Once Built Well, They Might Come: An Empirical Study of Mobile E−Mail

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Abstract

In this exploratory study, we seek to help explain and predict the success of mobile in−formation systems based on a research model that joins key elements of the theory of task−technology fit and the technology acceptance model. To account for idiosyncrasies of the mobile technology artifact, as exemplified by mobile e−mail, we include user mobil−ity and user−perceived technology maturity in our research model. Using structural equa−tion modeling with PLS and content analysis, we analyze 55 responses that we collected from employees at a Fortune 100 firm. For non−users of mobile e−mail, we find a signifi−cant association between task−technology fit and expected usefulness of the technology that corroborates a previously suggested link between the technology acceptance model and the theory of task−technology fit. For users of mobile e−mail, however, we find tech−nology maturity to be a dominant explanatory factor that exhibits strong associations with extent of use of mobile e−mail and with actual user−perceived usefulness and related performance impacts. We further identify a need to advance the measurement of user mobility. Our findings complement the suggestion to apply a technology−to−performance chain in order to understand the success of information technology. Our results indicate that user−perceived technology maturity may play an important role to explain use and performance impacts of information technology, in particular during the early stages of technology development. Our study has theoretical implications for the application of earlier information system theories to mobile technology innovations, and practical impli−cations for the understanding about the requirements of mobile technology to adequately support a mobile workforce.

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ABSTRACT

In this exploratory study, we seek to help explain and predict the success of mobile information systems based on a research model that joins key elements of the theory of task-technology fit and the technology acceptance model. To account for idiosyncrasies of the mobile technology artifact, as exemplified by mobile e-mail, we include user mobility and user-perceived technology maturity in our research model. Using structural equation modeling with PLS and content analysis, we analyze 55 responses that we collected from employees at a Fortune 100 firm. For non-users of mobile e-mail, we find a significant association between task-technology fit and expected usefulness of the technology that corroborates a previously suggested link between the technology acceptance model and the theory of task-technology fit. For users of mobile e-mail, however, we find technology maturity to be a dominant explanatory factor that exhibits strong associations with extent of use of mobile e-mail and with actual user-perceived usefulness and related performance impacts. We further identify a need to advance the measurement of user mobility. Our findings complement the suggestion to apply a technology-to-performance chain in order to understand the success of information technology. Our results indicate that user-perceived technology maturity may play an important role to explain use and performance impacts of information technology, in particular during the early stages of technology development. Our study has theoretical implications for the application of earlier information system theories to mobile technology innovations, and practical implications for the understanding about the requirements of mobile technology to adequately support a mobile workforce.

Keywords: mobile business applications, task-technology fit, technology-to-performance chain, technology acceptance model, mobile e-mail, technology maturity

Introduction

The use of mobile information systems has received growing attention, not only as part of consumer-oriented products and applications (Coursaris et al., 2004), but also to augment business strategies and to support organizational processes, in particular when integrated with internet-based technologies (Barnes, 2003, Varshney et al., 2002). Recent technology innovations, such as smart phones and personal digital assistants (PDAs), allow employees to communicate, not only using voice but also through written communication (e-mail, short messaging), and enable access to the corporate information system infrastructure while being away from their offices, whereas in the past it was quite difficult to establish continuous electronic links in convenient and affordable ways. Mobile information systems have the reported potential to increase the efficiency of mobile employees as a result of improved distribution of information and lower operational cost (Leung and Antypas, 2001), as well as increase effectiveness, for example in the form of higher quality decision-making (Beulen and Streng, 2002, Varshney et al., 2002). Systematic assessments of the antecedents and consequences of the use of mobile information systems, however, are still outstanding (Alanen and Autio, 2003, Liang and Wei, 2004, Smith et al., 2002). In addition, the research question remains open to what extent previously developed theories to explain information system use and impacts are applicable to mobile information systems (Mylonopoulos and Doukidis, 2003).

To address these two stated research issues, we focus on mobile e-mail as one type of mobile technology that has achieved relatively widespread adoption among mobile knowledge workers (Alanen and Autio, 2003, Anckar, and D'Incau, 2002, Computerworld, 2003, Lopperi and Sengupta, 2004). Our discussion centers around two information system theories, namely the theory of task-technology fit (Goodhue, 2007, Goodhue and Thompson, 1995) and the technology acceptance model (Davis, 1989, Davis et al., 1989), that have broadly established the need to provide information systems that fit user tasks, and that are perceived as useful and easy to use, as conditions of system use and positive performance impacts. The applicability of these earlier theories to mobile information systems depends on the effect that is exhibited by the idiosyncrasies of the mobile technology artifact on the various theoretical constructs (Orlikowski and Iacono, 2001). For example, differences of user requirements as a result of user mobility have been attributed to the fact that mobile users tend to be more often distracted and multitasking than non-mobile users (Lee and Benbasat, 2004); encounter specific security requirements (Ghosh and Swaminatha, 2001); and experience a greater need for specific non-functional features, such as device portability (size, weight), screen size and input components (Gebauer and Ginsburg, forthcoming). In addition, compared to established non-mobile applications, mobile information systems are still under development and as a whole have not reached a level of technology maturity that matches the level of technology maturity of established non-mobile information systems. Shortcomings impact usability and include potentially tedious setup procedures; complex content presentation and navigation structures; and lack of user guidance, bandwidth, and robustness (Buchanan et al., 2001, Chan and Fang, 2003, Gebauer and Shaw, 2004). Research studies related to the technology acceptance model have identified the level of user experience with a particular technology as a moderator of the relationship between user-perceived ease of use, and intention to use to the extent that ease of use has more explanatory power for inexperienced users than for experienced users (Taylor and Todd, 1995). In addition, for personal computing in small firms, data that were collected from users with a "very low level of personal computing sophistication" also suggested perceived ease of use to be a dominant factor in explaining (actual) system usage (Igbaria et al., 1997). The findings support the suggested association between system quality and use that have long been identified as two measures of system success (DeLone and

McLean, 1992). In contrast, the impact of technology maturity and dynamic changes as a result of technological developments are not typically included in studies of the adoption and use impacts of information systems (Legris et al., 2003).

The current research study seeks to contribute to the understanding of the reasons of mobile professionals to use mobile information systems—exemplified by mobile e-mail—and the subsequent perceived impacts on individual performance. We present a research model that joins key elements of two related streams of information systems research, namely the technology-to-performance chain that has been suggested by scholars of the theory of task-technology fit and the technology acceptance model, and take into account user mobility and technology maturity. To test the research model, structural equation modeling using partial least square analysis and content analysis are applied to a dataset of 55 responses that we collected at a Fortune 100 firm in 2002-3 and 2006-7.

Theoretical Foundations

We now discuss the theoretical foundations of our research model, namely the theory of task-technology fit and the technology acceptance model that have been developed to explain and predict the preconditions and impacts of information system use. We also present examples of the application of the two theories to innovative information technologies.

Theory of Task-Technology Fit

Conceptually, the theory of task technology fit is related to contingency theory that has been developed by scholars of organizational science (Drazin and Van de Ven, 1985, Van de Ven and Drazin, 1985), and strategy (Venkatraman, 1989) in an effort to explain and predict the conditions of an adequate match between the environment of an organization, and its internal structure. In the research discipline of information systems, the theory of task-technology fit has been developed in an effort to identify the requirements of an adequate relationship between the information technology artifact and the supported user tasks (Goodhue and Thompson, 1995, Zigurs and Buckland, 1998). A key component of the theory of task-technology fit is the technology-to-performance chain, asserting that "for an information technology to have a positive impact on individual performance, the technology *must be utilized*, and the technology must be a *good fit with the tasks it supports*" (Goodhue and Thompson, 1995, p. 213). In other words, it is suggested that a joint consideration of information system use and of task-technology fit can explain impacts on user performance better than either factor alone (Goodhue, 2007). Applications of the theory of task-technology fit to various task and technology situations have demonstrated the relevance of the concept to explain and predict information system use and positive impacts on individual performance (Goodhue and Thompson, 1995) and on group performance (Zigurs and Buckland, 1998, Zigurs et al., 1999).

Researchers have applied different approaches to determine the extent to which information systems fit the underlying user tasks. In one stream of research, fit has been determined directly, for example based on the perception of users regarding a number of dimensions, such as data quality and accessibility (Goodhue and Thompson, 1995, Lee et al., 2007). Others presented a more indirect approach and determined fit as the extent to which technology complied with theoretically derived requirements to support a particular task. For example, Zigurs and Buckland (1998) determined fit based on the adherence of group support systems to ideal profiles of requirements of group tasks, whereas Dishaw and Strong (1998) used a computational approach to determine fit as a match between user-indicated requirements of software maintenance tasks, and the functionality that was actually provided by the systems.

Applications of the theory of task-technology fit to technologies, such as web-commerce (D'Ambra and Wilson, 2004), mobile e-procurement (Gebauer and Shaw, 2004), and mobile commerce in the insurance industry (Lee et al., 2007), have provided empirical evidence for the ability of task-technology fit to help explain and predict the success of innovative information systems. A recent study of wireless technology acceptance uncovered variations of functional and non-functional requirements, depending on specific tasks (Fang et al., 2005-6).

Technology Acceptance Model

The technology acceptance model represents a large body of behavioral information systems research studies that discusses the antecedents of users' intention to use information technology (Davis, 1989, Davis et al., 1989), based on the assumption that intention to use is associated with actual use (see Bagozzi, 2007 for a cautionary note on this assumption). Among the main results of technology acceptance model-related research studies is the finding that user-perceived usefulness and user-perceived ease of use are both relevant to explain and predict the intention to use an information system. Still, usefulness generally appeared to be the dominant factor, whereas ease of use worked through usefulness, in particular for more experienced users (Taylor and Todd, 1995). In line with the general perspective of the technology adoption model, user-perceived usefulness pertains to the expectations of a prospective user and the construct has been shown to include anticipated impacts on individual performance, such as effectiveness (Chin and Todd, 1995, Venkatesh et al., 2003a).

The application of the technology acceptance model to technology innovations, such as the World Wide Web (Lederer et al., 2000, Moon and Kim, 2001) and internet-shopping (Gefen et al., 2003, Gefen and Straub, 2000) uncovered further evidence for the relevance of both factors: usefulness and ease of use. While usefulness typically provided the strongest explanation for intention to use (and actual use), conflicting results were obtained by different scholars regarding the impact of user-perceived ease of use. Explanations for the discrepancies and subsequent extensions of the technology acceptance model include the consideration of intrinsic versus extrinsic characteristics (Gefen and Straub, 2000), trust (Gefen et al., 2003), and differing requirements for differing tasks (Fang et al., 2005-6).

