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The Impact of Online Mobile Office Applications on the Effectiveness and Efficiency of Mobile Workers Behavior: A Field Experiment in the IT Services Sector

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THE IMPACT OF ONLINE MOBILE OFFICE APPLICATIONS ON THE EFFECTIVENESS AND EFFICIENCY OF MOBILE WORKERS' BEHAVIOR: A FIELD EXPERIMENT IN THE IT SERVICES SECTOR

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Abstract

The wireless application protocol (WAP) is an example of technology that has found itself "stuck in the middle." Its introduction is not a clear success, especially when compared to the high expectations during its launch at the end of the 1990s. However, it is not dead. There is a significant number of users, and the telecommunications and content industry continue to invest. The interesting phenomenon is that "nonbelievers" say, "We don't need WAP," and that "believers" say, "Wait until we have resolved the technical problems."

This paper discusses a field experiment that tested the hypothesis that mobile workers benefit from a specific kind of WAP technology: the mobile office. In an 8-week pilot, 40 mobile workers of an IT services company in the Netherlands received a WAP phone providing them with mobile access to their agenda, mail, directory services, outstanding invoices information, and resource availability. They could also access public information services such as stock market information, weather forecasts, and traffic information. For research purposes, we distinguished two groups of workers: relationship managers and technicians. We expected that relationship managers would benefit more from their WAP phone than technicians.

During the 8-week period, all participants were closely monitored on a daily basis. We collected data on perceived usefulness and on the impact of using the mobile office on the efficiency and effectiveness of the work of relationship managers and technicians. The results show a clear increase in perceived usefulness and also in effectiveness, especially for relationship managers. In our discussion section, we argue there is indeed hope for the believers. Mobile workers have a positive attitude towards WAP if it brings their working environment within reach at any place. As the initial focus for WAP application was on mass private market services, this may explain the initial lack of success of WAP.

1 INTRODUCTION

For more than 100 years, society has used the public switched telephone network—the telephone—to talk to each other. In the last decades, we have increasingly used it for other services than this basic voice service. When we are using a fax or a modem, we actually get data services. These data services are a commodity nowadays and are a market by itself, with its own networks and service providers.

There seems to be a similarity for the mobile phone, although the timeframe is much shorter. Mobile phones were quite rare until 1993. In that year, cellular networks were introduced based on digital standards such as GSM. In 2001, Dataquest stated that

the number of mobile phone users grew exponentially, from 0.3 million in 1994, to 300 million in 2000. In analogy with the fixed net, the "killer application" was voice. The use of data services was limited to SMS, the short message service. Although especially teenagers frequently use SMS to send short messages to each other, SMS revenue is significantly lower than revenue from "normal" telephone calls. In terms of pull and push factors for innovation (Zmud 1984) we conclude that the driver for innovation is primarily a push by the telecommunications industry.

With the clear success of data services on the fixed net in mind, the mobile standardization group (WAP Forum) has developed a protocol that enables Internet on a mobile phone. This wireless application protocol (WAP) contains a simplified form of HTML allowing the display of Web-pages on the small screen of a mobile phone. This is one of the most important limitations of WAP (DeZoysa 2001).

Marketing budgets were very high when WAP was introduced in 1999. A hype was created that lasted until 2000. As *The Banker* reported,

> The hype has grown to a point where, according to Roy Smith, managing director at Brokat: "Banks are buying WAP servers despite not knowing what WAP is or how it will help their organization." He adds that banks do not want to make the same mistakes as in the past with the Internet—being in the game too little and too late.

The WAP killer application has yet to be found. This holds especially for the mass private market which clearly did not react very enthusiastically to applications such as stock market information, weather forecasts, and traffic information. *The Financial Times* (2000) reported a low demand for mobile phones linked to the Internet:

> Fewer than one in 50 UK adults are using mobile phones to access Internet services despite millions of pounds spent on advertising and subsidizing handsets, according to new research. Consumer campaigns promoting WAP, the current mobile Internet technology, have been branded "worse than a waste of money" by critics because of WAP's technical shortcomings.

