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Abstract

Researchers have extensively and intensively examined Technology Acceptance Model (TAM) for many years. Unfortunately, despite years of research regarding technology acceptance, researchers today still cannot conclusively answer the question raised by Baron and Kenny (1986): "What processes link traits to behavior?" With respect to the role of individual traits within TAM, at least two research streams can be identified. However, they have generated conflicting results. Our study addresses this question by examining the effects of one set of individual traits, technology readiness (TR) which has four dimensions according to Parasuraman (2000), within TAM.

Specially, our research question is about the role of the fours dimensions of TR. We argue that the four dimensions will moderate the hypothesized relationships within TAM. We believe that such a research attempt is a timely response to Venkatesh and Davis's (2000) call for examining major contingency factors that moderate the effects of subjective perceptions on behavior intentions (BI). Data were collected via online survey. Two dimensions of TR, i.e., innovativeness and optimism, were found to interact with perceived usefulness to determine people's intention to accept new technologies. Specifically, perceived usefulness was insignificant to influence behavior intention for people who are either optimistic or innovative with respect to new technologies. Such findings were quite interesting as previous research seldom explored contingencies for the perceived usefulness-behavior intention relationship.

Introduction

Based on the theory of reasoned action (TRA) (Ajzen and Feishbein 1980), Technology Acceptance Model (TAM) (Davis 1989; Davis et al. 1989) is one of the most widely examined models establishing causal relationships between perceived ease of use (PEOU) and perceived usefulness (PU) and intentions to accept new technologies. However, researchers (Agarwal and Prasad 1999; Dabholkar and Bagozzi 2002) argued that TAM failed to explicitly consider a set of important constructs, namely, individual traits. People may accept a new technology because it is easy to use or using it is beneficial. However, is this true for all individual with different traits?

As early as 1986, Baron and Kenny (1986) asked: "What processes link traits to behavior?" Unfortunately, despite years of research regarding technology acceptance, researchers today still cannot conclusively answer the question since prior studies have provided mixed results. Regarding the role of individual traits within TAM, at least two research streams can be identified. The first stream argues that individual traits affect behavior intentions (BI) through direct effects on perceptions (Agarwal and Prasad 1999). The second stream argues for the moderating effects of traits within TAM (Dabholkar and Bagozzi 2002). Interestingly, for the same traits different researchers argued for different effects. For instance, Venkatesh and Davis (1996) argued that computer self-efficacy affects BI indirectly via PEOU. However, Dabholkar and Bagozzi (2002) argued for a moderating effect of self-efficacy. Both studies found empirical support for their arguments. The contradicting conclusions have brought confusions for both researchers and practitioners.

As we have mentioned, previous research has paid limited attention to the effects of personal traits on new technology adoption and, worse of all, extant research has generated confusing

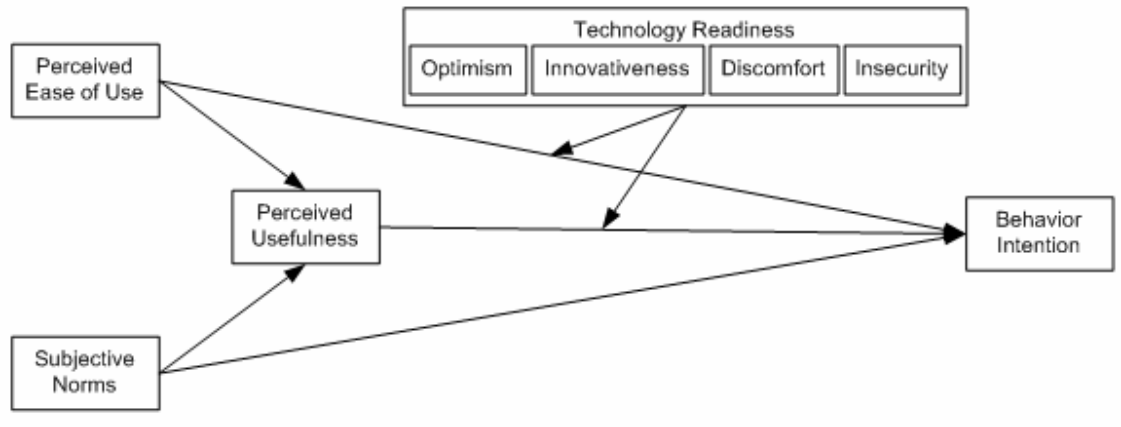
results. Our study addresses the question raised by Baron and Kenny (1986) through examining the effects of one set of individual traits, technology readiness (TR), on people's new technology adoption behaviors. TR was defined as people's propensity to embrace and use new technology for accomplishing goals in home life and at work (Parasuraman 2000). Whereas most studies regarding TAM tend to study *direct effects* of external variables, our study advances theory in yet another important way. We focus on how TR, which has four dimensions according to Parasuraman (2000), i.e. optimism, innovativeness, discomfort, and insecurity, *moderates* the relationships within TAM.

