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Explaining consumer acceptance of handheld Internet devices

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Abstract

The emerging mobile commerce (m-commerce) technology promises exciting possibilities for marketplace exchanges, but expected benefits to consumers as well as businesses await an understanding of consumer acceptance of this technology. Borrowing the technology acceptance model (TAM) from the work environment, we apply it to the consumer context (c-TAM) and extend it by incorporating both utilitarian and hedonic aspects of technology use. In workplace settings, perceived usefulness has been the predominant driver of technology adoption. Our empirical results show that while perceived usefulness (a utilitarian aspect) contributes to consumer adoption of Internet devices, what contributes even more is their ''fun'' attribute (a hedonic aspect). Moreover, some consumers are more visually oriented than others and are likely to adopt these devices even more than those who are less visually oriented. Marketing implications of these findings are described.

Keywords: m-Commerce; Wireless; TAM; Technology adoption; Innovation; Fun

1. Introduction

The success of mobile commerce (m-commerce) hinges on consumer willingness to adopt new technology and engage in activities using systems and devices different from what they have used in the past. Practitioners are struggling to predict the usage of such technology. Insight into the factors affecting acceptance of technology in consumer contexts may be gained by examining the applicability of the technology acceptance model (TAM) to such contexts.

TAM has been used for several years to predict the attitudes and behaviors of employees as they are introduced to new technologies in the workplace (e.g., Davis, 1986). The model posits that *usefulness* and *ease of use* (EOU) of a system influence a person's intentions to use the system. Various versions of the model have been proposed over time in the workplace context. The key difference between workplace and consumer contexts with respect to TAM is that in the latter, a hedonic factor may be an important addition to the model (Childers et al., 2001; Dabholkar and Bagozzi, 2002). This study reports on an investigation of TAM in a consumer context that is augmented with a hedonic factor, resulting in c-TAM (the consumer technology acceptance model). Further, it examines how two external variables, device used to access the Internet and consumers' preferred style of processing, influence variables in TAM.

2. Theoretical background

The central idea underlying TAM is that a person's behavioral intention (BI) to use a ''system'' (the new hardware, software, etc.) is determined primarily by two assessments: its *usefulness* and its EOU. Usefulness has to do with the degree to which a person believes a certain system will help perform a certain task. In contrast, EOU has to do with the extent to which a person thinks that use of a system will be relatively free of effort.

Fig. 1 shows the model tested in this study (c-TAM). The theoretical rationale for each of the paths in c-TAM is given below.

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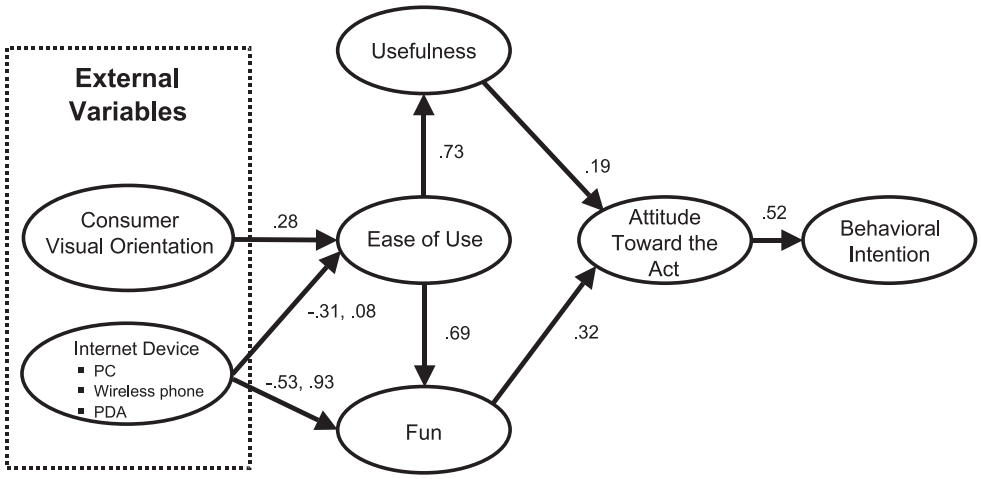

* The numbers near the arrows are path coefficients. In the case of the two paths from Internet Device, the first number in each pair is the path coefficient of the wireless phone/PC comparison and the second number is the PDA/PC comparison.