For a WAP application in the business market, we studied perceived usefulness and the impact on effectiveness and efficiency of the work of relationship managers and technicians. The research described in this paper is carried out within a large IT services company. In 1999, the management of this company realized that WAP was only approached from a consumer perspective. The questions corporate clients of the IT services company were asking their IT services providers were: Do we need WAP? What are the costs? Is it a worthwhile investmentment? What are the benefits for my business? No data was available and, for that reason, management decided to start a WAP pilot to investigate if a mobile office would provide significant benefits for mobile professionals.

In section 2 of this paper, we explore the literature on the adoption of new technologies and the definition of *mobile professional*. In section 3, we introduce our problem statement and hypotheses. Section 4 describes the experimental setting. In section 5, we describe the results. The paper concludes with a discussion (section 6).

2 LITERATURE OVERVIEW

2.1 The Adoption of New Technology

The adoption of new technology is a topic that has been researched for many years (Burns and Stalker 1968; Daft 1978; Daft and Weick 1984; Pierce and Delbecq 1977; Rogers 1983; Tornatzky and Klein 1982).

Fichman (1992) provides a review of empirical research on information technology diffusion. In his vision, diffusion theory provides a useful perspective on how to improve technology assessment, adoption, and implementation. "However," he states, "much of diffusion theory was developed in the context of adopters making *voluntary* decisions *to accept or reject* an innovation based on the benefits they expect to accrue from their own *independent use* of the technology." This context does not hold completely for many IT adoptions, including the mobile office. Based on the business and IT strategy, companies may decide to invest in mobile office solutions to change work practices and business processes. Then usage becomes mandatory. The individual employees do not have the choice to use or not to use the mobile office.

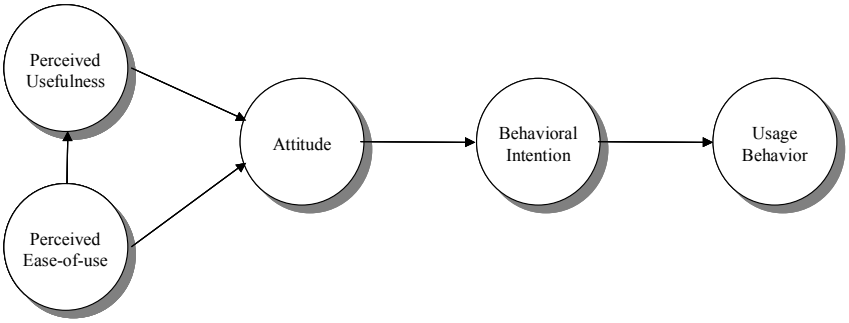

Figure 1. Technology Acceptance Model (TAM) (Davis 1989)

Kwon and Zmud (1987) have developed a comprehensive framework for studying organizational adoption and diffusion. Their framework defines five contextual factors: user community characteristics, organizational characteristics, technology characteristics, task characteristics, and environmental factors. These factors will be used to describe the experiment in section 4. Davis et al. (1989) investigated the current use and actual future use of a word-processing package by MBA students. This research is based on Davis' technology acceptance model (TAM; see Figure 1) (Davis 1989). They found that perceived usefulness and ease of use have a significant direct effect on behavioral intentions. They also found that behavioral intention to use is significantly related to actual self reported use.

Fichman distinguishes two classes of technologies: type 1 and type 2. Type 1 technologies are characterized by a lack of user interdependencies and a lack of substantial knowledge burden on would-be adopters. Type 2 technologies, by contrast, are characterized by high knowledge barriers or significant user dependencies. Fichman also distinguishes two loci of adoption: the individual adoption and the organizational adoption. Individual adopter studies are usually confined to a single organization. Typical dependent variables are binary adoption/non-adoption, time of adoption, and frequency of use. Organizational adoption studies look at adoption by large aggregates, such as companies. Typical dependent variables here include binary adoption/non-adoption and stage of implementation. The TAM model is useful for what Fichman calls "individual adoption of type 1 technologies." He remarks that there are many parallels between diffusion theory and TAM. The TAM model has been applied successfully in several individual adoption of type 1 technologies studies.

