Moderating Effects of Task Type on Wireless Technology Acceptance

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ABSTRACT: The technology acceptance model (TAM) is one of the most widely used models of information technology (IT) adoption. According to TAM, IT adoption is influenced by two perceptions: usefulness and ease of use. In this study, we extend TAM to the mobile commerce context. We categorize the tasks performed on wireless handheld devices into three categories: (1) general tasks that do not involve transactions and gaming, (2) gaming tasks, and (3) transactional tasks. We propose a unified conceptual model for wireless technology adoption. In this model, task type moderates the effects of four possible determinants: perceived usefulness, perceived ease of use, perceived playfulness, and perceived security. We postulate that, under the mobile context, user intention to perform general tasks that do not involve transactions and gaming is influenced by perceived usefulness and perceived ease of use, user intention to play games is affected by perceived playfulness, and user intention to...
transact is influenced by perceived usefulness and perceived security. A survey was conducted to collect data about user perception of 12 tasks that could be performed on wireless handheld devices and user intention to use wireless technology. Multiple regression analyses supported the proposed research model.

**KEY WORDS AND PHRASES:** mobile commerce, perceived ease of use, perceived playfulness, perceived security, perceived usefulness, TAM, task performance, task type, user intention, wireless handheld devices.

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**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 mobile commerce transactions and process facilitation for managing personal activities, mobile office, and mobile operations [1]. However, certain factors hinder access, such as small screen display, limited bandwidth, and multiple functionalities of handheld devices.

Research suggests that interface developers need to consider the interaction among the interface design of user tasks, form factors, and application objectives [7, 27]. Mobile commerce assumes that users primarily access the Internet or wireless applications away from their home or office while either on the move or stationary. Since mobile users have only limited time and cognitive resources for performing a task, the design of mobile applications is important. Anckar and D’Incau [2] suggest that services that emphasize mobile values (e.g., meeting time-critical and spontaneous needs) are more suitable for wireless devices. In designing mobile commerce applications, it is essential to determine which tasks are suitable for wireless applications [6] and how to implement the tasks.

Human–computer interaction (HCI) studies tend to focus primarily on designing easy user interfaces. There has been little research that provides empirical evidence about how task implementation may affect user adoption of mobile applications. In this study, we will derive a task definition and its taxonomy from prior research on group tasks. The objective of this research is to investigate how tasks may affect wireless technology adoption and to acquire a better understanding about the key determinants. Constructs and hypotheses are formulated based on prior research findings. Regression analyses examine the empirical relationships among the constructs and user intention to adopt the wireless technology, and to perform the task on handheld devices.

**Background Literature**

**USABILITY RESEARCH IN MOBILE COMMERCE** is a new area of study. Previous research has typically focused on addressing the design constraints imposed by band-
width limitations and the small display size of handheld devices [21], content presentation issues [4, 5], and context factors [23]. Chan and Fang [6] point out that identifying the essential tasks for mobile users and wireless applications is a critical step in designing wireless applications.

A few studies have examined mobile tasks from a broad perspective. Based on a study of 19 novice wireless phone users who were closely tracked for the first six weeks after service acquisition, Palen and Salzman [36] describe the wireless telephone 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 et al. [39] present a study of mobile workers that highlights remote “anytime, anywhere” 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 aimed at understanding how mobile Web access affects home Internet usage, McClard and Somers [31] 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) the software must contain features that are perceived as useful, (2) the device must be highly portable and comfortable to use, and (3) the screen and keyboard of the device must be large enough to be usable. McClard and Somers [31] have also identified the top three preferred tablet features: (1) surfing the Web, (2) Internet availability anywhere in the home, and (3) e-mail. These studies have provided some general guidelines regarding appropriate tasks for wireless applications.

User adoption of technology applications focuses on tasks and their fit with selected technologies [6, 16]. An essential goal of studies involving mobile commerce applications is to identify mobile values for individual users. Anckar and D’Incau [2] 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). Wireless values are best represented by convenience and cost savings, which are important features provided on cell phones. Services that deliver strong mobile values would make mobile 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, e-mail, and news; (3) entertainment needs; (4) efficiency needs and goals; and (5) mobility-related needs. A consumer survey based on this framework reveals that e-mail, routine banking services, and movie ticket booking are among the most desired mobile services [2]. Desired mobile services also include restaurant reservations, calendaring and alert services, and access to news sources. Fewer than 30 percent of the respondents were interested in services involving transactions, such as online purchasing. Since this survey did not require participants to have prior experience with mobile services, discrepancies may exist between user expectations and responses based on task experience. These research findings suggest
that an understanding of user preferences and perceived value of mobile tasks is essential for improving the usability of mobile tasks.

Theoretical Foundation and Hypotheses Development

Task

The study of task has a long history from both the organizational and group process perspective [13, 17, 32, 38, 42]. Many researchers of group behavior have argued that the nature of the task plays an important role in a group’s interaction process and performance [41].

After summarizing classifications of tasks that are typically encountered in organizational decision-making groups, Zigurs and Buckland [53] identified four conceptualizations of task: (1) task as behavior description, (2) task as ability requirements, (3) task qua task, and (4) task as behavior requirements. Task as behavior description defines a task by activities. Task as ability requirements defines a task in terms of its own properties. The task qua task approach focuses on aspects of the actual task materials that are presented to the group. Task as behavior requirements looks into characteristics of tasks. Because required behaviors vary from task to task, it is argued that behavior requirements can be legitimately viewed as characteristics of tasks rather than characteristics of the performer [18]. McGrath’s task circumplex [32] is based on task as behavior requirements to the extent that each task is categorized by its objective—that is, what the group members are supposed to do to accomplish the task. In this paper, we adopt the final view of task as behavior requirements. A task is defined as the behavioral requirements for accomplishing stated goals, via some process, using given information. This definition allows us to study characteristics of the process of a task. Using this definition, we categorize the tasks to be performed on handheld devices based on their objectives into three types: (1) general tasks that do not involve transactions and gaming, (2) transactional tasks, and (3) gaming tasks. These three types of tasks differ in their objectives. The goal of general tasks is to seek information or to communicate with other parties. The objective of transactional tasks is to commit financial transactions. The goal of gaming tasks is to entertain their performers.

Technology Acceptance Model

The technology acceptance model (TAM) [10, 11] is one of the most widely used models for information technology (IT) adoption. According to TAM, an individual’s IT adoption is influenced by perceived usefulness and perceived ease of use. Perceived usefulness is defined as the degree to which a person believes that using a particular system would enhance his or her job performance [10]. Perceived ease of use refers to the degree to which a person believes that using a particular system would be free of effort. The perceived ease of use influences the user intention indi-
rectly through the perceived usefulness. These two perceptions help shape the user’s attitude toward usage and intention to use. Davis’s [10] scale items for measuring the two independent variables, perceived usefulness and perceived ease of use, have shown high internal validity. TAM is a parsimonious and robust model, consistently validated by numerous studies across different settings and technologies. Beyond IT applications for corporate use, recent studies have also established the model’s applicability for user adoption of cellular phones [25], World Wide Web use [26], smart card payment systems for e-commerce merchants [40], e-commerce [14, 24], digital library [19], and telemedicine [20].

