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A Study of Task Characteristics and User Intention to Use Handheld Devices for Mobile Commerce

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ABSTRACT

Interface design and the selection of appropriate tasks for small-screen mobile applications are issues critical for mobile commerce. Our earlier research has identified five major task factors that may influence user intention to use handheld devices for wireless applications. These factors are: perceived ease of use, perceived usefulness, perceived playfulness, perceived task complexity, and perceived security. We followed up with a questionnaire-based empirical study to validate the relative impact of these proposed task factors on user intention to use handheld devices for mobile commerce. This paper confirms significant correlations between the task factors and user intention. However, only three of the five factors -- perceived usefulness, perceived security, and perceived playfulness -- are important to user intention, explaining 30% of the variations in a multiple regression model. This study makes a unique contribution to HCI and MIS research by providing empirical evidence of user perception of task characteristics for mobile commerce.

Keywords

Task characteristics, mobile commerce, wireless handheld devices, usability study.

INTRODUCTION

The convergence of mobile Internet and wireless communication technology has promised users anytime, anywhere access of information for work and personal communication. Such opportunities include mobile services that support m-commerce transactions and process facilitations for managing personal activities, mobile office, and mobile operations. However, small screen display, limited bandwidth, and the multiple functionality of handheld devices hinder such access.

Researchers suggest that interface developers need to consider the interaction among the interface design of user tasks, form factors, and application objectives (Chan, Fang, Brzezinski, Zhou, Xu and Lam, 2002). M-commerce assumes that users primarily access the Internet or wireless applications either on the move, or while stationary but away from office or home. Since mobile users can spare only limited time and cognitive resources for performing a task, the choice of mobile

applications is important. Anckar and D'Incau (2002) suggest that services emphasizing mobile values, meeting time-critical and spontaneous needs are more suitable for wireless devices. In designing tasks for m-commerce applications, it is essential to determine which tasks are suitable for wireless applications (Chan and Fang, 2003).

The objective of this paper is two-fold. First, it intends to validate the relationship between five task factors and user intention to use handheld devices for wireless applications. The five factors are: perceived ease of use, perceived usefulness, perceived playfulness, perceived task complexity, and perceived security (Xu, Fang, Chan and Brzezinski, 2003). Second, the study intends to investigate the causal relationships between the five proposed task factors and user intention to perform tasks on wireless handheld devices. This study makes a unique contribution to usability studies for small-screen mobile devices and mobile commerce by empirically examining task factors and their relative importance on user intention in performing mobile tasks.

BACKGROUND LITERATURE

Usability research in mobile commerce is a new area. Based on a study of 19 novice wireless phone users who were closely tracked for the first 6 weeks after service acquisition, Palen and Salzman (2002) describe the wireless telephony system as having four socio-technical components: hardware, software, "netware," and "bizware." They indicate that each of these four components must have a user-friendly design. Their research recommends a systems-level usability approach. Perry, O'Hare, Sellen, Brown and Harper (2001) present a study of mobile workers that highlights remote "anywhere, anytime" access of information and individuals. They identify four key factors in mobile work: the role of planning, working in "dead time," accessing remote technology and informational resources, and monitoring the activities of remote colleagues. In a study aiming to understand how mobile web access affects home Internet usage, McClard and Somers (2000) have investigated the household integration of tablet computers and the defined user requirements for similar devices. They suggest that an Internet appliance intended for general web access and text-based communication must have three characteristics: 1) Software must contain features that are perceived as useful; 2) The device must

be highly portable and comfortable to use; 3) The screen and keyboard of the device must be large enough to be usable. McClard and Somers also identified the top three preferred tablet features: 1) surfing the Web, 2) Internet availability anywhere in the home, and 3) email. These studies have yielded some general guidelines regarding appropriate tasks for wireless applications.