Fig. 1. The c-TAM. The numbers near the arrows are path coefficients. In the case of the two paths from Internet device, the first number in each pair is the path coefficient of the wireless phone/PC comparison and the second number is the PDA/PC comparison.

2.1. Effects and antecedents of EOU

2.1.1. EOU→usefulness

Although the original TAM posited and found EOU affected usefulness of a system in work place environments, studies done in the consumer domain (Childers et al., 2001; Dabholkar and Bagozzi, 2002) have not tested this relationship. It is expected here that as consumers believe systems are easier to use, they are likely to also perceive these systems to be more useful as they can spend their time doing other things rather than figuring out how to use the systems.

2.1.2. EOU→fun

Similarly, systems that are easier to use will also be perceived as more fun to use than those that are more cumbersome and frustrating to use. Consumers are likely to derive greater enjoyment and have more fun doing a given task on a system that is easier to use than on a system that is more cumbersome to use. As systems become easier to use, they provide users with a greater sense of mastery that in turn, leads to greater enjoyment and fun.

2.1.3. Mediated effects of EOU on BI

Although there is general consensus on the importance of EOU in predicting technology adoption, there is some inconsistency in the literature on *how* this variable affects BI. The EOU → BI path has been found to be significant in some studies and nonsignificant in others. A careful review of the literature revealed that typically, in studies where the EOU → BI path is nonsignificant (e.g., Gentry and Calantone, 2002), the effect of EOU on BI is mediated through attitude toward the act of using the system (Aact). In the current study, we posit that EOU influences Aact (which in turn affects BI) through two mechanisms: one is by influencing subjects' perceptions of how useful a system is (the utilitarian path) and the other is by influencing their perceptions of the fun/enjoyment associated with using the system (the hedonic path). Aact is an overall evaluation, encompassing both utilitarian and hedonic components; hence, it is viewed as completely mediating the effects of antecedent variables like EOU. We believe that whenever a hedonic construct like fun is included in a study, EOU is likely to have only indirect effects on BI (or Aact) and direct effects on usefulness and the hedonic construct.

A detailed review of various studies found that the above rationale could explain most of the inconsistent findings in the literature. For example, several studies (Venkatesh and Davis, 2000; Hong et al., 2002; Johnson and Hignite, 2000) found a significant EOU → BI path but none of these studies included a hedonic construct. Gentry and Calantone (2002) measured Aact and found that it completely mediated the effect of EOU on BI. Two marketing studies, Childers et al. (2001) and Dabholkar and Bagozzi (2002), had a hedonic construct and yet found direct effects of EOU on Aact. However, they did not posit any effect of EOU on the hedonic construct or on usefulness, although all the prior literature using TAM variables suggest an EOU → Usefulness path. Thus, in these studies, the hedonic path through which EOU influenced attitudes had to be a direct path (as the authors did not allow a mediated path like EOU → Enjoy/Fun → Aact).

2.1.4. Usefulness→Aact→BI

Prior research (Davis et al., 1989) has found that in workplace contexts, usefulness is typically the primary

driver of BI. An exception to this was the finding by Johnson and Hignite (2000) that the usefulness → BI (or usage) path was nonsignificant. A closer examination of the measures used in their study revealed that the result could have been driven by the fact that usefulness was measured with respect to a particular activity (usefulness of the web for an activity) while usage was measured at an overall level (overall web usage). This could explain their anomalous finding and suggests that the notion that perceived usefulness impacts usage is still valid.

Drawing on the theory of reasoned action (Fishbein and Ajzen, 1975), some researchers have suggested that one's Aact of using a system would mediate the relationship between usefulness and BI. The rationale for incorporating Aact is that people develop intentions to engage in behaviors toward which they have positive attitudes. In consumer contexts, Childers et al. (2001) found support for the usefulness → Aact relationship. Although they did not have BI in their study, it is posited here that Aact will mediate the usefulness → BI relationship.