Specifically, our research question is: do the four dimensions moderate the relationships within TAM? If yes, how? We focus on the moderating effects of the four dimensions rather than direct effect for the following reasons. First, as we will elaborate on in a later section, there is a significant body of both theoretical and empirical research that lends support to the moderating effect of four dimensions of TR within TAM. Second, the research model with individual traits as moderating variables within TAM is more appropriate to explore whether the perceptions affect BI to the same extent across all individuals with different degree of technology readiness. Third, since previous research tends to study direct effects of external variables, researchers have called for examination of moderating effects. Venkatesh and Davis (2000), for instance, suggested that, "Further research on TAM…should …continue to map out the major contingency factors moderating the effects of perceived usefulness, perceived ease of use…on intention." We believe that our research attempt is a timely response to Venkatesh and Davis's appeal.

It should be noted that we never claim that there is no direct effect of TR, explicitly or implicitly. Rather, TR may affect perceptions and behavior intentions directly. However, our research focus is the moderating effect of TR within TAM.

Literature Review and Research Model

Figure 1 Research Model



Several theoretical models have been proposed to examine people's acceptance and usage of emerging technologies. Among these models, TAM has been demonstrated by various researchers (Gentry and Calantone 2002; Ventatesh et al. 2003) to be superior to other models such as Theory of Reasoned Action (Ajzen and Feishbein 1980) and Theory of Planned Behavior (Ajzen 1991) to explain people's intention to adopt new technologies. TAM states that intention to use a new technology is fundamentally determined by two specific beliefs, perceived usefulness (PU) and perceived ease of use (PEOU). PEOU refers to "the degree to which a person believes that using a particular system would be free of effort" while PU refers to "the degree to which a person believes that using a particular system would enhance his or her job performance" (Davis 1989). In addition, PU is posited to be affected by PEOU since effort saved due to improved ease of use may be employed to increase performance via enabling a person to accomplish more work with the same effort. However, the original version of TAM does not account for the effects of social influence, which is an important determinate of BI (Ajzen and Feishbein 1980). Here we tap into social influence via subjective norm (SN), defined as a "person's perception that most people who are important to him think he should or should not

perform the behavior in question" (Ajzen and Feishbein 1980). In the TAM version 2 (Venkatesh and Davis 2000), SN was posited to affect PU and BI respectively. Here, we expect the same associations regarding SN. Figure 1 highlights the research model for this study. Attitude is not in our model, which is consistent with previous TAM research (e.g., Davis et al. 1989; Venkatesh and Davis 2000). Actually, Davis et al. (1989) found that attitude only partially mediated the impact of beliefs on intention and that PU only weakly linked to attitude while it strongly directly affected behavior intention.

Technology Readiness Index (TRI)

Parasuraman (2000) finalized a 36-item TRI scale with the above-mentioned four components. Optimism is defined as a positive view of technology and a belief that it offers people increased control, flexibility, and efficiency in their lives. Innovativeness refers to people's tendency to be a technology pioneer and thought leader. Discomfort measures people's perceived lack of control over technology and a feeling of being overwhelmed by it. Insecurity captures people's distrust of technology and skepticism about its ability to work properly.