Several studies have extended the TAM model by identifying antecedent attributes to the user’s perceived usefulness and perceived ease of use. Lederer et al. [26] validated that perceived ease of use can be explained by usability characteristics (usability guidelines), and perceived usefulness by characteristics of useful information, task environment, and functional needs to perform jobs.

The role of perceived ease of use in TAM, however, remains controversial because some studies show that perceived ease of use directly affects either self-reported use or intended IT use, whereas other studies have not found a direct linkage between perceived ease of use and IT adoption. In a study of e-commerce adoption, Gefen and Straub [14] find that the nature of the task may influence the perceived ease of use. Their empirical evidence shows that perceived ease of use and perceived usefulness affect intended use when a Web site is used for an inquiry task and where IT is intrinsic to the task and interface design is critical. When the Web site is used for performing a purchasing task, IT is extrinsic to the task and only perceived usefulness affects intended use. This study suggests that the type of task may have an effect on one of the two beliefs—perceived ease of use.

Wireless technology is one type of IT. We postulate that user intention to perform general tasks that do not involve transactions and gaming can be predicted by TAM [10].

\[ H1a: \] The intention to perform general tasks on handheld devices is positively influenced by perceived usefulness.

\[ H1b: \] The intention to perform general tasks on handheld devices is positively influenced by perceived ease of use.

Playfulness

Microcomputer playfulness is defined by Webster and Martocchio [48] as a situation-specific individual characteristic that represents a type of intellectual or cognitive playfulness. It describes an individual’s tendency to interact spontaneously, inventively, and imaginatively with microcomputers. Two approaches have been used to study playfulness: (1) playfulness is treated as a trait and as a motivational characteristic of individuals, and (2) playfulness is treated as a state and is defined as a situational characteristic of the interaction between the individual and the situation.
In this study, we use the second approach and treat playfulness as a situational characteristic of the interaction between the individual and the situation. This approach allows us to study playfulness as a process. Martocchio and Webster [29] found that employees having higher cognitive playfulness demonstrated higher test performance and more positive affective outcomes than those having lower cognitive playfulness. In another study examining the effects of task labeling (as play or work) and trainee age on learning outcomes, Webster and Martocchio [49] found that younger employees who received training labeled as “play” showed higher motivation to learn and performed better in an objective test of software knowledge than older employees.

Yager et al. [52] extended the investigation of playfulness as an individual trait by using a longitudinal study to examine its temporal and situational stability. Trevino and Webster [43] investigated the effects of flow on the computer-mediated communication environment. They find that it is influenced by the technology type, ease of use, and computer skill. Webster et al. [50] examined the state of flow in a specific HCI and found that the flow experience is associated with perceived characteristics of the computer software as well as with relevant work-related outcomes. Venkatesh [45] conducted two studies to compare a traditional training method with a training method that included a component aimed at enhancing intrinsic motivation. The results from this study support the theory that the potential acceptance of a system was higher among users who underwent a game-based training program compared to users who were trained using a traditional method. In a more recent study, Moon and Kim [35] introduced playfulness as new factor to reflect user’s intrinsic belief in World Wide Web acceptance. They also found that perceived playfulness has a more significant effect on behavioral intention than perceived usefulness for entertainment purpose users.

Mobile applications are not only used in the workplace but also outside of the workplace. In the mobile context, play itself may become the task objective. Many studies have confirmed this notion. Entertainment is identified as one of the five types of user needs for wireless services by Anckar and D’Incau [2]. Since a wireless device can be accessed anytime and anywhere, many users prefer to use the mobile Web services to kill time [2, 39]. Many participants mentioned during an interview conducted by Xu et al. [51] that they had played games or listened to MP3 music files on wireless devices simply for fun and pleasure.

Because playfulness is treated as a situational characteristic of the interaction between the individual and the situation in this study, we argue that it can be defined based on characteristics of the process. Perceived playfulness is defined as the degree to which a person believes that using a particular system would make him or her joyful. Because perceived playfulness measures how the system helps users achieve the task-related objective, “play,” it becomes an outcome expectancy and can be considered as a measure of extrinsic motivation similar to “perceived usefulness” [10]. Therefore, it is expected that perceived playfulness will affect intention to perform gaming tasks. According to TAM [10], perceived ease of use is expected to influence the intention to play games on handheld devices as another factor. Van der Heijden [44] found that perceived enjoyment and perceived ease of use are stronger determi-
nants of intentions to use than perceived usefulness for pleasure-oriented (or hedonic) information systems. Gaming can be considered as a hedonic task. This finding supports the previous discussions about perceived playfulness and perceived ease of use.

\[ H2a: \text{The intention to perform gaming tasks on handheld devices is positively influenced by perceived playfulness.} \]

\[ H2b: \text{The intention to perform gaming tasks on handheld devices is positively influenced by perceived ease of use.} \]

Trust and Security

The introduction of new IT has been accompanied by security concerns. The future of electronic commerce depends on controlling information security threats, enhancing consumer security perceptions, and building trust [8]. Many studies have been undertaken to categorize antecedents or factors of consumer trust [3, 12, 30, 33, 34, 54]. Zucker [54] proposes three major categories that can be used to build trust—process-based (e.g., reputation, experience), characteristic-based (e.g., disposition), and institutional-based (e.g., third-party certification). Doney and Cannon [12] developed five distinct trust-building processes in business relationships—calculative process in which an individual or organization calculates the costs or rewards of another party cheating or staying in the relationship; prediction process; capability process, which involves determining another party’s ability to meet its obligations; intentionality process in which one party evaluates the other party’s motivations; and transference process in which one party draws on proof sources from which trust is transferred to the other party.

Bhattacherjee [3] proposed three key dimensions of trust—trustee’s ability, benevolence, and integrity—based on a cross-disciplinary literature review on the dimensions of trust. Mayer et al. [30] define trust as a behavioral intention centered upon the expectations of another person. Based on this definition, they proposed a model of dyadic trust in organizational relationships that includes characteristics of both the trustor and trustee that influence the formation of trust. The three characteristics included in the model, representing the perceived trustworthiness of the trustee, are benevolence, integrity, and ability.

More recent studies have focused on trust in e-commerce. Gefen et al. [15] show that consumer trust is as important to online commerce as the widely accepted TAM use antecedents: perceived usefulness and perceived ease of use. Kim et al. [22] show that consumers’ disposition to trust, privacy protection, security protection, perceptions about the selling party’s reputation, information quality, and system reliability are strong antecedents of consumers’ trust in business-to-consumer (B2C) e-commerce. Cheung and Lee [9] propose a theoretical model of trust in Internet shopping. Their model suggests that a customer’s trust in Internet shopping is positively related to the trustworthiness of Internet vendors and the external environment, which is moderated by one’s propensity to trust. One’s perceived risk in shopping is negatively related to trust in Internet shopping. Chellappa and Pavlou [8] show that consumer trust in ele-
Electronic commerce transactions is influenced by perceived information security. Mechanisms of encryption, protection, authentication, and verification are the antecedents of perceived information security. Pavlou [37] has developed and empirically validated a model to predict intentions to transact by integrating trust in electronic commerce with TAM. Figure 1 shows Pavlou’s model. This model suggests that perceived risk may influence user intention to transact.

