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U-Commerce: An Experimental Investigation of Ubiquity and Uniqueness

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U-COMMERCE: AN EXPERIMENTAL INVESTIGATION OF UBIQUITY AND UNIQUENESS

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Abstract

U-commerce extends traditional commerce (geographic, electronic, and mobile) to a world of ubiquitous networks and universal devices, a world in which users can access networks at any time from any place, using a range of devices to invoke unique and personalized services. As such, u-commerce presents a new perspective on time and space. Specifically, four constructs are discussed that form the fundamental dimensions of u-commerce: ubiquity, uniqueness, universality, and unison. This report presents an experimental investigation to examine how two of these u-constructs, namely ubiquity and uniqueness, impact individual task performance, perceptions of usefulness and ease of use across differing levels of u-commerce technology and a variety of tasks. A total of 117 senior level MIS students served as subjects using the latest currently available form of u-technology: wireless personal digital assistants (PDA).

Keywords: U-commerce, m-commerce, e-commerce, ubiquity, uniqueness, TTF, TAM

Introduction

Some authors introduce m-commerce as the "second wave" in the business revolution, continuing the impact of the Internet (or e-commerce) the "first wave," and the introducer of the digital economy era (Currie 2000). Before that, we experienced something that we would like to call g-commerce (or geographic commerce) where people had to physically come together in order to do business (see Figure 1). The other end of the evolutionary spectrum, however, is formed by u-commerce—a state of commerce that we have not yet reached and that goes over, above, and beyond traditional commerce and should, therefore, be called "ultimate commerce." Accordingly, u-commerce is defined as "the use of ubiquitous networks to support personalized and uninterrupted communications and transactions between a firm and its various stakeholders to provide a level of value over, above, and beyond traditional commerce" (Watson et al. 2002).

A glimpse of the potential of u-commerce can be seen today. For instance, in Texas, people are able to pay for gas at the pump with their mobile phones. Soon, they will also be able to pay for parking, fast food, etc. (Bresien 2003). IBM has launched smart laundry machines at colleges. Students can visit a Web site to find out when a machine will be available and can select functions, including soap and fabric softener dispensing. When the load is done, they are notified via an e-mail sent to a mobile device or PC (Wrolstad 2003a). MommyTrack is a baby monitor that allows remote viewing from a PDA (personal digital assistant) device running Microsoft's PocketPC Phone Edition (Wrolstad 2003b). Samsung Electronics introduced their first GPRS[1] wristwatch phone at the CeBIT 2003. The GPRS watch phone offers one and a half hours of continuous talk time and 80 hours of stand-by time at the flick of a wrist (Samsung 2003). Prior to this, Samsung had already issued the smallest cell phone TV in 2000—for which Samsung is listed in the Guinness Book of World Records (Samsung 2000).

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[1]General packet radio switched; for more information, see Junglas and Lehner (2001).

Figure 1. X-Commerce with x = g, e, m, u

The phenomenon of u-commerce is not new. The idea has been prevalent since the first time people started thinking about conducting innovative forms of commerce other than g-commerce. As such, u-commerce can be viewed as the conceptual extension of g-, e- and m-commerce. However, its purpose is not to serve as a substitute for any one of them; rather different forms of commerce will coexist. U-commerce simply represents the final (and still emerging) destination of commerce—initiated by e- and propagated by m-commerce. Its purpose is to lay the groundwork for structuring future information systems and providing a discussion forum for trends in the field of IS.

Being among the first to take the challenge to explore this terra incognita, this study tries to answer the most fundamental issues. What are the constructs that emerge in u-commerce? How do these constructs fit into our traditional understanding of information systems? Under what task conditions does u-commerce technology impact perceptions of usefulness, ease of use, and performance?

The study further develops a set of four constructs, so-called *ultimate constructs*, or simply *u-constructs* (Watson 2000). These u-constructs include *ubiquity*, *uniqueness*, *universality*, and *unison*. An experimental set-up is chosen that examines how two of the four u-constructs (i.e., ubiquity and uniqueness) impact users' task performance as well as users' perceptions of ease of use and usefulness across differing levels of u-commerce technology and a variety of tasks. Four different treatment groups are created, each varying on combinations of high or low technology ubiquity and high or low technology uniqueness. A total of 117 senior level MIS students served as subjects for this study.

Theoretical Background

The theoretical background is divided into three parts. First, the theoretical building blocks of u-commerce (u-constructs) are presented by drawing on existing e- and m-commerce characteristics. Second, the same conceptual idea of the u-constructs is applied to specifications of tasks. Finally, both conceptionalizations are merged into a technology impact model (TIM) that draws on the technology acceptance model (TAM) and the task-technology fit model (TTF).

The U-Constructs

In order to describe the building blocks of u-commerce (or so-called u-constructs), we take a step back and examine the transition that took place between e- and m-commerce. Compared to e-commerce, m-commerce reveals five characteristics that make it distinct: (1) portability,[2] (2) reachability (Skiba et al. 2000), (3) accessibility (Buckler and Buxel 2000; Müller-Verse 1999), (4) localization (Buckler and Buxel 2000; Müller-Verse 1999; Skiba et al. 2000), and (5) identification.[3] Based on the differences described in the following, we will be able to infer more general constructs that form two of the four building blocks in u-commerce.

Portability

Portability comprises the physical aspects of mobile devices—one is able to readily carry them. We deliberately use the term *mobile device* to cover the aspect that extends beyond cellular phones which form only one end of the spectrum, providing a small, lightweight device for voice (and data) communication. The other end is formed by laptops equipped with a wireless communication facility, providing multipurpose capabilities at the cost of a bigger device. Along that spectrum, smart phones,

[2]Skiba et al. (1000) refer to this as *form factors*.