TRI is conceptualized as a trait, i.e., a relatively stable descriptor of individuals. Traits are generally not influenced by environmental or internal variables. In this respect, TRI is quite different from system-specific variables such as PU and PEOU that may vary across technologies, vendors and situations. In other words, TRI is conceptually distinct from PU and PEOU.

Research Model: Incorporating TRI into TAM

It is viable to incorporate TRI into TAM due to the following reasons. First, both TRI and TAM were proposed to explain technology acceptance (Parasuraman 2000; Davis 1989). Second, they are conceptually different in that TRI accounts for technology acceptance via individuals'

general predispositions while TAM uses system-specific perceptions to explain technology acceptance. Thus, it is theoretically appropriate to integrate TRI into TAM.

As figure 1 illustrates, we focus our analysis on the roles of the four components of TRI in moderating hypothesized relationships within TAM. There has been some theoretical and empirical research indicating the existence of our proposed moderating effects. Dabholkar and Bagozzi (2002) conceptually argued that individual traits would moderate the relationships within TAM. Specifically, Agarwal and Prasad (1998) proposed that PIIT (Personal Innovativeness in the domain of IT) moderates the relationships between perceptions and intention to use new technologies. They failed to empirically support the argument that PIIT moderates PU-BI and PEOU-BI relationships. However, they attributed the lack of moderation of PIIT to world-wide-web specific factors and called for additional studies regarding this issue. With respect to innovativeness, Leonard-Barton and Deschamps (1988) found that personal innovativeness exhibited a negative moderating effect on the relationship between management's urge to use an innovation and individuals' actual use of it. Although there is some theoretical and empirical research that suggests the moderating effects of some components of TRI on hypothesized links within TAM, extant literature captures only part of the domain of TRI. Since TRI is currently the most integrative measure of technology readiness, which has four conceptually different dimensions, it is both theoretically and practically meaningful to investigate in one study the moderating effects of the four dimensions.

Hypotheses

Optimism

A technology optimist believes that new technologies will offer people increased control, flexibility, and efficiency in their lives (Parasuraman 2000), which means they have a

predeterminate positive view of a new technology before they are introduced to a new technology. Accordingly, PU as a determinate of people's intention to accept a new technology is not so salient to technology optimists as it is to technology pessimists. Since technology optimists also tend to need more control in life and are more prestige conscious (Parasuraman and Colby 1997), they would have the intention to accept a new technology no matter how useful the new technology is as long as they would gain the prestige through affiliations with a new technology. Consequently, the PU-BI relationship would be weakened for technology optimists. On the other hand, since technology optimists generally expect things to go their way and consider that good rather than bad things will happen to them (Lee et al. 1993), the PEOU-BI relationship would be attenuated in that technology optimists would have an innate positive perception of new technologies due to the self-confidence in their abilities to master the new technologies.

Hypothesis 1:

a) Optimism will moderate the relationship between perceived usefulness and behavior intention such that the relationship will be weakened for people with high level of optimism.

b) Optimism will moderate the relationship between perceived ease of use and behavior intention such that the relationship will be weakened for people with high level of optimism.

Innovativeness

Individuals high in technology innovativeness have stronger intrinsic motivation to use new technologies and enjoy the stimulation of trying new technologies. Compared with less innovative individuals, innovative individuals would not be greatly concerned about whether the

new technologies are easy to use and may still intend to try them despite the possible difficulties in using them (Dabholkar and Bagozzi 2002). Therefore, PEOU would not be quite so important to them, as it would to individuals low in technology innovativeness, weakening the PEOU-intention relationship would be weakened for innovators (Hypothesis 2a). Also, trying new technologies is arguably associated with great risks and uncertainties. Innovators, however, are able to cope with and prone to higher level of risks and uncertainties (Agarwal and Prasad 1998). Thus, for the same level of new technologies usage intentions, individuals with higher technology innovativeness would require lower levels of positive perceptions like PU, than less innovative individuals. Consequently we have Hypothesis 2b.

