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LET'S GET MARRIED: ADOPTION OF INTERACTIVE PRODUCT INFORMATION FOR BUNDLE PURCHASES BY TANGIBLE USER INTERFACES

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Abstract

Tangible User Interfaces (TUI) extend Human-Computer Interaction to physical environments. In this study, TUI are used as front ends for E-Commerce applications for the first time. Based on consumer behaviour research and a taxonomy for TUI, we describe a research model for TUI-enhanced E-Commerce applications that provide interactive product information in shopping situations. We compare passive product information of printed catalogues with interactive product information offered by a newly developed TUI-enhanced E-Commerce application by means of an empirical innovation adoption study with 32 subjects based on Innovation Diffusion Theory and Technology Acceptance Model. Partial least square (PLS) based structural equation modelling is used for data analysis. In addition, the prototype is tested with the system usability scale (SUS) for a global assessment of its usability and to support the evaluation of interactive product information. Results show a higher-than-average SUS score. Furthermore, interactive product information offered by TUI-enhanced E-Commerce applications exhibit relative benefits compared with similar passive product information if task involvement and hedonic values are high, and prior knowledge of customers is low.

Keywords: electronic commerce, tangible user interface, technology acceptance, adoption and diffusion.

1 INTRODUCTION

With upcoming technologies of Ubiquitous Computing and Pervasive Computing, new directions for HCI are investigated under the umbrella term of Tangible User Interfaces (TUI), which provide alternatives to WIMP (windows-icon-menu-pointer) interactions with MIS (Fishkin 2004, Ishii and Ullmer 1997). With TUI, users interact with digital representations and applications by means of physical representations, e.g. with cubes (Zhou et al. 2004). To the best of our knowledge, TUI have been investigated within various domains but not as interfaces for E-Commerce applications. In contrast to HCI for online shopping and mobile shopping applications, TUI provide additional multi-sensory cues, such as touch and smell, which result in richer mental representations and might lead to higher purchase intentions, as shown with 3D simulations for online E-Commerce applications (Schlosser et al. 2003).

Impressions of products and shopping environments can be distinguished for E-Commerce applications with TUI, online E-Commerce applications and printed catalogues by three characteristic factors (Baker et al. 2002, Bitner 1992): sensory factors (ambience), store appearance and layout (design), and presented symbols and languages (social factor). For all factors, TUI-enhanced E-Commerce applications – for short Tangible E-Commerce (TEC) applications – provide the potential for differentiation and innovation which might support the argument that TUI inherently carry the potential to generally extend the conception of HCI research in MIS (Nah et al. 2005, Zhang et al. 2002) by a dimension of physical objects with corresponding concepts of spatial cognition and language of space (Herskovits 1986). TUI provide an innovative means to interact with customers and in particular to transmit interactive product information to customers as opposed to passive product information (Schlosser et al. 2003) provided by printed and online catalogues (Vijayasarathy and Jones 2000). As a first step towards a full understanding of TEC applications, we pose two questions: (1) will customers adopt interactive product information provided by TEC applications, and (2) which factors will predict their adoption. We conducted therefore an adoption study for which we combine innovation diffusion theory (Rogers 2003) and technology acceptance research (Davis 1989).

Because TEC applications are not available yet, we had to develop a prototypical TEC application as part of our research and applied therefore a general design science method as proposed by Hevner et al. (2004). In order to achieve a complex purchase situation that exhibits high involvement on customer side, we have implemented a tangible wedding shopping environment in which customers can completely plan their wedding. The wedding shopping is a purchase task that results in complex product bundles (Adams and Yellen 1976) and, caused by first time experience, it requires extensive mental processing (Yadav 1994). The basis of the TEC application is a doll's house, which taps into knowledge acquired during childhood. Because all physical product avatars are equipped with RFID tags, users were able to freely move them around. Interactions with product avatars were possible at dedicated locations within the doll's house.

In the following sections, we will first discuss characteristics of product information offered by regular stores, online E-Commerce, mobile E-Commerce, and TEC applications. Then, we describe our focused frame of research that leads to our research model and the preliminary study on the adoption of interactive product information provided by TEC applications. This study provides us with first answers to the research questions stated above. After the discussion of results and their limitations, we conclude the current work by a summary and an outlook on future research.