Complementarities of the Theory of Task-Technology Fit and the Technology Acceptance Model

As previous research studies have established the applicability of both the theory of task-technology fit and the technology acceptance model to innovative forms of information technology, including mobile applications, both theories appear to be well suited for our research purpose. Furthermore, previous research studies have acknowledged a number of complementarities between both approaches, and have subsequently joined elements from both theories into integrated research models (Dishaw and Strong, 1999, Pagani, 2006). Whereas the technology acceptance model uses the intention of individuals to use a particular technology as its main dependent construct, based on the assumption that intention to use will eventually lead to actual use, the theory of task-technology fit focuses more explicitly on actual use and subsequent impacts on performance. Whereas expected usefulness is a key independent variable in the technology acceptance model that helps to explain and predict intention to use, the theory of task-technology fit examines an important antecedent of usefulness that is expressed as the extent to which technology matches the underlying business task (Dishaw and Strong, 1999). Whereas scholars of the theory of task-technology fit often derive fit objectively (directly or indirectly), scholars of the technology acceptance model view usefulness as a behavioral, subjective (user-perceived) construct, whereby both constructs of fit and expected usefulness are strongly associated with use. The link between the objective approaches that are applied by some scholars of the theory of task-technology fit, and behavioral approaches that are predominantly applied by scholars of the technology acceptance model, has been established, as users have been found to be able to correctly assess fit (Goodhue, 1998).

A key difference can be found in the main objectives of the two approaches. While scholars of the technology acceptance model seek to understand better the conditions that lead to the intention to use an information system, the theory of task-technology fit is concerned with the antecedents of actual use and the resulting impacts on performance. However, the implicit (and empirically validated) assumption within the technology acceptance model that intention to use typically leads to actual use of an information system provides the link between both approaches. A more subtle distinction comes in the form of the usefulness/performance component that plays a role in both approaches: User-perceived usefulness that is included in studies of the technology acceptance model typically encompasses a variety of items, such as effectiveness (Chin and Todd, 1995), that are *expected* to impact user performance upon use (Venkatesh et al., 2003a). In contrast, scholars of the theory of task-technology fit typically focus on the consequences of *actual* system use, such as impacts on individual or group performance (Goodhue and Thompson, 1995, Zigurs et al., 1999). Actual usefulness, as we will refer to it in the current paper, may be user-perceived (Goodhue, 1998), or may be derived objectively through observation (Goodhue et al., 2000). Both approaches complement each other well: The theory of task-technology fit provides fit as an important antecedent of usefulness that is not included in the technology acceptance model, whereas the technology acceptance model provides ease of use as an important antecedent of use that is not included in the theory of task-technology fit. Our suggested research model is described next.

Research Model

The current research model builds on the theory of task-technology fit and the technology acceptance model in an effort to explain and predict the use and impact of mobile e-mail-systems in support of general tasks that are of relevance to a mobile workforce. Two factors that are specific to current forms of mobile technology are given particular attention, namely user mobility and technology maturity. Figure 1 provides an overview of the research model that is explained in more detail in the following sections.

General Business Tasks

Previous research studies of management provide a conceptual basis to assess the requirements of general business tasks that are not related to transactions and gaming (Fang et al., 2005-6). Two dimensions have been identified as relevant to such managerial tasks, namely non-routineness and task interdependence (Goodhue and Thompson, 1995, Karimi et al., 2004).

Task non-routineness is related to characteristics, such as structure, repetitiveness and novelty of a task (Simon, 1960), whereby higher levels of non-routineness have been found to make it difficult to program (automate) decision making, and to require judgment and intelligent, adaptive, problem-oriented action. Related is the degree to which a task is predictable and analyzable (i.e., relying on past experiences and previously developed concepts and routines), or unpredictable and unanalyzable (i.e., not logical or unanalytic, often requiring intuition, chance, and guesswork), and with the number of exceptions that need to be processed during task performance (Perrow, 1967, Van de Ven and Ferry, 1980). Tasks of high non-routineness tend to be characterized by a high number of exceptions, poor predictability, and low levels of analyzability and programmability. In addition, the need to perform non-routine tasks tends to be greatest at higher levels of the organizational hierarchy (Anthony, 1965, Gorry and Scott Morton, 1971), including corporate leadership and contract negotiations (Mintzberg, 1973).

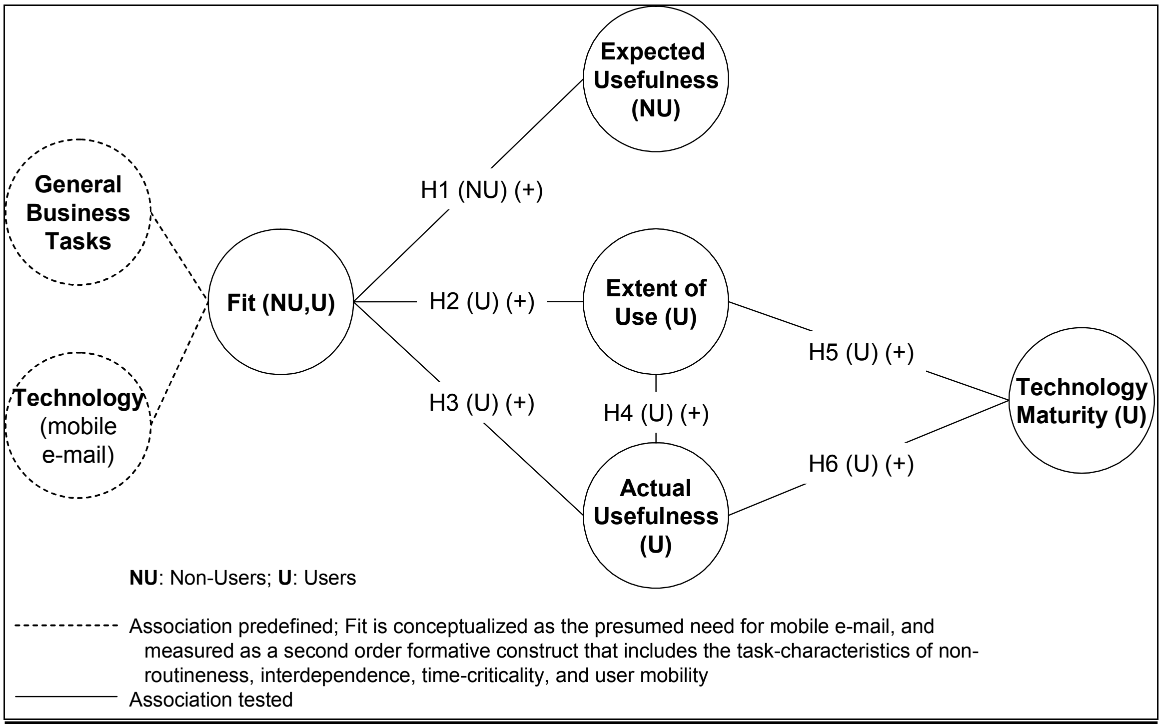

Figure 1. Combined Research Model for Non-Users (NU) and Users (U)

Task interdependence has been defined as the exchange of output between segments within a subunit and with other organizational units (Fry and Slocum, 1984). As interdependence requires coordination between activities (Malone and Crowston, 1994), it generally increases the difficulty and costs that are associated with task performance (Barki and Pinsonneault, 2005). Highly interdependent tasks, such as the development of an advertising campaign, require actors to interact extensively to generate the desired outcome, while a task that has no interdependence, such as telemarketing, can be executed entirely by one person (Wageman and Gordon, 2005). Interdependence affects the number of regular communication channels and partners that a user interacts with, the pattern of interaction between tasks and resources that are consumed and produced jointly or individually (Crowston, 2003), and consequently lends itself well to technological support (Thompson, 1967), in particular with communication technology.

For the analysis of mobile technology in general and mobile e-mail applications in particular, two additional dimensions of tasks appear to be relevant, namely time-criticality (Anckar and D'Incau, 2002), and user mobility. Time-criticality relates to the importance with which a task needs to be performed promptly (urgency) and depends on the dynamics of business environments. Even though time-criticality has received limited attention by scholars of organization science, the need for organizations to respond quickly to changing market requirements has been highlighted in management and strategy research (Bradley and Nolan, 1998, D'Aveni, 2004. In addition, research studies of information systems have established the ability of information technology to help users achieve immediacy. For example, Straub and Karahanna (1998) found the urgency of communication tasks to influence the type of media (synchronous vs. asynchronous) that communicators preferred to support their tasks.

Mobility is relevant for our research purpose because the use context of mobile technology is typically different from the stationary context in which more traditional types of information technology are used (Kim et al., 2002, Turel, 2006). Mobile situations, such as travel, tend to limit a user in the ability to carry equipment and to access standard corporate information system resources, including various enterprise applications. As a consequence of such limitations, changes in the way that tasks are performed in mobile use contexts have been reported (Perry et al., 2001, Zheng and Yuan, 2007). For example, compared to a non-mobile user with ready access to the corporate information system infrastructure that is sufficient to complete a given business task (e.g., approval of a purchasing request), a mobile user may perceive a need to delegate parts of the task to non-mobile co-workers, and use available forms of communication, such as mobile phone or e-mail for directional and supervisory purposes (Gebauer and Shaw, 2004).

Mobile E-Mail Technology

Mobile business applications tend to resemble traditional information systems in terms of functionality and variety (Computerworld, 2003, Smith et al., 2002). As a difference to traditional information systems applications, however, mobile applications bring back to attention the devices that are used to access and utilize application functionality, and the non-functional features that distinguish mobile from non-mobile information systems. No longer can we assume more or less one kind of access device, namely a stationary terminal or personal computer with a standard monitor and keyboard that is utilized for a variety of applications. Devices have instead become portable and include cellular phones; personal digital assistants (PDAs); laptop, pocket and tablet computers; and one- and two-way pagers. New challenges emerge from this shift, stemming for example from form factors such as small screens and keyboards, as well as from the fact that technology developments are ongoing.

Mobile e-mail constitutes an early, and comparatively successful, application of mobile technology (Alanen and Autio, 2003, Anckar, and D'Incau, 2002, Computerworld, 2003, Lopperi and Sengupta, 2004). Providing the mobile user with access to e-mail allows for the notification about waiting tasks, task progress, and other issues of significance, thus supporting reachability. In addition, user-initiated communication is supported via the creation of e-mail-messages by the mobile user.

