Association for Information Systems
AIS Electronic Library (AISeL)

ICIS 2010 Proceedings

International Conference on Information Systems (ICIS)

2010

Exploring Technology and Task Adaptation Among Individual Users of Mobile Technology

Kurt Schmitz
University of Texas at Arlington, Kurt.schmitz@mavs.uta.edu

Kimberly Webb
University of Texas at Arlington, Kimberly.webb@mavs.uta.edu

James Teng
University of Texas at Arlington, jtteng@uta.edu

Exploring Technology and Task Adaptation Among Individual Users of Mobile Technology

Completed Research Paper

Kurt Schmitz
University of Texas at Arlington
Arlington Texas, 76019, USA
Kurt.schmitz@mavs.uta.edu

Kimberly Webb
University of Texas at Arlington
Arlington Texas, 76019, USA
Kimberly.webb@mavs.uta.edu

James Teng
University of Texas at Arlington
Arlington Texas, 76019, USA
jtteng@uta.edu

Abstract

IS research often focuses on the contributions of information systems to organizational productivity. The task-technology fit theory proposes a positive contribution to performance when there is a good fit between the technology and the task. The fit appropriation model further proposes that the relationship between fit and performance is moderated by the user's appropriation of the technology. This research extends these theories by investigating the role of adaptation in the fit between task and technology. Prior research has modeled adaptation as a single construct encompassing task, technology and the individual, which does not allow for an understanding of the relationship among these items. We propose that adaptation should be measured as two distinct constructs. We develop and validate a scale to measure task adaptation and technology adaption and find support for task adaption as a mediator of the effects of technology adaptation on performance.

Keywords: Information technology, Adaptation, Task-Technology Fit, Task Adaptation, Technology adaptation, Survey research

Introduction

As organizations continue to invest heavily in information systems to drive process improvement and operational efficiency, the question of value and impact on productivity has come to the forefront (Skinner 1986). Some scholars have begun to characterize Information and Communication Technologies as a modern General Purpose Technology with revolutionary impact comparable with the steam engine and electricity (Breshan and Trajtenberg 1995). However, a "productivity paradox" has emerged (Lin 2010; Carlaw and Oxley 2008) as scholars attempt to understand why productivity statistics and broad economic growth indicators fail to reveal the performance expected.

The field of Information Systems provides important theoretical explanations of how and where information system innovations contribute to organizational productivity. Task-Technology Fit (TTF) theory (Goodhue 1995) highlights the importance of matching technology to the needs of a task in order to optimize performance. Despite the strong theoretical grounding, empirical research has sometimes struggled to find support for the expected relationships between Task-Technology Fit and utilization (Goodhue and Thompson 1995; Staples and Seddon 2004) or between Task-Technology Fit and productivity (Wongpinunwatana 2000).

Additional insight is provided by the Fit Appropriation Model (FAM) (Dennis et al. 2001). FAM attempts to integrate two schools of research: (1) the "decision theorist school" whereby task-technology fit can be viewed as existing or not, with direct predictive implications for performance; and (2) the "institutionalist school" which draws heavily on Adaptive Structuration Theory (AST) (DeSanctis and Poole 1994) to describe social evolution such that technology adopted into organizations is associated with changes to social structures, behaviors and work processes with predictive implications for performance. According to FAM, the performance affects of information technology emerge not simply from the confluence of task and technology fit, but also how a user chooses to apply the technology. Case study investigations demonstrate that users adapt their appropriation over time resulting in modifications that change the nature of the task, team and technology (Fuller and Dennis 2009; Jarvenpaa 1989; Majchrzak et al. 2000; Todd and Benbasat 1999). The literature provides an understanding that these factors must collectively exist to achieve performance. However, the primary operative information systems (IS) theories model adaptation broadly to capture all forms of appropriation and modification as a single construct spanning task and technology, so the relationship between these factors remains largely unexplained.

The analytical ideas of Structuration (Gidden's 1976, 1979, 1984) as applied to the IS field through AST suggests the concepts of task and technology may be distinct. AST recognizes the duality of structure inherent in the interaction between human actors and technology, whereby technology has some types of structures designed into it (structures in technology), while other types of structures emerge as the human actors use the technologies to accomplish tasks (structures in action.) These structuration ideas suggest that the appropriation and adaptation activities associated with task and technology should be operationalized as distinct constructs to capture their independent mechanisms.

While much of the Task-Technology Fit and Adaptation literature focuses on the dependent variable of usage, insights into productivity are more prized by organizations. Organizations typically invest in technology with the goal of improving performance, as suggested by the concern over a "productivity paradox" noted above. Performance follows not from the introduction of technology and its associated fit with a target task, but in how that technology is appropriated to work tasks (Beaudry and Pisonneault 2005; Jarvenpaa 1989; Majchrzak et al. 2000; Todd and Benbasat 1999). The primary purpose of this study is to explore and explain the relationship between technology adaptation and task adaptation with implications for performance. We propose to extend the investigation of fit and adaptation by modeling the distinct constructs of technology-adaptation and task-adaptation as a partnership that serves as the engine for the value that information technology (IT) brings to work system performance. More specifically, technology changes drive variations in how tasks are performed, and it is through task-adaptation that productivity changes emerge. In this study we examine the mediating relationship that task-adaptation has on technology-adaptation.

Communication, collaboration and group support systems have been frequent and recurring technologies of interest for researchers studying TTF (Dennis et al. 2001; Goodhue et al. 1997; Zigurs and Buckland 1998), appropriation (DeSanctis and Pool 1994) and adaptation (Majchrzak et al. 2000; Thomas & Bostrom 2010). In recent years cell phones have evolved to include powerful features that approach a general purpose computing and information device applicable to many of these same purposes. Cell phones have many capabilities which make them productive work tools by providing communication and collaboration support as well as by removing the time and location limitations of a work environment. These handy devices have also become a popular subject for IS scholars (Ahmadi et al. 2008; Gebauer 2008; Gebauer and Ginsburg 2009; Lee et al. 2008; Yuan et al. 2010). Given the highly personal nature of cell phones, they represent an ideal target to examine adaptation behaviors at the individual level.

The rest of this paper is organized as follows: The first section provides a theoretical foundation for decomposing technology-adaptation and task-adaptation and organizing the constructs into a mediation model to explain the variance in performance. The second section describes our research model and hypotheses. The third section explains the research method, data collection and analysis. The fourth section presents discussion of the results including implications of our paper and suggests an agenda for future research followed by concluding remarks.

Conceptual Development

Most organizations invest in IT in order to improve performance and productivity. It is easy to appreciate that a needed technology innovation may still fail to deliver performance if the implementation is poor. For instance, a software program riddled with bugs and a cumbersome user interface is unlikely to produce the productivity benefits promised. Setting aside the possibility of poor execution by the system developers, the Task-Technology Fit stream of research provides a powerful insight that even well implemented technologies in and of themselves do not generate performance improvement. According to TTF, appropriately matching technology to the task is key for achieving performance (Goodhue and Thompson 1995). A common analogy is that using a hammer, even a high quality hammer, to fasten a screw will not provide optimal results. Rather, employing the technology of a screwdriver to the task of a screw is far more productive, and it is the matching of the technology and task to optimize fit that rewards an investment with improved performance and productivity. Within IS research the concept of Task-Technology Fit has been variously operationalized as: (a) fit as a users evaluation or perception that a technology is appropriate for the task, commonly a formative construct of four dimensions (Dishaw and Strong 1998a; Goodhue 1995; Goodhue and Thompson 1995; Goodhue et al. 1997; Gebauer 2008; Staples and Seddon 2004); (b) fit as calculated from the interaction of technology functionality and task activities (Dishaw and Strong 1998b; Strong et al. 2006); (c) fit as a context specific construct where a technology is evaluated across a set of possible applications with best aggregate performance among alternate designs (alternate technologies) revealing the best fit (Venkatraman 1989; Zigurs and Buckland 1998); which is dramatically simplified to (d) fit as a uni-dimensional construct reflected by user perception of usefulness (Yuan 2010). All of these conceptualizations are constrained in that they view fit as a fixed characteristic of the task situation with a direct effect on performance. This preoccupation with finding more sophisticated and accurate methods to characterize and operationalize fit has done little to advance our understanding of the mechanisms through which fit effects performance.