[3]Müller-Verse (1999) refers to this as *security*.

communicators, and personal digital assistants (PDA) line up accordingly. The list is just a momentary snap-shot of the current products available. One can expect the range and the form of mobile devices to proliferate. Nevertheless, all mobile devices have and will have in common the striving for miniaturization while maximizing their capabilities.

Among the five characteristics, portability has a unique standing. In fact, it enables the other four constructs to be unique and distinct from the traditional e-commerce setting, i.e., reachability, accessibility, localization, and identity are inherent characteristics of the mobile world if—and only if—they occur in the context of portability. As such, portability is an inherent part of the other four characteristics by causing a quantum shift within them.

Reachability

Reachability covers the idea that a person can be in touch and reached by other people 24 hours a day, 7 days a week—assuming that the mobile network coverage is sufficient and the mobile device is switched on. Nevertheless, users have the possibility to restrict their reachability to particular persons or times. With the current transmission technologies (i.e., GSM, global system mobile), mobile devices require a user to actively initiate a session and invoke an application—just like an Internet session. With future mobile technologies, however, users will stay connected permanently—without explicitly establishing a connection.[4]

In an e-commerce setting, reachability is limited to the computer level, or rather the plug-in level. An Internet user is reachable only (in synchronous terms) when sitting in front of a computer that is plugged into an Internet socket.

Accessibility

As opposed to reachability, accessibility describes the fact that a user can access the mobile network at any time from any location—again, assuming adequate mobile network coverage. With current transmission technologies, a user has to proactively initiate a session. Future mobile technologies, however, will allow users to stay connected permanently. In contrast, in an e-commerce setting, accessibility (just like reachability) is limited to the plug-in level. A user can access the Internet only when sitting in front of a hardwired computer.

Localization

Localization describes the ability to locate the position of a mobile user. As such, localization is key to providing geographically specific value-added services (so-called location-based services) and is expected to be the most distinct characteristic of m-commerce compared to e-commerce. Location-based services are defined as any kind of services that take into account the geographic position of an individual. These services may include geographic information about the individual (e.g., for navigational purposes) or location information about others (e.g., for finder services that let mobile users locate friends or family, businesses, or landmarks). Currently, mobile networks are able to determine the physical position of a mobile user at the cell level. From a technological point of view, this is to ensure a reliable connection when a mobile user roams across cell boundaries. Future technology, however, will make it possible to determine the exact geographical latitude and longitude of a mobile user.[5] In the Internet context, the geographical position of a user cannot be determined at any point during the session. The only possibility is to identify a computer's physical IP (Internet Protocol) address and, based on that, its physical location. However, even this approach is not always applicable since most computers use a dynamic addressing scheme.

Identification

Second-generation mobile devices employ a smart card as a secure device for the authentication of the subscription and the mobile user. The smart card, also called a SIM (subscriber identity module) card, contains subscription and security related data as well

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[4]Müller-Verse (1999) calls this *instant connectivity* and states that it is an m-commerce characteristic on its own.

[5]A more detailed description of the underlying technologies can be found in Junglas and Lehner (2001).

as user data, and is plugged into the mobile device.[6] By doing so, it decouples the identity of a mobile user from his device, thus allowing a user to switch physical devices without changing identities. The SIM card can be viewed as a virtual substitute of an individual's identity, containing not only personal information, but also billing information.[7] In contrast, in the Internet context, the identity of a user is always bound to the computer—specifically, to its IP (Internet Protocol) address. However, dynamic IP addressing schemes may impair or even thwart this approach.

With the help of the aforementioned distinguishing characteristics of e-commerce and m-commerce, we are now able to create two higher-level constructs that form two out of the four building blocks in u-commerce: ubiquity and uniqueness. *Ubiquity* builds upon the two complementary ideas of accessibility and reachability. Assuming device portability and sufficient network coverage, ubiquity allows a user to access the network as a well as be reached via the network 24 hours a day, 7 days a week. In addition, a user can do so from any place—thus, abstracting from any space dimension. *Uniqueness* builds upon the ideas of identification and localization. Combining the ability to identify a person with the aspect of localization, the ability to geographically localize a user, provides the foundation for unequivocal profiles, i.e., one-to-one marketing will in fact become possible.

Currently, we are experiencing a world that is typically characterized by decent network coverage, where one has to search for an Internet connected computer to read e-mails and in which one has profiles stored that are inconsistent across multiple platforms. What we are heading toward is a world that provides ultimate ubiquity and uniqueness. However, there are factors that will inhibit this transition. A further examination of the inhibiting factors leads to the formation of the two remaining u-constructs: universality and unison (Junglas 2003). Since this is not the focus of this paper, we only provide brief definitions of these constructs.

Universality aggregates the aspect of network and devices into one logical construct. It recognizes that current combinations of mobile devices and networks are limited because they are not universally interchangeable. For instance, U.S. cell phones are unlikely to work in Europe because of different standards and network frequencies, and vice versa. *Unison* aggregates the aspects of application and data into one construct. It covers the idea of integrated data across multiple applications so that users have a consistent view on the their information—irrespective of the infrastructure and device used.

All four u-constructs were supported by interviews conducted with IS practitioners (Junglas 2003). Each of them spans a dimension along which information systems are able to advance. Some technologies provide high levels of one characteristic and low levels of others. The ultimate vision is to create an information system that is strong on all four dimensions. Current information systems, in contrast, can often be viewed as one particular instantiation of the four dimensions.

