomenon of interest in the workplace.

Participants

A total of 84 medical personnel from two military medical facilities participated in our study of handhelds in the workplace. Specifically, the sample distribution by occupation was as follows: 30 physicians, 26 nurses, 15 pharmacists, and 13 combat medics. The overall gender distribution was fairly even: 45 males and 39 females. Ethnic origin was representative of the U.S. military population and the area labor force.

Procedure

The concept of the study was to provide training and experience with handhelds that were equipped with a variety of applications (i.e., 10 medical applications and 14 personal information management applications) to incumbents in the two medical facilities, and subsequently gather: (a) objective data on application usage, (b) feedback through a diary style logbook on the handheld, (c) qualitative information through focus groups, and (d) priorities regarding the information gathered from this group of "experienced" users in a final Delphi-oriented focus group session. In addition to these primary data, secondary

analyses were conducted to examine the utility of monitoring handheld use in the workplace as a potential source of workflow mapping and rudimentary job analysis data.

Readiness to Participate

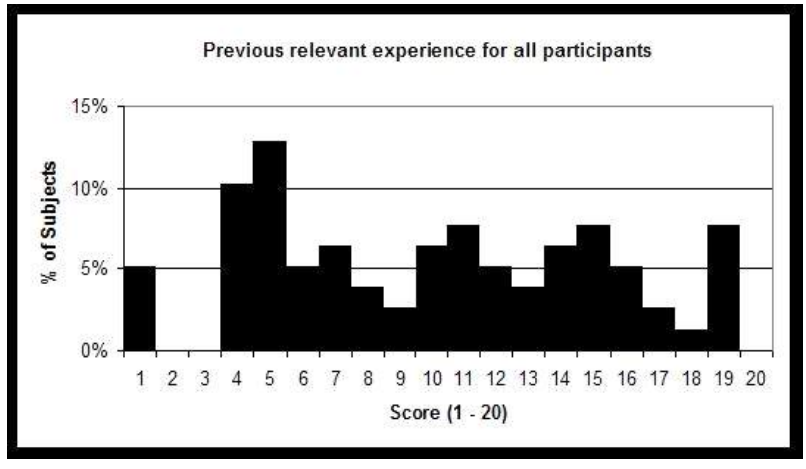
In order to assess readiness to participate in the study and to plan training, we administered a 20-item survey during the initial session with the participants, measuring past experience with handhelds, computers in general, and software use. Figure 2 shows the distribution of survey scores. It is important to note the wide range of scores, indicating that participants came into this study with relevant experiences ranging from none (i.e., "1") to high expertise (i.e., "19"). This is important to note in light of the findings in this study that regardless of previous relevant experience, the majority of participants were willing and eager to use the handheld computers with adequate training and support.

Training

Participants were provided training in three two-hour sessions, one week apart. Training was conducted by an expert in medical informatics with several years of experience with handheld computers, who was assisted by two PhD psychologists. The design of the sessions was interactive, with hands-on experiential learning as the primary focus. After each of the sessions, the participants completed questionnaires to assess increases in relevant knowledge and attitudes towards the handheld devices. Additionally, a 15-minute 'mini' focus group was conducted after each session in order to elicit the major strengths and weaknesses of using the handheld computers in the work environment.

The training sessions were a critical factor in the success of this study. From the results of the knowledge questionnaires, focus group findings, and the observations of the training teams, the trainings effectively prepared even the least experienced participant to use the handheld computer in his/her work. In most cases, attitudes toward the devices (as elicited in the focus groups) moved from negative to positive and fear to trust. Any initial resistance to the use of handhelds by this group of medical professionals was found to diminish across the span of the three training sessions. From our observations, this change was

Figure 2. Histogram of previous relevant experience survey scores by percent of participants at each score point, 1-20



due to an increased understanding of the benefits of the handheld computers to the work through personal experiences and anecdotal learning from fellow professionals (i.e., "I was able to access a necessary medical reference book on my PDA during a critical diagnosis at bedside and this made me more confident in my decision").

Focus Groups

The mini focus group results provided focus for subsequent trainings and support follow-up with individual participants, as well as a basis for the Delphi portion of the study. The primary findings from these early group sessions included:

- Caregivers are enthusiastic about using the handheld computers.
- Caregivers readily adopt both personal information management (PIM) and selected medical applications into their daily practices.
- The handheld computers were easily configured and deployed to the physicians, nurses, medics, and pharmacists.
- Skills sufficient to use the handhelds are easily acquired with limited training and "buddy" support.

- Caregivers request additional functionalities for the handhelds: access to patient records, lab data, x-rays, patient instructional materials, CME credits, and the Internet.

Support

Participants also received ongoing support in their use of the handheld computers through a buddy system. We actively promoted less well-prepared participants to team with better prepared participants within their work environment. This was also a critical success factor in conducting the study and for implementing the technology. Through this system, individuals were able to access support specific to the problem encountered, both at the point in time most needed and from a recognized coworker. Participants were also provided support from the research team via e-mail, telephone contact, site visits, and from the base IT staff on an ongoing basis.

Research Methods

Throughout the course of the study (i.e., eight weeks), we utilized application use tracking software on the handheld computers to track the use of various handheld applications. We employed "App Usage Hack, Version 1.1" from Benc Software for this purpose (Benc, 2002). In addition, we requested the developer of App Usage Hack to create a version that would also record the date, time, and duration of each use of each application. The latter version, designated App Usage Hack Version 1.2, was employed for our studies. In this manner, we were able to examine patterns of use by participant, day, time of day, and day of week.

Use of this advanced version resulted in a decreased need for frequent HotSyncing (i.e., linking the handheld computer to a desktop computer through a cradle to synchronize the data on shared programs) on the part of participants. Even if the participant HotSynced only once — at the end of the study — we could still identify the pattern of use, day-by-day and week-by-week (provided that data were not lost or corrupted due to battery failure or inappropriate use of Backup and Restore functions).