2 RELATED WORK

In purchase situations, the transmission of product values differs characteristically between in-store and online sale situations (Alba and Lynch 1997). For the evaluation of products, Nelson distinguishes search and experience attributes of products (Nelson 1970, Nelson 1974). Search attributes can be accessed before purchases while experience attributes are evaluated after purchases. Search attributes stem either from direct experience through, for instance, touch and smell, or are mediated by advertising, catalogues and word-of-mouth. Hence, E-commerce applications mainly support search attributes but are affected by experience attributes for subsequent purchases.

Online E-Commerce applications but also Mobile E-Commerce applications provide interactive product information that can be controlled by users (Ariely 2000). The interactivity spectrum is spanned from low information interactivity with no freedom in determining the information's sequence characteristics, and high information interactivity with complete freedom (Ariely 2000).

Ariely found that situations with high information control resulted in better memorisation of product knowledge than low information control conditions. Purchase decisions are moderated by customer involvement that describes the perceived personal relevance of a product based on the individual needs, interests, and values of a customer (Zaichkowsky 1985). For online E-Commerce applications, it is argued that involvement is a moderator for the impact of the quantity and quality of product reviews on purchase intentions (Do-Hyung et al. 2007). Generally, the higher the involvement the more important is the quality of product information (Johnson and Eagly 1989).

Mobile E-Commerce is perceived as a specialisation of online-based E-Commerce, i.e., E-Commerce applications via mobile devices, such as phones or personal digital assistants (Mennecke and Strader 2002). Mobility also adds a spatio-temporal dimension so that E-Commerce applications can be used anytime and anywhere. The spatial context is largely restricted to value-added services based on geo-referencing of the user's location while the interaction between users and mobile E-Commerce applications resemble online E-Commerce applications with additional resource limitations.

Online and mobile E-Commerce applications provide user interfaces that are two-dimensional analogues of print catalogues that "rely almost exclusively on the customer's conscious processing of visual (and some audio) stimuli to convey information" (Rosa and Malter 2003, p. 63). Simple verbal descriptions and pictures are typically sufficient for goods with search qualities that require little physiological or emotional involvement and clear envisioning of usage scenarios (Rosa and Malter 2003).

Under the umbrella of Ubiquitous Computing and Pervasive Computing context-aware applications are currently introduced. In extension to mobile E-Commerce applications based on standard mobile devices, context-awareness computing has the potential to penetrate all life situations (Chairs et al. 1999) and to provide users with commerce-relevant information and services (Dey and Abowd 1999, Rodden et al. 1998). Fishkin (2004) proposes a taxonomy for tangible user interfaces that encompasses two dimensions: embodiment and metaphor. Embodiment characterises the proximity of input and output devices by four levels: full, nearby, environmental and distant. For instance, full embodiment means that an output device is the input device. The metaphor dimension encompasses the semantic level of a TUI and is described by five levels: none, noun, verb, noun and verb, and full. Noun relates a physical object of a TUI to a physical object in the real world but no object specific operations. Accordingly, verb is a metaphor of the operation performed independent of the object. Full means that the virtual system is no representation but the physical system itself. Up until now, tangible user interfaces have been investigated for various product designs, games, and collaborations (for an overview, see Ullmer et al. 2005) but not within the context of E-Commerce applications.

3 RESEARCH MODEL

It can be assumed that TUI-enhanced E-Commerce (TEC) applications will exhibit characteristic differences compared to online E-Commerce applications and printed catalogues. In the following, we will present a study that investigates the adoption of interactive product information and that tests the usability of a particular TEC application. The investigation of product involvement and effects of prior customer knowledge is beyond the scope of a single research study and will be the target of future work. We focus with a wedding shopping task on a particular instance of possible TEC applications that exhibits high product involvement and little prior knowledge. High product involvement is given, as the wedding shopping task requires customers to buy a bundle of several products and services, which increases task complexity. Thereby, we investigate more complex purchase situations with the underlying assumption that this will increase the utility of interactive product information provided by TEC applications. Hence, we focus on interactive product information that helps customers to buy product bundles.

