

ADOPTION OF PERSON DIGITAL ASSISTANTS: AN EMPIRICAL STUDY

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Abstract

Despite downturn in economy, mobile commerce or M-commerce is well poised to take off in the US and worldwide. According to Ware (2011) of the Future of Work Institute, about 15 percent of US employees are already considered “mobile”, and this is expected to rise to 25 percent in 2015. Access to mobile network is usually gained through wireless PDAs, smartphones, interactive pagers, and other portable computing devices such as wireless notebook, iPad, wearable computers, etc. This study examined adoption of PDA by individuals. The findings showed that PDA adoption can be well predicted by TAM.

Keywords: *Adoption; M-commerce; Personal Digital Assistants; PDA; TAM*

INTRODUCTION

Portable computing devices with wireless links have been depicted as a new paradigm for computing and communication (Keen, 2001; Zimmerman, 1999). PDAs, cell phones, smartphones and portable computers such as netbooks and tablets are expected to drive mobile commerce and increase organizational reach. A number of recent surveys indicate exponential growth of mobile device adoption (mobileThinking, 2011). Currently 77 percent of the world population is subscribers to one or other mobile devices (mobileThinking, 2011). From a marketer's perspective, people who use mobile devices to access Facebook or similar webpages are twice as likely active as non-mobile users (<http://www.facebook.com/press/info.php?statistics>, 2011). Obviously marketers and vendors have a great interest in adoption of mobile devices by individuals.

This study focuses on PDA adoption. PDA has been used for information management for from library services (Cummings, Merrill, and Borrelli, 2010), to pharmaceutical detailing (Shim, and Viswanathan, 2007), to boundary management resource between work and personal life (Golden and Geisler, 2007), et cetera. They have quickly become tools of trade for information management for knowledge workers in a number of professions, such as education (Koeniger-Donohue, 2008), engineering (Cheng, 2007), nursing (Rodriguez, 2003), medicine (Kim, Yoo, and Kim, 2005), etc.

Except Ching-Chang, Hsing, and Hui-Hsin (2007) and Yi, Fiedler, and Park (2006), there have been few theory-driven empirical research on adoption and use of PDAs

by individuals. Ching-Chang, Hsing, and Hui-Hsin (2007) examine a mobile commerce system in the insurance industry using PDA. They use a modified task-technology fit model to explore the factors affecting the effective adoption of mobile commerce in the insurance industry. Yi, Fiedler, and Park (2006) study the role of individual innovativeness in the acceptance of IT-Based innovations using PDAs. Shim (2004) explores the perceptions of pharmaceutical sales representatives toward the use of personal digital assistants (PDAs) in pharmaceutical detailing but without any theoretical underpinning. Using widely used theoretically grounded technology acceptance model (TAM) we investigate the adoption of PDA by individuals in this study and fill this gap in the literature.

The remainder of the paper is organized as follows. In the next section, we briefly describe what a PDA is and its capabilities. In the following section, we describe our theoretical framework and research model. We then describe the research methodology used and discuss reliability and validity issues. Following this, we present our findings and discuss the results. Finally, we conclude with implications for practice and research.

PERSONAL DIGITAL ASSISTANTS (PDA)

The term personal digital assistant was coined by Apple computer with its introduction of the failed Newton in 1993 (Coyle, 2001). PDAs are highly portable, easy to use computing and communications devices aimed at the mass market. Basic PDAs enable users to organize schedules and contact information, create to-do lists, play music, record memos, track expenses, and jot down notes in their own handwriting (Cassey, 2007). More sophisticated PDAs can run word processing, spreadsheet, and electronic book reading programs and provide e-mail and Internet access. The purpose of a PDA is to help people communicate more effectively and efficiently in an era of global mobile communications.

The PDA really took off with the introduction of Palm Pilot in 1996. PDAs success at that point in time can be attributed to a combination of form and function. Its size lends to its carrying in a shirt pocket or purse. It is easily held in one hand and is capable of running on battery for long periods of time. It offers flexible communications options. It has a stylus (pen-like wand), a miniature keyboard and handwriting recognition technology to simplify data entry. It is bundled with useful software such as calendars, address books, and games. It has the ability to synchronize data with a desktop computer. It is affordable, costing much less than personal computers.