The aforementioned studies clearly indicate that consumer’s trust and perceived risk play important roles in electronic commerce transactions. In this study, we use perceived security in place of perceived risk so that users may view this construct more positively. Perceived security is defined as the extent to which a user believes that using a particular application will be risk free. Based on Pavlou’s model, perceived security should be an antecedent of intention to transact. Gefen and Straub [14] also suggests that transactional tasks are IT extrinsic, and intention of use for such tasks should not be influenced by perceived ease of use. Therefore, for transactional tasks on handheld devices, it is expected that intention of use will be influenced by perceived usefulness and perceived security.

**H3a:** The intention to transact on handheld devices is positively influenced by perceived usefulness.

**H3b:** The intention to transact on handheld devices is positively influenced by perceived security.

A Unified Conceptual Model for Wireless Technology Adoption

Based on the discussions above, a unified conceptual model for wireless technology adoption is proposed in Figure 2. In this model, there are four possible determinants of intended use of handheld devices: perceived usefulness, perceived ease of use, perceived playfulness, and perceived security. Task type moderates the effects of these determinants. Table 1 shows how task type affects these four determinants.
For general tasks, only perceived usefulness and perceived ease of use will influence intention of use. Because general tasks do not involve gaming and transactions, perceived playfulness and perceived security should not influence user intention according to prior discussions on playfulness, trust, and security. The following hypotheses are added for general tasks:

**H1c**: The intention to perform general tasks on handheld devices is not influenced by perceived playfulness.

<table>
<thead>
<tr>
<th>Task type</th>
<th>Perceived usefulness</th>
<th>Perceived ease of use</th>
<th>Perceived playfulness</th>
<th>Perceived security</th>
</tr>
</thead>
<tbody>
<tr>
<td>General tasks</td>
<td>Influential (H1a)</td>
<td>Influential (H1b)</td>
<td>Noninfluential (H1c)</td>
<td>Noninfluential (H1d)</td>
</tr>
<tr>
<td>Gaming tasks</td>
<td>Noninfluential (H2c)</td>
<td>Influential (H2b)</td>
<td>Influential (H2a)</td>
<td>Noninfluential (H2d)</td>
</tr>
<tr>
<td>Transactional</td>
<td>Influential (H3a)</td>
<td>Noninfluential (H3c)</td>
<td>Noninfluential (H3d)</td>
<td>Influential (H3b)</td>
</tr>
</tbody>
</table>

Table 1. The Effect of Task Type on Determinants of Intended Use of Handheld Devices

*Figure 2. Conceptual Model for Intended Use of Handheld Devices*
H1d: The intention to perform general tasks on handheld devices is not influenced by perceived security.

For gaming tasks, the extrinsic motivation is measured by perceived playfulness, instead of perceived usefulness. Therefore, perceived usefulness is no longer influential to intention to play games on wireless handheld devices. Because gaming tasks do not involve transactions, perceived security should not significantly affect intention of use. We add two hypotheses for gaming tasks:

H2c: The intention to perform gaming tasks on handheld devices is not influenced by perceived usefulness.

H2d: The intention to perform gaming tasks on handheld devices is not influenced by perceived security.

Transactional tasks are IT extrinsic and intention of use for such tasks should not be influenced by perceived ease of use [14]. Because transactional tasks do not involve gaming, perceived playfulness should not have a significant effect on intention of use. The following two hypotheses are formed for transactional tasks:

H3c: The intention to transact on handheld devices is not influenced by perceived ease of use.

H3d: The intention to transact on handheld devices is not influenced by perceived playfulness.

Method

We developed a questionnaire-based empirical study to test the conceptual models presented in Figure 2 and the 12 hypotheses derived from prior research findings.

Participants

One hundred and one participants took part in this survey. The majority of the participants were working adults. Some were alumni of a midwestern university in the United States and others were still enrolled at the time of their participation. The participants represented a racially diverse group with ages ranging from about 20 to 50 years old. The participants’ prior experiences with handheld devices also varied. Of the participants, 97 percent had used wireless phones before and 75.2 percent used wireless phones on a daily basis; 22.8 percent had used Pocket PCs before and 8.9 percent used the device on a daily basis. Since the tasks in this study were presented in the format of screenshots of Palm VII, a more detailed profile of usage of Palm Pilot is provided: 19.8 percent of participants used Palm Pilot daily, 13.9 percent weekly, 4 percent monthly, 26.7 percent rarely, and 35.6 percent had never used this type of device before, so the participants included both novice and experienced users of Palm Pilot.
Tasks

Participants were asked to evaluate the following constructs for each of 12 tasks selected for this study: perceived ease of use, perceived usefulness, perceived playfulness, and perceived security. At the end of the survey, participants ranked and rated their future intention to perform each task on a wireless handheld device. To ensure that the resulting regression model was generalizable, task selection considered two requirements: (1) the selected tasks must be realistic and represent a wide range of possible mobile applications on handheld devices, and (2) the selected tasks must incorporate diverse characteristics. Accordingly, 12 tasks were selected for this study:

- General tasks: managing an address book, sending/receiving e-mail, checking flight information, reading the news, checking weather information, and sending short messages.
- Transactional tasks: purchasing movie tickets, banking online, purchasing books, purchasing clothes, and trading stocks.
- Gaming task: playing games.

These tasks were identified by users as appropriate for mobile commerce tasks from previous research [2, 36]. As a set, these 12 tasks represent a wide range of mobile applications and are real tasks performed on wireless handheld devices. As shown in Table 2, some of the tasks are drawn from the wireless Web sites of well-recognized e-commerce players (e.g., Amazon), content provider (USA Today), portal (Yahoo!), and financial services (E*Trade). A few tasks were drawn from wireless service providers (e.g., ThinAir).