Our analysis of the use-tracking data resulted in profiles of application usage at the person and group level, and provided a basis for describing differences

in handheld application usage across medical professions. In order to better understand the usage data, we employed focus groups and logbook software on the handheld devices for gathering reaction data from participants.

The logbook, a form of electronic diary, was designed as a standardized survey form. It was well received by participants and would be useful for gathering a variety of input from employees. The participants were instructed to access the logbook at least once a day, and each time they had a critical experience with the handheld computer. Also, the participants received automatic alarms on their handheld every week reminding them to HotSync, as well as reminders every second day to make a recording in their logbooks. The logbook asked five questions with a five-point response scale for each:

1. If a specific application was the subject of the report, which application was it?
2. How many times was the application used today, or if not a specific application, how many times the handheld was used?
3. Did the application or handheld save time, and if so, how much?
4. Did the application or handheld make your job easier?
5. Comments.

The participants had the option to change answers, which were then stored in a HanDBase file for downloading at HotSynch and collection by the research team.

Focus groups were conducted at the end of each training session and followed appropriate protocol for qualitative data gathering (Berg, 2001). The participant discussion was guided by two or three primary points provided at the beginning of the focus group by a trained facilitator. Participants were given the opportunity to speak to the points, with the goal of eliciting the most information possible from the group. The groups were recorded in both audio and video format for content analysis. The audio recordings were transcribed and content analyzed using the Qualrus (2002) software program.

A special type of focus group was conducted at the end of the eight-week study. Ten to 15 participants were assigned to each of five Delphi focus groups. The Delphi method uses a conventional facilitated focus group format, but adds structured lists of issues within a topic of interest. Each member of the group independently reads and rates the importance of the issues on the list, and then

the facilitator provides the mean ratings for the group back to the individuals. The differences between any one member and the group mean are then used as a lever to elicit discussion from the group in defense of each individual's ratings. After two iterations of ratings and discussion, a final rating for the list is agreed upon through group consensus. This method provides an optimum amount of group discussion concerning a specific set of issues.

Results

The initial training and focus group sessions were attended by all 84 participants in the study. However, due mainly to work-related reasons (e.g., base transfer, shift change), only 80% completed the training sessions and remained active in the study. To reduce the probability of attrition, the requirements for the study were clearly stated in the materials for recruitment of subjects, in the informed consent, in the initial questionnaire, and in the announcements at the initial session. Conceivably, some or many of these individuals may have been motivated to obtain a handheld computer for their own use, but did not wish to participate actively in the study. This behavior persisted despite the fact that (a) announcements of meetings were made at staff meetings, (b) e-mail reminders were sent prior to each of the focus groups and Delphi sessions, (c) frequent reminders were sent urging participants to enter observations into their logbooks and to HotSync, and (d) the participants received automatic alarms on their handheld reminding them to HotSync and to make recordings in their logbooks.

From the logbook results, we found that across the eight weeks of the study, 47 of the 84 participants made 826 logbook entries for an average of 18 entries per participant who used the logbook and 103 entries per week of the study. It was apparent that many of the participants who did not make logbook entries were also the participants who did not complete training. The participants provided comments on 34 different applications and stated that the handheld saved time in 81% of entries and saved effort in 73% of entries. Overall, the logbook was well accepted and, according to the focus group findings, was unanimously preferred to paper records or e-mail-based data collection.

According to analysis of the application usage data, the total study population of 84 individuals used the PDA 20,250 times during the two-month study. Physicians accounted for 8,751 uses, nurses — 4,839, pharmacists — 2,853, and medics — 3,807. The total number of uses cannot be compared directly

because the number of subjects in each occupational group was not identical. Table 1 presents the results relative to the number of individuals in each group, that is, showing number of uses per individual for the total study period.

From our analysis of results such as those presented in Table 1, we found that usage monitoring was useful for examining occupational differences in overall handheld use. Physicians and medics had the highest usage, followed by pharmacists, then nurses. In order to better understand these differences, we analyzed differences in the applications used by each group as well. As expected, we found meaningful differences across medical professions in the types of applications most used by each group. For example, the physicians used medical references and diagnostic applications much more frequently than did the medics, while the medics more frequently used PIM applications for administrative functions. Both groups used the address book, calendar, memo pad, and calculator the most of any non-medically related applications, but we found differences in how these applications were used in participant focus groups. This was a critical component of the study — qualitative input from the participants to help us understand the application usage results collected from the handhelds.

From the usage data, we were also able to chart handheld use patterns over time. Figure 3 shows the aggregate use of the handheld by an average

Table 1. Total uses of handheld applications by medical profession

	USES	
	TOTAL	**AVERAGE**
Physicians	8,751	292 (n = 30)
Nurses	4,839	186 (n = 26)
Pharmacists	2,853	190 (n = 15)
Medics	3,807	293 (n = 13)
Total	20,250	241 (n = 84)

participant by day over two months of use. The number of applications used daily rose through the period of the training sessions, then dropped off to the number that the participant used on a regular basis.

Figure 4 shows the overall use across participants by time of day. These data were useful for examining differences in handheld use across work shifts. Alone, these results can show differences in overall usage by occupational group and provide insights for training and IT support. When analyzed in relationship to application usage by day of the week, these daily use patterns provided important information concerning the manner in which the handhelds were being used in work-related tasks.

Results obtained at the Delphi sessions at the close of the study corresponded closely to the actual level of usage throughout the study. The final ratings across participants for each topic in the Delphi study are presented in Tables 2, 3, and 4. The participants in each Delphi group individually rank ordered a list within each of the three topic areas, then through an iterative process of group discussion and reranking came to a final consensus set of rankings. The mean rankings provided in each table are the mean consensus rankings for all Delphi groups.