User adoption of technology applications focuses on tasks and its fit with selected technologies. An essential goal of m-commerce is to identify mobile values for individual users. Anckar and D’Incau (2002) present a framework that differentiates between the values offered by wireless Internet technology (wireless values) and the values arising from the mobile use of the technology (mobile values). Convenience, cost savings, and cell phones best represent wireless values. Services that deliver strong mobile values would make m-commerce a dominant channel. These services meet the following five types of user needs: 1) time-critical needs and arrangements; 2) spontaneous needs and decisions, such as auctions, email, and news; 3) entertainment needs; 4) efficiency needs and ambitions; and 5) mobility related needs. A consumer survey based on this framework reveals that email, routine bank services, and booking theatre tickets are among the most desired mobile services (Anckar and D’Incau, 2002). Desired mobile services also include restaurant reservations, calendaring and alert services, and access to news sources. Fewer than 30% of the respondents were interested in services involving transactions, such as online purchasing. Since this survey did not require participants to have experience with mobile services, discrepancies might exist between user’s expectations and responses based on task experience.

These research findings suggest that an understanding of user preferences and perceived values of mobile tasks is essential for improving the usability of mobile tasks. Towards this goal, we have conducted an exploratory study that involved interviews of 37 participants upon completion of an observation experiment (Xu et al., 2003). Stemming from these interviews are five factors that would affect the preference of tasks to be performed on wireless handheld devices. These factors are perceived ease of use, perceived usefulness, perceived playfulness, task complexity, and perceived security.

HYPOTHESES

In our current research, we undertook a questionnaire-based empirical study to validate the five hypotheses proposed earlier (Xu et al., 2003):

- Hypothesis 1: Higher perceived ease of use of a task performed on wireless devices will result in higher user intention to perform the task.

- Hypothesis 2: Higher perceived usefulness of a task performed on wireless devices will result in higher user intention to perform the task.
- Hypothesis 3: Higher perceived playfulness of a task performed on wireless devices will result in higher user intention to perform the task.
- Hypothesis 4: Higher perceived complexity of a task performed on wireless devices will result in lower user intention to perform the task.
- Hypothesis 5: Higher perceived security of a task performed on wireless devices will result in higher user intention to perform the task.

METHODS

Participants

The research team recruited 101 participants for the experiment. The majority of these participants were working adults. Some were alumni of a Midwest university while others were still enrolled at the time of their participation. The participants represented a very diverse group. Their ages ranged from about 20 to 50 and there was a wide representation of different cultures and races. Their experiences with handheld devices also varied. Of the participants: 97% had used wireless phones before and 75.2% used wireless phones on a daily basis; 22.8% had used Pocket PCs before and 8.9% used the device on a daily basis. For Palm Pilot, 19.8% of participants used Palm Pilot daily, 13.9% weekly, 4% monthly, 26.7% rarely, and 35.6% had never used this type of device previously, so the participants included both novice and experienced users of Palm Pilot.

Tasks

Participants were asked to evaluate task characteristics of each of the twelve tasks in five aspects: perceived ease of use, perceived usefulness, perceived playfulness, task complexity, and perceived security. At the end of the experiment, participants rated their intention to perform each task in the future using a wireless handheld device. To ensure that the resulting model was generalizable, task selection considered two requirements: 1) the tasks must be realistic and cover a wide range of possible mobile applications on handheld devices and 2) the tasks must have diverse characteristics. Accordingly, twelve tasks were selected for this study: 1) managing an address book, 2) sending/receiving email, 3) checking flight information, 4) purchasing movie tickets, 5) reading news, 6) banking online, 7) playing games, 8) checking weather information, 9) purchasing books, 10) purchasing clothes, 11) sending short messages, and 12) trading stocks. These tasks were identified by users as appropriate for mobile commerce tasks based on two prior research studies (Anckar and D’Incau, 2002; Xu et al.,

2003). As a set, these twelve tasks covered a wide range of mobile applications and were real tasks performed on wireless handheld devices.

Independent and dependent variables

There were five independent variables describing task characteristics: perceived ease of use (Davis, 1989; Venkatesh & Davis, 1996), perceived usefulness (Davis, 1989; Venkatesh & Davis, 1996), perceived playfulness (Venkatesh, 1999, 2000), task complexity (Campbell, 1988), and perceived security (Xu et al., 2003). In order to establish the validity of the measurements, most of the definitions and questions of these independent variables were derived from well-established studies as referenced.

The dependent variable was the intention to use a wireless handheld device for performing the selected tasks. It was measured by one question in the final questionnaire: "Assuming that you have access to a wireless handheld device, assign a score of intention to use to each task to indicate to what extent you intend to use the handheld to perform this task." A score of zero meant no intention to use the handheld devices while seven implied the highest level of intention.