Hypothesis 2:

a) Innovativeness will moderate the relationship between perceived usefulness and behavior intention such that the relationship will be weakened for people with high level of innovativeness.

b) Innovativeness will moderate the relationship between perceived ease of use and behavior intention such that the relationship will be weakened for people with high level of innovativeness.

Discomfort

People who are highly uncomfortable with technologies believe that they are controlled by technologies and that technologies are not designed for ordinary people (Parasuraman 2000). Furthermore, individuals with low comfort using new technologies are associated with relatively great complexities and uncertainties (Gefen et al. 2003). Thus, to achieve the same level of intention to use a new technology, it must be much easier for them to use than for those with higher comfort level. Hence we have Hypothesis 3b. Similarly, to have the same level of

behavior intentions, these individuals must believe that that using new technologies is useful to a greater extent than those with higher level of comfort do. Thus, the PU-BI relationship will be strengthened for those with low comfort level.

Hypothesis 3:

a) Discomfort will moderate the relationship between perceived usefulness and behavior intention such that the relationship will be strengthened for people with high level of discomfort about technologies.

b) Discomfort will moderate the relationship between perceived ease of use and behavior intention such that the relationship will be strengthened for people with high level of discomfort about technologies.

Insecurity

Since Individuals high in insecurity lack confidence in the security of new technologies and need for assurance (Parasuraman and Colby 1997) and individuals with high insecurity are skeptical about technologies' ability to work properly, only when they believe that they would greatly benefit from using new technologies are they willing to taking the risk in doing so. Accordingly, the PU-BI relationship would be strengthened (Hypotheses 4a). Similarly, PEOU would be more important for those with high in insecurity level to use new technologies. Since they are inherently unconfident in new technologies, an easy-to-use new technology would encourage them to adopt it and establish confidence afterwards. In addition, a hard-to-use new technology might insinuate that the vendor is hiding something through an unnecessarily intricate interface (Gefen et al. 2003), which will further deter them from using it. Consequently, the PEOU-BI relationship would be strengthened (Hypothesis 4b).

Hypothesis 4:

a) Insecurity will moderate the relationship between perceived usefulness and behavior intention such that the relationship will be strengthened for people that are highly insecurity about technologies.

b) Insecurity will moderate the relationship between perceived ease of use and behavior intention such that the relationship will be strengthened for people that are highly insecurity about technologies.

Research design

Two studies were conducted to test the research model. Undergraduates of business school in a local university were chosen in both studies as our research subjects. We chose them because: 1) subjects in both studies were being introduced to new technologies; 2) before the introduction of the new technologies, subjects in both studies had no prior knowledge of the technologies; 3) use of the new technologies was voluntary for subjects in both studies and subjects could use other means to realize the same functions provided by the new technologies to which they were introduced; and 4) the two technologies to which subjected were introduced represent two different types of technologies—one technology is an Internet-based information system and another is an ordinary statistical program.

Online survey was used to collect data. Online survey has several advantages over traditional paper-based mail surveys: lower costs and faster responses (Bhattacherjee 2001; Tan and Teo 2000). In addition, online survey is gaining acceptance in IS research (Bhattacherjee 2001; Tan and Teo 2000). The whole system used to collect data was developed by the first author. Subjects can quit the survey at any time while they were using the system. No default values were set for any questions. If the subjects click the submit button, JavaScript was used to check whether they complete every questions on the screen. Once they miss any question, they were told the number

of question they miss and subsequently the cursor focuses on the question. The design and organization of the web pages were carefully designed so that subjects were comfortable about the online survey. Pilot test was used and several rounds of revisions were made based on feedbacks.

Study 1

Subjects were 600 first-year undergarduates who were being introduced to an e-learning system. It is an Internet-based server software that is adopted as a teaching platform of many courses provided by a local university. Students can logon the system to download lecture notes, communicate with their peers and course instructors, share documents with their project teammates, and post announcement. The subjects received two sessions of training with two hours each session and one session each week. One hundred and thirteen subjects completed the online survey.