PDAs along with other wireless devices bring three new dimensions to the web: localization, personalization, and immediacy (Coyle, 2001). Localization is the ability to geographically locate wireless devices using either the global positioning system (GPS) or taking advantage of sophisticated cellular triangulation techniques to pinpoint location to within several feet. Wirelessly connected users can enter their

street location on a PDA and receive information about nearby shops, restaurants, etc. Another major advantage of is its ability to immediately deliver or push information to users when they need it rather than when it is requested. Since wireless network providers already track user identity for billing purposes, wireless applications can leverage this information to personalize content based on user preferences and/or patterns of use. These provide businesses new opportunities for building trusted and sustainable relationships with customers and suppliers as well as efficiently utilizing an increasingly mobile workforce.

A MODEL OF PDA ADOPTION BY INDIVIDUALS

Adoption and diffusion of information technologies has been studied extensively in the information systems (IS) research at the individual level. The theoretical models employed to study individual adoption and usage behavior include the theory of reasoned action (TRA), the technology acceptance model (TAM), and the decomposed theory of planned behavior (TPB). When compared to other theoretical models at understanding IS adoption behavior, TAM has been found to have similar or better explanatory power than more sophisticated models, such as TRA and TPB, while at the same time being parsimonious (Taylor and Todd, 1995). Thus, we use TAM to understand the adoption of PDA by individuals in this study (see Figure 1).

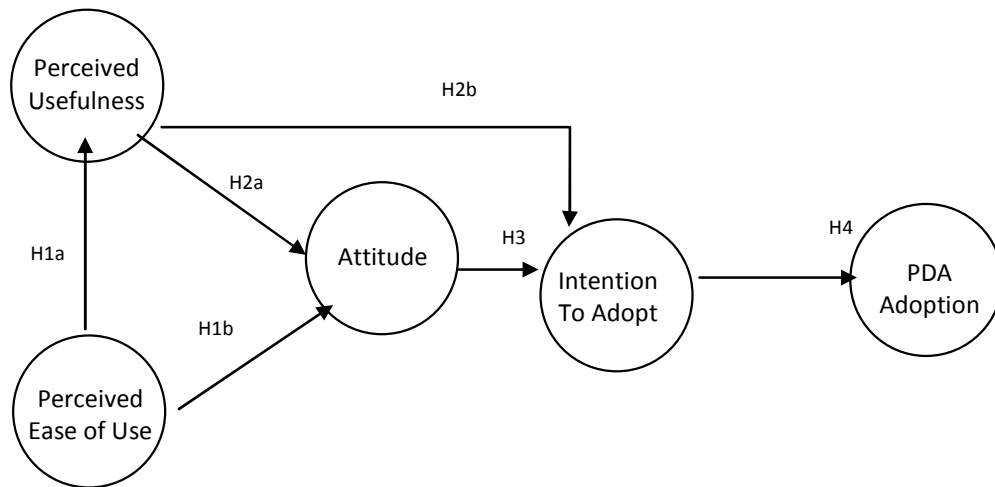
TAM posits perceived ease of use and perceived usefulness as two beliefs that determine users' attitude towards their intention to use and actual usage (Davis, Bagozzi, and Warshaw, 1989). Intention to use is in turn is the sole direct determinant of actual usage. Perceived ease of use is defined as the extent to which a person believes that using the information technology (IT) will be free of effort. Perceived usefulness is defined as the extent to which a person believes that using the IT will enhance his/her job performance. Perceived usefulness has a direct impact on adoption intention. Perceived ease of use has both a direct and indirect effect on attitude, which is defined as the feeling of favorableness or unfavorableness towards using the technology and mediates affective response between beliefs and usage intentions. Our dependent variable is intention to adopt. According to the theory of reasoned action, studies need to be specific in regards to the target behavior of interest. If adoption is of interest, then the dependent variable should be intention to adopt or adoption behavior, intention to use and actual usage.

From a theory testing point of view, PDA is different from many information technologies that have been examined in prior TAM studies. Most of prior studies using TAM have investigated ITs such as mainframe computers, microcomputer technology, personal computing, telemedicine technology, etc, which can be used either stand alone or part of a wired network. While PDAs can be used stand alone, they also provide entry point into a wireless network. PDAs along with cell phones and portable computers are expected to drive mobile commerce and extend the reach of organizations to their customer anywhere, anytime. Despite the large body of existing research on TAM the need for continuing research using TAM remains, as it

is imperative to examine the generalizability of a theory in the context of different technologies in various user populations. There is some evidence that TAM may not be applicable to some technologies in different contexts (Jackson, Chow, and Leitch, 1997; Lucas and Spittler, 1999). In that spirit, we tested the following hypotheses derived from our research model:

- H1a: User's perception of PDA's ease of use will strongly determine his/her perception of its usefulness.
- H1b: User's perception of PDA's ease of use will strongly determine his/her attitude towards using PDA.
- H2a: User's perception of PDA's usefulness will strongly impact his/her attitude towards using PDA.
- H2b: User's perception of PDA's usefulness will strongly impact his intention to adopt it.
- H3: User's attitude towards PDA will strongly determine his/her intention to adopt it.
- H4: User's intention to adopt PDA will strongly determine his/her actual adoption.