Fit of Mobile E-Mail Technology to Support General Business Tasks

Dishaw and Strong (1998) computed task-technology fit "by matching characteristics of a maintenance task to supporting functionality in a software maintenance tool." The fit was assessed by comparing the functionality that was available in a tool with the expectations of users regarding the functionality that was required to complete various tasks. The higher the number of expected functionalities that were available in a particular tool, the better the fit was determined to be. For group support systems (GSS), task-technology fit has been presented as rationally developed, "ideal profiles composed of an internally consistent set of task contingencies and GSS elements that affect group performance", where ideal profiles were seen as viable alignments of task and technology (Zigurs and Buckland, 1998) ("fit as profile deviation", Venkatraman, 1989). A comparable approach is followed in the current paper, where we determine fit as the extent to which the technology of mobile e-mail supports the presumed needs of a particular task-profile. In contrast to Zigurs and Buckland (1998), however, the technology of mobile e-mail is regarded as a constant given its narrower functional scope compared to group support systems. Our perception of fit is, consequently, associated directly with the degree to which the task-characteristics of non-routineness, interdependence, time-criticality, and user mobility translate into a presumed need for mobile e-mail. In the following, we discuss the presumed fit of mobile e-mail with the four task-characteristics of non-routineness, interdependence, time-criticality, and user-mobility.

Earlier, we described non-routine tasks as needing judgment and often to be one-of-a-kind decisions, such as for strategic management and contract negotiations. Research studies of information richness (Daft and Lengel, 1984) have emphasized the importance to support such highly complex and non-routine tasks with rich and flexible means of communication, enabled for example by face-to-face meetings and the telephone. In the framework of information richness (Daft and Lengel, 1984), written communication based on e-mail can be considered of moderate to high information richness that is situated between the communication media of telephone and paper-based written communication and that is based on natural language and personal interaction. Feedback can be obtained faster than for traditional written communication, yet is typically slower than in the case of a telephone conversation. Cues are limited to the written word, even though e-mail communication tends to be more informal than traditional, paper-based written communication and to use certain symbols (e.g., emoticons). We consequently regard e-mail as a communication tool of moderate to high information richness with a good fit for business tasks that are characterized by moderate to high non-routineness (Markus, 1994).

Coordination has been defined as the management of interdependencies (Malone and Crowston, 1994). Varying degrees of interdependence, thus, determine the need for coordination, whereby the ability of information technology to enable and support coordination has been emphasized. E-mail appears to be a tool what is particularly well suited to support and enable coordination, and, thus, the management of interdependencies between multiple actors, as it allows for multiple addressability of communication partners, and provides an externally recorded and computer-processable memory (Markus, 1994). Consequently, we regard e-mail as providing a good fit for tasks that are characterized by a high level of interdependence.

E-mail has also been acknowledged to provide the opportunity for fast response between communication partners (Markus, 1994), and as a result, to support tasks that are time-critical. The aspect of time-criticality becomes even more prominent with mobile e-mail applications, as has been emphasized by scholars of mobile information systems who identified time-criticality as an important dimension of mobile systems (Balasubramaniam et al., 2002); suggested that mobile commerce was well suited for emergency and time-critical services (Liang and Wei, 2004, Yuan and Zhang, 2003); and stated that mobile technologies provide immediacy (Siau et al., 2001). In addition, it has been found that users' value of mobile devices and services revealed their desire to obtain rapid feedback (Jarvenpaa et al., 2003), and that time-criticality as a trigger for use might be more important in wireless than in wired environments (Venkatesh et al., 2003b). In practice, support for time-critical tasks (e.g., notification of emergency situations) has been among the earliest applications of mobile technologies (Ammenwerth et al., 2000). Mobile e-mail provides an instantaneous delivery and access mechanism that appear to be highly supportive of time-critical tasks and should consequently provide a good fit.

Lastly, the context in which a task is performed contributes to the need for mobile technology in general, and for mobile e-mail in particular. Mobile use contexts are typically associated with limited access to the corporate information technology infrastructure that is available in a stationary office environment. Upon determining the need for mobile e-mail, however, we need to keep in mind that user requirements in mobile versus non-mobile use environments, are most likely not identical. For example, mobile users face restrictions in their ability to carry equipment (Kim et al., 2002), or to concentrate for prolonged periods of time due to environmental distractions (Lee and Benbasat, 2004). Perry et al. (2001) have suggested that the result of such restrictions may be a particular need for basic yet versatile means of communication support, such as what is provided by mobile phones and mobile e-mail devices.

To summarize, the construct of fit in our research model is predetermined, based on the assumption that mobile e-mail systems provide a particularly good fit with tasks that are characterized by a moderate to high level of non-routineness, and high levels of interdependence, time-criticality, and user-mobility. In other words, we use the composite of the tasks characteristics of non-routineness, interdependence, time-criticality, and mobility, as a proxy for the fit between mobile e-mail systems and general business tasks that should be applicable for pre-adoption and post-adoption situations.

Expected User-Perceived Usefulness

User-perceived usefulness is one of the key constructs of the technology acceptance model, and is associated with the degree to which a user *expects* the use of an information system to have positive consequences for the performance of his or her tasks (Davis, 1989, Davis et al., 1989). Conceptually, expected usefulness is typically based on user-perceptions that were acquired for example as a result of user training or introductory use, rather than based on extensive actual use experience. Expected usefulness has been associated with task-technology fit in research models that have integrated task-technology fit with the technology acceptance model (Dishaw and Strong, 1999, Pagani, 2006). More specifically, task-technology fit as an objective, rational choice construct, has been conceptualized as an antecedent of the behavioral construct of user-perceived usefulness. It has been contended that task-technology fit can help to improve the explanatory power of the technology acceptance model for intention to use and subsequently also for actual use. Consistent with Dishaw and Strong (1999) we hypothesize for pre-adoption situations:[1]

H1: Task-technology fit is associated positively with expected *user-perceived usefulness.*

[1] Even though Dishaw and Strong (1999) provided strong theoretical arguments for the expected positive association between fit and expected usefulness, the suggested link was in fact not empirically significant in the tested model. To explain this research finding, the authors pointed to the significant *indirect* association between fit and usefulness where perceived ease of use may have been acting as a mediator. As we point out below, our model contains a construct that is conceptually related to perceived ease of use namely user-perceived technology maturity. In addition, and as discussed earlier, we apply an approach to fit that is different from Dishaw and Strong's approach where fit was derived "by matching characteristics of a maintenance task to supporting functionality in a software maintenance approach, using an interaction approach" (p. 14).

Extent of Use

As one of the key elements of the research model, research studies of task-technology fit are based on the assumption that a good fit between the technology and the tasks that the technology is meant to support results in actual use (Dishaw and Strong, 1999, Goodhue and Thompson, 1995). We hypothesize accordingly:

H2: Task-technology fit is associated positively with extent of use.

Actual User-Perceived Usefulness

In the form of actual, realized positive impacts on the performance of an information system user, usefulness is an important component of the theory of task-technology fit (Goodhue and Thompson, 1995). Its scholars contend that performance impacts, such as improved effectiveness, that are conceptually related with usefulness (Chin and Todd, 1995), cannot be explained well with (intention to) use alone (see also Schwarz and Chin, 2007). Instead, other factors need to be taken into consideration, such as task-technology fit. For post-adoption situations, we hypothesize:

H3: Task-technology fit is associated positively with actual *user-perceived usefulness.*

An important aspect of the technology-to-performance chain is the assumption that the utilization of information technology explains performance impacts (i.e., actual usefulness), in particular in combination with task-technology fit (Dishaw and Strong, 1999, Goodhue and Thompson, 1995, also DeLone and McLean, 2003). Consequently, we add to H3, with the following hypothesis in a post-adoption situation:

H4: Extent of use is associated positively with actual *user-perceived usefulness*.

User-Perceived Technology Maturity

Regarding the second idiosyncratic factor of mobile e-mail systems to be included in our research model, we note that the development of mobile technology is presently ongoing, and resulting in technology artifacts that are often considered difficult to use in comparison with more established technologies (Buchanan et al., 2001, Chan and Fang, 2003). Technology maturity corresponds with the idea of facilitating conditions (Triandis, 1980) that can range from optimal to most unfavorable and that have been suggested to moderate the link between intention and behavior by scholars of motivation. On a more operational level, maturity corresponds with system quality that has been identified as an important contributor to system success (Lucas, 1975) and that has been measured for example with ease of use (DeLone and McLean, 1992, DeLone and McLean, 2003). Indeed, reported usability issues with mobile systems include tedious setup procedures, complex content presentation and navigation structures, and lack of user guidance, bandwidth and robustness. Dynamic changes of the technology artifact as a result of the ongoing efforts of vendors and system providers towards technological advancements pose additional challenges.

In light of the current level of maturity of the technology artifact, we expect *limiting* effects of user-perceived shortcomings on two elements of our research model, namely extent of use and actual user-perceived usefulness (performance impacts). Our expectation is in line with the results reported by earlier research studies of mobile applications. For example, strong relationships were found between technology performance (=maturity) and actual use for both mobile commerce (Jarvenpaa et al., 2003) and mobile electronic procurement applications (Gebauer and Shaw, 2004), whereby, again, weak technology performance had a particularly strong negative effect on actual use. The findings are consistent with the results of research studies that are presented by scholars of the technology acceptance model who reported ease of use to be a dominant factor to explain *actual* usage of personal computing among users of a "low level of personal computing sophistication" in small firms (Igbaria et al., 1997), and who found that for novice users in particular, user-perceived ease of use can explain a rather significant portion of a user's intention to use (Taylor and Todd, 1995). We note that for expert users who are thought to be very familiar with the technology, the association between user-perceived ease of use and (intention to) use turned out to be much weaker (Davis, 1989, Davis et al., 1989). We posit parallels between the situations of novice users and novel technologies, given that both relate to instances in which users are likely to be unfamiliar with the technology, and in which the human-computer interface is likely not fully reflective of the user requirements. Applying the findings from the technology adoption literature to post-adoption use situations, we hypothesize:

H5: User-perceived technology maturity is associated positively with extent of use.

H6: User-perceived technology maturity is associated positively with actual *user-perceived usefulness.*

Research Methodology

Data Collection

To test the research model, we collected data at a Fortune 100 provider of communication technology. The company operates in a number of global, dynamic, and highly competitive markets, and considers a significant portion of its professional staff (30%) to be mobile.

Survey data were collected at two separate times and included a total of 55 responses. In 2002/early 2003, we collected data from 27 respondents that had expressed an interest to participate in one of several mobile e-mail trial applications that were conducted in various parts of the company. The effective response rate of this first survey that was administered internally by members of the trial project group was about 20%. We monitored the rollout of the trial applications through approximately fortnightly conference calls and a number of meetings with members of the project management group during the timeframe of 2001 to 2003. In addition, we reviewed related documents that were made available to us by the project group. Shortly after the survey (and partly due to the findings from our study), the trial applications were terminated and the mobile application server was shut down, which prevented the collection of additional data and the observation of long-term effects. In 2005, we conducted a follow-up interview with a project director to assess the current state of mobile e-mail use in the company and to discuss the experiences with the trial applications in retrospect. For the second survey, we successfully contacted just under 100 members of the company who had previously been involved with or had expressed an interest in mobile business applications. During a three-week timeframe at the end of 2006/beginning of 2007, we collected a total of 28 responses for an effective response rate of approximately 30%. Nine respondents participated in both surveys.