In Table 2 are the mean rankings made by the groups for the most important medical application types on the handhelds. The rankings largely supported the results from the application usage data and from the logbook results.

Figure 3. Daily use of handheld for one participant, based on application usage data

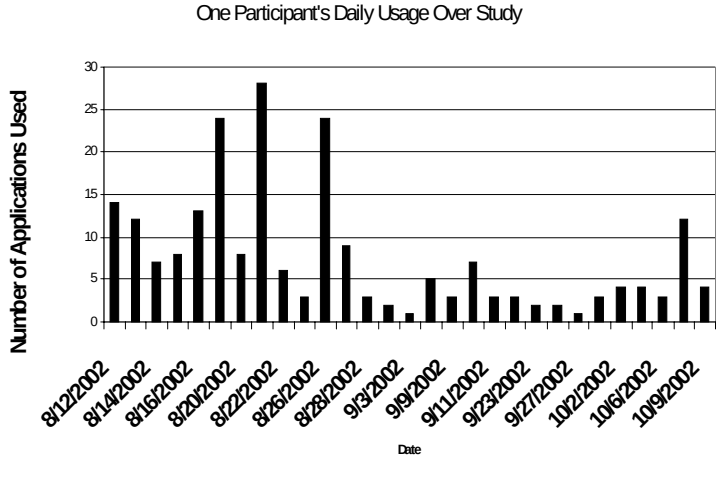


Figure 4. Application usage by time of day for all participants, based on application usage data

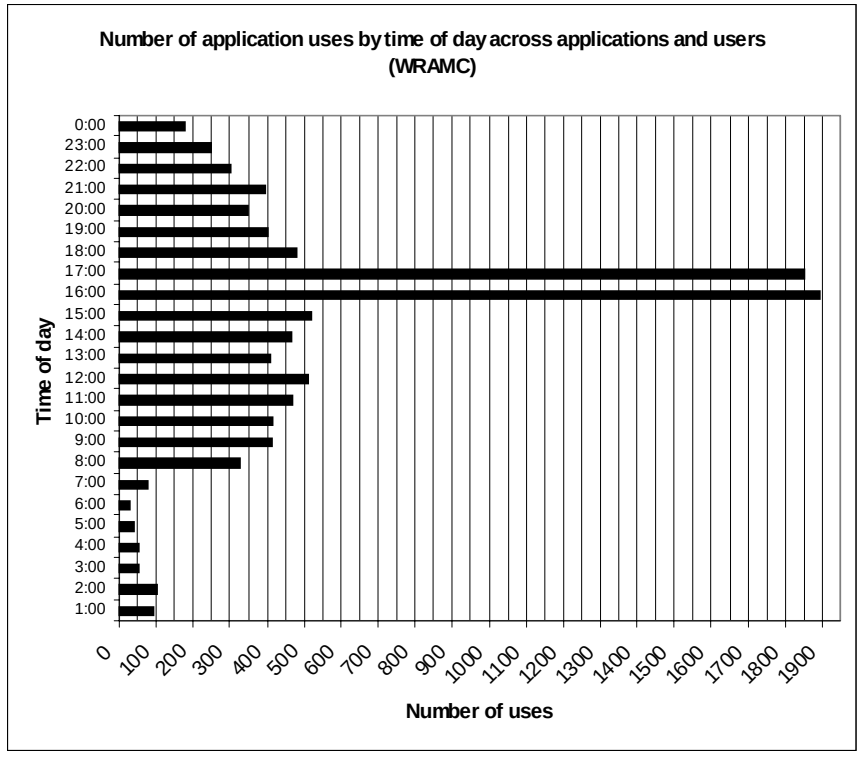


Table 2. Final ranking of the priorities for 10 medical applications

PDA Medical Applications (All Participants)		
Rank of Mean	**Application**	**Mean Rank**
1	Drug formularies (e.g., ePocrates, Tarascon, LexiDrug)	2.1
2	Reference materials, textbooks, manuals (e.g., Harrison's, Merck Manual, Wash U., Harriet Lane)	3.2
3	Medical calculations (e.g., MedCalc)	4.3
4	Patient data retrieval, H&P, lab, x-ray	4.4
5	Patient data entry (e.g., PatientKeeper, Patient Tracker)	4.8
6	Treatment guidelines (e.g., ATP III, Shots)	5.5
7	Decision support (e.g., 5 Min Clinical Consult)	6.0
8	Administrative (e.g., ICD coding, visit coding)	8.0
9	CME multiple topics	8.2
10	Prescription writing	8.5

In Figures 5, 6, and 7 are the mean across Delphi groups of the final set of rankings by occupational group before the consensus round. As shown in Figure 5, the overall ranking trend across occupation groups was similar across applications, but there were group differences. The differences were largest for the applications that were found to be of great importance to one occupational group and of low importance to another group (i.e., patient data entry to medics and pharmacists).