2.1.5. Style of processing→EOU

Prior research has found that people have the tendency to mainly process information in either a visual or a verbal modality (e.g., Heckler et al., 1993). In consumer contexts, it is expected that consumers who are more predisposed toward a visual mode of processing will find it easier to use devices to perform tasks on the Internet compared to those who have low visual orientations. This will be true irrespective of the device used to access the web because consumers with high visual orientations are more likely to find it easier to use devices where clicking on icons and symbols are a natural way to move from one piece of information to another in an interactive manner. They are more likely to attend to visual cues and also more likely to use mental imagery to process information compared to those with low visual orientations. Consumers who prefer visual processing would be expected to use working memory to elaborate on textual cues in order "to represent cues in the preferred modality" (Heckler et al., 1993, p. 121). The high use of mental imagery is also likely to make it easier for these consumers to use these devices to perform online tasks as they can visualize goods and services better than those who are low on the visual orientation.

2.1.6. Device→EOU

Until recently, consumers had few options for the "systems" (hereafter referred to as devices) they used to access the Internet. The device used was limited to a desktop computer or possibly a laptop computer. Today, consumers have a growing number of options (e.g., PDAs, wireless phones, tablet PCs, etc.). From a consumer's point of view, these devices vary with respect to their EOU. The very nature of handheld devices is that they are small, making text, and graphics more difficult to decipher and entry of data more effortful. This tends to make handheld devices less easy to use than the more familiar desktop computer systems. Thus, EOU is likely to be influenced by the type of device used to access the Internet.

2.2. Effects and antecedents of fun

2.2.1. Fun→Aact→BI

Higher levels of fun associated with a system lead to more favorable attitudes toward using a system and greater inclination to purchase a product (e.g., Sheppard et al., 1988). A hedonic factor was not part of the early work on TAM but eventually was explored by a few researchers. In the workplace, Davis et al. (1992) concluded that enjoyment was one of the primary constructs through which other factors influenced usage intentions although it was not nearly as powerful as usefulness. In consumer contexts, Childers et al. (2001) found that enjoyment had significant effects on Internet shopper's attitudes while Dabholkar and Bagozzi (2002) found that Aact completely mediated the effects of fun on users' BIs toward using technology-based self-service. Thus, we posit that Aact will mediate the relationship between fun and BI in the context of consumers performing Internet-related tasks.

2.2.2. Device→fun

The fun of accessing the Internet and performing a task can also vary with the device used. Although handheld devices may be less easy to use than a desktop, they may provide greater intrinsic motivation to consumers, as the relative novelty and mobility of a handheld device will result in an element of discovery associated with their usage. All other things being equal (e.g., product involvement, knowledge, etc.), this added intrinsic motivation will provide greater enjoyment and fun in the foreseeable future to consumers than a traditional "large box" computer (Davis et al., 1992).

3. Methodology

At a large Midwestern U.S. university, 212 undergraduate students were randomly assigned to three different conditions in a single-factor (device), three-level, between-subjects experimental design. The three types of devices were desktop PC, wireless phone simulation, and PDA. Participants in the wireless phone condition interacted with a simulation, professionally developed and used in industry, running on laptop PCs that allowed subjects to click buttons on the phone to access and navigate websites. (The simulation was necessary because at the time the study was conducted, wireless phones

with Internet services were rare, expensive, and had unpredictable receptivity inside buildings.) In the PDA condition subjects used top-of-the-line *Pocket PCs*, with Internet Explorer that were only available to government and educational researchers at the time. Along with the phone simulation, the PDAs connected to the web via "wi-fi" (802.11b) in one of the first buildings on the campus with such wireless capability. These facts made it unlikely that subjects would have had such a wireless experience previously. Each device accessed the same websites although they appeared somewhat differently due to their varying capabilities (screen size and extent of graphics).

Upon arrival, subjects answered questions that assessed their preference for a visual style of processing, provided demographic information, and then engaged in a warm-up task to familiarize themselves with the device. After that, subjects were instructed to go to a company's website by clicking on icons/hyperlinks, search for information, and make some decisions. Finally, they completed the main portion of the questionnaire that had measures of all the constructs in the model shown in Fig. 1. Scale reliabilities and sample items are provided in Appendix A.