In the following, we study the adoption of interactive product information for bundle purchases by applying Innovation Diffusion Theory (IDT) and Technology Acceptance Model (TAM). In line with IDT, interactive product information provided by TUI therefore represents an innovation that the user can adopt for application in purchase situations (Rogers 2003). The second line of research studies intention-based models to understand the adoption of IT. Accordingly, corresponding models such as the theory of planned behaviour (Ajzen 1991) are grounded in social psychology to identify attitudes, social influences and facilitating conditions that predict the intention of usage. The behavioural intention to use interactive product information predicts their adoption, respectively. For instance, TAM is based upon this line of research (Davis 1989). In addition, several studies successfully integrate both research domains due to some similarities such as Rogers' relative advantage and the construct of perceived usefulness from Davis. In particular, the work of Venkatesh et al. (2003) and Moore and Benbasat (1991) integrate those constructs. Consistent with the latter, this article takes both perspectives into account, too.

Two constructs are adequate for the utilization of TEC applications that provide interactive product information. The first is relative advantage, which is defined as the degree "to which an innovation is perceived as better than the idea it supersedes" (Rogers 2003, p. 476). In our context, interactive product information represents the innovation that adapts to the customer's needs in purchase decisions and thus supersedes passive product information as it can be found traditionally in brick-and-mortar stores (e.g. printed product labels) or in print catalogues. As we focus on bundle purchase, we hypothesize the following relationship:

H1: Compared with passive product information, perceived relative advantage of interactive product information provided by a TEC application has a positive relation with the intention to use interactive product information for buying product bundles.

Perceived ease of use is the second construct adequate for our approach. It refers to the degree "to which a person believes that using a particular system would be free of effort" (Davis 1989, p. 320). Here, our TEC application supports the customer with interactive product information on demand. The customer is therefore able to choose information, which she perceives as relevant for her purchase decision. In particular, ease of use becomes obvious, if a TEC application recommends only those products that are compatible or complementary with each other in the case of a bundle purchase. Thus, we postulate the second hypothesis as follows:

H2: Perceived ease of use of interactive product information provided by a TEC application has a positive relation with the intention to use interactive product information for buying product bundles.

Regarding to the discussion of Maass and Kowatsch (2008) in the context of bundle purchases, perceived ease of use predicts relative advantage of interactive product information. Although they use a mobile E-Commerce application that provides product information, we assume also a significant positive correlation for interactive product information that is provided by a TEC application due to similarities; in both scenarios, customers are provided with product information on demand. They differ only in the user interface that is used to request the information. Hence, our last hypothesis is formulated as follows:

H3: Perceived ease of use of interactive product information provided by a TEC application has a positive relation with perceived relative advantage of interactive product information.

To summarize, Figure 1 illustrates the independent variable perceived ease of use and the depended variables perceived relative advantage and the behavioural intention to use interactive product information for bundle purchases.

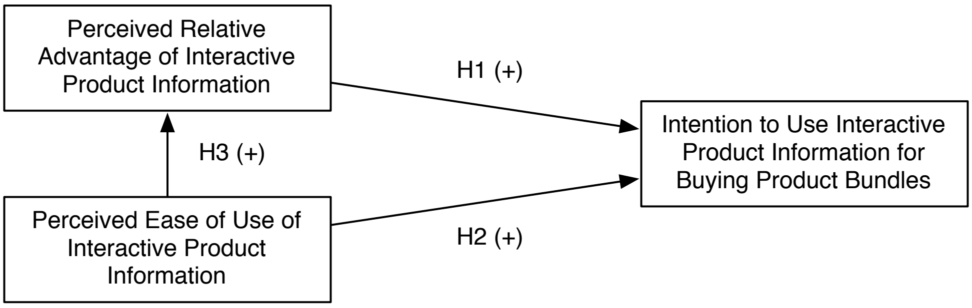

Figure 1. Research Model.

4 METHOD

In order to test the research model, we first developed a TEC application that implements a TUI based upon prior work (Ishii and Ullmer 1997) before we conducted a preliminary lab experiment as a first step towards a better understanding of those applications. In the following, the implementation of our TEC application is described. Then, a detailed overview of the lab experiment is presented.