FIGURE 1: Model of Individual PDA Adoption



METHODOLOGY

We conducted a survey to test the hypotheses derived from the TAM model. The sample comprised of students in undergraduate and graduate courses in information systems at a mid-western university. A total of 214 students participated in the survey. Table 1 shows the demographic of the survey respondents. As evident from Table 1, the majority (86.9%) of the respondents worked, either part-time or full-

time. Their beliefs about the expected consequences of use should be comparable to business users who use the technology for generic tasks.

Measures of the constructs/variables in TAM were adapted from previous TAM studies (see Table 2). LISREL VIII (Joreskog & Sorbom, 2007) was used to evaluate the reliability and validity of the items. It was also used to test the goodness-of-fit of the research model (Figure 1) against the sample of 214 observations. Chi-square was used to measure the goodness-of-fit of the model. Although the chi-square statistic is a global test of a model's ability to reproduce the sample variance/covariance matrix, it is sensitive to sample size and departures from multivariate normality. For this reason, we also report two other fit measures CFI and NNFI which are generally unaffected by sample size.

RESULTS AND DISCUSSION

Measurement Instruments

Confirmatory factor analysis was used to confirm the results of the measurement model. Parameter estimates and completely standardized parameter estimates for the items are illustrated in Table 3. The completely standardized item-factor loadings are high (all above .70) and significant, as evidenced by their *t*-values (from 8.78 to 18.23). All items had reliability scores (R-square) above .50 (from .53 to 1.00), indicating good reliability. Results of the confirmatory factor analysis confirmed the existence of five constructs. Reliabilities for these constructs varied from 0.82 to 0.89 (see the value in the diagonal cells in Table 2), indicating that each construct performs well (i.e. they are reliable). We also checked for discriminant validity to make sure that these constructs are different. The lower portion of the off-diagonal cells in Table 2 reported the differences between the chi-square values (with one degree of freedom) for the fixed and free solutions. The values range from 58.19 to 308.37. They are greater than 10.83, the critical value for a significant level at 0.01 for ten comparisons, suggesting that the variables exhibit sufficient discriminant validity.

Structural Model

Figure 2 displays the results of the structural analysis corresponding to six hypotheses in Figure 1. Overall, the model provides a good fit (Chi-square = 102.69 with 60 degree of freedom, *p*-value = 0.00050, NNFI = 0.95, CFI = 0.96). In addition, the root mean square error of approximation (RMSEA) is only 0.064, which is satisfactory.

TABLE 1: Demographics

Education	Freq.	A. Percent	Gender	Freq.	Percent
HS Grad	36	16.8	Male	104	48.6
Associate's	17	7.9	Female	107	50.0
Some College	179				
Bachelor's	23	10.7			
Missing	12	5.6	Missing	3	1.4
<i>Total</i>	<i>214</i>	<i>100</i>	<i>Total</i>	<i>214</i>	<i>100</i>
Age	Freq.	Percent	Family Income	Freq.	Percent
<=20	37	17.3	<30K	37	17.3
21-30	145	67.8	\$30K-\$40K	9	4.2
31-40	20	9.3	\$40K-\$50K	13	6.1
41-50	8	3.7	\$50K-\$75K	32	15.0
51 and above	1	.5	>\$75K	100	46.7
Missing	3	1.4	Missing	23	10.7
<i>Total</i>	<i>214</i>	<i>100.0</i>	<i>Total</i>	<i>214</i>	<i>100.0</i>
Work	Freq.	Percent	PDA Adoption	Freq.	Percent
Full-time	67	31.3	Adopter	146	68.2
Part-time	119	55.6	Non-adopter	68	31.8
Don't work	22	10.3			
Missing	6	2.8	Missing	0	0.0
<i>Total</i>	<i>214</i>	<i>100</i>	<i>Total</i>	<i>214</i>	<i>100</i>