The 2002-3 trial applications were accessible via cellular phones and were based on WAP Docomo, and iDEN technologies. Login procedures required a combination of login name, password, pin, and/or a physical access card. In comparison, the 2006-7 survey referred to the use of operational (=commercially available) mobile e-mail systems, whereby respondents indicated the use of a variety of state-of-the art smart cell phones and personal digital assistants, effectively mirroring the progress of mobile technology that has occurred during the previous four years.

The respondents were distributed quite evenly between users and non-users of mobile e-mail (see Table 1 for additional demographic information). Of the nine respondents that participated in both the 2002-3 and 2006-7 surveys, three indicated continuous use of mobile e-mail; one indicated continuous non-use; four previous users indicated that they were no longer using mobile e-mail; and one previous non-user reported the use of mobile e-mail in the more recent survey. Acknowledging the possibility for changes during the long timeframe between surveys of close to four years, we treat multiple responses from one individual as separate datasets that indicate information at the time that each survey was taken.[2] Forty percent of the respondents were located in North America, 32% in Europe, and 27% in Asia. Just under half (49%) of the respondents indicated their age to be between 34-44 years, while 31% of the respondents were between 44-45 years, and the rest of the respondents was almost evenly distributed among the age groups of 25-34 years (9%) and 55 years and over (11%). The respondents reported an average tenure with the company of 13 years, ranging from 1 year to 32 years. Job descriptions varied widely and included technical functions (e.g., systems engineer) as well as business functions (e.g., procurement, supply chain management, operations, sales, marketing, and finance), ranging from lower level management to vice president. All but two of the respondents were male.

[2] A comparison of the means between first and second survey responses did not reveal significant differences for any of the constructs, thus suggesting the absence of systematic changes that cannot be explained as part of the model, and supporting our decision to combine the responses of both surveys for a joint analysis.

Table 1. Demographic Information of Respondents			
	Mobile E-Mail Trial (2002-3)	**Operational Mobile E-Mail (2006-7)**	**Total**
Sample Size			
Responses	27	28	55
Users versus Non-Users			
Users	17	13	30
Non-Users	10	15	25
Locations			
North America	7	15	22
Europe	12	6	18
Asia	8	7	15
Age			
25-34 years	5	-	5
35-44 years	15	12	27
45-54 years	5	12	17
55 years and over	2	4	6
Tenure			
Average tenure with firm (in years)	9	17	13

Notes: All data pertain to the time when the survey was taken. Nine individuals participated in both surveys, meaning that responses effectively came from 46 individuals. Given the long timeframe of close to four years between the two surveys and possible changes with respect to most all of the collected data, we treat multiple responses from one individual as separate datasets in the quantitative data analysis.

Measurement Scales

The model constructs were measured with multi-item indicators, using validated scales when available. Table A-1 (Appendix) lists the measurement indicators and the research support for operationalization. Most indicators were measured or coded with a seven-point Likert-type scale. In addition to closed questions, several open-ended questions were included in the survey.

Fit for mobile e-mail was predetermined based on the task-characteristics of non-routineness, interdependence, time-criticality, and mobility that, in line with our earlier discussion, relate to the extent to which a task is presumed to require mobile e-mail communication. Based on Mintzberg's (1979) work on the nature of a manager's work, project initiation and leadership, and resource allocation were selected as two examples of tasks that exhibit moderate to high non-routineness. Similarly, interdependence was operationalized based on the extent to which a manager interacted closely with others and processed information from many different sources, whereas time-criticality was operationalized with the extent to which a job included emergency situations and required immediate decisions. The mobility construct that was used in the current study pertains to travel, and was operationalized with travel frequency and travel distance. To operationalize travel distance, we combined the responses to two questions pertaining to (1) home location and (2) regular destinations of business travel, and coded higher values for longer combined travel distances from the home location (see Table A-1 for details).

Fit was regarded as a formative second-order construct that included four reflective first-order constructs that measured the presumed need for mobile email via the task characteristics of non-routineness, interdependence, time-criticality, and user mobility. Whereas for reflective constructs the measurement items are viewed to be affected by the underlying latent construct, formative indicators are believed to cause changes in the latent constructs (Scott, 1995). The indicators in formative constructs consequently approximate the underlying construct in combination, whereby individual weights are determined according to the relative importance in forming the construct. Formative indicators are not necessarily correlated, as would be expected for a reflective construct. Acknowledging its three distinct determining factors of non-routineness, interdependence, and time-criticality, fit was modeled as a second-order construct.

Whereas the measurement items underlying the fit-construct were applicable to all respondents, the remaining constructs applied separately to situations of pre-adoption (non-users) and post-adoption (users) of mobile email. To measure usefulness, we asked respondents directly about the extent to which two basic functions, namely checking and creating e-mail messages, were considered useful in situations of pre-adoption ("would be useful", expected usefulness) or post-adoption ("is useful", actual usefulness). As pointed out earlier, expected user-perceived usefulness is a central component of the technology acceptance model that has consistently demonstrated strong explanatory power for intention to use, whereas actual usefulness can be equated with realized, perceived performance impacts as a result of system use. For a post-adoption situation (users), we also measured user-perceived impacts of mobile e-mail use on the performance of an individual user in the form of efficiency and effectiveness (Melville et al., 2004). Efficiency related to benefits from increased productivity of the user and of the people a user interacted with, and included the reductions in idle time while out of the office and the possibility to be more prepared upon returning to the office. Meanwhile, effectiveness referred to the possibility to make better decisions while out of the office and without immediate access to the regular information infrastructure. Impacts on effectiveness have also been shown to be associated with flexibility referring to the possibility to react faster to changing conditions and requirements inside and outside the organization (Pralahad and Krishnan, 2002).

We assessed the extent of use of a mobile e-mail system in terms of frequency of use and intensity, whereby we coded frequency based on open-form responses that we received from the respondents (see Appendix Table A-1 for details), and used the percentage of tasks that users performed with the mobile system as an indicator of intensity. A comparable approach has been applied by Goodhue and Thompson (1995) who conceptualized system use as the "extent to which the information systems have been integrated into each individual's work routine, whether by individual choice or by organizational mandate" (p.223, see also p. 218), and measured integration by the degree to which users were dependent on the individual systems. Dishaw and Strong (1998) operationalized the extent to which a software tool was used based on user-indications that ranged from a very small to very large extent.

Technology maturity was measured by three aspects that are considered idiosyncratic to current mobile e-mail applications, namely (1) user-perceived system availability, (2) user satisfaction with system performance, and (3) the user-perceived need for system improvement. Availability pertained to the quality of mobile services that are provided in the regular environment of the user and in the geographical areas where the user typically travels. The concept is comparable with the reliability measures that have been applied by Lucas and Spitler (1999) and Weill and Vitale (1999), and with the idea of facilitating conditions—ranging from optimal to most unfavorable—described by Triandis (1980). Need for improvement was reverse coded, such that the more respondents indicated a need for improvement the lower the maturity of the technology was rated; the less respondents indicated a need for improvement the higher the maturity of the technology was rated. With the third aspect of need for improvement, in particular, we highlight the presumably *temporary* nature of shortcomings of technology innovations, such as mobile e-mail. The presumption of temporary shortcomings is also evident in our choice of the term technology maturity over the more common term of system quality: “Maturity” implies the existence of a level of system quality that is perceived as satisfactory by the user, similar to “optimal facilitating conditions”, according to Triandis (1980). Tables 2 a) and b) provide the descriptive statistics and inter-item correlations for the two groups of non-users and users, respectively.

Tables 2 a) and b). Descriptive Statistics and Inter-Item Correlations

a) Non-Users (n=25)	**Min**	**Max**	**Mean**	**StDev**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
1. NONR1	1	7	5.3	1.464									
2. NONR2	1	7	5.0	2.051	.532								
3. INT1	4	7	6.2	0.924	.684	.274							
4. INT2	4	7	6.2	0.763	.689	.487	.695						
5. TCRIT1	2	7	4.7	1.745	.559	.626	.432	.546					
6. TCRIT2	3	7	5.5	1.225	.434	.278	.390	.486	.691				
7. MOB1	1	7	3.6	1.634	.248	.356	.124	.235	.369	.200			
8. MOB2	1	7	4.6	2.039	-.085	.335	-.110	-.114	-.018	-.245	.605		
9. USEFE1	2	7	5.2	1.690	.473	.472	.590	.439	.405	.057	.125	.014	
10. USEFE2	2	7	5.0	1.620	.469	.427	.628	.394	.299	.017	.131	.005	.940