Leonard-Barton and Deschamps (1988) discuss *managerial influence* in the implementation of new technology. Diffusion can be encouraged or discouraged, implicitly or explicitly, and it can be mandated (Moore and Benbasat 1991). Studies of individual adoption within organization settings should, therefore, either incorporate managerial influences into the analysis or rule them out as a potentially confounding factor.

2.2 Classification of Mobile Professionals

In this research project, we investigated the influence of the mobile office application on the behavior and effectiveness of two types of workers within the IT services company: relationship managers and technicians.

Iacono et al. (1995) discussed the nature of the job of the relationship manager. The relationship manager had to manage the relationship between user groups and the central information systems unit. After investigating the actual work practices of four relationship managers in four different industries, Iacono et al. concluded that the relationship managers acted more like real entrepreneurs, not intermediaries. They did not simply pass client information to the central information systems unit. Instead, they actively structured this unit and induced clients to see and understand backstage operations, which worked to the benefit of inter-functional efficiency and effectiveness. Similarly, our research focused on the work of the relationship managers. We studied the effect of the mobile office on the efficiency and effectiveness of relationship managers' work, and how this shapes their subsequent perceived usefulness of the technology.

The other group of workers that we investigated, the technicians, are not that mobile. They work mainly in the back office at a limited number of different locations per day, and have the task to deliver what has been agreed between the client and the relationship manager. They are IT professionals who are expert on a particular IT field, such as project management or consultancy. Some of them work on several projects at the same time. This results in mobility but the mobility is not as high as the mobility of the relationship manager. Table 1 summarizes the characteristics.

Table 1. Charactestics of Relationship Managers and Technicians

	Relationship Manager	Technician
Goal	Increase revenue, profit, and customer satisfaction	Execute contracted work and customer satisfaction
Location	Clients and back office	Back office and clients
Mobility	More than two locations per day	One or two different locations per day
Priority	1. Front office 2. Back office	1. Back office 2. Front office
Task	Balance between user groups and backstage: 1. Discuss and contract new business with client 2. Find right technicians to deal with clients' demand 3. Implement contract within own organization	Deliver and/or manage IT applications: 1. Execute contracted work 2. Manage other employees involved in the execution of contracted work 3. Discuss operational issues with clients
Orientation	Commercial orientation	Technical orientation

3 HYPOTHESES

3.1 Research Model

As mentioned above, we set out to explore the effects of the mobile office on the efficiency and effectiveness of professionals and how these effects, in turn, may influence the way professionals perceive and use the technology. In terms of the TAM model, we can say that our research focuses essentially on the perceived usefulness construct. We investigate how it may be influenced over time by practical experiences with the mobile office technology.

In our field test, we measured the perceived usefulness prior to the experiment and after the experiment (hypotheses 1 and 2). We also measured the performance effects after the experiment (hypothesis 3). During the experiment we also measured which part of the WAP application is used most, the usage of the application during the day, and the number of logins. In our research model, these findings are linked to *actual use of the WAP application*. Our research model is detailed in Figure 2.

We expected a feedback loop from performance effects to perceived usefulness (see the dotted line in Figure 2). We expected that a positive experience would result in a higher perceived usefulness. This is explained in more detail in the discussion section.