4. Results

4.1. Measurement model results

Confirmatory factor analysis was used to assess the psychometric properties of the multi-item scales employed to test the hypotheses. The correlations between the different constructs are shown in Table 1. An excellent overall fit of the measurement model was suggested by several indices including non-normed fit index (NNFI=.97), comparative fit index (CFI=.98), and incremental fit index (IFI=.98). Residual indices such as the root mean squared residual (RMR), standardized RMR (SRMR), and root mean square error of approximation (RMSEA) were all $<.05$ (excellent fit $<.06$). The average absolute standardized residual was .035.

Every item loaded significantly on the construct it was supposed to measure ($p<.01$). Composite reliabilities were calculated and found to be greater than .70 for all constructs. The average variance extracted by the items measuring a construct was greater than .50 for all constructs and the average variance extracted by each construct was found to be greater than the squared correlations between that construct and every other construct in the study (Table 1). Thus, all the scales met the requirements of unidimensionality, internal consistency, convergent, and discriminant validity (Fornell and Larcker, 1981) for inclusion in the structural model.

Table 1
Construct correlations and average variance extracted[a]

	Consumer visual orientation	Usefulness	EOU	Fun	Aact	BI
Consumer visual orientation	**.53**	.23	.21	.18	.06	.17
Usefulness		**.60**	.70	.61	.41	.21
EOU			**.74**	.57	.31	.15
Fun				**.70**	.47	.22
Aact					**.74**	.33
BI						**.82**

[a] The numbers above the diagonal represent the correlations between the constructs. The numbers in bold are the average variance extracted by each construct.

4.2. Structural model results

The structural model shown in the figure was tested using EQS 5.7b. Dummy variables, with desktops as the baseline for comparison, were created to capture the effect of device used to access the Internet. The overall fit of the model was assessed using the typical statistics, both incremental and absolute fit indices. The incremental fit indices (e.g., CFI, IFI, NNFI) were all >.95 and the absolute fit indices (e.g., RMSEA) were $<.05$. Thus, results of the structural model analysis suggest an excellent fit of the proposed model to the data.

4.3. Path coefficients

An examination of the parameter estimates (coefficients) and the associated t values obtained from the structural model analysis revealed that all the paths shown in Fig. 1 were statistically significant. The results show that the higher a subject's preference for processing information visually, the easier it was for the subject to use a device to access the Internet (b=.28, $t=3.74$). It was found that wireless phones were significantly less easy to use than desktops to access the Internet ($b=-.31$, $t=-2.46$) but PDAs were found to be as easy to use as the desktops (b=.08, $t<1.0$). On the other hand, as expected, PDAs were found to be more fun to use than desktops (b=.93, $t=7.61$) but contrary to our expectations, wireless phones were found to be less fun to use than desktops ($b=-.53$, $t=-3.75$). This shows that respondents perceived significant differences between devices used to access the Internet in terms of their EOU and fun associated with using them.

The results also show strong effects of the EOU of a device on perceptions of the usefulness of a device (b=.73, $t=8.65$) and the extent to which subjects felt the device was fun to use (b=.69, $t=7.91$). Subjects' perceptions of the usefulness of a device had a significant (b=.19, $t=2.17$) direct effect on Aact. Support was also found for significant effects of fun (b=.32, $t=4.86$) on

Aact. This effect was more than two times the effect of usefulness on attitudes ($\beta_{fun \rightarrow Aact}$=.38, $\beta_{usefulness \rightarrow Aact}$=.17), similar to the findings of Childers et al. (2001, p. 254). Further, subjects' Aact significantly influenced their intentions to use the devices (b=.52, t=4.76). To rule out the possibility of direct effects from EOU → Aact, EOU → BI, usefulness → BI, and fun → BI, a modified model that included these paths was estimated. Each of the four additional paths were nonsignificant (t<1.40, p>.10). Thus, the model as hypothesized (shown in the figure) and all of the hypothesized paths therein were supported.

5. Discussion

This is the first known study to have tested TAM in a consumer context where a hedonic construct, Aact, and BI are all included. The results of this experiment provide support for c-TAM and insights into the relative roles of its various components (including fun) in influencing variables of interest to marketers.