Procedure

Each participant was given one experiment packet (48 pages in length) containing all task scripts and questionnaires by email, mail, or in person. The experiment packet was organized in the following order: 1) A brief instruction to the study; 2) Pre-experiment questionnaire; 3) Twelve sets of task scripts and task characteristics questionnaire in a randomized order; 4) Final questionnaire about user intention. For each of the twelve tasks, an identical task characteristics questionnaire was provided following the task scripts. The participant was asked to evaluate all task scripts and complete all questionnaires page by page. Upon completing all the task scripts, the participant was asked to rate his/her intention to perform each of the twelve tasks on handheld devices in the final questionnaire. The participant was instructed that it was not necessary to complete the entire survey in one sitting but they should complete an individual task and the corresponding characteristics questionnaire in one sitting. This instruction was intended to enable participants to focus on each task.

RESULTS AND DISCUSSION

Internal Consistency of the Instrument

The high Cronbach's α values for perceived ease of use (3 items, $\alpha=.085$), perceived usefulness (3 items, $\alpha=.90$), perceived playfulness (2 items, $\alpha=.071$), and task complexity (2 items, $\alpha=.075$) imply that the measurements of these variables are reliable and valid.

However, a Cronbach's α value of 0.19 for perceived security (2 items) is unacceptable and suggests that the statements to measure this variable are unreliable. For the subsequent analysis, we only included data for one item "I feel secure to perform this task on the handheld computer" to measure the perceived security of a task.

Correlation Analyses

Hypotheses 1 to 5 postulate causal relationships between each of the five factors (perceived ease of use, perceived usefulness, perceived playfulness, task complexity, perceived security) and user intention to perform a task on wireless handheld devices. Correlation analyses were performed to test these five hypotheses. Table 1 presents the correlation matrix.

The perceived ease of use has a significant and positive correlation ($r = 0.35448$, $p < 0.0001$) with user intention to perform a task on wireless handheld devices. This correlation supports the first hypothesis stating that higher perceived ease of use leads to higher user intention.

The significant and positive correlation ($r = 0.44705$, $p < 0.0001$) between the perceived usefulness and user intention suggests that higher perceived usefulness results in higher user intention. Hypothesis 2 is supported. These results are in agreement with the prior research findings. The technology acceptance model (TAM) proposed by Davis (1989) is one of the most widely used models of IT adoption. According to TAM, an individual's IT adoption is influenced by the perceived usefulness and perceived ease of use. The perceived ease of use influences the user intention indirectly through the perceived usefulness. These two perceptions help in shaping the user's attitude towards usage and intention to use.

Perceived playfulness has a significant and positive correlation ($r = 0.38177$, $p < 0.0001$) with user intention to perform a task on wireless handheld devices. This correlation implies that higher perceived playfulness results in higher user intention and thus supports hypothesis 3. Among the five types of user needs for wireless services identified by Ankar and D'Incau (2002), one is entertainment need. Prior research on the effectiveness of game-based training has also shown that manipulating the level of perceived enjoyment has a significant impact on user behavior in technology adoption (Venkatesh, 1999, 000). Because applications on wireless handheld devices can be accessed anytime and anywhere, users may use these applications to entertain themselves in their free time. Therefore, the perceived playfulness of applications on handheld devices becomes more important than that of ordinary applications.

	Perceived Ease of Use	Perceived Usefulness	Perceived Playfulness	Task Complexity	Perceived Security	User Intention
Perceived Ease of Use	1.00000	0.56436*	0.68731*	-0.87140*	0.37441*	0.35448*
Perceived Usefulness	0.56436*	1.00000	0.57551*	-0.48093*	0.33643*	0.44705*
Perceived Playfulness	0.68731*	0.57551*	1.00000	-0.57538*	0.33729*	0.38177*
Task Complexity	-0.87140*	-0.48093*	-0.57538*	1.00000	-0.32748*	-0.29761*
Perceived Security	0.37441*	0.33643	0.33729*	-0.32748*	1.00000	0.42549*
User Intention	0.35448*	0.44705*	0.38177*	-0.29761*	0.42549*	1.00000

$p < 0.0001$

Table 1. Correlation Coefficients

The task complexity has a significant and negative correlation ($r = -0.29761$, $p < 0.0001$) with user intention. This finding favors hypothesis 4 stating that higher task complexity leads to lower user intention. Because handheld devices are used on the move in many cases, tasks performed on these devices would become either secondary tasks or primary tasks with other secondary tasks. In either scenario, different tasks will compete for human cognitive resources. Because of the user's mobility, the interaction between the user and the mobile device is usually very brief. This implies that users will have much less capability of handling complex tasks on handheld devices under mobile conditions than under stationary conditions.