A New Task Classification Scheme

As seen in the last section, a very technical approach was taken to infer the four u-constructs. The conceptual understanding provided can also be used to characterize tasks. This makes sense since task and technology form an interactive cycle and perpetuate one another (Goodhue *et al.* 2001). For instance, an information system that is able to provide the ultimate form of any u-construct does indeed change the nature of tasks. It not only allows for tasks that used to be difficult to implement, but it also creates opportunities for tasks that were once non-existent, such as gathering information about a historical monument while driving past it, or doing on-line trading from any location on the globe. Alternately for instance, if ubiquitous[8] performance of tasks is in demand, technology is required to provide the means to support these tasks. As such, it is understandable that traditional classification schemes do not incorporate task characteristics that emerge with the origin of u-commerce.[9]

The classification scheme builds upon the ideas of ubiquity and uniqueness described earlier. Based on these, we are able to infer three task characteristics: (1) time-dependency, (2) location-dependency, and (3) identity-dependency (Junglas 2003).

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[6]A more detailed description of the underlying technologies can be found in Junglas and Lehner (2001).

[7]Network operators and providers have to authenticate a user and test financial status before the user can become a mobile subscriber. As a result, the personal information provided is close to 100 percent accurate.

[8]Please note that u-adjectives follow the definition given for the u-nouns.

[9]A summary of traditional task classification schemes can be found in Zigurs and Buckland (1998).

Time-dependent tasks are those that should be fulfilled as soon as possible. Depending on whether the task is initiated by the task doer or triggered by an external actor, the taxonomy distinguishes between intrinsic and extrinsic time-dependent tasks. Location-dependent tasks are those that require location information either about the user (intrinsic) or about somebody else (extrinsic). Finally, identity-dependent tasks are those that require a unique identification of a user, including preferences. Identity information can either be provided about the user (intrinsic, e.g., billing information) or about others (extrinsic, e.g., preferences for a one-to-one marketing).

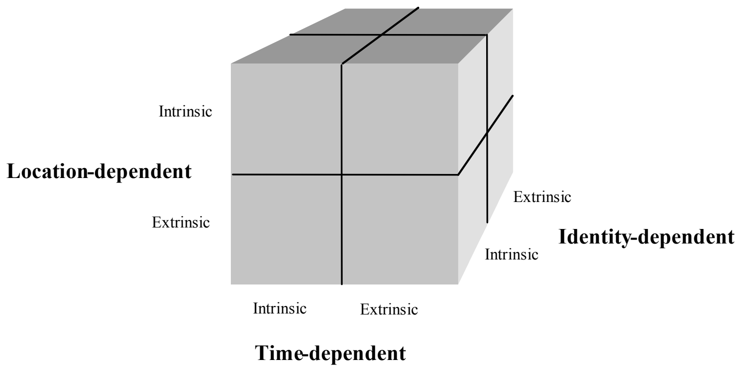

Figure 2. The U-Commerce Task Cube

Up to this point, we have introduced four u-constructs whose idea was derived from a rather technical background of e- and m-commerce and whose idea was also applied to tasks. In the following, we will introduce the third stream of research that reviews traditional IS utilization and performance models. The final step will be to collapse all streams into the conceptual model.

Conceptual Model

In order to address the research questions, we developed a model that extends traditional IS models—in particular the technology acceptance model (TAM) and task-technology fit model (TTF) (Davis 1986, 1989; Davis et al. 1989; Dishaw and Strong 1999; Goodhue 1998; Goodhue et al. 2001; Goodhue and Thompson 1995; Venkatesh 2000; Venkatesh and Davis 2000)—by incorporating the newly defined u-constructs.

TAM and TTF use different lenses to explain information system utilization (Dishaw and Strong 1999). TAM explains utilization through beliefs and perceptions a user has toward an information system, neglecting the fact that people use an information system even though they do not like it. TTF, on the other hand, explains utilization through expected performance increase, neglecting which kind of beliefs or perceptions a user has toward the information system.

In a combined model, called the technology impact model (TIM), we posit that the fit construct of the TTF model affects both perceptual measures of the TAM model (see Figure 3). User's perceptions about the usefulness and ease of use of an information system are likely to be derived from evaluating the fit between technology characteristics and the tasks for which it can be used. As such, TAM substitutes for the constructs of *precursors of utilization* and *utilization* in the original TTF model.

As can also be seen in Figure 3, the u-constructs can be integrated into TIM in a twofold manner. First, the u-constructs enhance our understanding of technology characteristics by providing four dimensions along which information technology is able to advance. Second, the u-constructs, in a derived manner, inform our understanding of task characteristics.

Both task and technology interact, resulting in differing levels of fit (Goodhue and Thompson 1995). Unfortunately, there has been limited progress in defining precisely what fit is and how to measure it (Goodhue et al. 2001). For the purpose of this study, we distinguish between three different stages: ideal fit, over-fit, and under-fit. Ideal fit reflects the ideal mapping of task requirements and technological functionality, over- and under-fit, respectively, describe a digression from the ideal mapping. In the case of over-fitting, the technology provides more functionality than required for the task. In the case of under-fitting, a technology does not provide sufficient functionality to perform that task efficiently. All conceivable combinations between task and technology are summarized in Table 1.