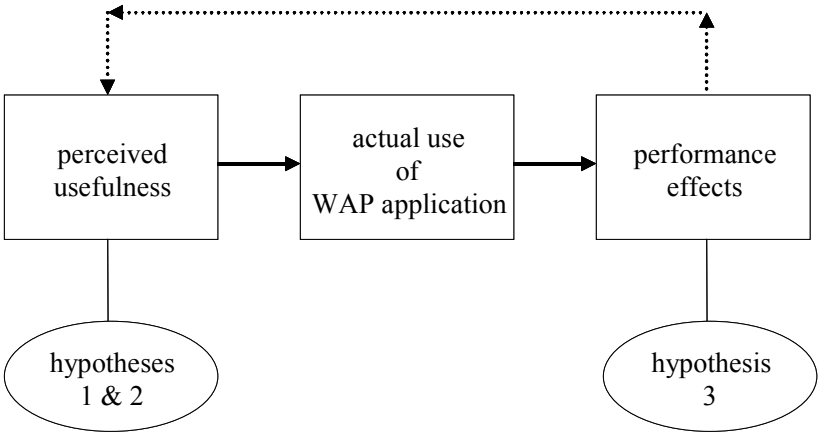

Figure 2. Research Model

3.2 Perceived Usefulness Prior to the Experiment

The participants of the pilot were volunteers: they reacted on a call for participation that was published on the internal news of the company. We measured their perceived usefulness of the proposed WAP solution at the outset. The mean value of perceived usefulness[1] was 6.39. A possible explanation for this relatively high score is that the participants were volunteers.

Given our earlier discussion about the work of relationship managers compared to the work of technicians, we expect a more positive attitude with the relationship managers than with the technicians:

H1-1: *The level of perceived usefulness of the relationship managers at the beginning of the experiment will be higher than the level of perceived usefulness of the technicians.*

3.3 Perceived Usefulness after the Experiment

For the whole population, we test the following hypothesis:

H2-1: *The perceived usefulness after the experiment will be larger than the perceived usefulness at the beginning of the experiment. We make a distinction between relationship managers and technicians.*

H2-2: *The perceived usefulness after the experiment of relationship managers will be higher than the perceived usefulness of technicians.*

H2-3: *The increase in perceived usefulness during the experiment will be larger for relationship managers than for technicians.*

3.4 Performance Effects

The following hypotheses deal with the effectiveness and the efficiency of the work that is carried out by the participants. To measure effectiveness, we asked participants to indicate on a 10-point scale the degree to which they had made better decisions thanks to the mobile office environment. To measure efficiency, we asked them if the mobile office environment saved them time during the experiment. The questions were phrased as follows: Please indicated if using the mobile office has benefitted your decision making. Please indicated if using the mobile office has resulted in time savings. Both questions also had an extra question attached, in which the participants were asked to be more specific: What decision? How much time? This allowed us to check the validity of the measurement.

H3-1: *The increase in effectiveness will be higher for relationship managers than for technicians.*

H3-2: The increase in efficiency will be higher for relationship managers than for technicians.

4 THE EXPERIMENT

We used the framework of Kwon and Zmud (1987) for describing the experiment. They have identified user community characteristics, organizational characteristics, technology characteristics, task characteristics, and environmental factors for the adoption of new technologies.

Organizational characteristics: The IT supplier is a global player with a European focus. The company employs about 28,000 people worldwide. Sultan and Chan (2002) provide factors to describe the ability to adopt new technologies. The IT supplier's culture is supportive of adopting new technologies and less risk averse toward technological changes. The management is also

[1]The question was phrased as follows: Please indicate the perceived usefulness of the proposed WAP solution on a scale of 1 to 10.

stimulating the adoption of new technologies. In terms of Moore and Benbasat (1991), the employees of the IT supplier are encouraged by their management to use the new technology— in this experiment,the mobile office.

Task characteristics: The task characteristics were detailed in section 2, the classification of the mobile worker. The tasks of the relationship manager are focused on the relationship with their customers. This requires frequent communication and interaction any place, any time. The tasks of the technician are focused on implementing and managing IT services. This requires communication and interaction that is more location and time related.

Environmental factors: The experiment was conducted within the operational environment of the IT services company. This implied that real employees were part of the experiment, and that a real IT environment was used for the implementation. This placed high demands on the set-up of the experiment because no harm could be done to any operational process. The ICT services company has a strong focus on client needs, and on following strict procedures regarding security and safety. This required a very detailed experimental design, including all risks and ways to deal with them.

Technology characteristics: For many corporations, information security is a key issue, and the company under investigation in this research project is no exception. These security issues mean that it is not easy to give new devices access to the corporate infrastructure, especially when the devices use the public mobile telephone network infrastructure and the public Internet to access corporate data.