Additional insight is provided by Adaptive Structuration Theory (AST) (DeSanctis and Poole 1994) which describes workplace structures as social norms, conventions, schemes and facilities which influence behaviors and the work process associated with accomplishing tasks. In the natural course of competition and organizational evolution, firms pursue new technologies to accomplish existing tasks in more efficient ways. However, new technologies are rarely perfect, and users applying technologies to a target task invariably reveal problems that necessitate a response in the form of an adaptation (Tyre and Orlikowski 1994). In the terminology of AST, when a new technology is introduced, human agents appropriate it by assigning shared meanings which influence how the technology's imbedded schemes and capabilities are put to use (Orlikowski 1992). As users are appropriating the features of the technology, this simultaneously influences the behavior of the team members and the way in which tasks are being accomplished. The workplace structures may be subtly changed or radically redefined, but rarely remain unchanged. The insights of AST provide a theoretical grounding to the Fit Appropriation Model (FAM) (Dennis et al. 2001) which contends that "how people use a technology is at least as important as its fit within the task." Interestingly, the appropriations may be "faithful" and employ the technology in a manner intended, or "unfaithful" and result in use that was not intended or even discouraged. FAM posits that the performance effect of task-technology fit is moderated by appropriation behaviors. The ability of a quality technology to impact performance is therefore contingent on both the fit to task and appropriations made by users.

Individual users appropriate technologies in different ways. Identical technology introduced into two different work groups will be appropriated differently by these different groups. One potential explanation for the different appropriations is provided by the Coping Model of User Adaptation (CMUA) (Beaudry and Pisonneault, 2005).

The CMUA proposes that users respond to the introduction of new technologies with adaptation behaviors in order to cope with the perceived consequences. One such coping behavior is the modification of task, technology and self. While some IS research has identified and modeled only certain dimensions of adaptation, the landscape of IS theory casts a net recognizing both adaptation of technology and tasks to be part of a users response.

Table 1. Important IS Theories related to Fit and Adaptation

Theory/ Model	Key Reference	Role of Appropriation & Adaptation	Role of Technology	Role of Task
TTF: Task-Technology Fit	Goodhue 1995 Goodhue and Thompson 1995	Discretionary Utilization: *utilization measured as dependence on information systems; the extent to which the information systems have been integrated into each individual's work routine.*	IV: Technology *Tools used by individuals in carrying out their tasks.*	IV: Task *Actions carried out by individuals in turning inputs into outputs.*
AST: Adaptive Structuration Theory	DeSanctis and Poole 1994	Appropriation of technology: involves how the technology is used (immediate response) Structuration: as structures are applied (structures in action), the outputs become additional sources for structure, and bring organizational change.	IV: Advanced IT *Static assets containing functionality to complete discrete work tasks and instantiate structures including rules, procedures and capabilities (structures in technology)*	IV: Task *Sources of social structure that serve as templates for planning and accomplishing tasks.*
FAM: Fit Appropriation Model	Dennis et al. 2001	*Appropriation relates to how people use a technology, which may be faithful (as intended by the designer) or unfaithful. It is the way individuals and groups use the technology that affects performance, not the fit itself.*	IV: Technology Capabilities Static features and capabilities.	IV: Task *Decision making tasks include: intellective tasks, judgment tasks with no "correct" answer, and "fuzzy tasks" such as sense-making.*
CMUA: Coping Model of User Adoption	Beaudry and Pisonneault 2005	*User adaptation behaviors are acts that users perform in order to cope with the perceived consequences of a technology event. This includes modifying tasks, reinventing and adapting the technology, resisting the technology, or adapting one's self.*	IV: new technology, modified existing technology *Introduction of a new technology or the modification of an existing technology …can constitute a disruption in organizations.*	Not an explicit independent variable (IV), but is implicit in the action process of task adaptation behavior which includes modifying procedures and routines

It may be tempting to view all adaptation behaviors as a single unified activity for purposes of modeling and studying IS. Just such an approach was employed in a recent study of IS Use Related Activity (Barki et al. 2007), but failed to find significant results for the aggregated task-technology adaptation dimension, notwithstanding solid theoretical justification. One plausible explanation is that aggregating task-technology adaptation as a single unidimensional construct has a confounding effect due to the independent manner in which the dimensions function.

Ethnographic research provides convincing support for disaggregation. Barley's (1986) case study research observed that introduction of new technologies is associated with organizational structure and work process changes, one causing a response from the other. Tyre and Olikowski (1994) observed distinct task adaptation and technology adaptation contingent effects across three case studies, such that task adaptations by users often become imbedded and routinized thereby impeding subsequent technology adaptations. In studying technology, Orlikowski (1992) observed that it is important to differentiate between the human actions affecting technology and the human actions affected by the technology. Classic software engineering practices go to great lengths to distinguish business process requirements which characterize *what* must be done, from technology specifications that relate to *how* one would implement a solution (Vick 1984). This *what* and *how* construct distinction represent the ying and yang of information processing by individuals that forms the pivotal juncture that is task-technology fit. Goodhue and Thompson (1995) describe technology as an aid that "assists an individual in performing his or her portfolio of tasks." The idea that technologies are not inherently an instantiation of an underlying process can be seen as users in different contexts appropriate the same technology in different ways (Alter 2006, Boudreau and Robey 2005, Dennis et al 2001). Within the field of applied psychology, Kirton (1976) described adaptation and innovation at opposite ends of a continuum. His description of *innovation* is one form of technology adaptation, whereas his *adaptation* is associated with task adaptation. Kirton went so far as to note that adaptation and innovation were "incommensurable viewpoints and different solutions to administrative and organizational problems." By decomposing task and technology adaptations we recognize the distinction that technology adaptations are the human actions affecting technology while task adaptations are the human actions affected by the technology. We propose to treat the constructs of task-adapatation and technology-adaptation as distinct, and seek to examine the operative relationship between them. This requires validated measurement scales, which are not readily available for deconstructed task adaptation and technology adaptation constructs.

Task Adaptation

The first step in the process of developing a valid measurement instrument is to clearly define the concept to be measured. *Task* has been defined as the actions that an individual performs while turning inputs into outputs (Goodhue 1995). A more encompassing definition of *task* is the activities a worker engages in to achieve a goal (Vakkari 2003). Bhattacherjee and Harris (2009) define *work adaptation* as the "user's appropriation and modification of relevant work structures to accommodate the target IT".

In defining how a user may modify work tasks in response to technology, it is helpful to look at literature relating to the effects of IT. Malone and Rockart (1991) suggest that IT can have a threefold effect on an organization's coordinating activities. IT enables a corporation to engage in more coordination than had been possible before IT, to manage the coordination activities much more effectively, and to also implement innovative coordination-intensive business structures. This suggests that as a result of IT implementation, organizations are able to do more of their current tasks and to do them better in addition to being able to accomplish new tasks. In a similar vein, Ward et al (2008) discussed three types of changes that organizations must undergo in order to realize the full benefit of IT. First, the organization can "do things better". This entails changing business processes to improve the performance of ongoing activities. Second, the organization can "do new things". This suggests that new business processes may be developed that had not been possible before the IT. Third, the organization may "stop doing things". As a result of the IT, the organization may discover that there are some activities which are no longer necessary in order to successfully operate the business. We believe that these broad organizational level concepts are applicable to the task adaptation process at an individual level. As individuals respond to the adoption and implementation of new technology in the workplace, they may modify their work tasks as necessary to do their current tasks better. Also as a result of the new technology, individuals may have the opportunity to attempt new and different work tasks which had not been possible before the technology. This opportunity may be possible due to the advanced functionality of the technology or due to the ability to stop performing some tasks thus freeing up time for new tasks.

Saga and Zmud (1994) identify three different ways in which technology may be applied to tasks. Extended use involves applying the technology to "accommodate a more comprehensive set of work tasks". Integrative use involves utilizing the technology in such a manner that existing work flow sequences among tasks can be changed. Emergent use enables the accomplishment of tasks that were not practical or possible before implementation of the technology. The extended use and integrative use together entail "doing things better" and represent a consequence of users becoming more familiar with the technology, as well as their ability to reconceptualize their work tasks by means of the technology. The emergent use entails "doing new things". Drawing on these ideas we define two dimensions of a more general task-adaptation construct:

- Integrative Task Adaptation involves: *a user appropriating and/or modifying existing work process activities and structures to accommodate or exercise a target technology*. This includes technology appropriations and structure adaptations to "do things better" and "stop doing things".
- Emergent Task Adaptation involves: *a user expanding the tasks or extending structures to new domains to accommodate or exercise a target technology*. This includes technology appropriations and structure adaptations to "do new things."