b) Users (n=30)	**Min**	**Max**	**Mean**	**StDev**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**	**21**	**22**	**23**	**24**	**25**
1. NONR1	3	7	5.1	1.213																									
2. NONR2	1	7	4.6	2.238	.536																								
3. INT1	3	7	6.2	1.064	.518	.310																							
4. INT2	3	7	6.0	1.174	.557	.262	.883																						
5. TCRIT1	2	7	4.5	1.757	.526	.395	.018	.134																					
6. TCRIT2	3	7	5.1	1.196	.466	.072	.168	.295	.542																				
7. MOB1	2	7	4.4	1.357	.224	.036	.033	.043	.369	.197																			
8. MOB2	1	7	4.9	1.893	.223	.291	.450	.230	-.032	-.090	.150																		
9. MAT1	1	7	5.3	1.620	.233	.064	.095	.151	-.015	.092	.037	-.113																	
10. MAT2	1	7	5.0	1.428	.047	.066	-.041	-.021	.024	-.065	.086	-.052	.586																
11. MAT4	1	6	2.6	1.429	-.175	.110	.145	.164	-.179	-.371	.039	.104	.137	.433															
12. MAT5	1	6	2.6	1.326	-.019	.019	.225	.244	-.185	-.381	.091	.096	.239	.411	.867														
13. MAT6	1	6	2.6	1.303	-.061	-.033	.209	.248	-.286	-.319	.023	.030	.069	.308	.819	.811													
14. USE1	2	7	4.6	1.741	-.095	-.040	-.101	-.051	.207	.060	.184	-.172	.434	.471	.455	.436	.286												
15. USE2	0	75	16.1	20.89	-.015	.003	.129	.033	.074	.096	.264	-.014	.179	.321	.451	.381	.292	.455											
16. USEFA1	1	7	5.8	1.808	.308	.150	.075	.081	.141	.093	.121	-.299	.562	.605	.262	.314	.243	.550	.383										
17. USEFA2	1	7	4.7	1.946	.245	.181	.277	.211	-.111	-.118	-.164	-.028	.638	.451	.394	.455	.297	.402	.174	.729									
18. USEFA3	1	7	5.4	2.059	.261	.070	.091	.128	.176	.190	.163	-.280	.513	.550	.321	.405	.198	.640	.533	.900	.696								
19. USEFA4	1	7	5.1	1.918	.277	-.063	.227	.199	.118	.174	.248	-.125	.493	.539	.317	.449	.182	.558	.431	.801	.682	.890							
20. USEFA5	1	7	5.0	1.630	.299	.160	.212	.159	.181	.090	-.005	-.033	.415	.493	.248	.365	.047	.412	.331	.713	.683	.794	.833						
21. USEFA6	1	7	4.9	1.807	.225	.101	.100	.162	.016	.054	-.010	-.359	.417	.423	.291	.344	.246	.389	.298	.880	.649	.835	.699	.652					
22. USEFA7	1	7	5.2	1.690	.259	-.024	.054	.087	.012	.174	.187	-.301	.549	.581	.177	.280	.179	.427	.203	.837	.667	.811	.792	.707	.763				
23. USEFA8	1	7	5.4	1.829	.263	.096	.032	.064	.145	.166	.198	-.275	.537	.653	.230	.271	.136	.482	.316	.920	.619	.870	.815	.744	.878	.879			
24. USEFA9	1	7	4.7	1.617	.137	.084	.212	.127	-.049	.090	.306	-.029	.402	.297	.236	.226	.144	.312	.172	.641	.623	.610	.609	.495	.651	.752	.664		
25. USEFA10	1	7	5.5	1.995	.279	.229	.133	.147	.197	.132	.037	-.213	.486	.548	.189	.223	.167	.455	.152	.887	.681	.763	.645	.649	.845	.800	.887	.692	
26. USEFA11	1	7	5.0	1.800	.142	-.017	.108	.098	-.087	.016	.000	-.267	.619	.536	.349	.433	.250	.560	.299	.858	.836	.865	.869	.736	.806	.839	.807	.710	.720

Data Analysis and Results

The data from the two surveys were analyzed using the structural equation modeling (SEM) approach with PLS Graph 3.0 software that applies the partial least squares (PLS) technique. SEM is a second generation statistical method that, in contrast to regression, allows for the simultaneous assessment of multiple independent and dependent constructs (Gefen et al., 2000). PLS was considered an appropriate method to test our research model for at least two reasons. First, there is broad agreement among scholars that PLS is well suited for exploratory research and theory development (in contrast to theory testing), which is the case in the current research study. Second, for small sample sizes, PLS is more robust than covariance-based structural equation models methods, such as LISREL, yet has the potential to provide acceptable statistical power, in particular for large-effect models (Goodhue et al., 2006). Emulating the consequences of pre- and post-adoption situations, the data was analyzed separately for non-users (n=25) and for users (n=30). Each model was tested in two steps (Anderson and Gerbing, 1988). In the first step, the quality of the measurement model was assessed by testing its factorial validity in the form of convergent and discriminant validity (Gefen and Straub, 2005). In the second step, path effects and significance levels in the hypothesized structural models were examined for purposes of hypothesis testing. Results from each step are presented next.

Measurement Models

The validity of the second-order formative construct of fit was assessed by examining the significance of the weights of the measurement items (Table 3). The values were derived by applying the bootstrap method based on 500 samples.

Table 3. Weights of Measurement Items of Formative Construct			
Formative Construct	**Estimated Coefficient (non users; users)**	**Standard Error (non users; users)**	**T-Statistic (non users; users)**
Fit (of mobile email with task-characteristics)			
NONR1	0.231; 0.284	0.023; 0.035	9.961; 8.728
NONR2	0.197; 0.191	0.039; 0.067	5.100; 2.837
INT1	0.225; 0.239	0.023; 0.057	9.875; 4.198
INT2	0.224; 0.246	0.029; 0.058	7.642; 4.258
TCRIT1	0.210; 0.183	0.022; 0.084	9.600; 2.191
TCRIT2	0.143; 0.175	0.045; 0.080	3.160; 2.180
MOB1	0.102; 0.101	0.055; 0.104	1.868; 0.977
MOB2	0.006; 0.104	0.070; 0.092	0.083; 1.136

In contrast to validity tests of reflective constructs, conventions to test the validity of formative measures are much less well refined (Gefen and Straub, 2005), but it has been suggested to assess the quality of formative constructs by examining the respective weights (and not the loadings) of the respective measurement items. The statistical significance of the weights indicates the relative importance of the indicators in forming the latent variable (Ravichandran and Rai, 2000). Our results show t-values that are significant at the $p<0.05$ level or lower for the constructs of non-routineness, interdependence, and time-criticality, for both groups of non-users and users. For the construct of mobility, however, the weight of only one item—namely MOB1 (travel frequency)—came close to a significance weight-level of $p<0.05$ for the non-user group. We note that the significance levels remain unchanged in an analysis where the responses of non-users and users are pooled for a combined sample size of 55.

To assess the factorial validity of the reflective constructs, we performed tests of convergent and discriminant validity. Our initial tests indicated a lack of discriminant validity for MAT3 with respect to the latent constructs of extent of use and actual usefulness. The analysis that is described in the following was performed after MAT3 was dropped from the analysis; in the interest of brevity, we have omitted the results of the initial validity tests. To determine convergent validity, that is the extent to which items are thought to reflect one particular construct (Straub et al., 2004) we examine the loadings of the measurement items of the reflective constructs (Table 4).

Table 4. Loadings of Measurement Items of Reflective Constructs

Reflective Construct	Estimated Coefficient (non users; users)	Standard Error (non users; users)	T-Statistic (non users; users)
Non-Routineness			
Non-Users (n=25): composite reliability 0.866; AVE=0.764; Users (n=30): composite reliability 0.865; AVE=0.763			
NONR1	0.899; 0.920	0.048; 0.032	18.712; 28.856
NONR2	0.848; 0.824	0.076; 0.186	11.195; 4.440
Interdependence			
Non-Users (n=25): composite reliability 0.917, AVE=0.847; Users (n=30): composite reliability 0.970; AVE=0.942			
INT1	0.911; 0.969	0.051; 0.021	17.740; 45.493
INT2	0.930; 0.971	0.051; 0.045	18.131; 21.690
Time-Criticality			
Non-User (n=25): composite reliability 0.915, AVE=0.844; Users (n=30): composite reliability 0.871; AVE=0.771			
TCRIT1	0.937; 0.885	0.020; 0.126	47.578; 7.022
TCRIT2	0.900; 0.871	0.062; 0.149	14.511; 5.849
Mobility			
Non-Users (n=25): composite reliability 0.820, AVE=0.704; Users (n=30): composite reliability 0.728, AVE=0.574			
MOB1	0.999; 0.696	0.318; 0.491	3.136; 1.419
MOB2	0.641; 0.814	0.333; 0.388	1.923; 2.095
Expected Usefulness			
Non-Users (n=25): composite reliability 0.985, AVE=0.970			
USEFE1	0.986	0.008	127.652
USEFE2	0.984	0.022	45.216
Technology Maturity			
Users (n=30), composite reliability 0.870, AVE=0.574			
MAT1	0.603	0.182	3.304
MAT2	0.779	0.134	5.822
MAT4	0.817	0.153	5.357
MAT5	0.841	0.146	5.757
MAT6	0.725	0.196	3.698
Extent of Use			
Users (n=30), composite reliability 0.838, AVE=0.722			
USE1	0.901	0.077	11.850
USE2	0.795	0.153	5.207
Actual Usefulness			
Users (n=30), composite reliability 0.975, AVE=0.783			
USEFA1	0.946	0.038	24.696
USEFA2	0.810	0.086	9.358
USEFA3	0.898	0.040	22.270
USEFA4	0.938	0.033	27.991
USEFA5	0.830	0.072	11.579
USEFA6	0.889	0.081	10.933
USEFA7	0.906	0.043	20.817
USEFA8	0.934	0.063	14.871
USEFA9	0.749	0.124	6.060
USEFA10	0.875	0.075	11.715
USEFA11	0.934	0.064	14.550

We note that for both groups of non-users and users each of the measurement items loads with a t-value on its latent construct that is significant at the p<0.01 level, well below the recommended p<0.05 threshold (Gefen and Straub, 2005). The exception is again the first-order construct of mobility where loadings below the p<0.05 level are found for MOB1 (travel frequency) for the user group and for MOB2 (travel distance) for the non-user group. We further note loadings above the recommended level of 0.7 for all items (Barclay et al., 1995), and AVE-values that are above the recommended level of 0.5 for all latent constructs (Gefen et al., 2000).

In a next step we assessed discriminant validity, that is, the extent to which the measurement items reflect their suggested construct differs from the relation with all other items in the measurement model (Straub et al., 2004). We first performed a confirmatory factor analysis where we correlated the latent variable scores with the measurement items, in an attempt to establish high loadings of the measurement items on their theoretically assigned construct but not on other constructs (Gefen and Straub, 2005).