From an implementation perspective, security was indeed the biggest challenge. Figure 3 shows the architecture that was designed. The WAP phones use the GSM network to access the WAP gateway operated by the telecom operator. The public Internet is used to access the corporate environment of the IT services company. In 1999, a security rule existed forbidding access to the company intranet from another IP address. To overcome this problem, an exception was created in the firewall of the IT services company that allowed traffic from one particular IP address (the WAP gateway of the telecom operator) to pass through. The chief information officer of the IT services company allowed this potential leak for the duration of the pilot (8 weeks) with frequent control for unauthorized access attempts.

Traffic going through the firewall of the IT services company that is recognized as "WAP-traffic" is passed to a dedicated WAP application server. This application server deals with all requests and contacts the underlying applications. Table 2 gives an overview of the available applications.

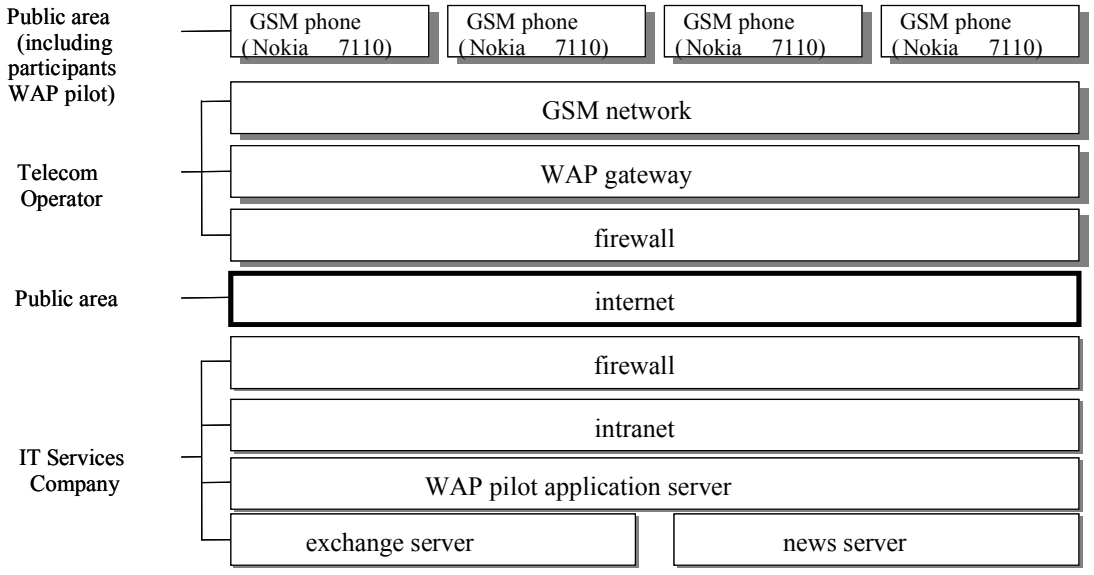

Figure 3. Architecture of the WAP Pilot

Table 2. Overview of WAP Applications Available and Their Benefits

Application	Benefits
E-mail	More immediate response to both the front and the back office
Calendar (agenda)	Enable carefulness in making appointments and enable making on line appointments by both the participant himself/herself and the secretary
Who's who (the internal phone book listing all 30.000 colleagues and their skills)	Enable quick response to back office, and to contact the right person
News on the intranet	Enable communication of success, pending questions and ways of working

To get access to the mobile office, the participant had to go through the following procedure:

1. The participant connects to the WAP gateway of the telecom operator via the GSM network
2. The participant selects the URL of the company and establishes contact with the WAP portal of the company
3. The participant types in his or her user ID
4. The participant enters his or her company network password

This procedure took about 2 minutes. All login attempts and usage of the applications were logged automatically, for the sole purpose of an anonymous analysis.