Technology Adaptation

Technology Adaptation can take many forms which are unique to the technology and do not extend to task or individual actors within the work system. Desouza et al. (2007) identified three types of modifications that occur to technology artifacts including personalization, customization and inventions. *Personalization* is motivated by a desire to make the technology flexible to the needs of the user and is accomplished by modifying parameter options intentionally provided by the creators of the artifact. Swapping the actions associated with left and right mouse buttons to accommodate a left-handed user is an example of this type of adaptation which does not create any new capability. In the context of mobile phone usage, this may take the form of personalized ringtones or background images. *Customization* is motivated by a desire to enhance the work group performance in a collective setting and is accomplished by modifying parameter options intentionally provided by the creators of the artifact. Adjusting the volume for an audio/visual presentation in a large conference room verses a small conference room is an example of this type modification motivated by the user's involvement in a specific environmental setting for the benefit of the group. An *Invention* is a very different type of artifact modification motivated by frustrations with the existing technology artifact coupled with unmet needs. Inventions are accomplished through changes which supplement the technology artifact or apply it to novel purposes not envisioned by the creator. Add-in scripts and "work-arounds" are examples of this type modification which often create something new in the process of altering the technology artifact. In the context of mobile phones, inventions may take the form of adding Apps to an iPhone, or more to the point, creating your own App. A different kind of example is the "hack" which some smartphone user implement to activate Skype™, an App the vendor of certain smartphones has attempted to block[1].

Developing a valid measurement instrument requires a clear definition for the concept of Technology Adaptation. Organizational literature defines technology broadly as "actions used to transform inputs into outputs" (Goodhue and Thompson 1995). Orlikowski (1992) observed that prior conceptualizations of technology combined task, technique, knowledge, and tools into one construct and was therefore unable to analyze the significant interactions between these individual components. Indeed, users do not view technology artifacts and targeted tasks as a fixed bundle, but rather as distinct participants in accomplishing objectives (Al-Natour and Benbasat 2009; Thomas and Bostrom 2010). Understanding technology more narrowly in terms of artifacts is more in line with the Task-Technology Fit grounding theory this paper begins with. The idea of a lack of fit between task and technology is meaningless without some boundary. Ahuja and Thatcher (2005) define an *adaption stage* "where IT is modified to foster a better fit between individuals, organizations and/or IT applications". Rice and Rogers (1980) define *reinvention* as "the degree to which an innovation is changed by the adopter in the process of adoption". Bhattacherjee and Harris (2009) define *IT adaptation* as "the extent to which a system is modified by users to fit their personal needs, preferences and work patterns". Drawing on these ideas we define two dimensions of the general technology adaptation concept:

- Exploitive Technology Adaptation involves: (a) *personalization by the user to fit their personality, style, preferences and needs as well as* (b) *customizations by the user to better serve the work group, both using capabilities intended by the creator of the technology.*
- Exploratory Technology Innovation involves: *changes made to a technology by the user to* (a) *add functionality that did not previously exist or* (b) *activate functionality the provider intended to be unavailable.*

---

[1] Skype™ is a voice over IP telephony service which may avoid certain tariffs with lower cost to the users and lower income to the phone company.

A general technology innovation concept is only subtly different from the second definition proposed here. General technology innovation would involve actors other than the user, such as innovations introduced by the broader organization or implemented by a professional programming staff. Regardless of where the innovations come from, the work system is still faced with appropriations and structural adaptations that would then drive new performance outcomes.

Model and Hypotheses

Research Model

While much of the TTF literature views the role of task, technology and the individual as first order independent variables (Fuller and Dennis 2009, Goodhue 1995, Goodhue and Thompson 1995, Strong et al. 2006, Yuan et al. 2010), this may not fully characterize the relationship between these factors. A key insight from case study research examining the mutual and concurrent phenomenon of task-adaptation and technology adaptation is that the value of an innovation is not the new technology, but the working solution that results (Bygstad 2005; Leonard-Barton 1988). Indeed, value and productivity flow from technology only as it is appropriated and applied to a work task. This is highlighted by the observation that the same technology will be appropriated differently in different settings by different users generating different results. You could hypothetically remove technology from an organization and in many situations the remaining individuals can execute tasks to generate a productive output. By contrast, in the absence of a task the remaining individuals and technology do not create a productive output.

Numerous qualitative studies provide evidence of task adaptation in response to the introduction of IT. Boulus (2009) studied the impact of Electronic Medical Records technology on a medical practice. Once the IT was introduced, significant changes to work processes were observed including changes in the way information was collected, documented, and presented, the sequencing of tasks and the assignment of responsibilities. Orlikowski (1996) found that the introduction of new IT in a customer support department also resulted in changes to work practices. This qualitative study found that work processes changed in many ways such as the distribution of work tasks, the evaluation of work tasks, and work processes becoming more articulated and structured. In a study of a computerized physician order entry system, Davidson and Chismar (2007) found evidence of task adaptation upon implementation of the IT. Physicians saw work tasks increase, had access to better information, and could perform work tasks in new locations while administrative assistants saw their work tasks decrease and change significantly. Davis and Hufnagel (2007) also found evidence of task adaptation in conjunction with the implementation of an automated fingerprint system. It was noted that task variety and task intensity were both modified as a result, and the assignment and sequencing of work tasks among novices versus experts was modified. The conclusion of a case study investigation by Majchrzak et al. (2000) reveals appropriation and decision processes function as mediators in their process model. In the context of a decomposed technology-adaptation and task-adaptation variance model, this positions task-adaptation as a mediator of technology-adaptation leading to performance outcomes. These studies provide qualitative evidence of task adaptation as a response to the introduction of technology.

For the current study we model the role of technology as mediated in its influence on performance by the role of task. We have theoretically justified the separation of the two adaptation activities as distinct constructs. We further propose that technology adaptation may take either the form of exploitive behavior or exploratory behaviors. These two factors combine formatively into a second order endogenous construct representing overall technology adaptation. Similarly we propose that task adaptation may formatively take the form of changing existing processes (integrative task adaptation) or an emergent form whereby users apply the technology to new tasks they previously were not attempting (emergent task adaptation). All first-order constructs are reflective and survey efforts to collect theses measures will be conducted.

Much of the research in this area has approached adaptations as a dynamic process, with the theoretical models involving feedback loops and compounding effects. Indeed, many of the relevant theories involving adaptation use process models (e.g., Technology Performance Chain, AST, CMUA). Moving to a variance view allows extending the reach of empirical research beyond the limited settings of specific field study and laboratory experiment to a broad cross sectional population that can be efficiently accessed through survey mechanisms in a single data collection event. With ever increasing level of ease-of-use, modern IT such as smart phones do not usually take users drawn out efforts to adapt over an extended period of time. Consistent with this variance modeling approach, in this study we attempted to assess the "current" state of affairs and all questionnaire items are stated in present tense, in order to capture what were happening concurrently in various adaptation efforts and their performance effects.

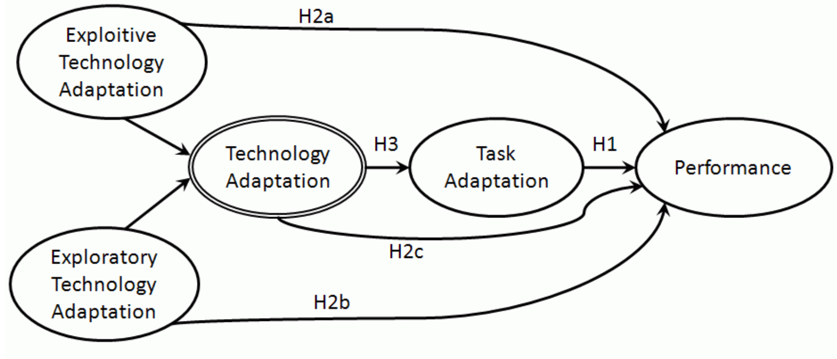

Figure 1: Model of Technology Task Adaptation

Hypotheses

FAM establishes a view that technologies introduced into an organization with the goal of improving performance must first be properly matched with the target task to create what AST describes as a potential for productivity enhancement (DeSanctis and Poole 1994). This potential can be understood as a theoretical maximum which would rarely if ever be achieved, largely due to the moderating effect of appropriations applied by the human actors of the work process. The appropriations (how technology is applied) represent micro-level variations in the behaviors of the users which in effect constitute changes to how the work task is performed. At a macro-level and across a broader time frame, a series of appropriations by users have a concurrent impact on social norms and processes that result in the changing and redefinition of group structures. According to AST, the technology spirit is less open to conflicting interpretations and does not change during the adaptation process. Therefore, we are guided to understand the operative mechanisms of AST and FAM, namely technology appropriation and structural adaptation, change individual behaviors and work processes (i.e., tasks), but not the technology itself. According to AST, introducing new technologies will result in decisions by users to appropriate and use a technology to specific work tasks. Decisions will be made on how to perform target tasks, and actions taken to perform variations within the task result in performance outcomes. Subsequently the social norms and structures associated with how these tasks are performed will be changed and reconstituted into new workplace structures. From an individual user perspective, the extant social structures are represented by work processes and work tasks (Bhattecherjee and Harris 2009). Thus, as users interact with a new technology, they may make modifications to work task behaviors in order to take full advantage of the benefits of the technology. The task adaptations may take the form of either adaptation of existing tasks (integrative use), or the incorporation of new tasks into the work process (emergent use). Therefore:

H1: Task adaptation behaviors are associated with improved work related task performance.