Tables 5 a) and b). Confirmatory Factor Analysis

a) Non-Users, n=25	*Non-Routine-ness*	*Inter-depen-dence*	*Time Criticality*	*Mobility*	*Expected Useful-ness*
NONR1	**0.900**	0.746	0.546	0.234	0.478
NONR1	**0.848**	0.420	0.511	0.363	0.457
INT1	0.569	**0.911**	0.449	0.113	0.617
INT2	0.682	**0.930**	0.564	0.220	0.424
TCRIT1	0.672	0.535	**0.937**	0.355	0.360
TCRIT2	0.414	0.479	**0.901**	0.179	0.039
MOB1	0.339	0.198	0.319	**0.999**	0.130
MOB2	0.120	-0.122	-0.129	**0.641**	0.010
USEFE1	0.539	0.554	0.272	0.121	**0.986**
USEFE2	0.513	0.548	0.188	0.127	**0.984**

b) Users, n=30	*Non-Routine-ness*	*Inter-depen-dence*	*Time Criticality*	*Mobility*	*Technol-ogy Ma-turity*	*Extent of Use*	*Actual Useful-ness*
NONR1	**0.920**	0.554	0.566	0.293	0.024	-0.072	0.279
NONR1	**0.824**	0.295	0.271	0.232	0.069	-0.026	0.095
INT1	0.492	**0.969**	0.104	0.346	0.149	-0.007	0.154
INT2	0.496	**0.971**	0.241	0.192	0.189	-0.019	0.150
TCRIT1	0.536	0.079	**0.885**	0.194	-0.142	0.177	0.081
TCRIT2	0.346	0.239	**0.871**	0.051	-0.248	0.087	0.111
MOB1	0.167	0.040	0.325	**0.697**	0.078	0.253	0.109

MOB2	0.284	0.348	-0.069	**0.814**	0.007	-0.125	-0.231
MAT1	0.186	0.127	0.042	-0.061	**0.603**	0.383	0.582
MAT2	0.062	-0.031	-0.022	0.013	**0.780**	0.477	0.590
MAT4	-0.066	0.160	-0.310	0.098	**0.817**	0.528	0.314
MAT5	-0.004	0.242	-0.319	0.123	**0.841**	0.482	0.394
MAT6	-0.056	0.236	-0.344	0.035	**0.725**	0.336	0.217
USE1	-0.083	-0.078	0.154	-0.017	0.569	**0.903**	0.544
USE2	-0.008	0.083	0.096	0.145	0.429	**0.793**	0.351
USEFA1	0.276	0.081	0.134	-0.146	0.561	0.561	**0.946**
USEFA2	0.248	0.251	-0.130	-0.117	0.615	0.359	**0.810**
USEFA3	0.208	0.113	0.208	-0.107	0.561	0.694	**0.938**
USEFA4	0.157	0.219	0.165	0.055	0.559	0.590	**0.898**
USEFA5	0.275	0.190	0.156	-0.027	0.457	0.441	**0.830**
USEFA6	0.198	0.136	0.040	-0.266	0.474	0.409	**0.889**
USEFA7	0.163	0.073	0.103	-0.109	0.507	0.390	**0.906**
USEFA8	0.221	0.050	0.177	-0.083	0.531	0.482	**0.935**
USEFA9	0.131	0.174	0.022	0.159	0.365	0.297	**0.749**
USEFA10	0.293	0.145	0.188	-0.133	0.463	0.385	**0.875**
USEFA11	0.087	0.106	-0.042	-0.194	0.611	0.527	**0.934**

As shown in Tables 5 a) and b), for both non-user and user groups, all but one items loaded highest on their suggested construct and at least an order of magnitude lower on any other variable. The exception is MAT1 that loaded relatively highly on actual usefulness in addition to its suggested construct of technology maturity. Despite the slightly limited discriminant validity of MAT1, we decided to keep the item in the analysis for at least two reasons. First, compared to the problems caused initially by the measurement item of MAT3, the lack of discriminant validity of MAT1 is limited. Second, an alternative analysis with averaged values of MAT1&2, and of MAT4-6 shows correct loadings, as does the initial analysis that included MAT3. Rather than dropping MAT1, we view the high loading on actual usefulness as an indication of the item's strong explanatory power of the dependent variable. We also examined the correlations among the latent variables where we expected to find the square root of every AVE to be much larger than any correlation among any pair of latent constructs. The correlations between the constructs are presented in Tables 6 a) and b), whereby the values shown in the diagonal cells report the square root of the respective AVEs.

Tables 6 a) and b). Correlations among Latent Constructs/AVE Analysis

a) Non-Users, n=25	*Non-Routine-ness*	*Inter-depen-dence*	*Time Criticali-ty*	*Mobility*	*Ex-pected Useful-ness*
Non-Routineness	**0.874**				
Interdependence	0.683	**0.920**			
Time-Criticality	0.605	0.554	**0.919**		
Mobility	0.334	0.184	0.300	**0.839**	
Expected Usefulness	0.535	0.559	0.235	0.126	**0.985**

b) Users, n=30	*Non-Routine-ness*	*Inter-depen-dence*	*Time Criticality*	*Mobility*	*Tech-nology Maturity*	*Extent of use*	*Actual Useful-ness*
Non-Routineness	**0.873**						
Interdependence	0.509	**0.971**					
Time-Criticality	0.505	0.179	**0.878**				
Mobility	0.305	0.276	0.141	**0.758**			
Technology Maturity	0.048	0.175	-0.220	0.051	**0.758**		
Extent of Use	-0.060	-0.013	0.152	0.058	0.596	**0.850**	
Actual Usefulness	0.232	0.156	0.109	-0.104	0.593	0.542	**0.885**

Note: The diagonals represent the square root of the average variance extracted.

Again, we note that for both groups, the results of the AVE analysis are satisfactory given the “much larger” values of the square roots of the AVE than any correlation between the respective construct and any other constructs. In combination, the results of the confirmatory factor analysis and AVE analysis largely support discriminant validity for both user and non-users, for all constructs of our model. The results are remarkable in particular in light of the small sample sizes.

Structural Model

The next step of data analysis involved examining the structural models in order to test our hypotheses. The results of the analyses for the situations of pre-adoption (non-users) and post-adoption (users) are presented in Figures 2 and 3 and summarized in Table 7.

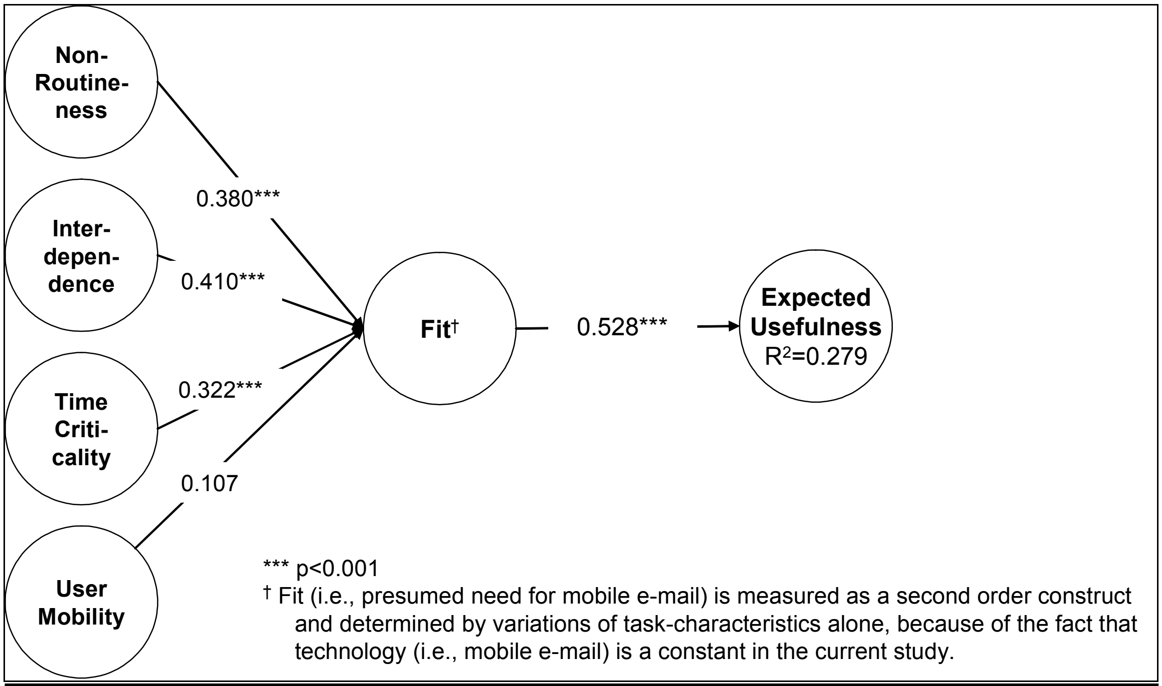

Figure 2. Structural Model, Non-Users (n=25)

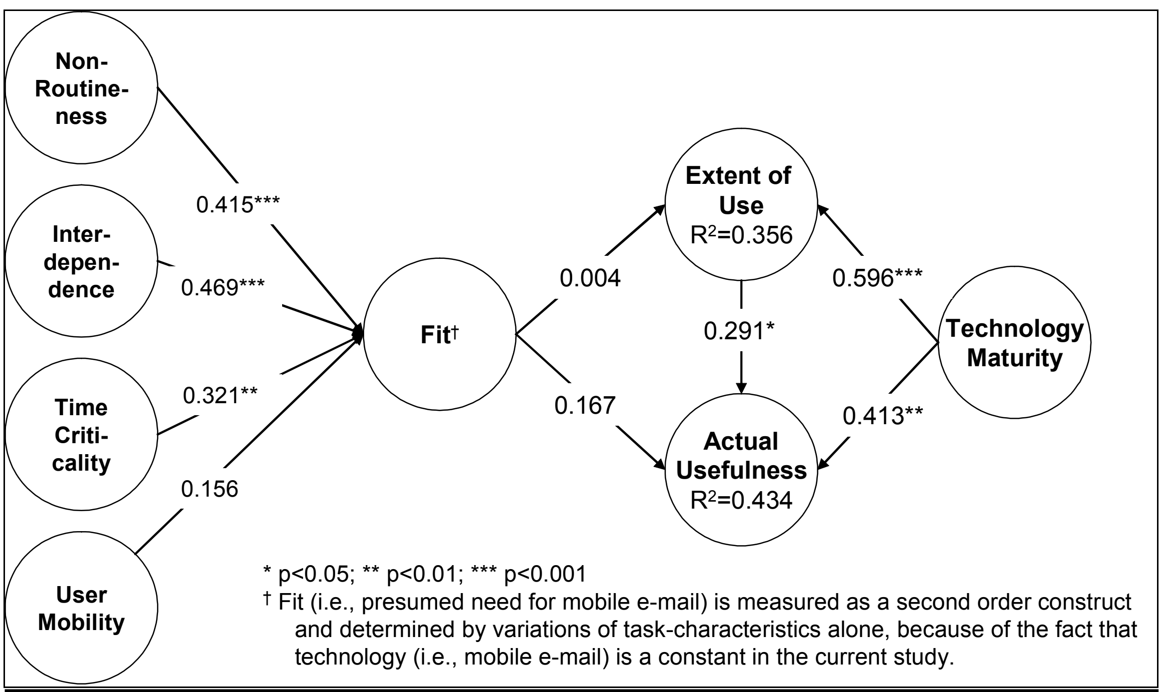

Figure 3. Structural Model, Users (n=30)

For both groups of users and non-users, the paths between three of the four first-order constructs and the second-order constructs of fit were significant at or below the $p<0.01$

level, indicating considerable statistical stability of the second-order construct of fit that was predetermined based on the presumed need for mobile e-mail. In contrast, and in line with the lack of significant weights in the measurement model, the path between the first-order construct of mobility and fit was not significant for either group.