User community characteristics: An announcement was placed on the internal newsletter that called for participation in the WAP pilot. The newsletter stated the requirements for a potential participant:

- Must be either a relationship manager or a technician
- Generally visiting two or more different addresses on a typical working day
- Shared access to their own agenda, so others can read it or write in it (usually the secretary of the participant)

A positive reaction came from 278 qualified people, of which 62 were relationship managers and 216 were technicians. Twenty people were selected at random from each group. These 40 people filled out a questionnaire with questions about their work and about their expectations of the pilot.

All participants received a WAP phone. This phone has a somewhat larger screen than a "normal" phone with four 20-character lines and is enabled for WAP use. A 2 hour instruction was given to deal with the data security issue and to show how the applications worked.

5 RESULTS

5.1 Perceived Usefulness Prior to the Experiment

Table 3 provides the means and variances of the dependent variables. Table 4 provides the results of the ANOVA tests (5 percent significance level) for the hypothesis H1-1.

Table 3. Results of Perceived Usefulness Prior to the Experiment

Nr	Dependent variable	Mean	Variance
R1	Prior Perceived Usefulness (all participants)	6.39	2.38
R2	Prior Perceived Usefulness (relationship managers)	6.57	2.59
R3	Prior Perceived Usefulness (technicians)	6.21	2.18

Table 4. Tests of Perceived Usefulness Prior to the Experiment

Hypothesis	Test	F	P	Significance
H1-1	R2>R3	0.44	0.51	Not significant

The participants, both the relationship managers and the technicians, seem to have a positive level of perceived usefulness prior to the actual experiment. But the results are not significant.

The mean for relationship managers is higher than for technicians, but the difference is not significant.

5.2 Perceived Usefulness after the Experiment

Table 5 provides the means and variances of the dependent variables. Table 6 provides the results of the tests for the hypotheses H2-1, H2-2 and H2-3.

Table 5. Results of Perceived Usefulness After the Experiment

Nr	Dependent variable	Mean	Variance
R4	Perceived usefulness (all participants)	7.29	1.91
R5	Perceived usefulness (relationship managers)	7.92	2.38
R6	Perceived usefulness (technicians)	6.61	0.59
R7	Increase in perceived usefulness (relationship managers) <R5-R2>	1.78	2.80
R8	Increase in perceived usefulness (technicians) <R6-R3>	0.46	1.27

Table 6. Tests of Perceived Usefulness After the Experiment

Hypothesis	Test	F	P	Significance
H2-1	R4>R1	8.98	0	Significant
H2-2	R5>R6	7.65	0	Significant
H2-3	R7>R8	5.73	0	Significant

The perceived usefulness has significantly increased during the experiment. The perceived usefulness of the relationship managers is significantly larger than the perceived usefulness of the technicians. The increase in perceived usefulness of the relationship managers is also significantly larger.

5.2 Performance Effects

Table 7 provides the means and variances of the dependent variables. Table 8 provides the results of the tests for the hypotheses H3-1 and H3-2. Since we did not have a control group in our research, we could not properly test hypotheses referring to an increase in effectiveness and efficiency. However, we openly asked experiment participants (on a scale of 1 to 10) the extent to which they experienced an increase in effectiveness and efficiency. Their responses yielded relatively high scores (see Table 7), which suggest there was indeed an increase. This supports the notion of a positive feedback loop from performance effects to perceived usefulness as shown in Figure 2.

Table 7. Results of Performance Effects After the Experiment

Nr	Dependent variable	Mean	Variance
R9	Increase in effectiveness (all participants)	6.60	1.54
R10	Increase in effectiveness (relationship managers)	7.16	1.25
R11	Increase in effectiveness (technicians)	6.05	1.27
R12	Increase in efficiency (all participants)	6.82	3.57
R13	Increase in efficiency (relationship managers)	6.65	2.38
R14	Increase in efficiency (technicians)	7.05	4.16

Table 8. Tests of Performance Effects

Hypothesis	Test	F	P	Significance
H3-1	R10>R11	9.19	0	Significant
H3-2	R14>R13	0.46	0.5	Not significant

The increase in effectiveness is higher for relationship managers than it is for technicians. The difference is significant and confirms our hypothesis (H3-1).