FIGURE 2: Structural Coefficients and t-values for TAM

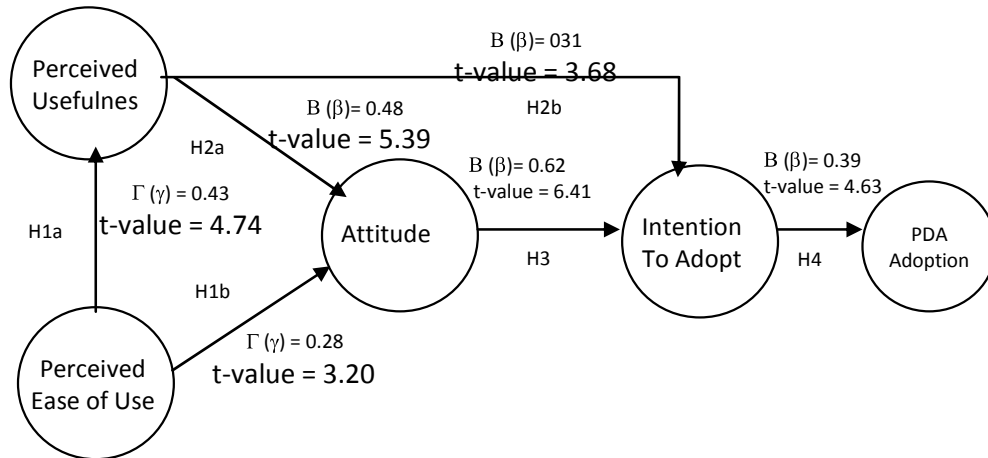


Table 2: Measurement Items (along with The Reliability, Correlation, and Discriminant Validity for the Variables in the Model

	Perceived Ease of Use (PEU, adapted from Davis, et al., 1989)	PEU	PU	ATA	IA
ICEOU1	I believe that it is easy to get the PDA to do what I want it to do.				
ICEOU2	I believe that the PDA is easy to use.				
ICEOU4	I believe that it is not difficult to use the PDA.				
<i>ICEOU3</i>	<i>I believe that learning to operate the PDA is easy for me. ♣</i>	$\alpha = .83$			
Perceived Usefulness (PU, Moore and Benbasat, 1991)					
ICRA2	Using the PDA would improve the quality of my work.				
ICRA3	Using the PDA would make it easier to do my job.				
ICRA5	Using the PDA would give me greater control over my work.				
<i>ICRA1</i>	<i>Using the PDA would enable me to accomplish tasks more quickly.*</i>	.402**			
<i>ICRA4</i>	<i>Using the PDA would enhance my effectiveness on the job. ♣</i>	$\Delta\chi^2 = 170.43$	$\alpha = .89$		
Attitude toward Adoption (ATA, Davis, et al., 1989; Taylor & Todd, 1995)					
BIATD2	Using the PDA is a wise idea.				
BIATD3	I like the idea of using the PDA.				
BIATD4	Using the PDA would be pleasant.	.399**	.529**		
<i>BIATD1</i>	<i>Using the PDA is a good idea.*</i>	$\Delta\chi^2 = 180.15$	$\Delta\chi^2 = 170.05$	$\alpha = .86$	
Intention to Adopt (IA, Taylor & Todd, 1995)					
INTUS1	I intend to adopt the PDA soon.				
INTUS2	I intend to adopt the PDA for my work.	.420**	.584**	.672**	
INTUS3	I intend to adopt the PDA frequently.	$\Delta\chi^2 = 166.13$	$\Delta\chi^2 = 102.30$	$\Delta\chi^2 = 58.19$	$\alpha = .82$
Adoption					
ADPTN	A single item indicating whether the respondent adopted PDA or not.				
	Mean	5.35	5.03	5.58	4.67
	Std. Deviation	1.47	1.71	1.54	1.85

*Items were deleted from the final instrument because of low item-to-total correlation.

♣Items were deleted because of high cross-loading.