Table 7. Model Results

Hypotheses	Sup-ported for Non-Users (n=25)	Sup-ported for Users (n=30)
H1: Task-technology fit is associated positively with *expected* user-perceived usefulness.	Yes***	--
H2: Task-technology fit is associated positively with extent of use of mobile e-mail.	--	No†
H3: Task-technology fit is associated positively with *actual* user-perceived usefulness		No†
H4: Extent of use is associated positively with *actual* user-perceived useful-ness.	--	Yes*
H5: User-perceived technology maturity is associated positively with extent of use.	--	Yes***
H6: User-perceived technology maturity is associated positively with *actual* user-perceived usefulness.	--	Yes**

Notes: * p<0.05; ** p<0.01; *** p<0.001. †: The small sample size limits the statistical power in the current study (Baroudi and Orlikowski, 1989, Goodhue et al., 2007). This shortcoming plays out in particular for the non-significant links that consequently need to be treated with caution. More specifically, our study does not allow us to reject the unsupported hypotheses.

For non-users, we found support for H1 that associated task-technology fit with expected usefulness, at the p<0.001 level (Figure 2). In contrast to results that were reported by Dishaw and Strong (1999) who did not find empirically significant evidence of a similar hypothesis, our data suggest a statistically significant association between a predetermined construct of fit and expected usefulness as indicated by the survey-participants. For the user group, we found support for the hypotheses that suggested positive associations between extent of use and actual usefulness (H4, p<0.05), between technology maturity and extent of use (H5, p<0.001), and between technology maturity and actual usefulness (H6, p<0.01). Not supported were two suggested associations within the technology-to-performance chain, namely the associations between fit and extent of use (H2), and between fit and actual usefulness (H3). In light of the surprising results that, in contrast to technology maturity, fit had so little impact on usefulness and use, we tested for multi-collinearity. Multi-collinearity primarily results from high correlations between independent variables. These correlations make it impossible to tell which specific construct has an impact on the dependent variables, but only suggest that all correlated variables together have an impact. However, multi-collinearity does not seem to be a problem in the current dataset based on the limited correlations between items that are related to task and to maturity (Table 2b)), and based on the fact that even after omitting the maturity construct from the model, the paths between task and use, and between task and usefulness did not become significant at the p<.05 level.

DISCUSSION

With a combined sample of 55 responses that we analyzed separately for users (n=30) and non-users (n=25), perhaps the most obvious challenge of the current study is the small sample size and resulting limit of statistical power (Baroudi and Orlikowski, 1989, Goodhue et al., 2007). This shortcoming plays out in particular for the non-significant links that consequently need to be treated with caution. More specifically, our study does not allow us to reject the unsupported hypotheses related to the theory of task-technology fit (H2, H3) that may refer to effect sizes that are too small to be detected in our specific research setting. In addition, our study does not shed much light on the specific role of user-mobility for the explanation and prediction of use and performance impacts of mobile (e-mail) technology.

In contrast, the evidence that we did find in the supported hypotheses is all the more remarkable. Complementing earlier research on the conditions of use and performance impacts of information systems, the results of the current study suggest that for technology innovations, such as mobile e-mail that are still under development, shortcomings in the eyes of the (potential) users may have a considerable effect on use and on actual usefulness. This finding is strongly supported by the results of a content analysis of the free-form comments that respondents provided as part of the surveys. As summarized in Appendix Table A-2, we identified a total of 128 comments that were provided to us by users and non-users. Of all comments, 63% related to various aspects of technology maturity or rather the lack thereof; and of all comments related to technology maturity, less than one tenth (9%) were positive and over ninety percent were negative. Furthermore, in an interview that we conducted in 2005, a project director summed up the experience of the 2002-3 trial by stating: “In retrospect, neither the people nor the technology were quite ready yet. We rushed into this project too quickly.” While previous research studies have discussed the effects on use of information systems that are difficult to use for novice users and for users of low computer sophistication (Igbaria et al., 1997, Taylor and Todd, 1995), the consequences for systems that are difficult to use because of their own novelty is much less recognized in studies of technology adoption.

In addition to the strong effect of technology-related shortcomings, we found support for two important aspects in our research model. First, for non-users, the suggested link between fit of mobile e-mail and user tasks, and expected usefulness was statistically significant, thus indicating correspondence between the researcher-determined need for mobile e-mail and the perceptions of potential users. Also, the statistical stability of the fit construct that included the three task-related components of non-routineness, interdependence, and time-criticality, and that applied to users and non-users (as well as to both groups combined), supports our understanding about the antecedents of user-perceived usefulness and consequently provides an important link between the theory of task-technology fit and the technology adoption model. Second, both the survey data (H4) and the open comments (Table A-2) corroborate expectations about the benefits of mobile e-mail use for individual performance (actual usefulness), and consequently support a key element of the technology-to-performance chain.

In summary, our data suggest that it is critical for novel technologies, such as mobile e-mail, to reach a certain user-defined (!) maturity threshold before more established antecedents of use and performance impacts, including expected usefulness and task-technology fit, can become fully relevant. Upon comparing the responses of the two surveys that were administered almost four years apart (in particular the responses from the nine individuals who participated in both surveys), we note that, despite technological progress that has not gone unnoticed by the respondents, mobile e-mail still appears to fall short of user expectations. We may be observing a moving target.

Conclusions

In the current research study, we have modeled and empirically tested a research model that included antecedents of the use of mobile e-mail for business tasks (task-technology fit, expected usefulness, and technology maturity), and consequences for individual performance (i.e., actual usefulness) in a real-world setting. The implications of our reported results for information systems research and management are discussed next.

Implications for Research

Upon the emergence of innovative technologies, such as mobile information systems to support business tasks, researchers need to determine the applicability of existing theories to assess the requirements for success, in the form of adoption, subsequent use, and performance impacts. With the current study, we re-iterate the long-stated need to take into consideration the idiosyncrasies of the technology artifact (Orlikowski and Iacono, 2001) in order to truly understand its requirements and implications. For mobile information systems, two such idiosyncrasies appear to be (1) user mobility inasmuch as it changes the use context of the information system (Kim et al., 2002, Turel, 2006), and (2) technology maturity, inasmuch as it facilitates use conditions (Triandis, 1980).

While we found empirical evidence for the explanatory power of technology maturity, the results for the mobility construct were weaker. With respect to mobility, our research study complements previous research studies that have applied the technology-acceptance model and task-technology fit to mobile technologies (Chau et al., 2002, Fang et al., 2005-6, Han et al., 2006) and that have confirmed changes of task requirements in mobile versus non-mobile environments (Gebauer and Shaw, 2004, Perry et al., 2001, Zheng and Yuan, 2007). In contrast to previous research studies, we included user-mobility as a characteristic of user tasks in the research model. We focused on travel as an example of a mobile use situation that may be rather different from a stationary office situation. The lack of empirical support for the construct, however, leads us to the conclusion that user-mobility may be more complex and multi-faceted than what we have captured. It appears that both the construct of mobility and its impact on the technology-to-performance chain need to be investigated more systematically.

The results of our data analysis suggest an important role of user-perceived technology maturity to explain the extent of use of mobile e-mail and the resulting user-perceived impacts on usefulness and performance. Scholars of the theory of task-technology fit and the related technology-to-performance chain have suggested the need to explore the links between task-technology fit, actual use, and user performance (here conceptualized as actual usefulness). In our study, however, such an exploration appears to be precluded to some extent because in the eyes of the users, the technology is just not sufficiently evolved yet. We suggest that this finding is not trivial, because many times questions regarding the antecedents of actual use and performance impacts are asked of technologies that are novel and may not be fully mature at the time of implementation.

Our results also augment previous research studies that have extended the technology acceptance model and that have found the extent to which a user is familiar with a technology to impact the extent to which user-perceived ease of use—conceptualized here as technology maturity—can explain and predict technology use (Taylor and Todd, 1995, also Igbaria et al., 1997). Equally strong for both surveys that we performed as much as four years apart, our data suggests a need to include into the analysis user perceptions of technology quality that are contextualized over time. As technology progresses, user perceptions of what constitutes a system that is built *well* appear to be progressing alongside and result in what may be called a moving target. Our results indicate a need to include into the analysis of information technology adoption and use, user expectations about system performance. User expectations constitute a key component of the expectation-disconfirmation theory (Oliver, 1980) and related approaches that have been applied to novel forms of information technology (McKinney et al., 2002) and to assess the continued use of information technology (Bhattacherjee, 2001). Future research studies may want to explore more explicitly the links between the theory of task-technology fit, technology acceptance model and expectation-oriented approaches, such as the expectation-disconfirmation theory.

The research model that was presented in the current paper further contributes to the theory of task-technology fit with a suggested construct of predetermined fit of general business tasks and information technology support. Statistically, the combination of the three factors of non-routineness, interdependence and time-criticality appeared to be stable and may provide a foundation for a more systematic development of task-technology fit measures than what is currently available. We suggest that the application of results that have been derived in research studies of contingency theory, in particular the various approaches to fit (Van de Ven and Drazin, 1985, Venkatraman, 1989) may be of great value for advancing the theory of task-technology fit.

Last but not least, our study contributes to recent research studies of mobile information systems. In order to explain and predict the success of mobile information systems, it is important to determine the applicability of previously established theories and approaches of information systems. As emphasized throughout the paper, our results indicate a need to take into explicit consideration the idiosyncrasies of the technology artifact, whereby we included the two factors of user mobility and technology maturity into our research model.

Implications for Practice

Our findings also have practical implications for the management of mobile information systems to support a mobile workforce. Managers need to examine carefully the task requirements prior to considering the adoption of a particular technology to support users. According to the results of our data analysis, the greater the fit between the capabilities of the technology and the task requirements, assessed in particular in the form of task non-routineness, interdependence of a user's tasks with others, and time-criticality, the higher the expected usefulness of the technology. In addition, our data suggest that frequent users of mobile e-mail achieved benefits of greater efficiency and higher effectiveness from using the technology. In other words, managers concerned about the returns from investments in technology could benefit from a detailed evaluation of task requirements, and user perceptions of usefulness.

A related point of concern for managers should be the maturity of the technology and how convenient it is to use for an average user. We found strong evidence for the fact that the linkages among fit, extent of use, and the resulting usefulness (including impacts on individual performance), are tempered by the role of technology maturity. The factor of technology maturity is particularly important in a setting where the use of technology is voluntary and user-perceived merits of the technology often drive the extent of use. Perceptions of difficulty in use due to technological immaturity as well as negative impressions from initial use of a (potentially immature) technology are likely to limit the willingness of users to invest their time and efforts in learning and adopting it (Igbaria et al., 1997).