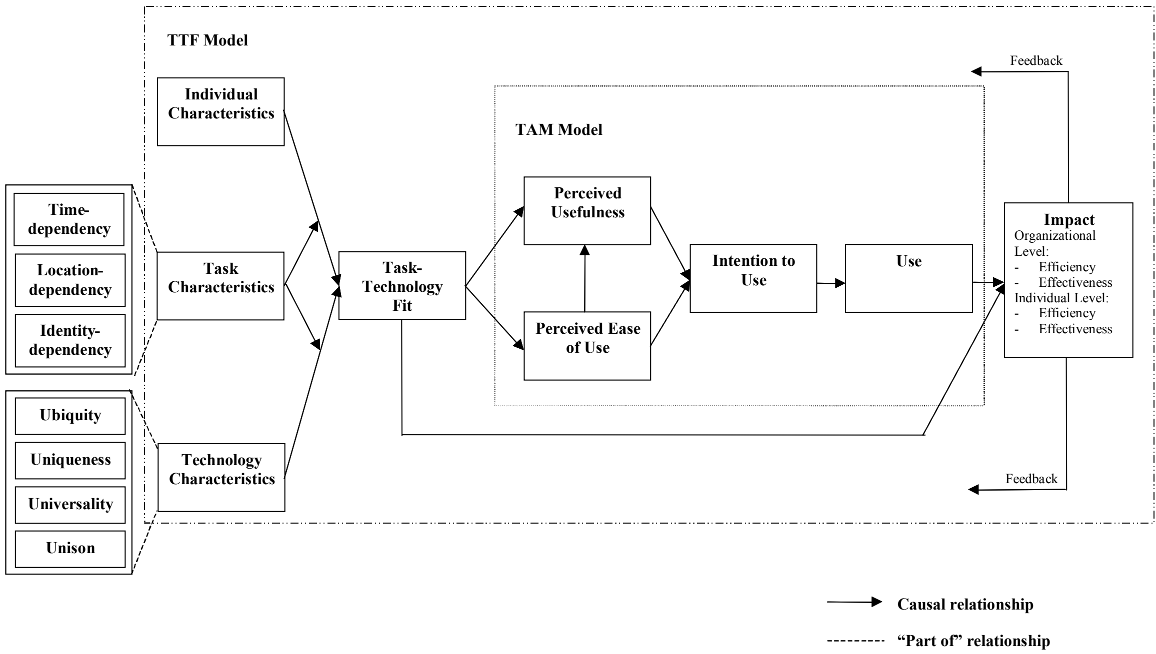

Figure 3. Technology Impact Model (TIM)

Table 1. Conceptual Task/Technology Combinations and Their Fit

Technology Task Set	Ub-H/Un-H	Ub-H/Un-L	Ub-L/Un-H	Ub-L/Un-L
Ti-H/Lo-H	Ideal fit	Under-fit	Under-fit	Under-fit
Ti-H/Lo-L	Over-fit	Ideal fit	Under-fit	Under-fit
Ti-L/Lo-H	Over-fit	Under-fit[a]	Ideal fit	Under-fit
Ti-L/Lo-L	Over-fit	Over-fit	Over-fit	Ideal fit

[a]The matrix is not symmetric. A combination of Ti-L/Lo-H task with a technology that provides Ub-H/Un-L results in an under-fit.

Legend:
Ub Ubiquity
Un Uniqueness
Ti Time-dependency
Lo Location-dependency
L Low
H High

Research Method

The conceptual model is reduced to the research model shown in Figure 4. The four reduced aspects include (1) focusing on time- and location-dependent tasks, (2) focusing on technology ubiquity and uniqueness, (3) focusing on individual performance, and (4) mandating usage. Based on interviews conducted with practitioners in the field, technology ubiquity and uniqueness, and time- and location-dependent tasks appeared to be the most prevalent features. The interviews were unstructured in nature and were aimed at capturing the domain of experiences individuals had with their mobile devices (cellular phones and PDAs). For a more detailed analysis, see Junglas (2003).

Hypotheses

Based on the previous considerations, we state the following hypotheses about ideal, over-fit, and under-fit:

PERF1: An ideal fit between task and technology will lead to higher individual performance than over- or under-fit.

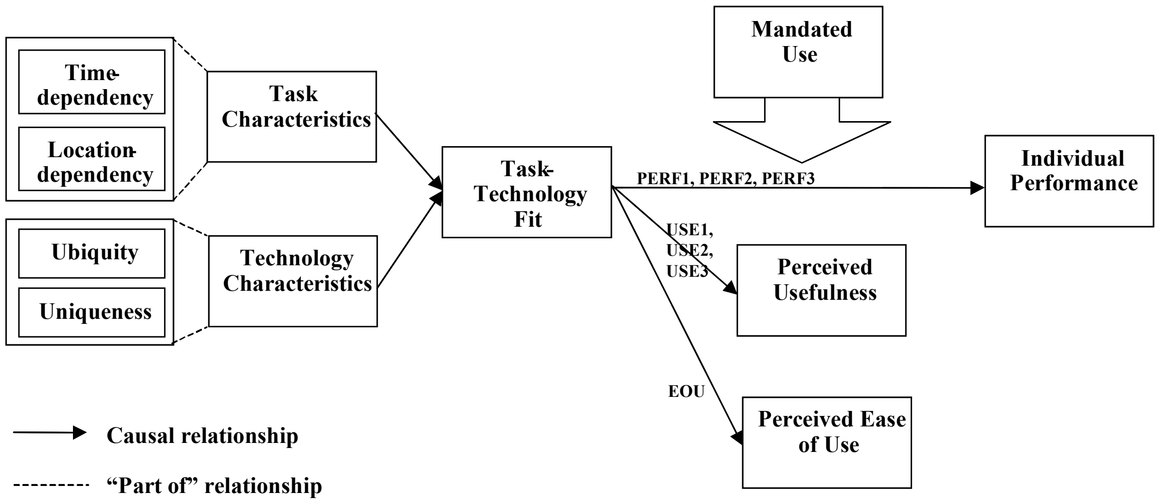

Figure 4. The Research Model

PERF2: An over-fit between task and technology will lead to higher individual performance than under-fit.
PERF3: An under-fit between task and technology will lead to lower individual performance than ideal or over-fit.
USE1: An ideal fit between task and technology will lead to higher perceptions of usefulness than over-fit or under-fit.
USE2: An over-fit between task and technology will lead to higher perceptions of usefulness than under-fit.
USE3: An under-fit between task and technology will lead to lower perceptions of usefulness than ideal or over-fit.
EOU: Perceptions of ease of use will stay the same across different levels of fit.