Research by Majchrzak et al. (2000) suggests that considering only task adaptation is short sighted and may reflect context specific artifacts of a few research settings. They observed modifications and adaptations to technology itself, noting that some "of this modification was in the addition of new features, some in the decision to not use certain features, and some in the intent to which the features were used, i.e., the spirit or norms of use". They concluded that "when a workgroup is allowed to modify its structures, it is possible that all structures may be changed". In other settings, such as the grounded theory field investigations of Leonard-Barton (1998), it has been demonstrated that "misalignments can be corrected by altering the technology or changing the environment – or both" and "change in *both* technology and user environment is more beneficial than holding one constant and changing the other." This supports extending the structuration process beyond appropriation to include adaptations of technology as the way in which users adapt and manipulate a malleable technology to facilitate the accomplishment of their work. This view effectively extends the appropriation and adaptation mechanisms of AST and FAM to include technology as a social actor along with human action.

In both voluntary and mandatory use situations, it is important not to discount the reality that technology adaptations can and do take place. Leonard-Barton (1988) observed that "the adaptation process is necessary because a technology almost never fits perfectly into the user environment… misalignments must be addressed if the implementation is to succeed". Rice and Rogers (1980) note that "the choices available to a potential adopter are not just adoption or rejection; modification of the innovation or selective rejection of some components of the innovation may also be options." Even in settings involving standardized practices, research has found as much as 92% of organizations adapt and innovate technology, including unusual and unintended ways which software vendors seek to discourage (Cole and McCain 1985). The adaptation is occurring not only at the organizational level by professional programming staffs, but also among users. Boudreau and Robey's (2005) case study of an Enterprise Resource Planning (ERP) system implementation reveals that employees found ways to avoid use of the new ERP by reproducing work practices established prior to the new technology implementation. "This period of inertia was followed by a period of reinvention, during which users reduced their use of the paper forms and interacted directly with the system". However, rather than using the technology as expected, users enacted numerous tweaks and workarounds, even overcoming intended restrictions, to make it respond to their needs.

Technology Adaptation can be thought of as exploitive and exploratory. *Exploitive* technology adaptations are those changes made to a technology to improve its fit for anticipated and intended functions. In the case of mobile phones, manufacturers have made such adaptations as custom ring tones, display backgrounds and menu customization very accessible to even the most casual user. When adaptations fit the characteristics of the user (left handed vs. right handed) or the work group that the user interacts with (high volume in a group setting with high ambient noise), these changes can be expected to have a direct effect on task performance. As explained by CMUA, the motives which drive adaptation include a range of strategies from benefits satisficing, to benefits maximizing, to disturbance handling and to self preservation. While only some of these strategies target performance outcomes, any technology change has the potential to impact performance. Fuller and Dennis' (2009) longitudinal study in a work place setting revealed that over time the appropriation moves of individuals and teams become tuned to improve performance. Therefore:

H2a: Exploitive technology adaptation is associated with improved work related task performance.

Exploratory technology adaptations are those changes made to a technology to add capabilities and functions not previously available to the user. Such changes are consistent with the concept of invention and allow the user to apply the technology to previously unmet needs. Consistent with the earlier definition of exploitive technology adaptation, some of these changes may allow functions that the creator or provider prefers not be exploited. For an individual user, each technology adaptation may facilitate performance of current tasks regardless of its novelty. Therefore:

H2b: Exploratory technology adaptation is associated with improved work related task performance.

This exploratory innovation construct is broadly overlapping with the introduction of new and different technologies initiated by other actors in its impact to the structures of a work system. The result is the proposed model subsumes the broader concept of general technology innovation within an organization. From the standpoint of the task, any change to relevant technology, whether exploratory or exploitive, represent a disturbance to which users will react. We represent this through a formative second order construct composed of both exploitive adaptation and exploratory adaptation, which leads to the more general hypothesis:

H2c: Technology adaptation is associated with improved work related task performance.

As new technologies are introduced into the work place, it can be expected that work tasks may need to be adapted in order to accommodate the new technology (Alter 2006). Saga and Zmud (1994) note that an organization can only reap the benefits of IT when it has a thorough understanding of both its fundamental work processes and the potential of IT to restructure these processes. Although this observation is at the organizational level, we believe that the concept also would apply at the individual level. Beyond initial introduction the benefit of the technology adaptation process can only be fully realized when the user "initiates corresponding changes to their own work structures to accommodate and take advantage of an adaptable IT" (Bhattacherjee and Harris, 2009). From a human agency perspective the human actors and technology artifacts interact in a mutually influencing manner to transform each other (Boudreau and Robey 2005). CMUA identifies three responses users have to IT events: (1) adapting one's self; (2) adapting the work by modifying procedures and routines; and (3) adapting the technology by changing its functionalities and features. When faced with complex IT events, users rely on both task and technology adaptation. The implication is that introducing a new technology will trigger adaptations of organizational structures in the form of task adaptations. Laboratory experiments employing detailed protocol analysis reveal that decision strategies (i.e., how the technologies are appropriated in the context of a target task – in effect task adaptation) are an "intervening variable" between technology features and capabilities and the resulting performance outcomes (Jarvenpaa 1989; Todd and Benbasat 1999).

Given that an individual technology can be applied in a multitude of ways, we suggest that performance outcomes do not emerge from technology alone. Rather the technology must first be applied to a process or task, from which performance emerges. Contrast this with business processes, which often exist in a fully manual form prior to the introduction of technology. We therefore posit that the performance effect of technology adaptation is to be mediated by task adaptation. Technology adaptations only influence performance to the extent they are appropriated into a work task. Therefore:

H3: Task adaptation will mediate the influence of technology adaptation on work related task performance.

Methodology, Data Collection and Analysis

Our research was a two part study. Our first goal was to clearly define the two independent constructs of technology adaptation and task adaptation including their appropriate sub-constructs. From these definitions, we then developed a measurement instrument for the latent variables. To assess the validity of our proposed measurement instrument, we evaluate assessments of both convergent and discriminant validity. In addition, the predictive validity of these new scales will be evaluated by assessing their effects on performance. Our second goal was to investigate the research model regarding the mediating role of task adaptation in the relationship between technology adaptation and its impact on performance. This evaluation will give us insight into the intricate relationship among these constructs.

Data Collection and Sample Demographics

To assess model constructs, a questionnaire was developed and administered by paper and pencil method. The survey instrument included items to measure exploitive and exploratory technology adaptation and the two task related components of integrative task adaptation (changing current tasks) and emergent task adaptation (taking on new tasks). We included in our survey previously validated items to capture perceived performance as a surrogate for performance. In particular we employed the nine item Relative Advantage instrument (Moore and Benbasat 1991) and the overlapping six item Perceived Usefulness instrument (Davis 1989). All items elicited responses based upon a seven point Likert scale ranging from Strongly Disagree to Strongly Agree. The items are worded in the present tense in order to elicit a response that captures current and on-going impacts.