The significant and positive correlation ($r = 0.42549$, $p < 0.0001$) between the perceived security and user intention indicates that higher perceived security results in higher user intention, as postulated in hypothesis 5. Security has been a major concern in e-commerce. It becomes a more sensitive issue in mobile applications due to doubts about the security and the inconsistent reliability of wireless connections. It is not surprising that the perceived security affected user intention to perform a task.

In addition, it is noted that the perceived ease of use is highly correlated with task complexity ($r = -0.87140$, $p < 0.0001$). This correlation suggests that the perceived ease of use and task complexity (as defined in this study) may be measuring the same construct from two directions. A possible explanation might be that participants of this study could not distinguish ease of use (i.e. the nature of the interface) from task complexity (i.e. the nature of the task). This finding implies that user perception of task complexity could not be separated from the perception of the interface design. Therefore, it may be better to combine them into one variable: perceived ease of use. The perceived ease of use may be sufficient to cover the aspect of task complexity. However, task complexity is deemed an important determinant of task characteristics

for e-commerce applications (Wells, Sarker, Urbaczewski and Sarker, 2002). As defined by Wood (1986), task complexity is determined by the number of distinct acts and the dynamic changes in the relationships between task inputs and task products. This definition may help users to better differentiate ease of use from task complexity.

Multiple Regression Analysis

We performed a stepwise regression analysis to further investigate the relative impacts of five factors on user intention. The regression results indicate that three of the five variables (perceived usefulness, perceived security, and perceived playfulness) entered the regression model at the 0.05 level and the r-square of the model is 0.2951. In other words, this model can explain only 30% of the total variance of user intention. It has limited power for predicting user intention to perform a task on handheld devices. There are two possible reasons for this limited regression model:

- User intention may be much more complicated than it was expected. Additional factors may influence user intention to use handheld devices, such as user's prior experience with wireless handheld devices and with the mobile tasks.
- The regression analysis has been affected by the correlations among the independent variables.

In either case, further studies are needed to explore a more feasible and accurate regression model. Nevertheless, the regression model does strongly suggest the relative importance of the proposed factors. Perceived usefulness is the first variable that entered the regression model and thus the most important factor impacting user intention. It accounts for about 20% of the variance ($p < 0.0001$). This means that users heavily rely on their perception of the usefulness of a task when deciding their intention to use a wireless device. Perceived security is the second most important factor. It accounts for about 8.5% of the total variance ($p < 0.0001$). Perceived

playfulness is the third most important factor. It accounts for about 0.99% of the total variance ($p < .0001$).

The above findings suggest that perceived usefulness, perceived security, and perceived playfulness outweigh perceived ease of use as a determinant of user intention to perform a task on handheld devices. Several prior studies reported similar findings about the perceived ease of use for IS adoption in a work environment (Legris, Ingham and Colletette, 2002) and in an e-commerce context (Koufaris, 2002). As usability is essential to mobile commerce (Chan and Fang, 2003), further research is needed to better understand the dimensions of ease of use to aid interface design for small-screen applications.

CONCLUSIONS

In this study, we conducted a questionnaire-based empirical study to investigate the factors affecting user intention to use wireless handheld devices. The main contribution of this study was the finding of the relative importance of factors affecting user intention to use handheld devices. Key findings from our preliminary results show:

- Perceived usefulness, perceived security, perceived playfulness, and perceived ease of use correlated positively with user intention.
- Perceived usefulness, perceived security, and perceived playfulness were the three most important factors affecting user intention. Together they accounted for 30% of the total variance in user intention. This finding implies that mobile commerce applications should be mapped closely to user needs. Interface design and task selection should consider security and motivational factors.
- The regression model resulted from this study could only predict user intention with 30% accuracy. Further study is needed to identify additional factors that contribute to a more explanatory model.
- The relationship between ease of use and task complexity needs further clarification in order to aid interface design for complex tasks.

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