However, different participants may have had different experiences with the same tasks due to inconsistent wireless connections and their varying familiarity with the wireless devices. Research has indicated that form factors and bandwidth may affect user perception of wireless applications and their intention [7]. By using a “live” handheld device, participants are more likely to perform the tasks following different steps. In determining whether to conduct the survey in a mobile setting with handheld devices, we needed to eliminate extraneous factors (e.g., user experience with form factors and latent network effects due to mobility) from biasing the results. Furthermore, participants needed to perform each task following identical steps. Therefore, we conducted the study in a static, printed format to direct participants’ attention to tasks alone. To exercise some control over participants’ attention to the tasks and to ensure that they experienced each task following the same steps, scripts were designed for each task. The task scripts included a brief description about the scenario, what needed to be done in each step, and screenshots of a Palm VII for all the steps involved in completing the task. Table 2 provides task scenarios and the complexity of the 12 tasks used in this study. These task scenarios represent how actual tasks are performed on some of the most popular wireless Web sites, such as E*Trade, United Airlines, and Amazon.
Table 2. Task Scenarios and Complexity

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Task scenarios</th>
<th>Number of steps</th>
<th>Number of screenshots</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing address book (Palm)</td>
<td>My friend Jane Smith just called and told me she recently moved to Naperville. I need to update the contacts in my address book with her new phone number and address.</td>
<td>6</td>
<td>6</td>
</tr>
<tr>
<td>Sending/receiving e-mail (ThinAir)</td>
<td>Using an e-mail application on Palm, check unread messages in my e-mail box.</td>
<td>8</td>
<td>10</td>
</tr>
<tr>
<td>Checking flight information (United Airlines)</td>
<td>I am going to O'Hare airport to pick up a friend. I need to check the status and gate information of her flight. However, I do not remember the flight number. All I know is that it is a United Airlines flight, departing from La Guardia airport, and should be arriving at 7:30 P.M.</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Purchasing movie tickets (Moviefone)</td>
<td>Check out the nearest theater that is showing “Finding Nemo” today, and buy two tickets online.</td>
<td>9</td>
<td>13</td>
</tr>
<tr>
<td>Reading the news (USA Today)</td>
<td>Check out today’s national headlines.</td>
<td>6</td>
<td>9</td>
</tr>
<tr>
<td>Banking online (E*Trade)</td>
<td>Check out my current balance and transfer some money from one account to another.</td>
<td>7</td>
<td>8</td>
</tr>
<tr>
<td>Playing games (Bejeweled!)</td>
<td>Play “Bejeweled” on Palm.</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Checking weather information (Yahoo! on OmniSky)</td>
<td>Check out today’s weather in downtown Chicago.</td>
<td>4</td>
<td>11</td>
</tr>
<tr>
<td>Purchasing books (Amazon)</td>
<td>I want to buy a book on ASP.NET for beginners.</td>
<td>13</td>
<td>24</td>
</tr>
<tr>
<td>Purchasing clothes (Amazon)</td>
<td>My friend’s nine-year-old boy will have his birthday in a few weeks. I want to buy a T-shirt for him as a birthday gift from ToysRUs hosted online by Amazon.com (mobile site).</td>
<td>9</td>
<td>14</td>
</tr>
<tr>
<td>Sending short messages (Monkey Mail)</td>
<td>I have an appointment with Dr. Smith at 3:00 P.M. However, I am stuck on the highway right now due to bad traffic. I have to send a message to tell him that I will be late.</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Trading stocks (E*Trade)</td>
<td>Check out current stock quote information and place a transaction or trade a certain number of shares.</td>
<td>7</td>
<td>9</td>
</tr>
</tbody>
</table>
Tasks were diversified. Some tasks involved only a few steps and screenshots. For instance, the task of sending a short message included three steps over three screenshots, whereas the task of reading news online involved six steps over nine screenshots. More complex tasks, such as checking flight status, involved 14 steps over 19 screenshots. Figure 3 shows one example of task scripts for purchasing movie tickets online.

Independent and Dependent Variables

There were four independent variables: perceived ease of use, perceived usefulness, perceived playfulness, and perceived security. To ensure the validity of the measurements, most of the questions used to measure these independent variables were derived from prior studies, as shown in Table 3.

Each task characteristics questionnaire contained the statements using a seven-point Likert-scale with 1 as "strongly disagree" and 7 as "strongly agree" (see Appendix D). Participants replied to a total of 12 task characteristics questionnaires, with one questionnaire for each task.

The dependent variable was the participant’s 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 of use to each task to indicate to what extent you intend to use the handheld to perform this task” (see Appendix E). A score of zero indicated no intention, whereas a score of seven indicated the highest level of intention. To assure the reliability of this measurement, participants were asked to rank the 12 tasks based on their level of preference to perform a task before they assigned an intention score to each task. We argue that preference ranking provides a more realistic context for participants to express their willingness to use wireless handheld devices to perform a task. Therefore, both scores of intention of use and preference ranking were used to measure the intention of use. The Cronbach’s alpha value of 0.78 (see Table 4) for intention of use confirms that these two scores are consistent and can be used as legitimate measures of the same construct.

Procedure

Each participant was given one survey packet (48 pages in length) containing all the task scripts and questionnaires by e-mail, mail, or in person. The survey packet was organized in the following order: (1) a brief instruction to the study (Appendix A); (2) a presurvey questionnaire (Appendix B); (3) 12 sets of task scripts (Appendix C) and a task characteristics questionnaire (Appendix D) in a random order; and (4) a final questionnaire about user intention (Appendix E). For each of the 12 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 or her intention to perform each of the 12 tasks on handheld devices in the final questionnaire. The participant was instructed that it was not necessary to complete the
Figure 3. An Example of Task Scripts

TASK – Check movie information and buy tickets online

Scenario: Check out the nearest theater that is showing “Finding Nemo” today, and buy 2 tickets online.

Figure 3. An Example of Task Scripts
10 tasks are not presented. The identical task characteristics questionnaire shown in Appendix D was used for all 12 tasks.

Findings and Discussions

Measurement Validation

A PRINCIPAL COMPONENTS FACTOR ANALYSIS with varimax rotation was performed to establish convergent and discriminant validity of primary constructs: perceived usefulness, perceived ease of use, perceived playfulness, perceived security, and intention of use. The factor analysis presented in Table 5 shows four orthogonal factors (perceived ease of use, perceived usefulness, intention of use, and perceived security) with eigenvalues above 1.0, together accounting for 74.0 percent of the variation, with item communality ranging between 0.50 and 0.94. The items for perceived usefulness and intention of use have a simple loading pattern with high convergent and discriminant validity. However, there are two observations that need attention: (1) items for perceived playfulness are loaded high on perceived ease of use, and (2) only one item shows high loading on perceived security.

The high loadings of perceived playfulness items on perceived ease of use imply that these measures are not discriminant. This phenomenon is consistent with some of
<table>
<thead>
<tr>
<th>Variable name</th>
<th>Definition</th>
<th>Statements to measure the variable</th>
<th>Source</th>
</tr>
</thead>
</table>
| Perceived ease of use | The extent to which a person believes that using a particular application would be free of effort. | • Learning to perform this task was easy for me.  
• I find it easy to perform this task.  
• I find it cumbersome to perform this task. | [10, 28] |
| Perceived usefulness | The extent to which a person believes that using a particular application would enhance his or her job performance. | • Overall, I find this task to be useful.  
• This task enhances my effectiveness.  
• This task enhances my productivity. | [10, 28] |
| Perceived playfulness | The extent to which the activity of using a specific system is perceived to be enjoyable in its own right, aside from any performance consequences resulting from system use. | • I find this task interesting and enjoyable.  
• I do not realize the time elapsed when performing this task. | [45, 46] |
| Perceived security  | The extent to which a user believes that using a particular application will not expose his or her private information to any unauthorized party. | • I feel secure to perform this task on the handheld computer.  
• There is feedback indicating the information is protected. |         |
In the studies undertaken by Ventakesh [45] and Moon and Kim [35], there is a positive relationship between perceived playfulness and perceived ease of use. We suspect that for nongaming tasks, perceived playfulness measures intrinsic motivation and is closely related to perceived ease of use. However, for gaming tasks, perceived playfulness measures extrinsic motivation and may be differentiable from perceived ease of use. Another factor analysis was performed for the gaming task only. The results are presented in Table 6. This second factor analysis shows four orthogonal factors (perceived usefulness, perceived ease of use, intention