4.1 Tangible E-Commerce Application: An Interactive Wedding Planner

A complex wedding planner scenario was developed as design guideline for our TEC application. In this scenario, future marriage partners are supported in buying decisions concerning their wedding, i.e. choosing the right honeymoon trip. But there are also more complex tasks supported, e.g. the price calculation of the wedding reception depending on the number of guests. The marriage partners are supported in their buying decisions by a witness doll, which is located beside a doll's house. By placing a bride doll in front of the witness, the marriage partners are instructed by voice output to place the bride into one of the rooms to activate them. After the activation of a room, the room lamp is turned on and physical product avatars can be placed into that highlighted room to add them to the shopping list. Here, physical product avatars are miniatures (e.g. a miniature of a salad bowl or a guitar) that represent physical products such as a mixed salad or services such as the performance of a music band. Supportive product information is presented on a computer screen. The rooms of the doll's house and the place in front of the witness are equipped with RFID readers while avatars and the bride doll are enriched with RFID tags. Changing the location of a physical product avatar triggers actions such as presenting product information. Hence, this TEC application deploys direct manipulation techniques through the implementation of a tangible user interface (Ishii and Ullmer 1997). The doll's house and the flow chart of this tangible wedding planner are shown in Figure 2 and Figure 3, respectively. According to Fishkin's taxonomy for TUI (Fishkin 2004), this TEC application exhibits a TUI with an embodiment classification of "nearby", i.e., the output takes place near the input object and is tightly coupled to the focus of input, and a metaphor classification of "noun", i.e., the physical product avatar looks or is shaped like the physical product it represents. The involvement for this wedding task is perceived as being high. Prior knowledge was low because none of the test persons was already married. Caused by the doll's house environment, hedonic values are addressed (Bellenger and Korgaonkar 1980).

RFID technology represents a suitable means for automatic object identification in our TEC application (Want et al. 1999). For RFID-based infrastructures, the EPC Network is the most prominent specification for RFID-based object environments. EPC Network consists of the following modules: reader, filtering and collecting middleware, and the EPC information service (EPCIS) (www.epcglobalinc.org). The reader module provides low-level management service, such as reading RFID data but also for event recognition, such as entry and exit events, and space aggregation that allows grouping of multiple RFID antennas to a single logical entity (Floerkemeier et al. 2007).

Figure 2. RFID-featured doll's house with the RFID-tagged bride puppet

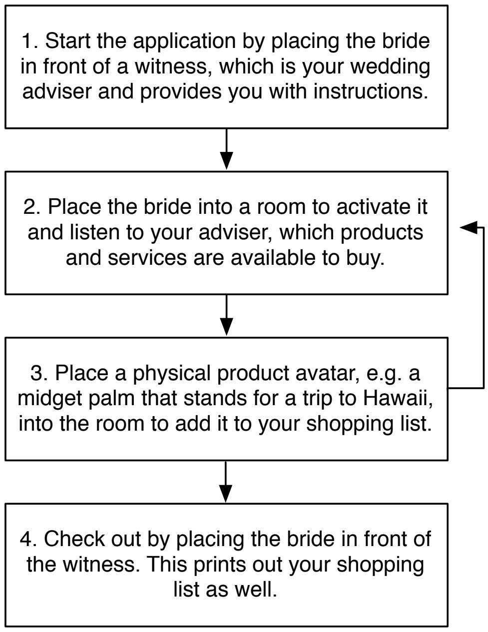

Figure 3. Flow-chart of the Tangible E-Commerce application.[1]

Since in a complex shopping scenario, many readers capture RFID data that need to be disseminated to higher layers, there is the need for software systems that manage readers and filter and aggregate captured RFID data. The reader module of the Fosstrak platform (previously Accada, see Floerkemeier et al. 2007) implements the EPCglobal Reader Protocol (Traub 2005). The Auto-ID object model is based on a symbolic location model, in which physical product avatars also define locations. Physical product avatars can have properties and functions. Auto-ID readers that identify physical product avatars can also act as property sources that set the values of object properties. A reference management mechanism recognises and keeps track of physical product avatars as they enter and leave a location, e.g. a factory or a warehouse, and how products are related to one another in a certain geo-physical context. This is provided by mechanisms specified by EPC Network (Chawathe et al. 2004). In our TEC application, Fosstrak is used for interaction with physical product avatars.