Figure 5. Final round mean ratings by occupation: medical functions

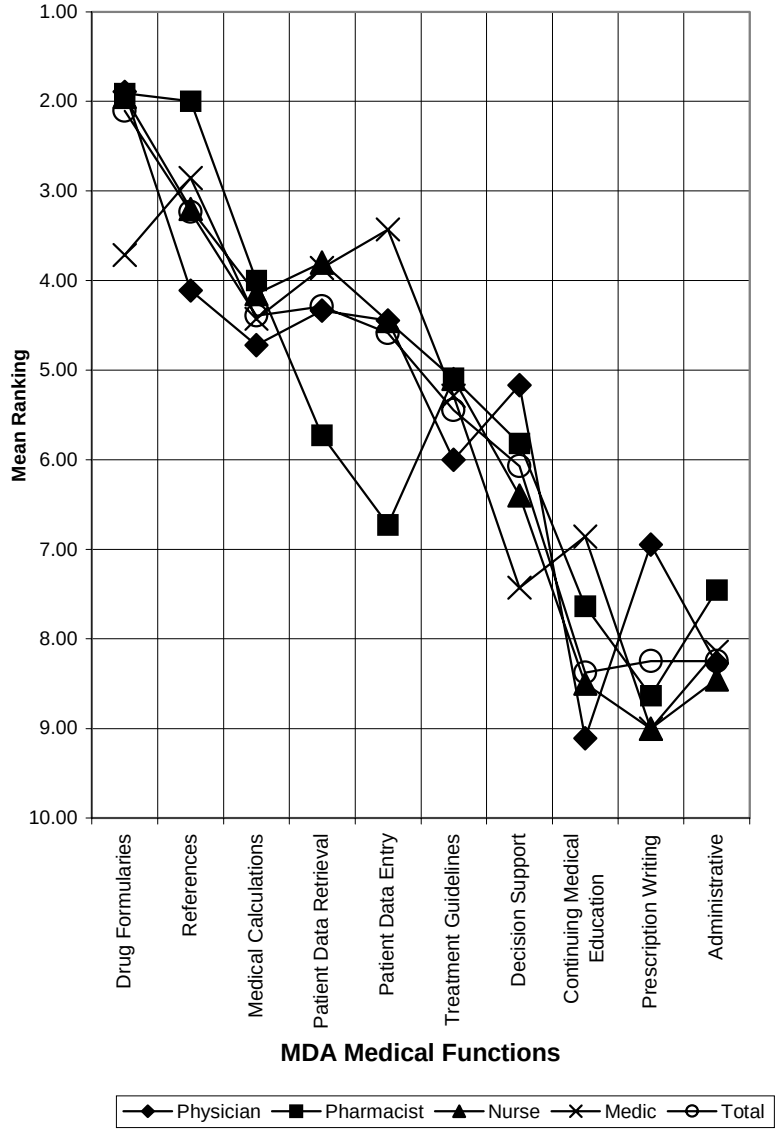


Table 3. Final ranking of the priorities for 10 personal information management (PIM) applications

Personal Information Management Functions (All Participants)		
Rank of Mean	**Application**	**Mean Rank**
1	Calendar/storing appointments	2.5
2	Storing addresses/phone numbers	2.8
3	Number calculation	4.9
4	Writing notes/data	5.0
5	Keeping a "to do" list	5.2
6	Reading/writing e-mail	6.1
7	Alarm function	6.2
8	Accessing notes/data	6.4
9	Storing voice recordings	7.7
10	Entertainment	9.2

In Table 3 are the mean rankings made by the groups for the most important PIM application types on the handhelds. The rankings also supported the results from the application usage data and from the logbook results.

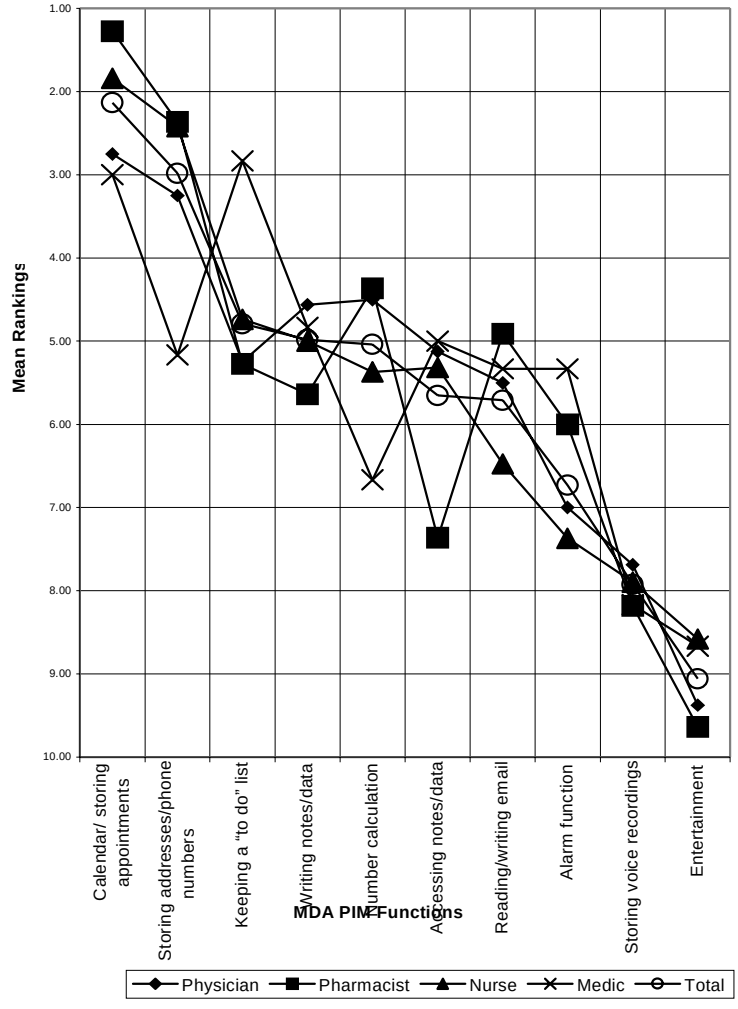
There were also differences evident across occupational groups in the Delphi rankings for the most important PIM applications, as shown in Figure 6. The differences in group ratings were similar to those found for the medical applications.

In Table 4 are the mean rankings for the most important areas for change on the handhelds. This information was not collected in the application usage data, but it does mirror what was found in the earlier focus groups.

The differences in mean occupational group ratings for "Most Important Areas for Change" topics are shown in Figure 7. Compared to the two topics presented in Figures 5 and 6, the differences in mean ratings for "Most Important Areas for Change" were less clearly defined for all groups.