With respect to the other hypothesis (H3-2), it is interesting to note that the mean of the relationship managers is lower than the mean of the technicians. This appears to be just the opposite of what we expected. The finding, however, is inconclusive because the difference between the means is not significant.

5.4 Other Results

During the experiment, we logged what applications were used and when. Figure 4 shows the division of the total usage over the available applications for the last week. E-mail is clearly used the most, but the least used application (who's who, the company's phone directory) is still used quite often.

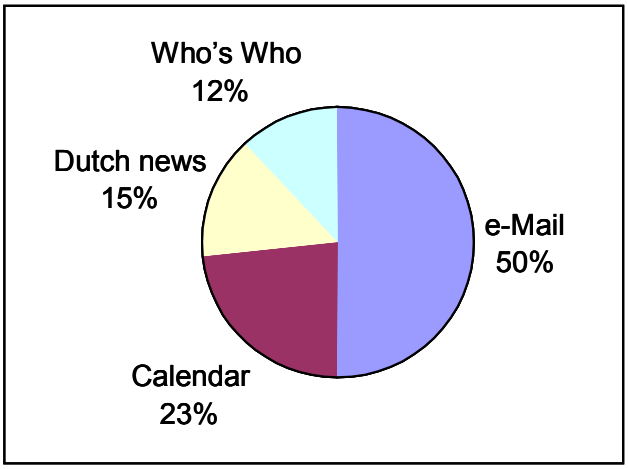

Figure 4. Usage Breakdown by Applications

When we look at the usage over the day (Fugre 5), a clear peak can be seen at 9:00 a.m. What is quite surprising is that usage in the evening hours is also quite significant.

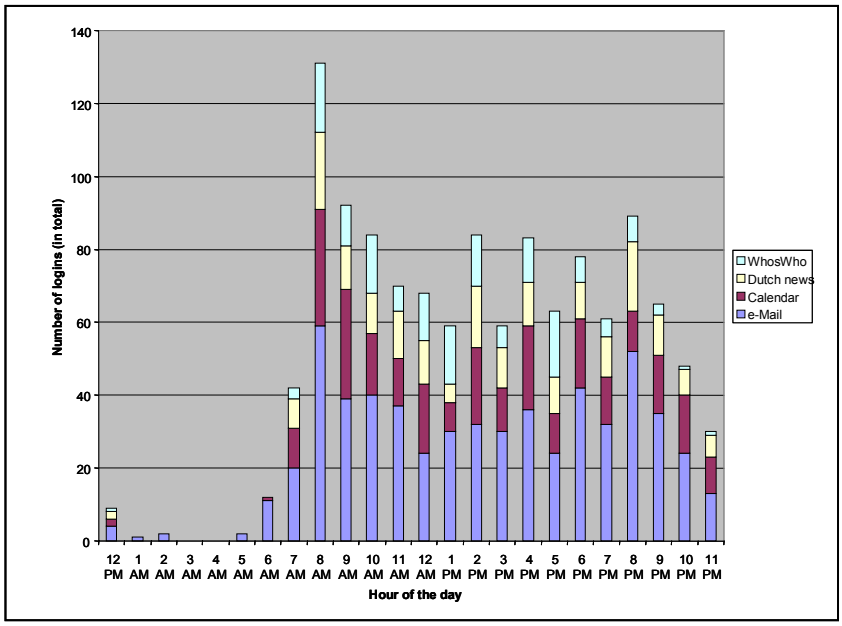

Figure 5. Usage During the Day (Average of the Last Week of the Experiment)

Per user, the number of logins per week is also measured. Figure 6 deals with the last week of the pilot.