Based on the research model and the fact that u-commerce is a phenomenon that does not exist yet, a laboratory experiment was chosen in which task and technology form the two dimensions along which different treatments were varied.

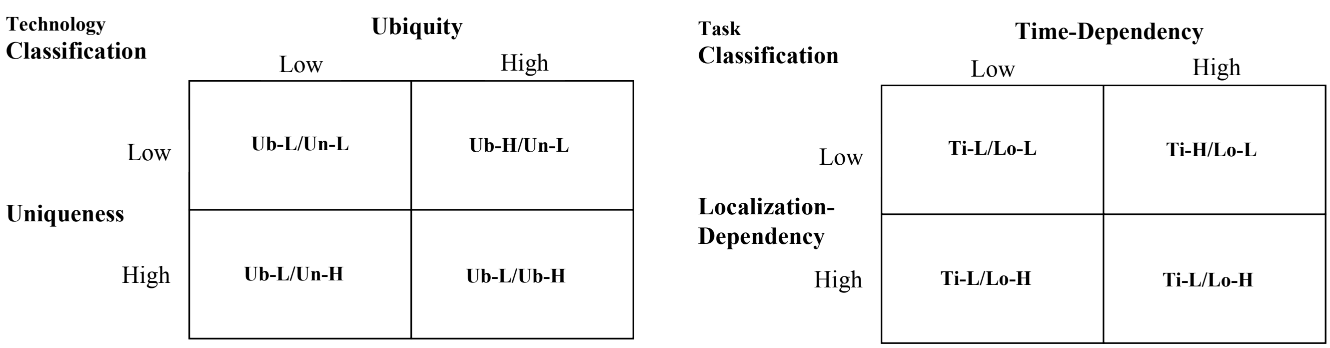

Figure 5. Technology and Task Classifications

The technology dimension distinguishes two components: ubiquity and uniqueness, each of which has a high or low level. A combination of high ubiquity and high uniqueness is simulated by a PDA with a wireless card in a local area wireless network environment, providing location-based services; accordingly, a combination of low ubiquity and low uniqueness is imitated by not providing any of those features. Wireless PDAs were chosen because they represent the latest form of technology available that can serve in a u-commerce environment.

The task dimension also distinguishes between two components: time- and location-dependent tasks, each of which can have a low or high level. Every subject is given two scenarios, which include four tasks each. Every scenario is designed in such a way that each task maps the four possible technology combinations in an ideal manner. That is, each of the four tasks of every scenario is characterized by a combination of high or low time-dependency and high or low location-dependency, mapping high or low technology ubiquity and high or low technology uniqueness. Tasks that require high time-dependency and high location-dependency are those that demand ultimate accessibility and reachability as well as location-based information, whereas tasks of low time- and location-dependency require neither. Table 2 provides a brief overview of the tasks sets (T1-T4) employed for the experiment.

Table 2. Task Descriptions

Task Set		**Brief Task Description**
T1	Ti-H/Lo-H	Find a nominated person as soon as possible Find the closest office that is currently open as soon as possible
T2	Ti-H/Lo-L	Write an e-mail as soon as possible Book a flight as soon as possible
T3	Ti-L/Lo-H	Find the closest office that is currently open Find a nominated person
T4	Ti-L/Lo-L	Get stock quotes Get weather information

Legend:
Ub Ubiquity
Un Uniqueness
Ti Time-dependency
Lo Location-dependency
L Low
H High

Combining task variation with technology occurrence results in 16 different treatment groups (see Table 1). The dependent variables are (1) individual performance, (2) perceived ease of use, and (3) perceived usefulness. Individual performance is measured by three measures: time-to-completion (TTC), time-to-start (TTS), and answer correctness (AC) (on a five-point scale). In addition to the time measures, location measures are recorded as well (see Figure 6).

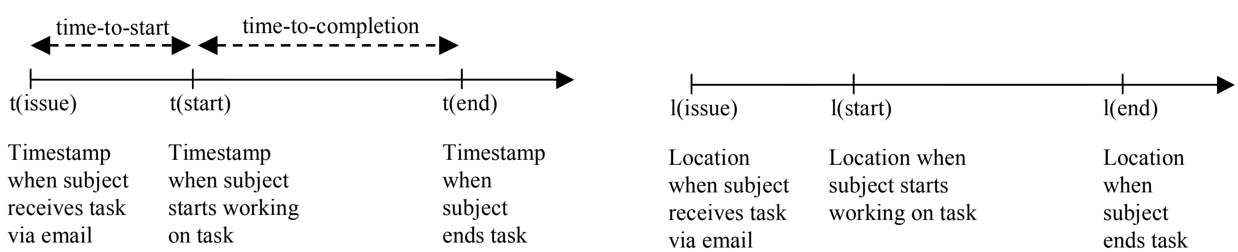

Figure 6. Time and Location Measures

The perceptual constructs make use of instruments on perceived ease of use and usefulness and use a seven-point Likert scale (Davis 1986; Davis et al. 1989). Both measures are modified in order to make them applicable to the technology used; they are administered before and after each task fulfillment. In order to avoid grouping and learning effects, task order, treatment group assignment, and the time between issuing tasks is randomized. Figure 7 shows an exemplary procedural set-up that takes approximately three hours to complete and includes a training session of 30 minutes.