The transcripts of the Delphi sessions provided a rich source of data. From our content analysis of these data, the *main* theme expressed from all five Delphi sessions was the need for integration between the PDA applications and clinical work systems. In addition, three *sub-themes* arose from the main theme: (1)

Figure 6. Final round mean ratings by occupation: PIM functions



PDA integration with workflow, (2) PDA customization, and (3) PDA standardization.

Several suggestions were offered to improve the use of the PDA by integrating it with the daily workflow. Specifically, several comments focused on automating the workload management (WLM) reporting process for nurses by using PDA HotSync data. Similarly, participants also believed that the opportunity to download patient and staff schedules to their PDA calendars would provide significant time savings to their daily workload. Participants suggested that an

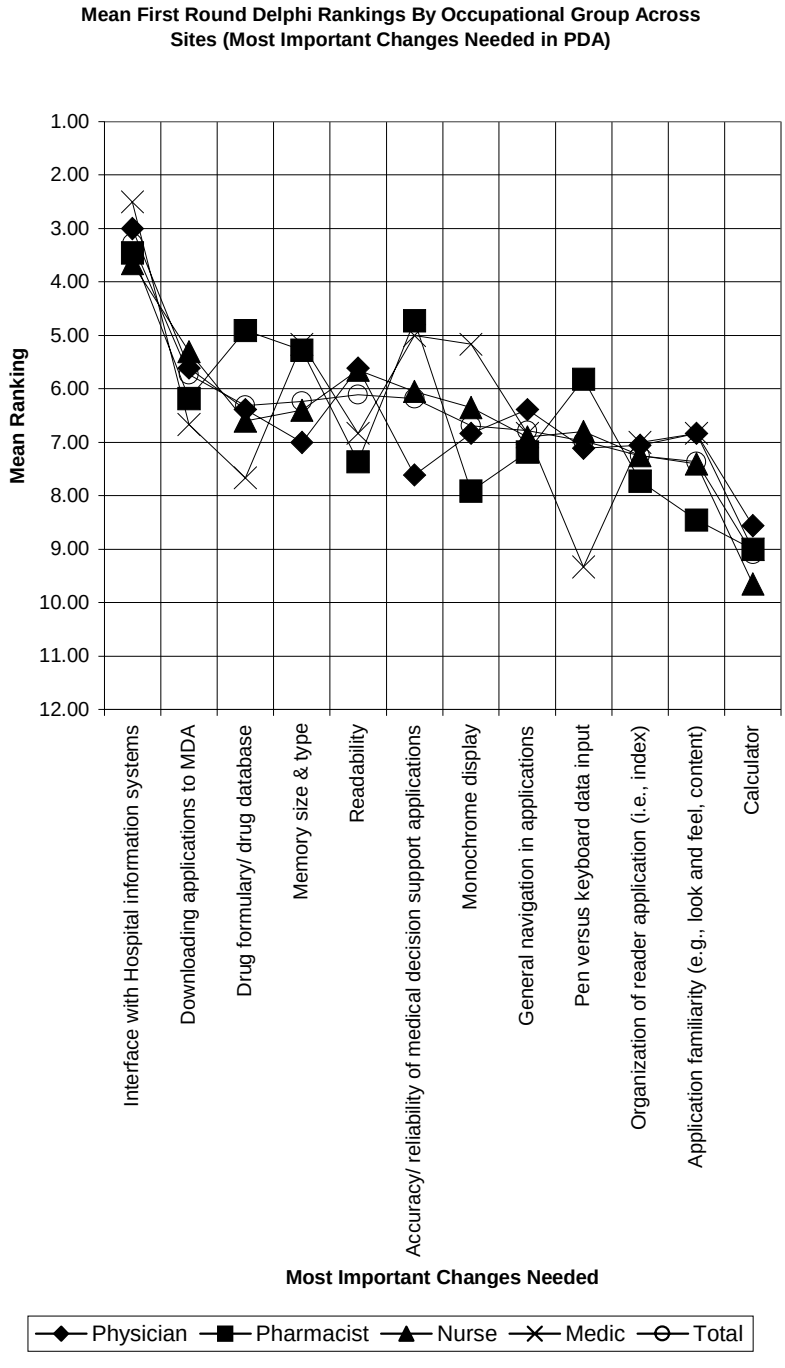
Table 4. Ranking of the priorities for 12 "Most Important Areas for Change in the PDA"

Most Important Areas for Change (All Participants)		
Rank of Mean	**Application**	**Mean Rank**
1	Interface with hospital information systems	2.0
2	Memory size and type	5.5
3	Downloading applications to PDA	5.7
4	Drug formulary/drug database	5.9
5	Monochrome display	5.9
6	Readability	6.4
7	Accuracy/reliability of medical decision support applications	6.4
8	Pen (handwriting recognition) versus keyboard data input	7.5
9	Organization of reader applications (i.e., index)	7.5
10	Application familiarity (e.g., look and feel, content)	7.8
11	General navigation in applications	8.0
12	Calculator	9.7

interface between their PDAs and hospital patient information management system would allow them to input and extract patient data at the point of care. By integrating the PDA and hospital patient information management, participants also envisioned the ability to receive wireless notification of laboratory results to their PDA, resulting in savings of a considerable amount of time.

Participants expressed the need for their PDA applications to be specific to their professional specialty. Several participants suggested that the ability to annotate references and to customize provider-specific applications would be useful. Similarly, participants expressed the need to customize each PDA's applications to the individual, professional group, and medical specialty area (e.g., gastroenterology or pediatrics reference materials for nurses). Participants also desired facility-specific applications (e.g., facility-specific drug formulary and staff telephone/address book) adaptable to their PDA. Finally, some participants suggested that the use of multilingual translations (Spanish,

Figure 7. Final round mean ratings by occupation: "Most Important Areas for Change"



Chinese, etc.) in each application would be helpful when they are on duty in foreign countries, and when providing care to non-English-speaking patients.