Individuals applying cell phones to work related tasks are the target of our survey instrument. Cell phones are used for both personal as well as work purposes and have many features which make them productive tools for communication and collaboration support. Cell phones provide a mobile computing environment whereby users can download files or access information at any location or time (Choi et al, 2007). Yuan et al. (2010) identified four broad functions provided by contemporary mobile devices that are useful in a work environment: mobile communication, mobile information searching, mobile transaction processing, and mobile office functionality. In the past, email and group support systems have been important tools for work group interaction and collaboration. With their expanding capabilities, cell phones, particularly smart phones, have now become an important work tool enabling group interaction and collaboration. Features such as portability, social interactivity, and interconnectivity position handheld devices as the next ideal collaborative platform (Ahmadi et al, 2008). Additionally, cell phones offer a wide range of possibilities for technology adaptation in the three areas of personalization, customization, and invention which make them an appropriate technology from which to study task-technology adaptation.

In an effort to add robustness to our study, we included a series of control variables to identify and remove their respective variances from the perceived performance outcome explained by our research model. This includes the demographic variables of AGE and GENDER. Due to the rapidly evolving nature of mobile phone technology which is the subject of our investigation, two control variables related to the sophistication of the phone were measured: FEATAMT recorded the number of features as an ordinal variable; NEWNESS recorded as number of months the user has had their current mobile phone. Finally a control variable of IMPORTANCE was collected as the reflective measure of two items. This allowed us to confirm that the technology was in fact a significant and important factor in work related perceived performance as well as separate the baseline variance of smartphone usage from that attributable to technology-task adaptation. Additional discussion of control variables appears below.

Subjects were asked to respond to the survey questions based upon the use of their current cell phone for work related tasks. We administered the questionnaire to graduate business students receiving a total of 166 respondents. Our target sample was graduate students working in a professional career. The university is in a large metropolitan area where most evening graduate students are working adults thus presenting a good population from which to sample. Of the 166 responses received, 6 were eliminated due to large amounts of missing data, 29 were eliminated due to responses indicating that their cell phone was not used for work related tasks, and 8 were eliminated due to responses indicating that use of their cell phone was not important to their job. Our final data set used for the analysis included 123 responses of which 65% were male and 80% were between the ages of 21 and 40. Recognizing that cell phones are used for both personal and work related tasks, we measured how important the cell phone was to work related activities and included this as a control variable in our model (IMPORTANCE). The mean score for "I am dependent on my current cell phone for work related activities" was 3.97 on a scale of Strongly Disagree (1) to Strongly Agree (7), and the mean score for "How important is your cell phone to your job?" was 4.5 on a scale of Not Important at All (1) to Very Important (7). In our final sample, only 21% had cell phones provided by their employer thus providing support that most use is voluntary.

Assessment of Measurement Properties

As our questionnaire included scales not previously validated to measure four new constructs, we first assessed the reliability of these measures (exploitative technology adaptation, exploratory technology adaptation, integrative task adaptation, and extended task adaptation). To do this, an exploratory factor analysis with a principal component method and varimax (orthogonal) rotation was conducted in SPSS, followed by a measurement model and structural model analysis using Partial Least Squares (PLS). Computations were made using SmartPLS 2.0 (Ringle et al, 2005). PLS was appropriate as it is suitable with smaller datasets, allows testing of the measurement model and estimation of the structural model. To determine the appropriateness of performing the factor analysis, the Kaiser-Meyer-Olkin measure of sampling adequacy was calculated, and the Bartlett's Test of Sphericity was conducted with both tests indicating factor analysis was appropriate. We used a combination of the Kaiser criterion method (eigenvalues > 1), the scree test and interpretability in order to determine the number of factors to retain. Five factors were extracted from the 44 individual variables accounting for over 70% of the total variance in the original data. For each extracted factor, we examined the individual variables having a factor loading of .50 or greater. For an exploratory factor analysis, a measurement item with a loading coefficient above .60 is considered to load highly and does not load highly when the loading coefficient is below .4 (Hair et al., 1998). If a construct had more than six high loading measurement items, we only retained the top six items. Of the five factors extracted, three were interpreted as adaptation constructs, one was the dependent variable perceived performance, and one was uninterpretable with only two items loading highly. The three retained adaptation variables along with the survey questions that are substantially associated with each factor and the corresponding factor loadings are summarized in table 2. To assess the reliability of the factors, we computed Cronbach's alphas which are above the acceptable level of .70 and the composite reliabilities which are all above the acceptable level of .80. The Cronbach's alpha and composite reliability for each factor are shown in table 3.

Based upon the exploratory factor analysis, we discovered that all task adaptation items loaded onto one factor, thus we proceeded with our research treating task adaptation as one overall construct. This reflects that in the mind of our respondents the concept of changing an existing task and the concept of taking on a new task were sufficiently close as to be indistinguishable by this measurement instrument. The technology adaptation items did load onto two separate factors interpreted as exploitive technology adaptation and explorative technology adaptation as we had expected. The results of the exploratory factor analysis provide strong evidence for the convergent validity of the three measurement scales.

For analysis purposes, a second order technology adaptation factor is formed by the two factors of exploitive technology adaptation and exploratory technology adaptation. The second-order factor was created within SmartPLS using the indicators of its lower-order factors (figure 2). Results reveal that the two dimensions forming technology adaptation have significant paths with exploitive technology adaptation having the larger path coefficient of .589 ($\underline{p} < .001$) and exploratory technology adaptation having a path coefficient of .542 ($p < .001$). This provides further evidence in support of the convergent validity of the three measurement scales (Gefen and Straub 2005). When assessing the hypothesis in a full structural model, we conceptualize technology adaptation as an aggregate, second-order construct with significant paths linking the first-order factors of exploitive technology adaptation and exploratory technology adaptation to the second-order factor of technology adaptation. Overall, the data supports use of these latent constructs for hypothesis testing with the pre-validated construct of perceived performance.

Table 2: Items for Adaptation Constructs

	Name	Statements	loading
Task Adaptation	TSC03	The way that I access reference information with my current phone changes the way I complete my work related tasks.	.817
	TSASUM	Overall, I feel that use of my current phone has enabled me to accomplish new and different work related tasks.	.814
	TSC02	I perform work related tasks in new places and settings that were not possible without my current phone.	.798
	TSA4	I am managing my work relationships in new and different ways with current cell phone.	.797
	TSC10	I have changed the way I keep track of my work related information due to how I use my current phone.	.791
	TSC07	I have changed the way I manage my time due to how I use my current phone.	.783
Technology Exploration	TKI5	I have developed a way of using my phone which deviates from the standard usage.	.860
	TKI4	I am using at least one phone feature or capability in an unusual manner which the vendor does not encourage.	.859
	TKI3	I have modified something on my phone to use it in a nonstandard way.	.804
	TKI7	I am using my cell phone in new ways because of changes I have made.	.620
	TKC3	Changes I have made to my phone have introduced problems with its operation.	.618
	TKI6	I have added functionality to my phone that was not present when I first activated my current phone.	.504
Technology Exploitation	TKCSUM1	Overall, I feel that I have taken advantage of the adaptability of the features available on my phone as they were intended to be used.	.788
	TKC2	I change the settings/preferences on my phone to alter the way I interact with it.	.768
	TKC1	I experiment with new features on my phone.	.768
	TKSUM2	Overall, I feel that I have adapted my phone in new and creative ways.	.693
	TKSUM3	I have increased usage as a result of the features of my current phone.	.558

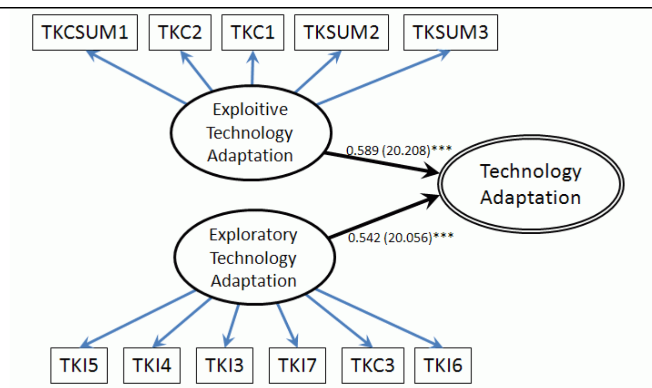

Figure 2. Technology Adaptation Measurement Model

Table 3: Reliability of Reflective Constructs			
Latent Factor	Cronbach's Alpha	Composite Reliability	AVE
Perceived Performance	0.962	0.967	0.766
Task Adaptation	0.959	0.967	0.829
Exploitive Tech Adaptation	0.908	0.932	0.733
Exploratory Tech Adaptation	0.887	0.914	0.642
Importance	0.700	0.865	0.763
Technology Adaptation	0.909	0.924	0.529

Discriminant validity is assessed by analyzing three measurements related to factor loadings and the average variance extracted (AVE). All measurement items load higher on their own theorized construct than on any of the other constructs. In addition, the average variance extracted (AVE) reflecting the percent of variance captured by a construct, as shown in table 4 is larger than .50 for each, supporting discriminant validity (Fornell and Larcker, 1981). Third, the square root of the AVE for each reflective construct is larger than its correlation with the other constructs as shown in table 4 (Chin, 1998). These assessments provide evidence that the three constructs display adequate discriminant validity. The results of the exploratory factor analysis support the validity and reliability of the six item instrument for task adaptation, the six item instrument for exploitive technology adaptation, and the five item instrument for exploratory technology adaptation.