There were several findings in this study that support the use of c-TAM as opposed to TAM in consumer contexts. First, unlike what was found in a workplace context (Davis et al., 1992), the fun of using a device was a more powerful determinant of attitudes toward usage than the perceived usefulness of the device. Also, in contrast to previous findings where usefulness was found to have both direct and indirect (through attitudes) effects on BI, usefulness in the present study had no direct effects on BI.

Second, in addition to emphasizing the importance of making devices fun to use, c-TAM provides guidance as to *how* devices can be made more fun to use. Our results suggest that an important way to increase the fun associated with using a device is to make it easy to use. Although in retrospect, this might seem like a simple, intuitive observation, there are many instances of device manufacturers who add "cool" features that are supposed to make the device fun to use but in the process make the device less easy to use. This study reinforces an important point for product designers and marketers that the fun of using a device should not come at the expense of the device being easy to use. If manufacturers do not adhere to this principle, then the benefits of adding fun features may be reduced or even eliminated by the drop in EOU.

Another important result of this study was that consumers who were high on visual orientation found it easier to use devices to access the Internet than those who were low on visual orientation. The theoretical implication is that consumer acceptance of these sorts of technological innovations is related to their visual orientations. The practical implication for firms introducing such devices is to find actionable segmentation variables such as gender and age that can be used as surrogates of high visual processing.

Consumer preference for visual processing is an individual-level characteristic and our results can help firms identify and target groups of consumers who might be more inclined to adopt new devices. For those with low visual orientations, the implications are less clear and further research is necessary to determine if some design features could be used to compensate for their lower inclination to accept the technology.

A limitation of the present study is that it did not determine exactly which specific aspect(s) of a device were responsible for influencing EOU and fun. To be able to do that, devices are needed that are identical on all aspects except one. This is a limitation of most research in this area (e.g., Davis et al., 1989, p. 999). While acknowledging this limitation, it does not in any way compromise the significant findings in this study pertaining to the components of c-TAM or the role of visual style of processing in influencing individual consumers' perceived EOU of devices.

Another limitation of the study was that the model was not tested under different consumer goal conditions. However, the fact that the hedonic component had a more important effect on attitudes than the utilitarian component in a study that encouraged goal-directed behavior suggests that the role of a hedonic component would, if anything, have only increased if a hedonic task had been included in the experiment.

The above findings have significant implications for manufacturers and marketers of consumer Internet devices and highlight one of the contributions of this study. Manufacturers of devices like PDAs and wireless phones that are guided by the basic, stripped-down version of TAM might allocate resources to increasing the usefulness of devices expecting that it will improve purchase intentions, whereas using the more appropriate c-TAM might reveal that the hedonic component plays a more important role in predicting consumer intentions. Similarly, this finding has important implications for m-commerce, too. It suggests that consumers are likely to have favorable attitudes to adopt handheld devices as much or more for the fun they can have with them as for the ability to accomplish certain functions. Hence, marketers may need to emphasize both the fun aspect as well as the usefulness aspect in communication with their target markets.

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Appendix A

Reliabilities and sample items of scales used in experiment[1]

Visual processing (adapted from Heckler et al., 1993, α=.87)
1. When listening to someone describing their experiences, I try to mentally picture what was happening
2. When I think of someone I know, I often "picture" in my mind what they look like

Usefulness (Lund, 1999, α=.88)
1. It helped me be more effective
2. It helped me be more productive

EOU (Lund, 1999, α=.93)

1. It was easy to use
2. I learned to use it quickly

Fun to use (some items adapted from Karson, 2000, α=.92)
1. I had fun using it
2. I found using it to be enjoyable

Aact (Bagozzi et al., 1992; Sawyer and Howard, 1991, α=.91)
For me, using the _____ to _____ is:
1. *bad* (1)/*good* (5)
2. *negative* (1)/*positive* (5)

BI (e.g., MacKenzie et al., 1986, α=.92)
Assuming you have access to such a device in the future, what is the probability that you would use it to accomplish a similar task?
1. unlikely/likely
2. improbable/probable

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[1] Except as noted, all scales used the following Likert-type reponse format: 1 = strongly disagree, 2 = disagree, 3 = neutral, 4 = agree, 5 = strongly agree. The full set of items is available from the authors upon request.