The third sub-theme that arose during the five sessions, standardization, primarily focused on the reliability of the PDA when utilizing it in the clinical workplace (e.g., checking drug dosages, writing prescriptions). Participants wanted each application standardized and reliable across locations to help meet medical certification guidelines. To ease the transition to a PDA-based process, participants also suggested that the forms-based data input screens on their PDA be similar to the current paper-based forms. Finally, participants wanted to incorporate medical error reporting features into the PDA application.

Discussion

Although there was a fairly high attrition rate among the participants, we judged the overall study design and implementation a success. We were able to show that regardless of previous experience, participants were able to use the handheld computers with little training. Also, we were able to show that the handheld computers were useful for providing HR-practice-related applications and for the collection of research data for a variety of HR-related needs. Finally, we found that as a byproduct of handheld use, rudimentary job analysis data could be collected passively from the participants.

That the participants were able to use the handhelds effectively with little training and even less organizational support was an important finding. With only three training sessions provided and minimal follow-up support, most participants were able to successfully utilize the handheld hardware and applications to enhance their work. However, we found one primary support dimension lacking for the participants — integration of the handhelds with the organizational IT system. This lack of support from the IT system resulted in most of the reported usage problems in the study and was the foundation for including this factor in our model (Figure 1).

Our results did show that the handheld could be used successfully to deliver applications and collect data such as that needed for HR practice and research. The logbook application was well received and did show that standardized questionnaires could be administered over a handheld platform. The basic PIM applications were utilized in a work-related fashion and would be beneficial to capturing schedules and contacts across an organization. Finally, with access to a wireless network, the participants reported that they would have utilized

forms-based reporting of many administrative work functions. From these results, the second factor in our model in Figure 1 was supported.

Our last claim in the first paragraph of this discussion section, that rudimentary job analysis data can be collected passively from the handheld use, was a primary finding of this study and was supported through the logbook, application usage, and focus group data. The logbook data did show that the handheld computer is useful for collecting job-related information in a standardized format in real time. The application usage data did show that patterns of work-related behaviors, specific to occupation, can be inferred from the applications used by an individual. This is the linchpin in the model presented in Figure 1, that the handheld can be used to provide useful applications in the workplace (i.e., for conducting work and administering strategic HR functions), and through this use, valuable HR-related research data can be collected and utilized.

Handheld technology must be introduced with careful attention to existing workflow processes and possibly combined with process reengineering to take advantage of the mobile and wireless functions. As depicted in the Delphi sessions, there were requests for a single "system" rather than a myriad of disconnected, stand-alone applications. In general, the results from this study should be utilized as a framework for future assessments of handhelds in the workplace.

Our plans for continuing this line of research involves "process reengineering" to permit and facilitate the integration of handheld technology into the clinical and administrative processes utilized by healthcare providers. We plan to examine clinical business practices to evaluate how workflows can be modified to take maximum advantage of handheld technologies. By identifying locations in workflow processes to insert and implement handheld technologies, as well as performance measurement indicators, we will be able to evaluate the impact of handhelds on work performance.

Beyond the Current Research: HR Functions on Handhelds

Beyond the current organizational research that is utilizing handheld technology, there are additional HR functions that could be streamlined via handheld computers. These include areas within performance appraisal/management, selection, and training.

Performance Appraisal

A key concern within the performance appraisal framework, for example, has been the accuracy of the ratings provided by raters. Two proposed solutions to this concern have been frame-of-reference (FOR) training (Murphy & Cleveland, 1991) and behavioral diaries (Sulsky & Day, 1994; Maurer, Palmer, & Ashe, 1993). With frame-of-reference training, a set of raters will typically view vignettes that contain critical incidents of job performance. Each of these is designed to contain examples of outstanding, average, and unsatisfactory performance, and raters are asked to rate the behaviors within the vignettes and provide justification for their ratings. Trainers then inform the raters about what the intended ratings were supposed to be; a discussion follows to determine where there are discrepancies between the "true" ratings and the ratings the individuals provided (Keown-Gerrard & Sulsky, 2001). This calibration task then serves to provide a consistent "frame-of-reference" that is used to evaluate actual performance as it is observed and subsequently rated. In other words, a common framework is established that has been shown to increase 'interrater' agreement on performance ratings. Subsequently, this increase in interrater agreement has been shown to positively impact the accuracy of the performance ratings (McIntyre, Smith, & Hassett, 1984).

With behavioral diaries, raters keep a diary of each ratee's behavior throughout the performance appraisal cycle (Murphy & Cleveland, 1995). These do not need to include lengthy entries on a daily basis, but rather should be meaningful entries of critical incidents that can serve as retrieval cues when it is time to appraise. The rationale is that the rater will then be able to access the behaviors within the journal instead of relying strictly on memory, which can affect accuracy. Furthermore, the diaries will allow raters to establish more accurate descriptions of "typical" performance. Often times a rater can recall extreme performance (either good or bad), but often struggles to describe average performance. The diaries will allow raters to document the full range of each ratee's performance. Lastly, the diaries may help raters organize information into meaningful performance categories (DeNisi, Robbins, & Cafferty, 1989).

Unfortunately, very little technology has been utilized within the performance appraisal framework. However, the opportunities available for technology to address certain issues that can directly affect rating accuracy are limitless. For example, in frame-of-reference training, raters typically work through the initial exercise that is used to calibrate the various raters. However, over time, the raters may become forgetful of what was meant by the different levels of

performance. This could lead to a decrease in the accuracy of the ratings, which is a key concern within the literature (Murphy & Cleveland, 1991). A quick reference of the different critical incidents that define outstanding, average, and unsatisfactory performance on something like a handheld computer would be both easy for the rater and would ensure the frame-of-reference training is not lost over time. Furthermore, there may be different sets of criteria for different jobs, and all of this could be centrally located and easily accessible via a handheld computer.