Table 4. Internal Consistency of the Instrument

<table>
<thead>
<tr>
<th>Variable</th>
<th>Number of items</th>
<th>Cronbach’s alpha</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived ease of use</td>
<td>3</td>
<td>0.85</td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>3</td>
<td>0.90</td>
</tr>
<tr>
<td>Perceived playfulness</td>
<td>2</td>
<td>0.71</td>
</tr>
<tr>
<td>Perceived security</td>
<td>2</td>
<td>0.19</td>
</tr>
<tr>
<td>Intention of use</td>
<td>2</td>
<td>0.78</td>
</tr>
</tbody>
</table>

Table 5. Factor Analysis—All Tasks

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1 perceived ease of use</th>
<th>Factor 2 perceived usefulness</th>
<th>Factor 3 intention of use</th>
<th>Factor 4 perceived security</th>
<th>Item communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOU1</td>
<td>0.80</td>
<td></td>
<td></td>
<td></td>
<td>0.71</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
<td>0.81</td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.77</td>
<td></td>
<td></td>
<td></td>
<td>0.67</td>
</tr>
<tr>
<td>PU1</td>
<td></td>
<td>0.84</td>
<td></td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>PU2</td>
<td></td>
<td>0.79</td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>PU3</td>
<td></td>
<td>0.88</td>
<td></td>
<td></td>
<td>0.86</td>
</tr>
<tr>
<td>PP1</td>
<td>0.71</td>
<td></td>
<td></td>
<td></td>
<td>0.59</td>
</tr>
<tr>
<td>PP2</td>
<td>0.62</td>
<td></td>
<td></td>
<td></td>
<td>0.59</td>
</tr>
<tr>
<td>PS1</td>
<td></td>
<td>0.96</td>
<td></td>
<td></td>
<td>0.94</td>
</tr>
<tr>
<td>PS2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.50</td>
</tr>
<tr>
<td>Intention ranking</td>
<td></td>
<td>0.85</td>
<td></td>
<td></td>
<td>0.76</td>
</tr>
<tr>
<td>Intention score</td>
<td></td>
<td></td>
<td>0.84</td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>3.26</td>
<td>2.56</td>
<td>2.00</td>
<td>1.06</td>
<td></td>
</tr>
<tr>
<td>Percentage of explained variance</td>
<td>27.2</td>
<td>21.3</td>
<td>16.7</td>
<td>8.8</td>
<td></td>
</tr>
</tbody>
</table>

Absolute values < 0.30 were suppressed.
of use, and perceived playfulness) with eigenvalues above 1.0, together accounting for 69.4 percent of the variation, with item communality ranging between 0.73 and 0.85. The simple loading pattern suggests high convergent and discriminant validity. Perceived security does not emerge as one of the main factors.

The Cronbach’s alpha values were computed to check the internal consistency of the statements used to measure the five constructs. Table 4 lists the results and shows that four constructs (perceived usefulness, perceived ease of use, perceived playfulness, and intention of use) exceed the cutoff point of 0.7. The high Cronbach’s alpha values for perceived ease of use, perceived usefulness, perceived playfulness, and intention of use imply that the measurements of these constructs are reliable and valid. However, a Cronbach’s alpha value of 0.19 for perceived security is unacceptably low and suggests that the statements used to measure this variable were unreliable. Together with the factor analysis results, the low Cronbach’s alpha value suggests that the two items for perceived security are measuring differing factors. After a close analysis of the two statements measuring perceived security, we found that the second item, “There is feedback indicating the information is protected,” may not have been appropriate because it merely refers to a state of a fact instead of user perception. Perceived security is a complex construct that may be influenced by many factors. Feedback information may enhance the perception of security but cannot itself

<table>
<thead>
<tr>
<th>Item</th>
<th>Factor 1 perceived usefulness</th>
<th>Factor 2 perceived ease of use</th>
<th>Factor 3 intention of use</th>
<th>Factor 4 perceived playfulness</th>
<th>Item communality</th>
</tr>
</thead>
<tbody>
<tr>
<td>PEOU1</td>
<td>0.74</td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>PEOU2</td>
<td>0.79</td>
<td></td>
<td></td>
<td></td>
<td>0.83</td>
</tr>
<tr>
<td>PEOU3</td>
<td>0.86</td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>PU1</td>
<td>0.87</td>
<td></td>
<td></td>
<td></td>
<td>0.82</td>
</tr>
<tr>
<td>PU2</td>
<td>0.84</td>
<td></td>
<td></td>
<td></td>
<td>0.80</td>
</tr>
<tr>
<td>PU3</td>
<td>0.88</td>
<td></td>
<td></td>
<td></td>
<td>0.81</td>
</tr>
<tr>
<td>PP1</td>
<td></td>
<td>0.83</td>
<td></td>
<td></td>
<td>0.79</td>
</tr>
<tr>
<td>PP2</td>
<td></td>
<td>0.87</td>
<td></td>
<td></td>
<td>0.73</td>
</tr>
<tr>
<td>PS1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.75</td>
</tr>
<tr>
<td>PS2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0.85</td>
</tr>
<tr>
<td>Intention ranking</td>
<td></td>
<td>0.86</td>
<td></td>
<td></td>
<td>0.77</td>
</tr>
<tr>
<td>Intention score</td>
<td></td>
<td></td>
<td>0.86</td>
<td></td>
<td>0.81</td>
</tr>
<tr>
<td>Eigenvalue</td>
<td>2.71</td>
<td>2.15</td>
<td>1.87</td>
<td>1.60</td>
<td></td>
</tr>
<tr>
<td>Percentage of explained variance</td>
<td>22.6</td>
<td>17.9</td>
<td>15.6</td>
<td>13.3</td>
<td></td>
</tr>
</tbody>
</table>

Absolute values < 0.30 were suppressed.
represent the user’s perceived security. Therefore, data from the item, “There is feedback indicating the information is protected,” were excluded in subsequent analyses. Only one item, “I feel secure to perform this task on the handheld computer,” was used to measure the perceived security of a task.

**Hypothesis Testing**

The intent of this study was to investigate the relationships between user intention to adopt wireless technology and the following constructs: perceived usefulness, perceived ease of use, perceived playfulness, and perceived security. Hypotheses were formulated for general tasks, gaming tasks, and transactional tasks on the basis of prior research findings and theories. The hypothesized relationships were tested using multiple regression analyses to maintain consistency with earlier TAM studies. Tables 7, 8, and 9 present the results of stepwise multiple regression analyses and hypothesis testing for general tasks, gaming tasks, and transactional tasks, respectively. In all the regression analyses, all four independent variables (perceived usefulness, perceived ease of use, perceived playfulness, and perceived security) were included in initial analyses, but only significant factors were kept in the models and shown in the tables.