4.2 Experimental Setting

A lab experiment was conducted to test the usability of the interactive wedding planner application and to test the research model. A pre-test with eight subjects was conducted to get preliminary feedback in advance of the experiment, which was then used to optimize the application and the instructions of the questionnaire. Then, in the first part of the experiment, subjects in groups of two were asked to buy a complex product bundle for their wedding. Each group had to consist of one female (the bride) and one male subject (the bridegroom) or two female subjects (the bride and the bride's best friend) as some miniatures of the interactive wedding planner such as the wedding dress

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[1] The witness and the physical product avatars are placed beside the doll's house and are therefore not visible in Figure 2.

required these roles. Subjects were shortly briefed according to their roles and the objective of the wedding planner, before each group was given 20 minutes to finish their purchase.

Then, in the second part of the experiment, subjects were given a questionnaire with the system usability scale (SUS) items (Brooke 1996). They were used to calculate the SUS score for the TUI-enhanced wedding planner application, which is not only an important indicator for the usability of our TEC application but also for the investigation of interactive product information over TUI. Correspondingly, the study of the more general concept of interactive product information is only reasonable if the whole TEC application gains sufficiently high usability scores. In addition, the questionnaire was used to ask for the perceived characteristics relative advantage and ease of use. Corresponding items were adapted from Moore and Benbasat (1991) and Davis (1989). Furthermore, two items have been created to measure the behavioural intention to use interactive product information. According to Ajzen and Fishbein (1980), both statements cover the four behavioural elements action (usage), target (interactive product information provided by a TUI implementation), context (buying a complex product bundle), and time (the next three years) when measuring the behaviour in question (see Table 1). Consistent with prior research on the adoption of IT, all items were based on seven-point Likert scales, ranging from extremely agree to extremely disagree. At last, the questionnaire was used to collect demographic data and to ask for the length of the experiment and the comprehensibility of the instructions.

5 RESULTS

Nineteen female and 13 male students participated in the lab experiment. All of the subjects were not married and their age ranged from 19 to 24 (N = 22), 25 to 29 (N = 7) and 30 to 34 (N = 2) with one participant giving no answer. Thus, they were potential users of our wedding planner application. The subjects were grouped in 13 pairs each consisting of one female and one male student and three pairs consisting of female students only. Overall, the instructions of the experiment and the questionnaire were perceived as being reasonable and acceptable on its length.

The usability of our TEC application resulted in an average system usability score of feasible 73 with a standard deviation of 15.9 (the scale ranges from 0 to 100, see Brooke 1996). This score was significantly above the neutral test value of 50 by applying a t-test for one sample ($p < .001$). As a result, the investigation on interactive product information is based upon a usable TEC application.

Consistent with prior research (Komiak and Benbasat 2006, Kamis et al. 2008), partial least squares (PLS) was used for data analysis. PLS belonging to structural equation modelling (SEM) was chosen over regression analysis, because SEM can analyze all of the paths in one analysis (Barclay et al. 1995, Gefen et al. 2000). PLS provides the analysis of both the structural model (assessing relationships among theoretical constructs) and the measurement model (assessing the reliability and validity of measures) (Komiak and Benbasat 2006). In our research, all constructs were modelled as reflective, because their measurement items are manifestations of these constructs (Barclay et al. 1995) and because these items covary (Chin 1998). By using G*Power3 (Faul et al. 2007), a sample size of 25 was calculated for two predictors to be good enough to detect PLS path coefficients with large effect sizes (f^2=.35). A statistical power of .80 was used, which is common in MIS research (Baroudi and Orlikowski 1989, Cohen 1977). Thus, a sample of 32 subjects was chosen for our preliminary study.

In order to test the validity of our constructs, we performed confirmatory factor analysis using SEM with SmartPLS 2.0 and the bootstrapping resample procedure (Ringle et al. 2005). Although items from the perceived ease of use scale had factor loadings slightly below the recommended value of .70, we retained them in order to maintain continuity with prior research using the same scales. All of the items loaded significantly on their assigned latent variables. Thus, our scales show good convergent validity. According to Nunnally (1967), the Cronbach's alpha values for all constructs are above the recommended 0.7 value, indicating good reliability. The factor loadings, Cronbach's alpha values, and descriptive statistics of all constructs are shown in Table 1.