A handheld computer would also be a logical choice for keeping track of a ratee's performance over the period of performance (i.e., an electronic diary). Often times, raters do not take the time to fill in their diaries, or they do not have their diaries handy when certain critical incidents occur during the period of performance. With the handheld computer, the rater would always be able to track performance; this would help in providing accurate examples during the performance review. The handheld computer would also make the categorization of critical incidents into performance dimensions a more manageable task. For example, the handheld computer would allow individuals to search, reconfigure, and crunch data quickly from anywhere (Greene, 2001). This would enable individuals to determine where more data is needed (e.g., certain performance dimensions that do not have any behavioral indicators) as well as sort the data that has already been gathered.

Specifically, a handheld computer would be valuable in both storing and retrieving information on employees which are the areas that often times impact the accuracy of the ratings (i.e., raters have difficulty retaining critical incidents on employees — and often they are responsible for multiple employees — and subsequently retrieving representative behavioral examples of performance over a set period of time). The use of a handheld computer to directly enter performance data would also eliminate the need for later manual data entry of responses written on paper forms (Fletcher, Erickson, Toomey, & Wagenaar, 2003).

Furthermore, by tracking critical incidents of ratee performance as they occur, this will also help in the development (or revising) of the performance appraisal system. The typical method for creating a performance appraisal rating form is to gather a large number of critical incidents that are then sorted into unique performance dimensions. Information contained within each critical incident is then used to define what is meant by good, average, and poor performance via specific behavioral examples (Murphy & Cleveland, 1991; Sanchez & De La Torre, 1996; Smith & Kendall, 1963). A typical problem with this type of

development of performance dimensions is that it takes several hundred (at a minimum) critical incidents to complete the process. If the critical incidents were gathered via each rater's handheld computer, as was mentioned above, a large number of critical incidents would be available that could then be leveraged in creating a group's performance dimensions. For example, each rater would be informed of how to generate critical incidents. They would then be asked to provide ratings of each incident. All critical incidents gathered from the various raters could then be grouped together to assist in the process of developing performance dimensions. This use of handheld computers would specifically assist in the gathering of examples of average performance. Often times, individuals do not have any difficulty in describing exceptionally good or exceptionally poor performance. However, as was mentioned above, it can be difficult to describe average performance. The raters who are creating the behavioral diaries should be able to document numerous instances of average performance. Furthermore, all critical incidents would be recent, which is a key element in ensuring that the performance dimensions that are created are relevant to the existing job(s).

Lastly, once the performance dimensions have been created, this information could easily be made available to each rater via a handheld computer. Each rater could make their ratings electronically, and this information could then be linked up to a central database within HR immediately. The transportability of the rating process would also benefit individuals who often find it difficult to find time to complete their ratings (which definitely influences the negative attitude that typically exists with respect to the performance appraisal process). That is, they would be able to carry their ratings around with them, reference the critical incidents as they relate to each individual's performance, and complete their ratings when it is most convenient. Lastly, the interface provided by most handheld computers is very natural (i.e., much like filling out a paper-and-pencil form) which should decrease the time needed to complete the ratings (Tseng, Tiplady, Macleod, & Wright, 1998). The various ways in which handheld computer technology can improve the current performance appraisal framework is truly limitless!

Selection

In addition to the examples with the performance appraisal domain, there are also many facets within the selection framework that could be improved by utilizing a handheld computer. From the applicant side, the application form

itself could be posted on a handheld computer. More and more companies are moving in the direction of posting application forms on a computer (Sinar, Reynolds, & Paquet, 2003), so the use of a handheld computer may be an option (especially for jobs where the use of handheld computers will be required). Furthermore, selection tests, as well as real-life scenarios contained within an assessment center or an in-basket task, could be developed and administered via a handheld device. This would contain all the benefits associated with selection tests that may already be in electronic format (e.g., automated scoring, immediate data storage, applicant profile development) as well as allow for better transportability within the selection environment (Burke, 1993). The one facet of using handheld computers in selection that would need to be further examined, though, is an individual's familiarity and comfort level with these devices. A fair amount of research has been conducted recently examining individuals' reactions to computerized testing within the selection context (Heil & Agnew, 2000; Wiechmann & Ryan, 2003), which may transfer directly to handheld computers (i.e., will individuals who are not as familiar with handheld computers be less comfortable and subsequently perform less well than those who are familiar with them?).

From the supervisor side, ratings about different applicants' performances can be made directly into a handheld computer, and analyses can be generated immediately. For example, structured interview questions (complete with rating scales) can be posted on handheld computers. Raters can then take notes directly into the handheld computer and generate ratings in real time. Furthermore, handheld computers can be used by raters to provide ratings in real time for work samples. Lastly, handheld devices allow for greater flexibility in the selection procedure than typical paper-and-pencil formats (e.g., pulling items from larger databases). This would allow supervisors the ability to pull different questions (albeit in a semi-structured format) when evaluating an applicant. Of course the issues of familiarity and comfort level are again facets that may impact the use of handheld computers by supervisors within the selection process. Furthermore, the ability to simultaneously manipulate the PDA while tracking performance (especially within a simulation) has the potential to increase the supervisor's workload rather than reduce it (Johnston, Rushby, & Maclean, 2000). Specifically, there may be certain jobs/situations where the data needs to be collected at a rate that will not make the PDA a viable option. In these instances, however, the use of a handheld computer to enter/summarize the data immediately upon completion of the exercise may still provide for richer data than are currently available.

Training

Lastly, training is an area within the personnel assessment framework that can be assisted via technology. For example, certain training courses can be offered online complete with certification exams at the conclusion of each module. More and more companies are moving to this concept of distance learning (Burgess & Russell, 2003; Kosarzycki, Salas, DeRouin & Fiore, 2003) that allows for individuals (via larger structured classrooms) to complete required training at the learner's pace. Within the online learning framework, the training can be broken down into manageable modules that are self-contained and allow individuals to complete smaller sections of training at their leisure. These self-contained modules will also provide the individual with easily accessible reference guides that they can access while on the job or in the field (i.e., examine a small section of the content that is relevant to the employee's current situation).