In H1a and H1b, we investigate the influence of perceived usefulness and perceived ease of use, respectively, on user intention to perform general tasks that do not involve transactions and gaming on wireless handheld devices. Table 7 indicates that user intention is significantly influenced by perceived usefulness ($\beta = 0.661, t = 8.669, p < 0.0001$) and perceived ease of use ($\beta = 0.209, t = 3.063, p < 0.002$). The regression analysis also suggests that the proposed model “Intention = PU + PEOU + Errors” explains a significant percentage of variance in intention ($R^2 = 0.244, F = 94.04, p < 0.0001$). Therefore, the results support H1a and H1b. This result is consistent with the original TAM [10].

The fact that perceived playfulness and perceived security did not enter the regression model suggests that perceived playfulness and perceived security had no

<table>
<thead>
<tr>
<th>Model</th>
<th>$R^2$ (change)</th>
<th>Beta</th>
<th>$t$-value</th>
<th>Hypothesis testing result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intention = PU + PEOU + Errors</td>
<td>0.244 (&lt; 0.0001)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Perceived usefulness</td>
<td>0.232</td>
<td>0.661</td>
<td>8.669</td>
<td>H1a was supported</td>
</tr>
<tr>
<td>Perceived ease of use</td>
<td>0.012</td>
<td>0.209</td>
<td>3.063</td>
<td>H1b was supported</td>
</tr>
</tbody>
</table>

Table 7. Results of Hypothesis Testing for General Tasks
significant effect on intention of use. Therefore, H1c and H1d are supported. In order to examine the differences among individual general tasks, we conducted regression analysis for each of them. Table 10 presents the results. Perceived usefulness was retained in the regression model as a significant factor for all the general tasks, but perceived ease of use was only retained as a significant factor for the task “reading the news.” This result is consistent with the prior research findings (e.g., [14]) about the inconsistent role of perceived ease of use. Table 10 suggests that differences among general tasks may affect the role of perceived ease of use.

H2a and H2b examine the impact of perceived playfulness and perceived ease of use, respectively, on user intention to play games on handheld devices. Table 8 shows that user intention is significantly influenced by perceived playfulness ($\beta = 1.146, t = 5.791, p < 0.0001$). However, perceived ease of use did not enter the regression model. The model “Intention = PP + Errors” accounts for a significant percentage of variance in intention ($R^2 = 0.269, F = 33.54, p < 0.0001$). Therefore, H2a is supported, but H2b is rejected. Because perceived playfulness may actually measure user’s extrinsic outcome in gaming tasks on handheld devices as perceived usefulness in TAM does in general tasks, it is not surprising that perceived playfulness acts as the key determinant of user intention.

Although H2b is not supported by this study, the result is not contradictory to prior research findings. As suggested by Gefen and Straub [14], perceived ease of use

<table>
<thead>
<tr>
<th>Table 8. Results of Hypothesis Testing for Gaming Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Intention = PP + Errors (p-value)</td>
</tr>
<tr>
<td>Perceived playfulness</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Table 9. Results of Hypothesis Testing for Transactional Tasks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
</tr>
<tr>
<td>-----------------------------------------------</td>
</tr>
<tr>
<td>Intention = PU + PS + Errors (p-value)</td>
</tr>
<tr>
<td>Perceived usefulness</td>
</tr>
<tr>
<td>Perceived security</td>
</tr>
</tbody>
</table>
Table 10. Regression Analyses of Individual General Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Model</th>
<th>$R^2$ (p-value)</th>
<th>$R^2$ change (PU)</th>
<th>$R^2$ change (PEOU)</th>
<th>Beta (PU) (p-value)</th>
<th>Beta (PEOU) (p-value)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Managing an address book</td>
<td>Intention = PU + Errors</td>
<td>0.110 (0.0009)</td>
<td>0.110</td>
<td>0.554</td>
<td>3.441</td>
<td>(0.0009)</td>
</tr>
<tr>
<td>Sending/receiving e-mail</td>
<td>Intention = PU + Errors</td>
<td>0.219 (&lt; 0.0001)</td>
<td>0.219</td>
<td>0.971</td>
<td>5.157</td>
<td>(&lt; 0.0001)</td>
</tr>
<tr>
<td>Checking flight information</td>
<td>Intention = PU + Errors</td>
<td>0.194 (&lt; 0.0001)</td>
<td>0.194</td>
<td>0.637</td>
<td>4.807</td>
<td>(&lt; 0.0001)</td>
</tr>
<tr>
<td>Reading the news</td>
<td>Intention = PU + PEOU + Errors</td>
<td>0.252 (0.018)</td>
<td>0.205</td>
<td>0.046</td>
<td>0.568</td>
<td>2.903 (0.0046)</td>
</tr>
<tr>
<td>Checking weather information</td>
<td>Intention = PU + Errors</td>
<td>0.181 (&lt; 0.0001)</td>
<td>0.181</td>
<td>0.662</td>
<td>4.603</td>
<td>(&lt; 0.0001)</td>
</tr>
<tr>
<td>Sending short messages</td>
<td>Intention = PU + Errors</td>
<td>0.200 (&lt; 0.0001)</td>
<td>0.200</td>
<td>0.777</td>
<td>4.876</td>
<td>(&lt; 0.0001)</td>
</tr>
</tbody>
</table>
affects IT adoption only when the primary task for which the IT is deployed is directly associated with intrinsic IT characteristics. Gaming tasks may fall into one of the two types of tasks: IT intrinsic and IT extrinsic. Only the intended use of IT-intrinsic gaming tasks may be affected by perceived ease of use. The regression analysis indicates that perceived usefulness and perceived security did not show a significant impact on user intention to play games on handheld devices. H2c and H2d are supported.

H3a and H3b postulate that perceived usefulness and perceived security, respectively, are positively associated with user intention to transact on handheld devices. Results shown in Table 9 suggest that user intention is significantly influenced by perceived usefulness ($\beta = 0.663$, $t = 8.387$, $p < 0.0001$) and perceived security ($\beta = 0.245$, $t = 4.024$, $p < 0.0001$). The proposed model “Intention = PU + PS + Errors” explains a significant percentage of variance in user intention ($R^2 = 0.215$, $F = 64.90$, $p < 0.0001$). The results support H3a and H3b and agree with previous research findings. Gefen and Straub [14] find that transactional tasks are IT-extrinsic and that perceived ease of use does not affect user intention in this case. In a study of user intention to transact by integrating trust with TAM, Pavlou [37] has also noted that user intention to transact is affected by perceived usefulness and perceived risk, but not perceived ease of use. Perceived ease of use and perceived playfulness were not retained in the regression model and thus showed no significant impact on intention to transact on wireless handheld devices. H3c and H3d are supported.