Table 4: Intercorrelation Matrix									
Construct	1	2	3	4	5	6	7	8	9
Perceived Performance (1)	**.875**								
Task Adaptation (2)	.799	**.911**							
Eploitive Tech Adaptation (3)	.599	.604	**.856**						
Exploratory Tech Adaptation (4)	.450	.463	.562	**.801**					
Control Variables:									
Importance (5)	.748	.574	.448	.378	**.874**				
Amount of Features (6)	.212	.279	.392	.142	.109	**1.00**			
Newness (7)	.183	.123	.052	.007	.218	.044	**1.00**		
Age (8)	.044	-.113	-.024	-.211	.117	.077	.133	**1.00**	
Gender (9)	-.089	-.071	-.013	-.014	-.090	-.071	-.132	-.112	**1.00**
Diagonal elements are the square roots of average variance extracted.									

Test of the Research Model

We check first for direct effect of technology adaptation. This can be seen in the PLS structural model (Figure 3) whereby the second order technology adaptation construct has a positive path coefficient of 0.614 ($p < 0.001$) to task adaptation. Examination of the constituent first order factors also reveals a positive direct effect on the presumed mediator (Figures 4 and 5).

Next we confirm that variations in the task adaptation mediator significantly account for variations in perceived performance. Again, the overall PLS model (Figure 3) records the observed positive path coefficient of 0.528 ($p < 0.001$) from task adaptation to perceived performance. We therefore conclude in favor of hypothesis 1, that task adaptation behaviors will be associated with changes in work related task performance In addition we examine the direct path effects from our independent variable technology adaptation. When examined in isolation (represented in the top portion of Figure 3), technology adaptation has a positive path coefficient of 0.297 ($p < 0.001$) to perceived performance, supporting hypothesis 2c. Similarly the constituent constructs of exploitive adaptation (Figure 4) and exploratory adaptation (Figure 5) also demonstrate a positive direct association to perceived performance when examined in isolation, supporting hypotheses 2a and 2b. The significance of these direct effects as tested in hypotheses 1, 2a, 2b, and 2c also provide support for the predictive validity of the new measurement instruments for these constructs.

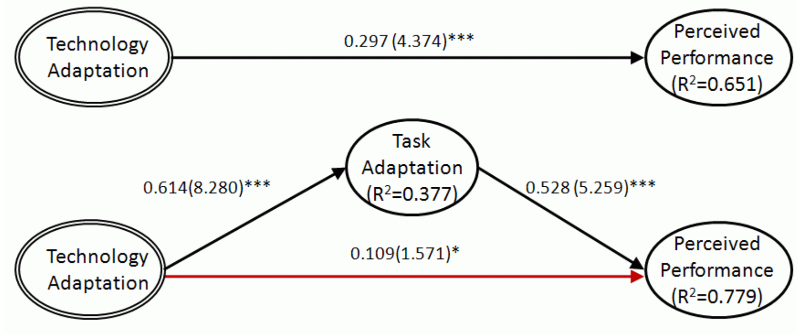

Figure 3: Full Model tests results (H1, H2c, H3)

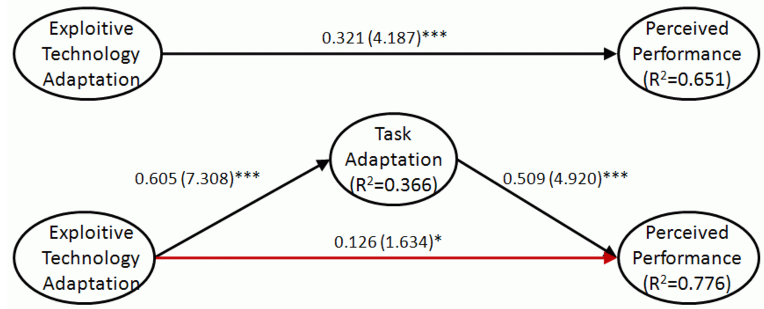

Figure 4: Exploitive Technology Adaptation (H2a)

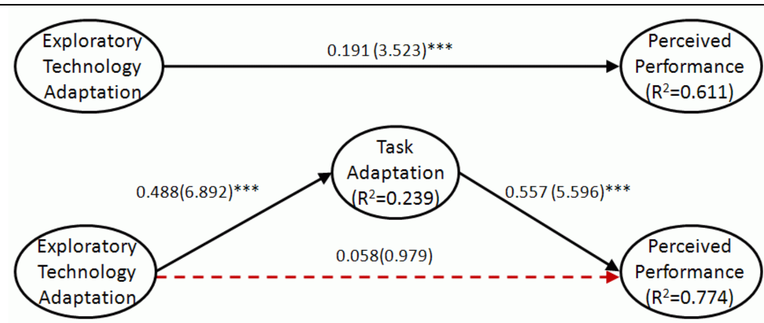

Figure 5: Exploratory Technology Adaptation (H2b)

In conformance with the final step in the Baron and Kenny (1986) mediation test, we examine our model with the mediating variable of task adaptation included, as shown in Figures 3, 4, and 5. As seen in Figure 3, while we have significant path of 0.614 ($p < .001$) between technology adaptation and task adaptation ($R^2 = .377$), and 0.528 from task adaptation to performance ($p < .001$), the direct path from technology adaptation to performance is now reduced from 0.297 ($p < .001$) to just 0.109 with marginal significance ($p < .10$). These findings indicate that the effects of technology adaptation on perceived performance are partially mediated by task adaptation. Thus technology adaptations impact perceived performance partially through their impact on task adaptations, and Hypothesis 3 is supported. In Figures 4 and 5, we examined the mediation role of task adaptation for the two constituent components of technology adaptation, and the results are consistent. While both components show much reduced effect on performance, the exploitive adaptation is marginally significant ($p < .10$), and the effect of exploratory adaptation is insignificant. Thus, we conclude that task adaptation partially mediates the effect of exploitive adaptation on performance. For the effect of exploratory adaptation on performance, we found full mediation from task adaptation.

In addition to our constructs of interest, we also included several control variables. We found insignificant association for the demographic variables AGE (coefficient=0.060, t-score=1.127) and GENDER (coefficient= -0.010, t-score=0.232). We similarly found insignificant association for the technology specific control variables NEWNESS (coefficient=0.027, t-score=0.595) and FEATAMT (coefficient=-0.026, t-score=0.535). Assessing the importance of a mobile phone for work was done with the latent construct IMPORTANCE. The path coefficient (0.382) between this variable and perceived performance is significant (t-score=4.766, $p<0.001$). When control variables are included in the structural model, the full model capturing the role of technology and the role of task explains 77.9% of the variance in perceived performance. The results indicate that both technology adaptation and task adaptation are positively associated with perceived performance but that the impact of technology adaptation on perceived performance is mediated by task adaptation.

Discussion

Implications for Practice

The importance of post implementation adaptations is emphasized by the observation that these emergent changes have a deeper level of impact than an initial innovation (Boulus 2009). It has been argued that the ability to adapt IT in response to changing business climate is key to a firm's ability to sustain a competitive advantage (Beimborn et al. 2007, Duncan 1995, Evans 1991). By preferring technologies which are more flexible and amenable to user adaptation, an organization may optimistically expect to facilitate future performance outcomes.

Creators and vendors of IT artifacts should understand user malleability as a feature exploitable by attentive users and organizations. This is particularly salient for technologies which have a revenue stream associated with usage. Examples of such technologies include mobile phones with tariffs that are a function of usage intensity, web search engines with their advertising based revenue model, and even infrastructure services such as cloud computing that collect fees for amount of computing resources consumed. To the extent that inventors make their technologies more flexible, they become better positioned to tap new and growing revenue streams.