Technology can also play a role in providing a trainee with immediate feedback when the training is online (Goldstein & Ford, 2002). Information about a trainee's performance within a training module can be summarized in real time, and the trainee will be able to understand where follow-up training is needed (and potentially be directed to specific locations that can provide the trainee with detailed information in their weak areas). For example, the trainee would be able to complete a module of training and an online assessment that measures their knowledge based upon the training. The trainee would then be provided with feedback that demonstrates their strengths and weaknesses on the subject matter, and be provided with references that would allow them to review areas where they are deficient. Again, with the use of handheld computers, all of this information could be directly at their fingertips.

Discussion

In this chapter, we have provided a conceptual model of integrating handheld computer technology into HR research and practice, with ties to IT infrastructure. We have presented research supporting our model and described topics for additional empirical work and application in this area. It was not our goal to present only positive aspects of handheld computer technology as related to

HR, although many of our results have been positive and we find the potential for research is exciting. In order to provide a balanced view, we put forward in this Discussion section the most salient negative aspects of utilizing handhelds in HR research and practice.

One of the primary issues regarding new technology is cost. As is true of all current technology solutions, costs are ever changing and, for the most part, diminishing. At the time of publication of this chapter, handheld computer hardware with sufficient capacity to handle the tasks we describe were available for less than US$200 each. The necessary software for performing HR activities on handheld computers varies in scope/price and is often custom built by an organization's MIS department. Also, much of the software infrastructure necessary for implementing handheld computers already exists in an organization's IT system. However, cost will continue to be a major consideration for using handhelds in HR research and practice.

A related issue to new technology implementation is the potential for using "technology for technology's sake." One of the main findings from our research was that in a high-stakes, fast-paced profession that relies heavily on forms, such as the U.S. medical field, handheld computer technology provided several benefits over paper-based solutions and was not viewed by our participants as "technology for technology's sake," but rather technology for the sake of improved patient care. The benefits identified by our focus groups included time savings in critical situations (e.g., emergency room situations) and increased accuracy of job performance.

However, it will be important to revisit this issue in other settings, for the factors identified as benefits in our research setting (i.e., U.S. medical field) may not outweigh the perceived costs in other settings (e.g., other cultures, other professions), where personal interaction is the most important process variable and the handheld computer is perceived as an impediment to this interaction. While our findings replicate those from other U.S. medical settings, such as at Baptist Health (Extended Systems, 2004), St. Vincent's Hospitals, and the University of Miami School of Medicine (Clarinet Systems, 2004, 2004a), little empirical work is currently available from other professions or cultures.

A final issue related to technology in general and specifically the use of handhelds by professionals as a means of accomplishing their work is that of resistance to technology by the professionals themselves. According to research in the U.S. medical field, this does not appear to be a problem. For example, Manhattan Research (Miller, 2004) has found that approximately

two-thirds of practicing physicians are currently using a handheld computer in their work and they expect that number to increase drastically as hospitals increase supporting IT infrastructure. These professionals find the handhelds to be one answer to problems created by ever-increasing needs for services often accompanied by decreases in available staff resources. However, differences in reaction to and adoption of handheld technology will be found at the individual, organizational, occupational, and cultural level, requiring additional research on these moderating variables and their impact on the potential value of handhelds as an HR research and practice tool.

Future Opportunities for Handheld Computers in e-HRM

As we pointed out in an earlier section, opportunities abound in this area for both research and application. As the technology continues to improve and expand, the limits to new research on handheld computers in HR will be bounded only by a lack of ideas and resources. Few researchers outside the IT community are currently examining the impact of handheld computers on work at any level, and we propose that this situation leaves us (i.e., HR practitioners and researchers) as spectators in a game we know much about and that would benefit from our direct participation.

As is the case for many organizational research topics, access to data will be an issue, as will security risks and personal privacy issues (particularly with increased use of wireless access). On the other side of the security coin, handhelds are becoming increasingly popular as security enhancements. For example, HP's wireless iPAQ Pocket PC 5500 currently has thermal biometric fingerprint authentication technology capability. It is reasonable to assume that for some organizations, handhelds will become wireless security badges that identify the carrier of the device to the organization's network. The 21st century has brought a heightened awareness of security in organizations around the globe, the impact of which on individuals has not yet received sufficient attention from researchers. The handheld computer provides a platform for gathering diary and behavioral data for forwarding this research.

We anticipate major improvements and widespread implementation of wireless networks within the near future, with resulting implications for worker mobility,

availability, and communication. These factors will impact the way we plan work schedules, conduct meetings, share organizational data, and balance work with life. There are a multitude of research questions — both basic and applied — that will be generated from this single facet of implementing mobile handheld computer technology.

We predict that handheld technology in some form, be it PDA, tablet computer, cell phone, or a platform yet to be released, will become a standard component of organizational IT systems — with or without input from HR practitioners and researchers. If we provide our input as the systems and applications are being developed, we stand to gain an excellent opportunity to integrate research opportunities into a system of HR-related applications. As we found in our research, handheld computer use provides both a platform for research and a rich data source.

We hope that this chapter has provided a basis for moving HR practice and research on handheld computers ahead in a focused manner, possibly using the conceptual model presented in Figure 1 as a basis. We also hope that our empirical work will be an impetus to others in the field to conduct additional laboratory and applied research to provide empirical tests of our model. The need for basic human factors research continues to exist as new handheld programs are written and applied in new ways. And the potential for applied research for handheld computer technology within organizations is immense.

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Endnotes

1 The generic "handheld computer" refers to Personal Digital Assistants of all types, including the currently popular Pocket PC and Palm Pilot models.

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