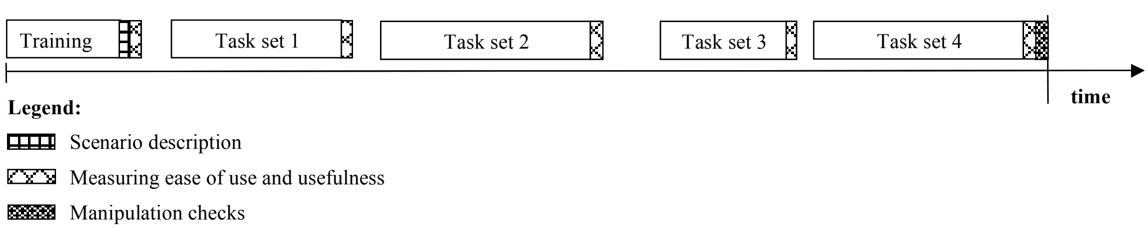

Figure 7. Experimental Procedure

Data Analysis

A total of 117 MIS students from a southeastern university participated in the experiment of which 41.9 percent were female and 58.1 percent male. Students received course credit for participation. The majority of students (88.3 percent) were between 19 and 23 years old; 83.7 percent were seniors in MIS. None of the students stated that they had no experience with the Internet, computers, or cellular phones. The majority of students (88 percent) had either moderate or intensive experience with at least one of the three. Manipulation checks show that the different treatment groups were perceived as intended.

For each task set (T1-T4), the average of all usefulness and ease of use items is calculated. Since both measures are ordinal in nature and do not obey the assumptions of parametric ANOVA tests, a nonparametric approach is chosen. In particular, Kruskal-Wallis tests, the nonparametric equivalent of ANOVA, and Mann-Whitney U-tests, the nonparametric equivalent of t-tests, are applied.

Table 3. Analysis of Perceived Usefulness and Ease of Use

Dependent variable	Task set	Fit level	N	Mean rank	χ^2	df	p-value
Perceived usefulness	Ti-H/Lo-H (T1)	Under-fit	87	52.51	11.360	1	.001*
		Ideal fit	29	76.47			
	Ti-H/Lo-L (T2)	Under-fit	57	60.87	3.885	2	.143
		Ideal fit	29	62.66			
		Over-fit	29	47.71			
	Ti-L/Lo-H (T3)	Under-fit	57	41.40	30.194	2	.000*
		Ideal fit	29	69.43			
		Over-fit	29	79.19			
	Ti-L/Lo-L (T4)	Ideal fit	29	53.41	1.099	1	.295
		Over-fit	88	60.84			
Perceived ease of use	Ti-H/Lo-H (T1)	Under-fit	87	55.26	3.343	1	.067
		Ideal fit	29	68.21			
	Ti-H/Lo-L (T2)	Under-fit	57	61.03	2.369	2	.306
		Ideal fit	29	60.16			
		Over-fit	29	49.90			
	Ti-L/Lo-H (T3)	Under-fit	57	44.64	19.106	2	.000*
		Ideal fit	29	68.47			
		Over-fit	29	73.79			
	Ti-L/Lo-L (T4)	Ideal fit	29	58.31	.017	1	.897
		Over-fit	88	59.23			

*Individual Kruskal-Wallis test with $\alpha = .05$

As can be seen in Table 3, for tasks that are location-dependent (i.e., T1 and T3), perceptions of usefulness differ across different levels of fit. In cases in which subjects had to find a person or a location as quickly as possible (T1), technology that provides an ideal fit is perceived to be more useful than technology that under-fits the task. In the case of perceived ease of use, perceptions differ across one form of location-dependent task only: finding a person or location without time pressure (T3). Conducting a *post hoc* analysis for that task (Table 4) reveals that under-fit conditions are perceived to be inferior compared to all other forms of fit. Subjects provided with an under-fit condition perceived their technology to be less useful and less easy to use than those equipped with an ideal fit, or those that were equipped with an over-fit. No statistical differences exist between ideal and over-fit.

Table 4. *Post hoc* Tests of Perceived Usefulness and Ease of Use for Ti-L/Lo-H Tasks (T3)

Dependent variable	Fit level comparisons	U-test	p-value
Perceived usefulness	Under-fit – Ideal fit	417.5	.000*
	Under-fit – Over-fit	289.5	.000*
	Ideal fit – Over-fit	343	.213
Perceived ease of use	Under-fit – Ideal fit	468	.001*
	Under-fit – Over-fit	423.5	.000*
	Ideal fit – Over-fit	365.5	.368

*Individual Mann-Whitney U-tests with adjusted $\alpha = .05/3 = .0167$

Performance measures are analyzed separately for time-to-completion, time-to-start, and answer correctness. In the case of time-to-completion, data preparation requires time measures for location-dependent tasks to be standardized by calculating the ratio between distance and time. The rationale behind this is that different subjects had to bridge different distances in order to accomplish a task. Standardizations are made possible because the distance between target and subject location was recorded for every subject and every task. Whereas time-to-completion and time-to-start fulfill the assumptions of parametric ANOVA tests, answer correctness is analyzed in a nonparametric fashion.

Table 5. Analysis of Performance

		Time-to-completion			Time-to-start			Answer correctness		
Task set		df	F	p-value	df	F	p-value	df	χ^2	p-value
Ti-H/Lo-H (T1)	Between groups	1	1.147	.287	1	.128	.722	1	1.767	.184
	Within groups	111			111					
	Total	112			112					
Ti-H/Lo-L (T2)	Between groups	2	.829	.439	2	.120	.887	2	.199	.905
	Within groups	112			114					
	Total	114			116					
Ti-L/Lo-H (T3)	Between groups	1	14.427	.000*	2	.463	.631	2	7.537	.023*
	Within groups	113			113					
	Total	115			115					
Ti-L/Lo-L (T4)	Between groups	1	.008	.929	1	.097	.756	1	.046	.831
	Within groups	113			114					
	Total	114			115					

*$p < \alpha = .05$

Table 6. *Post hoc* Tests for Ti-L/Lo-H (T3)