We also examined the differences among the transactional tasks by conducting regression analysis for each of these tasks. Results presented in Table 11 indicate that perceived usefulness entered the regression model for all the transactional tasks and perceived security was retained as a significant factor for all the transactional tasks but one: “purchasing movie tickets.” This result suggests the existence of differences among the transactional tasks and is still in agreement with the findings from the primary regression analysis when all the transactional tasks were analyzed together.

Comparing this Study with Other TAM Studies

Table 12 presents a comparison of $R^2$-square between this study and some other TAM studies. The comparison suggests that the $R^2$-squares obtained from this study are comparable to prior TAM studies.

Implications

This research investigates the key determinants of user intention to adopt wireless technology. Based on previous research findings, a conceptual model of user intention to adopt wireless technology was proposed for general tasks, gaming tasks, and transactional tasks. Twelve hypotheses were derived from these research models. The data collected from this study supported 11 of the 12 hypotheses. These results imply that user intention to adopt wireless technology for different types of tasks has different determinants.
Table 11. Regression Analyses of Individual Transactional Tasks

<table>
<thead>
<tr>
<th>Task</th>
<th>Model</th>
<th>$R^2$ (p-value)</th>
<th>$R^2$ change (PU)</th>
<th>$R^2$ change (PS)</th>
<th>Beta (PU) (p-value)</th>
<th>Beta (PS) (p-value)</th>
<th>$t$-value (PU)</th>
<th>$t$-value (PS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Purchasing movie tickets</td>
<td>Intention = PU + Errors</td>
<td>0.137 (0.0002)</td>
<td>0.137</td>
<td>0.653</td>
<td>3.879 (0.0002)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Banking online</td>
<td>Intention = PU + PS + Errors</td>
<td>0.296 (0.0106)</td>
<td>0.246</td>
<td>0.050</td>
<td>0.765</td>
<td>3.856 (0.0002)</td>
<td>0.348</td>
<td>2.606 (0.0106)</td>
</tr>
<tr>
<td>Purchasing books</td>
<td>Intention = PU + PS + Errors</td>
<td>0.265 (0.0046)</td>
<td>0.196</td>
<td>0.069</td>
<td>0.566</td>
<td>3.588 (0.0002)</td>
<td>0.369</td>
<td>2.907 (0.0046)</td>
</tr>
<tr>
<td>Purchasing clothes</td>
<td>Intention = PU + PS + Errors</td>
<td>0.216 (0.0433)</td>
<td>0.179</td>
<td>0.037</td>
<td>0.388</td>
<td>3.056 (0.0030)</td>
<td>0.211</td>
<td>2.049 (0.0433)</td>
</tr>
<tr>
<td>Trading stocks</td>
<td>Intention = PU + PS + Errors</td>
<td>0.193 (0.0150)</td>
<td>0.053</td>
<td>0.140</td>
<td>0.456</td>
<td>2.478 (0.0150)</td>
<td>0.378</td>
<td>2.522 (0.0134)</td>
</tr>
</tbody>
</table>
Implications for Researchers

The theoretical contributions of this study are (1) introduction of task type as a moderator on the determinants of wireless technology adoption, (2) study of task/technology fit using a profiling approach, and (3) extension of TAM to the adoption of wireless technology outside the workplace for a variety of tasks.

Based on prior research on task definition, we categorize tasks to be performed on handheld devices into three types: general tasks, gaming tasks, and transactional tasks. We empirically validated the moderating effects of task type on wireless technology adoption. This taxonomy is simple but enables HCI and MIS researchers to actively consider whether a technology is a good match for the tasks that users will perform. Researchers in the task–technology fit field have noted the lack of task focus in TAM [14, 16]. The introduction of task type as a moderator brings the task perspective to TAM and takes a step toward addressing the lack of task focus. TAM is an elegant general model for investigating the adoption of technology in general, but our study provides a more practicable approach for investigating various user tasks and how technology can support them.

This project can also be considered as a task–technology fit study. By using a profiling approach, we develop a task taxonomy and identify the characteristics of wireless technology. We then test whether these tasks and the technology profiles fit. TAM with different constructs serves as the technology profiles. This is an interesting and new use of TAM and contributes to methods of doing task–technology fit via profiling.

This study confirms that TAM is applicable to the intention to perform general tasks that do not involve transactions and gaming on wireless handheld devices. Our data supports the thesis that perceived usefulness and perceived ease of use are the two determinants of user intention. A closer examination of individual general tasks suggest that differences among tasks may impact on the role of perceived ease of use.

We show that perceived playfulness is a key determinant of user intention to play games on wireless handheld devices. TAM emphasizes the importance of perceived usefulness as the key determinant of user acceptance of IT. In this study, we argue that perceived playfulness measures the extrinsic outcome expectancy for gaming
tasks and therefore should be considered as a surrogate for perceived usefulness. In this regard, TAM is extended with the inclusion of perceived playfulness as the measurement of extrinsic outcome expectancy.

Our study suggests that perceived usefulness and perceived security are the two determinants of user intention to transact on wireless handheld devices. Perceived ease of use is no longer a key determinant of user intention to transact because transaction tasks are IT-extrinsic. This result confirms the proposition made by Gefen and Straub [14]. On the other hand, perceived security affects user intention.

Implications for Human–Computer Interaction Practitioners

In this study, we have demonstrated the importance of playfulness in user intention to play games, and the importance of perceived security in user intention to transact on wireless handheld devices. From the usability perspective, many researchers and practitioners have argued that the key barrier to user acceptance is the lack of user-friendliness of current systems and that improving usability is the key to success. HCI research has focused primarily on ease of use. However, it is perceived usefulness that determines how users may adopt the technology. HCI practitioners should first consider how an application may satisfy user needs. Results from this study show that playfulness for gaming tasks is more important than any other factors in shaping user intention and acceptance of wireless technology. Therefore, HCI practitioners must take playfulness into consideration when designing gaming tasks. This study also shows that perceived security affects user intention to transact on wireless handheld devices. HCI practitioners should design the interface to enhance user’s perception of security for the transactional tasks.

Conclusion and Future Research

PERCEIVED USEFULNESS AND PERCEIVED EASE OF USE were shown to be important to user intention to perform general tasks that do not involve transactions and gaming on wireless handheld devices. Perceptions of playfulness appear to influence user intention to play games using wireless technology. Perceived usefulness and perceived security affect user intention to transact on handheld devices.

Although these findings provide meaningful implications to both researchers and practitioners, there are some limitations in our study. First, this study used printed task scripts for evaluation. This setting might limit participants' task experience. Second, this study only included two to three items for each construct considering that a large number of questions in the survey may hinder participation. The reliability of the constructs might be affected by the small number of items. Third, only one item was finally used for perceived security. Caution should be exercised when interpreting this construct. Finally, perceived playfulness showed high loadings on perceived ease of use when all tasks were grouped together. Further research is needed to investigate the relationship between these two constructs. The next step for refining this
study is to revise the instrument and to test the proposed conceptual model in a more realistic setting.

This study has demonstrated the important role of tasks on technology adoption by categorizing tasks into three types. Future research should continue to investigate how tasks may affect technology adoption. In our study, we also found that there were still differences among tasks of the same type. This finding indicates that the task taxonomy needs to be further refined. It calls for future research on exploring new task taxonomy to make more accurate task–technology fit.