The results of partial least squares (PLS) analysis of our model can be seen in Figure 4. First, the coefficient between perceived relative advantage and the intention to use interactive product information for buying a product bundle is positive and significant (β=.723, $p < .001$), as is the coefficient between perceived ease of use and perceived relative advantage (β=.679, $p < .001$). This supports H1 and H3. By contrast, perceived ease of use does not predict the intention to use interactive product information for buying product bundles (β=.068, $p > .05$). Therefore, H2 is not supported by our empirical data.

	Construct **Scale item wording**	**Scale Reliability and Descriptives** **Standardized factor loadings**
	Perceived Relative Advantage:	**Cronbach's α = .903, Mean = 5.31, St. Dev. = 1.09**
PRA1	Using Interactive Product Information enables me to buy a product bundle more quickly than with Passive Product Information.	.851
PRA2	Using Interactive Product Information improves the quality of buying a product bundle in contrast to Passive Product Information.	.701
PRA3	Using Interactive Product Information makes it easier for me to buy a product bundle than with Passive Product Information.	.792
PRA4	I would find Interactive Product Information more useful to buy a product bundle than Passive Product Information.	.862
PRA5	Using Interactive Product Information increases my effectiveness to buy a product bundle compared with Passive Product Information.	.830
PRA6	I would find Interactive Product Information more helpful to buy a product bundle than Passive Product Information.	.882
	Perceived Ease of Use:	**Cronbach's α = .739, Mean = 5.19, St. Dev. = 0.72**
PEU1	I believe that Interactive Product Information is cumbersome to use for buying a product bundle.	.551
PEU2	It is easy for me to remember how to buy a product bundle using Interactive Product Information.	.549
PEU3	My using Interactive Product Information for buying a product bundle requires a lot of mental effort.	.688
PEU4	Using Interactive Product Information for buying a product bundle is often frustrating.	.675
PEU5	My interaction with Interactive Product Information is clear and understandable to buy a product bundle.	.619
PEU6	Overall, I believe that Interactive Product Information is easy to use for buying a product bundle.	.842
	Intention to Use:	**Cronbach's α = .849, Mean = 4.75, St. Dev. = 1.45**
IU1	I would use Interactive Product Information to buy a product bundle in the next three years.	.938
IU2	I intend to use Interactive Product Information to buy a product bundle in the next three years.	.926

Table 1. Survey instrument and descriptive statistics for the 32 subjects.

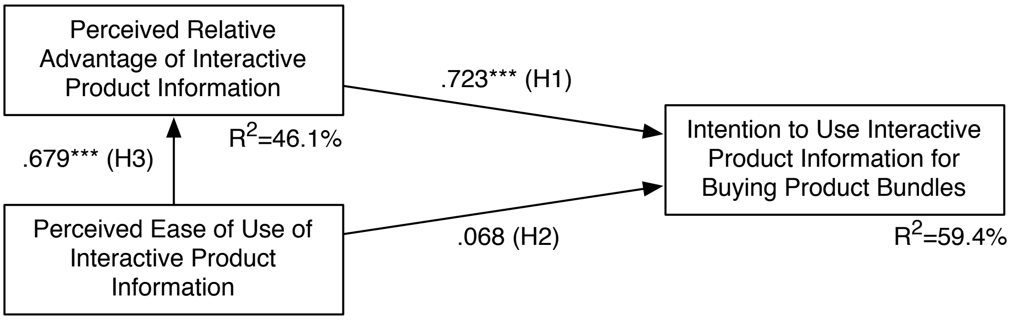

*Figure 4. Results of PLS Analysis; Note *** Significant at the .001 per cent level*

6 DISCUSSION

This study provides evidence for the usability of a particular instance of Tangible User Interfaces for E-Commerce (TEC) applications (interactivity: high/noun; product information: interactive/nearby; involvement: high; prior knowledge: low; hedonic benefits: high) and the utility of interactive product information delivered by TEC applications. TUI-enhanced E-Commerce applications contrast printed catalogue shopping and other E-Commerce applications with respect to object interactivity (Schlosser et al. 2003).