	Time-to-completion[a]		Answer correctness (AC)[b]	
Comparison	Bonferroni test	p-value	U-test	p-value
Under-fit – Ideal fit	-.2128	1.000	638	.008*
Under-fit – Over-fit	1.5304	.000*	739	.212
Ideal fit – Over-fit	1.7432	.000*	376	.155

*$p < \alpha = 0.05$
[a]Bonferroni Inequality test with $\alpha = 0.05$
[b]Three individual Mann-Whitney tests with adjusted $\alpha = .05/3 = .0167$

In the case of time-to-completion, subjects' performances do not differ for tasks, such as writing e-mail and booking flights under time pressure (T2), or searching for specific information (T4). These tasks do not contain a location-component (see Table 5). For those tasks that do contain a location component, only those where subjects had no time pressure differ across technology fit levels (i.e., T3). Here, a *post hoc* analysis shows (Table 6) that differences exist between over-fit and both other groups. Subjects with an over-fit performed tasks, such as finding a person or location with no time pressure, worse than anybody else. Best in class were those that had an ideal fit, followed by those with an under-fit.

Regarding the time-to-start, subjects do not differ across different levels of fit (see Table 5). Against our expectations that those with ubiquitous access should be aware of a new task earlier than those without, the data show no significant difference across fit levels. This effect may be caused by experimental conditions. All subjects expected tasks to arrive and thus checked their e-mail frequently.

Regarding answer correctness, differences exist only for task set T3. A *post hoc* analysis shows (Table 6) that significant differences exist between under- and ideal fit conditions. Subjects with an ideal fit delivered the highest quality answer, followed by over-fit. Subjects with under-fit performed worst.

Conclusions

Multiple conclusions can be drawn form the study. First, u-commerce technology providing location-based services is perceived to be very useful for location-dependent tasks. In line with this finding are market reports that identify location-based services to be the killer application for future wireless developments (Pottorf 2000). By 2005, 149 million location-enabled subscribers are expected to generate revenues of $5,762 million in the United States (Nelson 2001). In contrast, for tasks that are not location-dependent, such as writing e-mail, browsing the Internet to search for specific information, etc., u-commerce technology does not make a difference in usefulness perceptions.

Second, perceptions of ease of use do not significantly differ across treatment groups that provide an over-fit or ideal fit. Neither of the treatments seems to be superior to the other. However, it seems that situations in which subjects are presented with an under-fit condition tend to devalue the perceptions of ease of use dramatically. Since the u-commerce technology provided was not harder to use, the logical explanation would be that perceptions of usefulness (which tend to be low for under-fit conditions) create a halo effect in ease of use perceptions.

Third, user perceptions do not significantly differ across ideal and over-fit conditions. Whereas one stream of research states that technology over-fit leads to better performance since people can explore things and find new ways of solving tasks and, thus, be more efficient (Griffin 1991), another stream of research claims that technology over-fit reduces performance because users are either too overwhelmed with features and functionalities, or are too distracted by the same so that the task at hand suffers severe losses (Ackerman and Cianciolo 2002; Klein et al. 1999). Our study, in contrast, concludes that no difference exists between both conditions.

Fourth, u-commerce technology does not make a difference when performing *non*-location-dependent tasks. Irrespective of the technology treatment, these tasks were performed equally by every subject in terms of their time-to-completion, time-to-start, and answer correctness. In contrast, tasks that require finding a person or location without time-pressure yield variation across fit levels. Subjects not only differ on their time-to-completion but also on their answer quality. Table 7 provides a summary of the statistical findings based on the different task groups.

The u-constructs should force us to rethink and revisit the fundamentals of IS. Revalidating major IS theories will be essential because many of these were developed during the era of the mainframe computer or end-user personal computers where major information systems were centralized and mainly used for internal purposes. With the emergence of networking capabilities and client-server architectures, however, centralization turned into decentralization, thus reducing the geographical centrality of information systems. As such, the u-constructs should not only enhance our understanding of existing but also of emerging technologies. At the same time, they provide the foundation of a task taxonomy that is able to capture future task forms.

For IS practitioners, the same considerations apply. As mobile penetration increases and applications become more sophisticated, the transformation of the mobile phone into a fully integrated data, communications, and commerce tool seems inevitable. As such, the u-constructs not only provide a means to understand the potential of future u-technologies but also are able to serve as an instrument for identifying u-commerce needs and evaluating potential business benefits. For businesses, u-commerce will be a critical capability in improving customer sales, service, and loyalty, as well as in driving more efficiency in the supply chain and in enabling mobile workforces.

Table 7. Hypotheses in Summary

Hypothesis		Task Set	Statistical Finding
PERF1	An ideal fit between task and technology will lead to higher individual performance than over- or under-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	Not supported Not supported **Supported** Not supported
PERF2	An over-fit between task and technology will lead to higher individual performance than under-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	Not supported Not supported **Supported** Not supported
PERF3	An under-fit between task and technology will lead to lower individual performance than ideal or over-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	Not supported Not supported **Supported** Not supported
USE1	An ideal fit between task and technology will lead to higher perceptions of usefulness than over- or under-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	**Supported** Not supported **Partially supported*** Not supported
USE2	An over-fit between task and technology will lead to higher perceptions of usefulness than under-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	- Not supported **Supported*** Not supported
USE3	An under-fit between task and technology will lead to lower perceptions of usefulness than ideal or over-fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	**Supported** Not supported **Supported** Not supported
EOU	Perceptions of ease of use will be identical across different levels of fit.	Ti-H/Lo-H (T1) Ti-H/Lo-L (T2) Ti-L/Lo-H (T3) Ti-L/Lo-L (T4)	**Supported** **Supported** Not supported **Supported**
*Here over-fit was perceived to be highest, followed by ideal fit, followed by under-fit.			