Implications for Research

We have provided plausible explanation why multiple researchers who theorized a relationship between task-technology fit and usage were unable to find it. Other studies have demonstrated that decomposing dimensions of a theoretically supported construct has been instrumental in finding statistically significant results (Karahanna et al. 2006). With the reconceptualized technology-task adaptation model we provide the insight which may explain why researchers have sometimes been confounded by a unified task-technology adaptation construct (Barki et al. 2007).

Exposing the inner relationship between technology adaptation and task adaptation provides important insight for several theories which view adaptation as a single aggregated construct. CMUA describes a user's emotional response, leading to an adaptation cycle. This study extends that thread with a deeper explanation of how the adaptation responses can minimize the negative consequences of an IT event and improve individual efficiency and effectiveness. Similarly, by extending the personal innovativeness construct within the theory of Computer Self Efficacy (CSE) (Thatcher and Perewe 2002) with the technology-task adaptation model, a linkage is provided to performance outcomes described in behavioral research.

One of the central tenets of FAM is to extend appropriation from AST to include technology, a relationship supported by this research. In addition, a broader reconceptualization of FAM may be in order when the moderating construct of appropriation is extended with the mediated technology-task appropriation model. Where the original investigation stopped short of testing appropriation in action, the measurement scales validated in this study provide a powerful tool to enable additional research.

This research also complements the research on IT usage. The IT usage literature has called for a richer conceptualizion of IT usage behavior beyond lean measures such as frequency of use and amount of time spent on the system (Burton-Jones & Straub, 2006). In modeling richer measures of use, researchers often combine task and technology concepts. Our scale to measure the decomposed constructs of task adaptation and technology adaptation could be used to extend this area of research.

An even deeper insight may be had by broadening our conceptualization of exploratory technology adaptation to the general concept of technology innovation and diffusion. While the present study measures exploratory invention accomplished by the user, the impact technology invention has on the workplace structures and adaptation of tasks maintains its face validity even when the invention comes from other actors. The implication is that all technology innovations will only have an impact on performance outcomes when users and organizations engage in task adaptation. The relationship between technology events, and task-adaptation suggested by this study provides a fundamental insight into how Task-Technology Fit and Innovation Diffusion lead to performance outcomes.

Finally, we have provided a validated instrument for measuring technology and task adaptation. This instrument captures the dynamic relationship between user and IT artifact in a manner not currently available in extant usage scales. This instrument can be adapted for further research in the areas noted above, as well as other IS research modeling usage and adaptive behavior.

Limitations and Future Research

For individual adaptation practices, the individual technology user is a convenient subject. However, the current study is vulnerable to common method bias which may exist when the same individual provides the data for both the independent and dependent variables. The survey respondents in this study have provided data regarding adaptation practices as well as perceived performance.

One way to enhance the current study would be to segment the sample into adapters and non-adapters. The non-adapters would represent users who have not influenced the task-technology fit while the adapters have actively participated in enhancing the task-technology fit via personal modifications of the technology and/or the work task. This would allow an investigation into the similarities and differences brought about by a user having the ability to enhance the task-technology fit. In the current study, the sample of non-adapters was too small to analyze independently thus we leave this for future research.

Future research should consider further explication of task adaptations and disaggregate the factors related to the individual and those related to the task. This study viewed adaptations of an individual (for example training and skill development) as intertwined with and implicitly reflected by task adaptation behaviors. At face value this is appropriate as a task will not perform itself without a person, and without a task the individual does not generate outputs. Notwithstanding this simplification, there may be additional aspects of the technology-task adaptation model that can be revealed by a successful disaggregation of the task-adaptation construct.

As this study focuses on adaptations within the context of one particular technology, caution must be used when generalizing the results. We expect adaptations to occur across multiple technologies and contexts, and thus expect that our measurement scale and model would also generalize, although it could be that other contexts and technologies may not experience the same adaptations. Additionally, this research used graduate student subjects which may not be generalizable to other populations. Thus, future research should consider replicating these results in different settings and populations using different technology.

Conclusion

Upon investigating the expected contribution of technology to organizational productivity, it is important that technology be studied in the context of task adaptation. Information technology can only impact performance through its appropriation to work tasks. The TTF theory says that positive performance impacts will result when there is a proper fit between the technology and the task (Goodhue, 1995). FAM extends the TTF theory by showing that the relationship between fit and performance is moderated by the way users appropriate the technology (Dennis et al, 2001). As users become aware of misalignment between technology and task, they respond with adaptation behaviors such as the modification of task, technology and self. This study provides strong theoretical support for decomposing adaptation behaviors into two distinct components of task adaptation and technology adaptation with technology adaptation being a second-order construct composed of the two sub-dimensions of exploitive technology adaptation and exploratory technology adaption. The study further found that the impact of technology adaptation on perceived performance is mediated by task adaptation.

References

Al-Natour, S., Benbasat,I., 2009, "The Adoption and Use of IT Artifacts: A new Interaction-Centric Model for the Study of User-Artifact Relationships", *Journal of the AIS* (10:9), p661-685

Ahmadi,N., Repenning,A., Ioannidou,A., 2008, "Collaborative End-User Development on Handheld devices", *2008 IEEE Symposium on Visual Languages and Human Centric Computing*, IEEE Press

Ahuja,M.K., Thatcher, J.B., 2005, "Moving Beyond Intentions and toward the Theory of Trying: Effects of Work Environment and Gender on Post-Adoption Information Technology Use", *MIS Quarterly* (29:3), p427-459

Alter, S., 2006, *The Work System Method: Connecting People, Processes, and IT for Business Results*, Larkspur, CA: Work System Press

Barki, H., Titah, R., Boffo, C., 2007, "Information System Use-Related Activity: An Expanded Behavioral Conceptualization of Individual-Level Information System Use", *Information Systems Research* (18:2), pp 173-192

Baron,R.M. and Kenny,D.A., 1986, "The Moderator-Mediator Variable Distinction in Social Psychological Research: Conceptual, Strategic, and Statistical Considerations", *Journal of Personality and Social Psychology* (51:6), p1173-1182

Barley, S.R., 1986, "Technology as an Occasion for Structuring: Evidence from Observations of CT Scanners and Social Order of Radiology Departments", *Administrative Science Quarterly*(31), p78-108

Beaudry, A., Pinsonneault, A., 2005, "Understanding User Responses to Information Technology: A Coping Model of User Adaptation", *MIS Quarterly* (29:3), pp 493-524

Beimborn,D., Franke, J,, Wagner, H-T., Weitzel, T., 2007, "The Impact of Operational Alignment of IT Flexibility—Empirical evidence from survey in the German Banking Industry", *AMCIS 2007 Proceedings*

Bhattacherjee, A., Harris, M., 2009, "Individual Adaptation of Information Technology", *Journal of Computer Information Systems* (Fall 2007), p37-45

Boudreau, M-C., Robey, D., 2005, "Enacting Integrated Information Technology: A Human Agency Perspective" *Organization Science* (16:1), p3-18

Boulus, N., 2009, "Sociotechnical Changes Brought about by Electronic Media Record", *AMCIS 2009 Proceedings*

Bresnahan, T.F., and Trajtenberg, M., 1995, "General purpose technologies 'Engines of growth'?", *Journal of Economietrics*(65), p83-108

Burton-Jones, A., Straub,D.W., 2006, "Reconceptualizing System Usage: An Approach and Empirical Test", *Information Systems Research* (17:3), pp 228-246

Bygstad,B., 2005, "Managing the Dynamics of Mutual Adaptation of Technology and Organization in Information Systems Development Projects", *Software Process Improvement and Practice* (10), p341-353

Carlaw, K.I., and Oxley, L., 2008, "Resolving the productivity paradox", *Mathematics and Computers in Simulation*(78), p313-318

Chin, W.W., 1998, "Issues and Opinion on Structural Equation Modeling", *MIS Quarterly* (22:1), pp. vii-xvi

Choi, H., Im, K.S., Lee, M., Kim, J., 2007, "Contribution to Quality of Life: A New Outcome Variable for Mobile Data Service", *Journal of the Association for Information Systems* (8:12), pp 598-618.