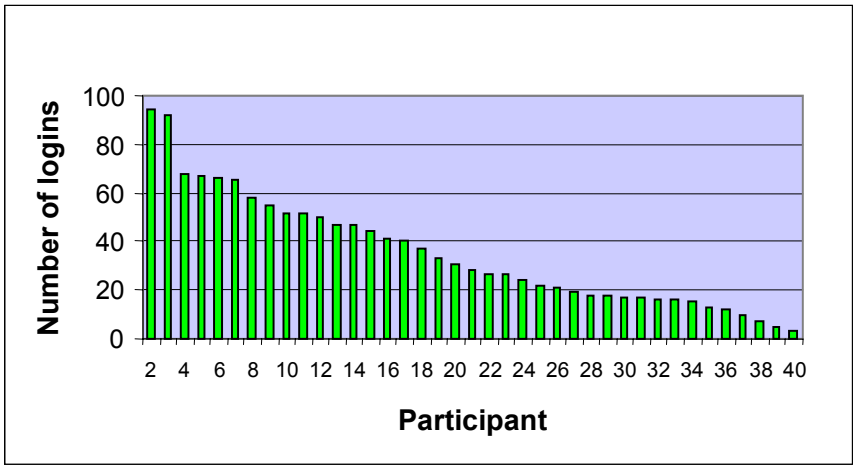

Figure 6. Usage per Participant in the Last Week of the Experiment, Sorted by Number of Logins
(The most active participant (nr. 1) has logged in 93 times in that week.)

6 DISCUSSION

After 8 weeks of using the mobile office, the perceived usefulness is significantly higher than before the actual use. This may sound like good news for the believers in this kind of technology: people start to like it when they are actually able to use it. The difference with WAP as it was presented to and received by the mass private market is remarkable compared to the business market that we researched. WAP's apparent lack of success has traditionally been attributed to technical shortcomings (e.g., small screen, slow connection). Our research shows, however, that a WAP phone that brings a professional his own office environment

seems to compensate for the technical deficiencies. It should be noted, in our case, that the participants did volunteer for the experiment, and that they were receptive to new technology. Still, after the experiment, many of the participants indicated on the written survey that, "It did help me much more than I had expected." We measured the performance effects of using the mobile office: efficiency and effectively. The performance effects for both the relationship managers and the technicians were relatively high. These scores will probably impact future scores on perceived usefulness when the participants will participate again in a project for WAP applications. In our research model (see Figure 2), we mentioned a feedback loop. The existence of such a positive feed feedback loop is supported by the average overall final mark of 7.36 for perceived usefulness at the end of the experiment. We thus conclude that it is useful to investigate the possibilities of WAP applications for the business market.

The results indicate that relationship managers are more positive about the technology than technicians. This is in line with our original expectation. There is strong evidence that this has to do with the improved effectiveness: relationship managers felt that they were able to make better decisions using the mobile office. Efficiency considerations seem to be less important to them. For the technicians, it seems that saving time is relatively more important, although this requires more research to test. The final survey shows that technicians were not significantly convinced that the time-saving characteristic of the mobile office has anything to do with the lengthy logon procedure and the slow connection. This has to do with security challenges on one hand, and network characteristics on the other. The first challenge requires a mind-shift for the information managers of large corporations: they will have to configure their firewall in such a way that mobile devices can pass through. The second challenge will be resolved by the next generations of mobile data, GPRS and UMTS.

We conclude that the characteristics of the participants influence the performance effects of the WAP application. This is supported by the different scores of relationship managers and technicians. We suggest that it is worth investigating the link between the characteristics of the participants and the performance effects of the WAP application in order to identify characteristics of participants that really benefit from WAP applications.

For companies that have to decide on implementing a mobile office environment for their employees, the experiment helps in defining the target employees, the target applications, and the targeted effectiveness and efficiency gains. Further research is required to determine if a solid business case can be developed for such a large-scale implementation. The reactions of the participants of the experiment are encouraging. Maybe the business market will provide the killer application for the proliferation of mobile data.

In our research, we only investigated one WAP application, the mobile office. An interesting research question is to identify the characteristics of useful WAP applications. In our research, the participants were able to use only a mobile phone. The participants faced serious technical limitations with this device mainly because of the small screen. Future research is needed to investigate the usefulness of other devices, such as PDAs.

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