For IS users, u-commerce technologies will become part of their daily life, turning time previously spent waiting, walking, and traveling into time spent communicating, working, and buying. With e- and m-commerce morphing into u-commerce, the borderlines between private and professional life will blur even more since the notion of an information system is not bound to the organizational context anymore.

References

Ackerman, P. L., and Cianciolo, A. T. "Ability and Task Constraint Determinants of Complex Task Performance," *Journal of Experimental Psychology* (8:3), 2002, pp. 194-208.

Bresien, T. "Mommy Track Marries Security and Mobility," Wireless NewsFactor, January 22, 2003 (available online at **http://www. wirelessnewsfactor.com/perl/story/20537.html**).

Buckler, F., and Buxel, H. "Mobile Commerce Report," March 8, 2000 (available online at **http://www.profit-station.de/metafacts/presse/M-Commerce.htm**.

Currie, W. *The Global Information Society*, John Wiley, New York, 2000.

Davis, F. D. *A Technology Acceptance Model for Empirically Testing New End-User Information Systems: Theory and Results*, Unpublished Ph.D. Dissertation, Sloan School of Management, Massachusetts Institute of Technology, Cambridge, MA, 1986.

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

Davis, F. D., Bagozzi, R. P., and Warshaw, P. R. "User Acceptance of Information Technology," *Management Science* (35:8), 1989, pp. 982-1002.

Dishaw, M. T., and Strong, D. M. "Extending the Technology Acceptance Model with Task-Technology Fit Constructs," *Information & Management* (36:1), 1999, pp. 9-22.

Durlacher. Mobile Commerce Report. http://www.durlacher.com, 09/14/00.

Goodhue, D. L., Gazioli, S., and Klein, B. D. "Beyond Task/Technology Fit: How Information Technology Affects Performance By Transforming the Task," Working Paper, University of Georgia, Athens, GA, 2001.

Goodhue, D. L. "Development and Measurement Validity of a Task-Technology Fit Instrument for User Evaluations of Information Systems," *Decision Sciences* (29:1), 1998, pp. 105-138.

Goodhue, D., and Thompson, R. L. "Task-Technology Fit and Individual Performance," *MIS Quarterly* (19:2), 1995, pp. 213-236.

Griffin, R. W. "Effects of Work Redesign on Employee Perceptions, Attitudes, and Behaviors: A Long-Term Investigation," *Academy of Management Journal* (34:2), 1991, pp. 425-435.

Junglas, I. A. "U-Commerce: An Experimental Investigation of Ubiquity and Uniqueness," Unpublished Ph.D. Dissertation, University of Georgia, Athens, GA, 2003.

Junglas, I. A., and Lehner, F. "2001 Mobile Business—Glossary & Dictionary," Bericht Nr. 55, Universität Regensburg, Schriftenreihe des Lehrstuhls für Wirtschaftsinformatik III, 2001.

Klein, G., Jiang, J. J., and Boyd, M. "Building a Case of Consonance," in *Proceedings of the Third International Conference on Business Information Systems*, W. Abramowicz and M. E. Orlowska (eds.), Springer-Verlag, London, 1999.

Müller-Verse, F. "Mobile Commerce Report," Durlacher Research Ltd., London, 1999.

Nelson, C. "Wireless Location-Based Services Update: Market Forecast and Analysis, 2000-2005," Document Number 24502, IDC Research, Framingham, MA, 2001.

Pottorf, C. "Shopping on the Go: Wireless mCommerce Market Forecast and Analysis, 1999-2004," Document Number 22573, IDC Research, Framingham, MA, 2000.

Samsung. "The Power to Lead a Revolution," 2000 (available online at **http://www.samsung.com/AboutSAMSUNG/CompanyProfile/AnnualReport/pdf/2000/eng_portfolio.pdf**; accessed January 14, 2002).

Samsung. "SAMSUNG Electronics Showcases the World's First GPRS Wrist Watch Phone On Sale in Europe Q4 2003," 2003 (available online at **http://www.samsung.com/PressCenter/PressRelease/TelecommunicationNews/TelecommunicationNews_20030313_0000004250.htm**; accessed March 13, 2003).

Skiba, B., Johnson, M., and Dillon, M. "Moving In Mobile Media Mode," 2000 (available online at **http://www.entsoftware.com**; accessed September 14, 2000).

Venkatesh, V. "Determinants of Perceived Ease of Use: Integrating Control, Intrinsic Motivation, and Emotion into the Technology Acceptance Model," *Information Systems Research* (11:4), 2000, pp. 342-365.

Venkatesh, V., and Davis, F. D. "A Theoretical Extension of the Technology Acceptance Model: Four Longitudinal Field Studies," *Management Science* (46), 2000, pp. 186-204.

Watson, R. T. "U-Commerce: The Ultimate," *Ubiquity: An ACM IT Magazine and Forum*, 2000 (available online at **http://www.acm.org/ubiquity/views/r_watson_1.html**).

Watson, R. T., Pitt, L. F., Berthon, P., and Zinkhan, G. M. "U-Commerce: Extending the Universe of Marketing," *Journal of the Academy of Marketing Science* (30:4), 2002, pp. 329-343.

Wrolstad, J. "IBM Sends Smart Laundry Machines to College," Wireless NewsFactor, September 4, 2002a (available online at **http://www. wirelessnewsfactor.com/perl/story/19294.html**).

Wrolstad, J. "Mobile Phones Pay for Gas at the Pump," Wireless NewsFactor, April 24, 2002b (available online at **http://www.wirelessnewsfactor.com/perl/story/17439.html**.

Zigurs, I., and Buckland, B. K. "A Theory of Task/Technology Fit and Group Support Systems Effectiveness," *MIS Quarterly* (22:3), 1998, pp. 313-334.