Our findings suggest that it is important that managers who consider implementing mobile technologies at the workplace to make sure to meet a user-defined threshold of technology maturity if they expect users to accept the technology for frequent use. In addition, managers need to be mindful of the fact that the threshold could be a moving target that is related to user expectations. Systematic technology evaluation and organizational fit assessment can help managers understand user expectations and make sound technological choices.

Limitations and Future Research

Limitations of the current research study need to be acknowledged, and provide opportunities for future research. First, the small sample size resulted in limited statistical power that may have confounded some of our findings, in particular regarding the unsupported hypotheses. Nevertheless, the supported results appeared to be statistically robust, consistent over time, and well supported by additional qualitative data and observations. We are hopeful that future research studies will provide additional support for the findings that are reported in the current paper, and provide scientific insights about the questions that we were not able to answer. Beyond a mere replication of our research approach, it will be important to assess its generalizability to applications of mobile technology other than e-mail, and to include a broader variety of business tasks. Testing the applicability of the current findings in less voluntary use settings may also be worthwhile.

Second, we identified a need to improve the operationalization of the latent construct of user mobility that appeared to be a complex and multidimensional concept that, to our knowledge, has not been explored systematically in information systems research. For example, managers who foresee needs of significant real-time interactions in the same location (local mobility) as well as synchronous and asynchronous interactions with distant locations (remote mobility) can expect users to have high expectations of technology maturity prior to adoption. Consequently, they might benefit from technologies that effectively incorporate multidimensional forms of mobility, including local and remote mobility (Luff and Heath, 1998).

Our study has applied a focused research model that presented a link between the technology acceptance model and the theory of task-technology fit, and that modeled the technology-to-performance chain, while taking into consideration two idiosyncratic factors, namely user mobility and user-perceived technology maturity. We analyzed two models for non-users (pre-adoption) and users (post-adoption) with a one-stage research design that did not explore in more detail the transition processes between non-use and use, but that instead relied on earlier research studies that have confirmed the assumed link (Davis et al., 1989). Future research might want to apply a multi-stage research design and long-term approach in order to assess the transitions from expected usefulness, to intention to use, to actual use, followed again by indications of actual usefulness and performance impacts (Bagozzi, 2007).

Its limitations notwithstanding, our study makes several important contributions to information systems research and practice. First, we provide insights about the appropriate technology-support of a mobile workforce with a research model that successfully linked the presumed need for mobile e-mail with user-perceptions of usefulness. Second, we identified a need to operationalize user-mobility as a multi-dimensional construct when applying established information system theories to mobile use contexts. Third, we confirm a previously suggested positive relationship between technology use and performance impacts for the case of mobile e-mail. Lastly, we identified user-perceived technology maturity as an important factor to help explain and predict use and use-impacts. In particular, the unanticipated problems with technology that a user may experience in practice are often not included explicitly in research studies of the conditions and consequences of information systems use. As we showed, only once the users determine it to be built *well*, will they embrace innovative technology, such as mobile e-mail.

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Appendix

Table A-1. Measurement Indicators

Construct	Survey item	Survey response (Coding: 1..7 unless noted)
Task Characteristics		
1. Non-Routineness (NONR)		
NONR1	I initiate and lead projects to improve my organization (Mintzberg 1979)	Never … Always
NONR2	I allocate resources, including budget and staff (Mintzberg 1979)	Never … Always
2. Interdependence (INT)		
INT1	To perform my job, I interact closely with others (Mintzberg 1979)	Never … Always
INT2	To perform my job, I process information from many sources (Mintzberg 1979)	Never … Always
3. Time-Criticality (TCRIT)		
TCRIT1	Dealing with emergency situations is part of my job	Never … Always
TCRIT2	My job requires immediate decisions	Never … Always
4. Mobility (MOB)		
MOB1	To perform my job, I travel	Never … Always
MOB2	In what city are you based? To what cities, states, and/or countries do you regularly travel when working?	No travel … Travel between more than two continents
Expected Usefulness (USEFE)		
USEFE1	Using the mobile e-mail system to check e-mail would be useful to me. (Lucas and Spitler 1999)	Strongly disagree … strongly agree
USEFE2	Using the mobile e-mail system to create e-mail would be useful to me. (Lucas and Spitler 1999)	Strongly disagree … strongly agree
Technology Maturity (MAT)		
MAT1	The mobile service providers available in my area provide good service	Strongly disagree … strongly agree
MAT2	The mobile service providers available in the areas where I travel provide good service	Strongly disagree … strongly agree
MAT3	I am satisfied with the performance of the mobile e-mail system	Strongly disagree … strongly agree
MAT4	If the performance of the mobile e-mail system were improved, my usage of the system would increase	Strongly agree … strongly disagree
MAT5	If the performance of the mobile e-mail system were improved, the system would be more useful to me	Strongly agree … strongly disagree
MAT6	If the performance of the mobile e-mail system were improved, the system would be easier for me to use	Strongly agree … strongly disagree
Extent of Use (USE)		
USE1	How many times have you successfully used the mobile e-mail system? (Compeau et al., 2007, Dishaw and Strong 1999)	Never … Thousands of times/Many times a day
USE2	I use the wireless e-mail system for ________ percent of my e-mails (Goodhue and Thompson 1995, p. 218).	Percentage
Actual Usefulness and Performance Impacts (USEFA)		
USEFA1	Using the mobile e-mail system to check e-mail is useful to me (Lucas and Spitler 1999)	Strongly disagree … strongly agree

USEFA2	Using the mobile e-mail system to create e-mail is useful to me (Lucas and Spitler 1999)	Strongly disagree … strongly agree
USEFA3	The mobile e-mail system allows me to be more prepared and efficient upon my return to the office (Davis 1989).	Strongly disagree … strongly agree
USEFA4	The mobile e-mail system increases my productivity (less idle time) (Davis 1989)	Strongly disagree … strongly agree
USEFA5	The mobile e-mail system increases the productivity of others who work with me (Davis 1989)	Strongly disagree … strongly agree
USEFA6	The mobile e-mail system allows me to make better decisions while mobile.	Strongly disagree … strongly agree
USEFA7	Using the mobile e-mail system improves my overall effectiveness (Davis 1989)	Strongly disagree … strongly agree
USEFA8	The mobile e-mail system helps me to react faster to changing circumstances	Strongly disagree … strongly agree
USEFA9	The mobile e-mail system helps me to capitalize on business opportunities when I am mobile	Strongly disagree … strongly agree
USEFA10	The mobile e-mail system helps me to handle emergency situations when I am mobile	Strongly disagree … strongly agree
USEFA11	The mobile e-mail system helps me to better balance my workload	Strongly disagree … strongly agree
Additional questions pertained to demographic data, including gender, job title, and tenure at the firm (in years). Open-ended questions included: (1) What factors if any have prohibited your use of mobile e-mail?; (2) What do you like most about the mobile e-mail system?; and (3) What difficulties have you experienced when using the mobile e-mail system? How could the system be improved?		

Notes: All items are user-perceived, and were measured or coded on seven-point Likert-type scales, except for USE2 that was measured with a percentage. In parentheses, we note previous research studies that have suggested similar items. Task characteristics determine fit as the presumed need for mobile e-mail, whereby fit is modeled as a second order formative construct. Coding for MOB2 was determined by the farthest travel destination(s) in relation to the indicated home-location, as follows: 1: no travel; 2: limited travel nationally; 3: extensive travel nationally; 4: limited travel within continent; 5: extensive travel within continent; 6: travel between two continents; 7: travel between more than two continents. Measurement item MAT3 was dropped from subsequent data analysis due to limited discriminant validity with the constructs of Extent of Use and Actual Usefulness. The three questions concerning the user-perceived need for technology improvements (MAT4-MAT6) were coded such that the more respondents indicated a need for improvement (i.e., agreed with the question) the lower the maturity of the technology was rated; the less respondents indicated a need for improvement (i.e., disagreed with the question) the higher the maturity of the technology was rated. Coding for USE1 was determined based on responses that indicated past use as: 1: zero times, never; 2: less than ten times; 3: less than fifty times; 4: less than one hundred times; 5: numerous times, few hundred times; 6: many hundreds of times, regularly, daily; 7: thousands of times, many times a day, over several years.

Table A-2. Free-Form Comments		
Comment category	**Count in full data set**	**Representative examples**
Task-requirements (fit)	Positive: 1 Negative: 3	"Very useful to help coordinate various projects and to stay in touch with the project team" "[I] need to instruct my staff more accurately and adequately than [what is possible with] email"
Mobility	Positive: 3 Negative: 4	"For travel in the United States, I find the mobile [e-mail system] very useful" "I rarely travel"
Technology maturity	Positive: 7 Negative: 74	
Functionality, e.g., related to e-mail management and attachments, and integration with other applications	Positive: 2 Negative: 14	"The [device] permits me to read attachments" "The system needs a 're-synch' function so the e-mail / calendar / phone book can all be re-synched to my [e-mail client] folders in a wireless manner, just like when it sits in the cradle" "Ability to manipulate office documents will help"
Operation and Network Access, e.g., related to access speed, performance, bandwidth, availability, and reliability	Positive: 2 Negative: 29	"[Performance] vastly improved over the years I've been using mobile email" "Very slow login time and response" "Bandwidth needs significant upgrade to cope with large data requirements of typical [firm] users" "I am waiting for better connection"
Ease of Use and Usability, e.g., related to setup and login procedures, e-mail access and creation, interaction with other devices	Positive: 2 Negative: 23	"The [device] is much better for data entry and navigation [than another device]." "The registration process is … a turn-off for most people in its current form – single sign-on is a must-have capability." "The appalling efficiency of several [mobile] e-mail clients … make all current solutions useless" "Going page by page down the e-mails is too tiresome and you keep needing to go in and out of the system and functions. I quickly concluded that it just wasn't worth the hassle"
Portability, e.g., related to form factor (size, weight), need to carry equipment, movement-related requirements	Positive: 1 Negative: 8	"I like using the keyboard on the [device]" "I prefer to carry a small handset, which by definition is not very useful for e-mail"
Other, e.g., cost, personal dislike	Positive: 0 Negative: 12	"Biggest limitation in use is still GPRS data charges" "I do find [mobile e-mail] personally intrusive"
Benefits, e.g., related to ubiquity (access anytime, anywhere), support for interactions with many people, efficiency, time manage-	Positive: 23	"I can see what is there; reply or make a call, and be finished within five minutes… often before my wife realizes that I am working" "Ability to keep business moving while I'm mobile

ment, responsiveness, home-work balance, convenience		(could be on campus, in car, airplane, home, hotel)" "Allows me to manage my time better and prune my email while in transit"
	Negative: 1	"It creates an illusion and expectation … that the reaction is improved, while not actually improving anything – therefore it actually makes things worse!"

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