**Table 3: Parameter Estimates and t-values for the Variables in the Model
(n=214)**

Items	Factor Loading	t-value	Completely Std. Factor Loading	Uniqueness/Error Term	R-Square (Reliability)
Perceived Ease of Use					
EOU1	1.00*		.73	.47	.53
EOU2	1.20	9.25	.86	.27	.73
EOU3	1.07	8.78	.74	.45	.55
Perceived Usefulness					
U1	1.00*		.83	.32	.68
U2	1.12	13.92	.90	.19	.81
U3	0.94	12.83	.84	.30	.70
Attitude					
A1	1.00*		.77	.41	.59
A2	1.21	11.20	.85	.27	.73
A3	1.12	10.61	.80	.35	.65
Behavioral Intention					
BI1	1.00*		.80	.36	.64
BI2	0.95	10.94	.80	.36	.64
BI3	0.93	10.11	.75	.44	.56
Adoption					
AD1	0.46	18.23	1.00	.00	1.00

* Indicates a parameter fixed at 1.00 in the original solution.

The results indicate that perceived ease of use has strong, positive, and direct relationships with perceived usefulness and attitude. These relationships are shown in hypotheses 1a and 1b, and they have structural coefficients (γ) of 0.43 ($t=4.74$) and 0.28 ($t=3.20$) respectively, which are statistically significant at $p<0.05$. Hypotheses 1a and 1b are supported, indicating that the higher the individual's perceived ease of use of the PDA, the higher the perceived usefulness and the more positive attitude toward the utilization of the PDA.

Perceived usefulness is found to have positive and direct relationship with attitude and behavioral intention with structural coefficients (β) of 0.48 ($t=5.39$) and 0.31 ($t=3.68$) respectively. Both relationships are significant at 0.01 and 0.05 level of significance respectively, supporting hypotheses 2a and 2b.

The results also indicate that attitude has a strong and positive impact on behavioral intention. The relationship has its structural coefficient (β) of 0.62 ($t=6.41$), significant at $p<0.01$, thus supporting hypothesis 3.

Finally, hypothesis 4 is also strongly supported with the structural coefficient (β) of 0.39 ($t=4.63$), confirming that the higher the behavioral intention of using the PDA, the more the users adopt the PDA for their work.

CONCLUSIONS

This study examined the adoption of PDAs by individuals. PDAs along with cell phones and portable computers are expected to drive mobile commerce. PDAs and other mobile devices with wireless connection are being touted to make the ideal of “information availability, anywhere, anytime” possible. The study showed that PDA adoption could be well predicted by TAM.

As any study it has limitations. The study’s sample was limited to students willing to participate in the survey, though this should not be a major weakness of the study as majority (86.9%) of them worked, either part-time or full-time. Thus, their beliefs about the PDA use should be comparable to those using PDAs in business organizations. However, because of the use of a convenient cross-sectional sample, the findings of this study should be carefully used. The research needs to be replicated to examine the robustness of the findings across a wide range of contexts and samples. The future efforts at examining the determinants of individual adoption of PDA should attempt to both broaden the sample base and utilize richer and multiple methodologies such as intensive case studies, longitudinal data gathering, etc., to uncover other artifacts and triangulate their findings.

Understanding PDA adoption has direct implications for the burgeoning mobile commerce as it along with wireless technology has the potential to reach any customer anywhere and make personalized, targeted message distribution possible. The current work provides managers with an understanding of the individuals who could potentially participate in the growing wireless electronic commerce. Factors similar to those important in the adoption of PDAs may be influential in individual adoption of wireless electronic commerce activities. Thus, understanding the adoption patterns and attitudes of individuals may provide a useful mechanism for managing information technology resources associated with an organization’s wireless e-commerce initiative.

PDAs, web-enabled mobile phones, portable computers and pagers/e-mail devices require a major shift in the design, operation, and support of the corporate technology platform, as did the networked PC (Keen, 2001). With the availability of full-fledged business applications for handheld devices, PDAs have become indispensable for businesses and business travelers. Percent of mobile business users is expected to rise from 15 in 2011 to 25 in 2015 (Ware, 2011), who are likely to access wireless data

using a handheld device. Thus, while the current work examines PDA adoption by individuals, the results can also shed light on the deployment of smartphones in organizations.

Personal digital assistants (PDAs) is a comparatively a new information technology, which provides its users the convenience of portability along with the access to the Internet along with horde of information available on it. It combines the features of traditional day planner, calculator, and cell phone which makes available a wealth of information to the users at their fingertips. PDAs are being used in disparate fields from downloading drug and disease databases by physicians and clinicians in medical field for coordination, to helping consumers in their shopping by retailers in supermarket to increase customer loyalty, to helping sailors work more effectively. As with a new information technology, it's important to examine why PDA is being adopted. Using TAM we tried to answer this question in this paper.

ENDNOTES

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