We found that the intention to use interactive product information for bundle purchases is strongly predicted by its relative advantage compared to passive product information. This indicates that product information provided by printed catalogues is perceived as being sub-optimal for at least some of the subjects. Based on the similarity of online E-Commerce applications with catalogue shopping (Jarvenpaa and Todd 1996, Lohse and Spiller 1998, Vijayasarathy and Jones 2000), the preliminary conclusion can be drawn that this also holds for online E-Commerce applications. These are astonishingly clear results that are moderated by the fact that subjects were mostly technically savvy individuals. Hence, it is expected that individuals with less technical knowledge might show smaller effects. Correspondingly, we need to repeat the study with real couples for which a wedding is imminent in order to add external validity to the research model (e.g., by attending a wedding fair with the interactive wedding planner).

The correlation between ease of use and relative advantage replicates the effect found by Davis (1989) for interactive product information provided by TUI. In addition, the findings of Maass and Kowatsch (2008) who investigated dynamic product information for bundle purchases within the context of a mobile E-Commerce application were replicated for TEC applications, too.

The effect size of the relation between ease of use and the intention to use interactive product information is too small, such that it can be detected significantly by the sample of our preliminary study. It can be therefore suggested that perceived relative advantage is quite more important for the adoption of interactive product information for bundle purchases than its ease of use.

Even though that this study does not directly relate TEC applications with catalogue shopping, online E-Commerce and mobile E-Commerce applications, it provides preliminary hints on the characteristics of TEC applications. First, for complex bundle shopping tasks with high involvement, high hedonic value and little prior knowledge, interactive product information provided by TEC applications exhibit a relative advantage compared to shopping applications that use passive product information. This proposition has been tested for printed catalogues but can be extrapolated to online and mobile E-Commerce applications with passive product information only (Jarvenpaa and Todd 1996, Lohse and Spiller 1998, Vijayasarathy and Jones 2000).

It is clear that this initial study only discusses a limited scope of research on TEC applications in general. A lot of research questions follow this study, which shall be briefly described. First of all, detailed comparison studies of printed catalogues, HCI for online and mobile E-Commerce applications and TEC applications need to be conducted. Another obvious field is the evaluation of all attributes of the framework for TEC applications. Different levels of interactivity of a TUI in general and product information in particular might change the adoption of TEC applications. Customer involvement, prior knowledge and hedonic values are supposed to change the intention to use a TEC application. Another important point is that physical products are not only characterized by tangible attributes but might also integrate services, as a car might integrate active services, e.g. BMW's or Toyota's rescue service. Information about services requires different forms of presentation via HCI in general and TUI in particular.

7 CONCLUSION AND FUTURE WORK

Tangible User Interfaces (TUI) have been investigated within the realm of Ubiquitous Computing and Pervasive Computing research which resulted in a vast amount of TUI prototypes. Up until now, a consideration of TUI as HCI for MIS was beyond the scope of research. Therefore, this initial study on the adoption of interactive product information provided by TUI-enhanced E-Commerce (TEC) applications opens a new and broad field for HCI research within the context of MIS.

Based on a short review of customer behaviour literature, we derived a set of key attributes that characterize HCI in general and TUI in particular within the domain of E-Commerce applications. (Object) interactivity has been identified by Schlosser as a key attribute for the analysis of digital product avatars (Schlosser et al. 2003). In this study, we extended this concept towards physical product avatars as well. The second attribute characterizes product information as being interactive or passive. Based on Fishkin's taxonomy (Fishkin 2004), this concept was also extended, so that it encompasses a physical domain. The other three attributes, involvement, prior knowledge, and hedonic benefits, are perceived as being moderators for the adoption of interactive product information provided by TEC applications.

According to this framework for TEC applications, we developed an instance for a complex product bundle-shopping task. Research on online and mobile E-Commerce applications indicate that it is rarely used for complex bundling tasks. Furthermore, previous research argues that printed catalogues are better perceived as online shopping with passive product information. Therefore, it was far from clear, whether TEC applications should be preferred over passive information provided by printed catalogues. Our study indicates that for complex bundle tasks, interactive product information provided by TUI with "nearby" and "noun" characteristics achieve relative advantages compared with catalogue-based shopping.

This framework and aforementioned limitations frame our current and future work that is part of a broad research agenda on TUI in E-Commerce domains. Research attempts in the area of TEC applications require a two-folded research programme. First, advanced TUI must be build before dedicated empirical studies can be conducted. Second, for TUI applications it occurs particularly promising to investigate adaptive TUI applications that use intelligent multimodal or natural language technologies. Whether these technologies help to increase the utility of TUI-enhanced MIS is an open issue.

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