Future research could also extend the profiling approach of tasks to investigate adoption of other technologies. In this study, we develop a task taxonomy and identify the characteristics of wireless technology. We then test whether these tasks and the technology profiles fit. This approach could be used in other technologies as well.

REFERENCES


37. Pavlou, P.A. Integrating trust in electronic commerce with the technology acceptance model: Model development and validation. In G. Gorgone and J. Fedorowicz (eds.), *Proceed-
Appendix A. Experiment Packet Cover Page

Experiment: What Tasks Are Suitable for Handheld Devices?

WELCOME TO PARTICIPATE IN THE RESEARCH PROJECT “What tasks are suitable for handheld devices?” This study is being conducted by Xiaowen Fang, Susy Chan, and Jacek Brzezinski. The general purpose of this research study is to examine the main factors that influence a user’s preference of tasks to be performed on handheld devices. You will be asked to review scripts of a set of tasks to be performed on a handheld device and answer questions regarding your perception of each task. The risks associated with participation in this study are minimal.

This package is organized in the following order: Preexperiment Questionnaire → Task Script #1 → Questionnaire About Task Script 1 → . . . → Task Script 12 → Questionnaire About Task Script 12 → Final questionnaire about all the task scripts.

The whole experiment may take one to two hours. You do not need to complete the whole experiment at once. However, it is recommended that you review the task script and finish the corresponding questionnaire for this particular task at one time. Please take your time to carefully review the task scripts and choose answers for the questions. No need to rush. Please do not skip any pages.

Thanks again for your participation.

Appendix B. Preexperiment Questionnaire

PLEASE CIRCLE ONE ANSWER for each question.

1. a. Have you ever used a wireless phone? Yes / No
   b. If the answer to above question is yes, how often do you use the wireless phone?
      Rarely Daily Weekly Monthly

2. a. Have you ever used a Palm Pilot? Yes / No
   b. If the answer to above question is yes, how often do you use the Palm Pilot?
      Rarely Daily Weekly Monthly

3. a. Have you ever used a Pocket PC? Yes / No
   b. If the answer to above question is yes, how often do you use the Pocket PC?
      Rarely Daily Weekly Monthly

4. a. Have you ever used any “Address Book” function on your computer? Yes / No
   b. If the answer to above question is yes, how often do you use the “Address Book” function?
      Rarely Daily Weekly Monthly
5. a. Have you ever sent/received e-mails on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you send/receive
      e-mails?
         Rarely       Daily       Weekly       Monthly

6. a. Have you ever checked flight information on the Internet? Yes / No
   b. If the answer to above question is yes, when you travel, how often do you
      check flight information on the Internet?
         Rarely       Sometimes   Always

7. a. Have you ever purchased movie tickets on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you purchase movie
      tickets on the Internet?
         Rarely       Sometimes   Always

8. a. Have you ever read news on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you read news on the
      Internet?
         Rarely       Daily       Weekly       Monthly

9. a. Have you ever done online banking on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you do online
      banking on the Internet?
         Rarely       Daily       Weekly       Monthly

10. a. Have you ever played games on the Internet? Yes / No
    b. If the answer to above question is yes, how often do you play games on
       the computer?
          Rarely       Daily       Weekly       Monthly

11. a. Have you ever checked weather information on the Internet? Yes / No
     b. If the answer to above question is yes, how often do you check weather
        information on the Internet?
           Rarely       Daily       Weekly       Monthly

12. a. Have you ever purchased books on the Internet? Yes / No
     b. If the answer to above question is yes, how often do you purchase books
        on the Internet?
        Rarely       Sometimes   Always
13. a. Have you ever purchased clothes on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you purchase clothes
      on the Internet?
         Rarely   Sometimes   Always

14. a. Have you ever sent/received short messages on a wireless phone?
      Yes / No
   b. If the answer to above question is yes, how often do you send /receive
      short messages on a wireless phone?
         Rarely   Daily   Weekly   Monthly

15. a. Have you ever traded stocks on the Internet? Yes / No
   b. If the answer to above question is yes, how often do you trade stocks on
      the Internet?
         Rarely   Daily   Weekly   Monthly
Appendix C. A Sample Task Script

Task—Checking Flight Status

SCENARIO: I am going to O’Hare Airport to pick up a friend. I need to check the status and gate information of her flight. However, I do not remember the flight number. All I know is that it is a United Airlines flight, departing from La Guardia airport, and should be arriving at 7:30 P.M.

TASK – Check movie information and buy tickets online

Scenario: Check out the nearest theater that is showing “Finding Nemo” today, and buy 2 tickets online.
Note: The original survey experiment packet includes scripts and screenshots for 12 tasks and their accompanying task characteristics questionnaires. Due to space limitation, only one task and its task characteristics questionnaire are included in the Appendix.

Appendix D. Task Characteristics Questionnaire

Assuming that you have no access to a regular PC, please circle one answer to indicate your agreement with the next set of statements regarding your perception of the task “Checking Flight Status.”

1. Learning to perform this task is easy for me.

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<td>Strongly disagree</td>
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2. This task may enhance my effectiveness.

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3. I do not realize the time elapsed when performing this task.

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4. I feel secure to perform this task on the handheld computer.

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5. I find it challenging to accomplish this task.

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6. Overall, I find this task to be useful.

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7. I find it easy to perform this task.

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8. I find it easy to accomplish the task.

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9. I find this task interesting and enjoyable.

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10. The wireless Palm device is suitable for performing this task.

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11. There is feedback indicating the information is protected.

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12. I find it cumbersome to perform this task.

1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree

13. This task may enhance my productivity.

1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree

14. The wireless Palm device makes it easy to perform this task.

1 Strongly disagree 2 Disagree 3 Somewhat disagree 4 Neutral 5 Somewhat agree 6 Agree 7 Strongly agree

Appendix E. Final Questionnaire

ASSUMING THAT YOU HAVE ACCESS to a wireless handheld device, assign a score of intention to use the device for performing each task.

<table>
<thead>
<tr>
<th>Task</th>
<th>Score of intention of use</th>
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<tbody>
<tr>
<td>Managing address book</td>
<td>(0: no intention;</td>
</tr>
<tr>
<td>Sending/receiving e-mail</td>
<td>7: highest intention;</td>
</tr>
<tr>
<td>Checking flight information</td>
<td>floating point number</td>
</tr>
<tr>
<td>Purchasing movie tickets</td>
<td>integer only)</td>
</tr>
<tr>
<td>Reading the news</td>
<td>is acceptable )</td>
</tr>
<tr>
<td>Banking online</td>
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<tr>
<td>Playing games</td>
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<tr>
<td>Checking weather information</td>
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<tr>
<td>Purchasing books</td>
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<tr>
<td>Purchasing clothes</td>
<td></td>
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<tr>
<td>Sending short messages</td>
<td></td>
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<tr>
<td>Trading stocks</td>
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End of experiment—Thank you!