Cole, E., McCain, K.W., 1985, "Adoption and Adaptation in the use of Transaction Processing Systems: The case of OCLC Software", *Information Procerssing and Management* (21:1), p27-34

Davidson, E.J., Chismar, W.G., 2007, "The interaction of institutionally triggered and technology-triggered social structure change: An investigation of computerized physician order entry", *MIS Quarterly* (31:4), pp. 739-758

Davis, C.J., Hufnagel, E.M., 2007, "Through the eyes of experts: A socio-cognitive perspective on the automation of fingerprint work", *MIS Quarterly (*31:4), pp. 681-703

Davis, F.D., 1989, "Perceived Usefulness, Perceived Ease of Use, and User Acceptance of Information Technology", *MIS Quarterly (*13:3), pp. 319-339

Dennis, A.R., Wizom, B.H., Vandeberg, R.J., 2001, "Understanding Fit and Appropriation effects in Group Support Systems via Meta-Analysis", *MIS Quarterly* (25:2), p167-193

Desouza, K.C., Awazu, Y., Ramaprasad, A., 2007, "Modifications and innovations to technology artifacts", *Technovation* (27), p204-220

DeSanctis, G., Poole, M.S., 1994, "Capturing the Complexity in Advanced Technology Use: Adaptive Structuration Theory", *Organization Science (*5:2), pp 121-147

Dishaw, M.T., Strong, D.M., 1998a, "Assessing Software Maintenance Tool Utilization using Task-Technology Fit and Fitness-for-use Models", *Software Maintenance: Research and Practice* (10), p151-179

Dishaw, M.T., Strong D.M., 1998b, "Supporting software maintenance with software engineering tools: A Computed task-technology fit analysis", *Journal of Systems and Software* (44), p107-120

Duncan, N.B., 1995, "Capturing Flexibility of Information Technology Infrastructure: A Study of Resource Characteristics and their Measure", *Journal of Management Information Systems* (12:2), p37-57

Evans, J.S., 1991, "STRATEGIC FLEXIBILITY FOR HIGH TECHNOLOGY MANOEUVRES: A CONCEPTUAL FRAMEWORK", *Journal of Management Studies* (28:1), p69-89

Fuller, R.M., Dennis, A.R., 2009, "Does Fit Matter? The Impact of Task-Technology Fit and Appropriation on Team Performance in Repeated Tasks", *Information Systems Research* (20:1), pp 2-17

Gebauer, J. 2008, "User requirements of mobile technology: A summary of research results", *Information Knowledge Systems Management* (7), p101-109

Gebauer,J., and Ginsburg,M., 2009, "Exploring the Black Box of Task-Technology Fit", *Communications of the ACM* (52:1), p130-135

Gefen, D., Straub, D., 2005, "A Practical Guide to Factorial Validity Using PLS-Graph: Tutorial and Annotated Example", *Communications of the Association for Information Systems* (16), pp 92-109

Giddens, A., 1976, *New Rules of Sociological Method*, New York: Basic Books.

Giddens, A., 1979, *Central Problems in Social Theory: Action, Structure and Contradiction in Social Analsis,* Berkley, CA: University of California Press

Giddens, A., 1984, *The Constitution of Society; Outline of the Theory of Structure,* Berkley, CA: Unveristy of California Press

Goodhue, D.L., Thompson, R.L., 1995, "Task-Technology Fit and Individual Performance", *MIS Quarterly* (June 1995), p213-236

Goodhue, D.L., 1995, "Understanding User Evaluations of Information Systems", *Management Science* (41:2), p1827-1844

Goodhue, D.L., Littlefield, R., Straub, D.W., 1997, "The Measurement of the Impacts of the IIC on the End-Users: The Survey", *Journal of the American Society for Information Science* (48:5), p454-465

Hair, J.F., Anderson, R.E., Tathan, R.L., Black, W.C., (1998), *Multivariate Data Analysis with Readings, 5thEdition.* Englewood Cliffs, NJ: Prentice Hall.

Jarvenpaa,S.L., 1989, "The effect of Task Demands and Graphical Format on Information Processing Strategies", *Management Science* (35:3), p285-303

Karahanna, E., Agarwal,R., Angst, C.M., 2006, "Reconceptualizing Compatibility Beliefs in Technology Acceptance Research", *MIS Quarterly* (30:4), pp 781-804

Kirton, M., 1976, "Adaptors and Innovators: A Description and Measure", *Journal of Applied Psychology* (61:5), p622+

Lee,S., Shin,B., and Lee, H.G., 2008, "What Makes Usage of Mobile Data Service Increase or Decrease: Perspective of Two-Factor Theory", *PACIS 2008 Proceedings,*

Leonard-Barton, D. 1988, "Implementation as mutual adaptation of technology and organization", *Research Policy* (17), p251-267

Lin,W.T., Chuang,C-H, Choi, J.H., 2010, "A partial adjustment approach to evaluating and measuring the business value of information technology." *Intl. J. of Production Economics* (127), p158-172

Majchrzak, A., Rice, R.E., Malhotra, A., King, N., Ba, S., 2000, "Technology Adaptation: The Case of a Computer-Supported Inter-Organizational Virtual Team", *MIS Quarterly (24:4), pp 569-600*

Malone, T.W., Rockart,J.F., 1991, "Computers, Networks, and the Corporation", *Scientific American* (265:3), pp. 128-136.

Moore,G.C., Benbasat,I., 1991, "Development of an Instrument to Measure the Perceptions of Adopting an Information Technology Innovation," *Information Systems Research* (2:3), pp. 192-222.

Orlikowski, W.J., 1992, "The Duality of Technology: Rethinking the Concept of Technology in Organizations", *Organization Science*, (3:3) p398+

Orlikowski W.J., 1996, "Improvising Organizational Transformation Over Time: A Situated Change Perspective", *Information Systems Research (*7:1), 1996, pp 63-92

Rice, R.E., Rogers, E.M., 1980, "Reinvention in the Innovation Process", *Knowledge: Creation, Diffusion, Utilization, (1:4), p499-514*

Ringle, C.M., Wende, S., Will, A., 2005. SmartPLS 2.0 [software]. Retrieved from University of Hamburg: http://www.Smartpls.de

Saga, V.L., and Zmud, R.W., 1994, "The Nature and Determinants of IT Acceptance, Routinization, and Infusion," in *Diffusion, Transfer and Implementation of Information Technology,* L. Levine (Ed.), Software Engineering Institute, Carnegie Mellon University, Pittsburgh, PA, pp. 67-86.

Skinner, W., 1986, “The productivity paradox”, *Harvard Business Review* (64:4), p55-59

Staples, D.S., Seddon, P., 2004, “Testing the Technology-to-Performance Chain Model”, *Journal of Organizational and End User Computing* (16:4), p17-36

Strong, D.M., Dishaw, M.T., Bandy, D.B., 2006, “Extending Task Technology Fit with Computer Self-Efficacy”, *DATABASE for Advances in Information Systems* (37:2and3), p96-107

Thatcher, J.B., Perrewe, P.L., 2002, “An Emperical Examination of Individual Traits as Antecedents to Computer Anxiety and Computer Self-Efficacy”, *MIS Quarterly* (26:4), p381-396

Thomsa, D.M., Bostrom, R.P., 2010, “Vital Signs for Virtual Teams: An Empirically developed trigger model for technology adaptation interventions”, *MIS Quarterly* (34:1) p115-142

Todd,P. and Benbasat, I., 1999, “Evaluating the Impact of DSS, Cognitive Effort, and Incentives on Strategy Selection”, *Information Systems Research* (10:4), p356-374

Tyre, M.J., Orlikowski, W.J., 1994, “Windows of Opportunity: Temporal Patterns of Technological Adaptation in Organizations”, *Organization Science* (5:1), p98+

Venkatraman, N. 1989, “The Concept of Fit in Strategy Research: Toward Verbal and Statistical Correspondence”, *Accademy of Management Review* (14:3), p423-444

Vick, C.R., 1984, “Introduction: A Software Engineering Environment”, *Handbook of Software Engineering* (ed. C.R.Vick and C.V.Ramamoorthy), Van Nostrand Reinhold Company, NY, p xi-xxxii

Ward, J., E. Daniel, and J. Peppard, 2008, “Building better business cases for IT investments”, *MIS Quarterly Executive (7:1), pp. 1-15*

Wongpinunwatana, N., 2000, “An experimental investigation of the effects of artificial intelligence systems on the training of novice auditors”, *Managerial Auditing Journal*, (15:6), p306-318

Yuan, Y., Archer, N., Connelly, C.E., Zheng, W., 2010, “Identifying the Ideal Fit Between Mobile Work and Mobile Work Support”, *Information and Management* (47), pp. 125-137

Zigurs,I. and Buckland,B.K., 1998, “A Theory of Task/Technology Fit and Group Support Systems Effectiveness”, *MIS Quarterly* (22:3), (p313-334)