Study 2

Subjects were 120 second-year undergraduates who were being introduced to a statistical program. Students can sue the program to conduct a wide range of data analysis such as regression. The subjects received three sessions of training with two hour each session and one session each week. Eighty eight subjects submitted the online survey.

Measurement

PU, PEOU, and BI were measured using items adapted from Davis (1989). Items measuring subjective norm were from Taylor and Todd (1995) and TRI from Parasuraman (2000) (See appendix). We measure all these constructs using 5-point Likert scale (strongly disagree=1, strongly agree=5).

Procedure

The same procedure was used in both studies. Since subjects were in different classes, one researcher went to each class room just before class begins, briefly introduced our research project to the students, and told them the address of the online survey. Only one researcher was present in each classroom. In case of study 1, after the students logon the e-learning system, they would see an announcement that was hyperlinked to the online survey website. The online survey was available only three weeks after they were introduced to the new system and it lasted for one week for each study.

Sample characteristics were shown in table 1. On average, the sample includes individuals who have reasonable years of computer experience and are thus likely to possess well-formed beliefs regarding new technologies in general. About 60% of the sample is female in both studies, which is typical of the college of business student body at this university. It is not surprising that on average subjects in study 2 are one year older than those in study 1 and that have more computer experiences considering that subjects in study 1 are first-year undergraduates while those in study 2 are second-year undergraduates.

Table 1 Sample characteristics

	Pooled			**Study 1**			**Study 2**		
	Mean	**S. D.**	**Missing**	**Mean**	**S. D.**	**Missing**	**Mean**	**S. D.**	**Missing**
Age	20.31	2.634	0	19.81	1.313	0	20.84	1.082	0
COM_EXP	7.21	2.494	0	7.09	2.214	0	7.50	2.393	0
Gender	Female 61.9%		0	Female 61.1%		0	Female 58%		0
	Male 38.1%			Male 38.9%			Male 42%		

Note:

1) COM_EXP=Computer Experience
2) age, COM_EXP are number of years
3) Subjects in study 1 are first-year undergraduates while those in study 2 are second-year undergraduates.

Data Analysis

Assessment of reliability and validity

To analyze the psychometric properties of the perceived usefulness, perceived ease of use, subjective norm, optimism, innovativeness, insecurity, discomfort, and behavior intention, the data was pooled across the two studies. The reliability coefficient (Cronbach's alpha) was found to be greater than 0.80 for perceived ease of use (α =0.8628), perceived usefulness (α =0.9168), subjective norm (α =0.8305), behavior intention (α =0.8938), and innovativeness (α =0.85). Reliability was poor for the other constructs. After deleting certain items, reliability was moderate for optimism (α=0.6869) and insecurity (α =0.6762) and reliability was still poor for discomfort (α=0.59). Thus, the construct of discomfort was deleted from all following data analyses.

Factor analysis with varimax rotation was performed to ascertain that perceived usefulness, perceived ease of use, subjective norm, optimism, innovativeness, insecurity, and discomfort are distinct constructs. The criteria used to identify and interpret factors were: each item should load greater than 0.3 on one factor and less than 0.3 on other factors. Those items that didn't satisfy the criteria were deleted. As a result, 6 items were retained for innovativeness, 7 items for insecurity, and 4 items for optimism. Appendix 2 presents factor loadings for the remaining items as well as the alpha values for each construct. Except for only four items, all items had high loadings on only one factor. These results therefore confirm that each of these constructs is unidimensional and distinct and that all items used to operationalize a particular construct loaded onto a single factor. Reliability for the final scale presented in appendix 2 to measure insecurity and optimism is 0.6485 and 0.6215 respectively, which were considered moderate. Thus, the two constructs were retained in the following data analyses.

Descriptive statistics for the research constructs were shown in table 2. The results suggest that although the students are generally optimistic about technology (mean=3.69), they also experience a considerable amount of insecurity concerning its role (mean=3.54). Analysis results showed that means are not significantly different (at the 0.05 level, two tailed) in terms of the innovativeness, insecurity, optimism, and computer experience level across the two studies. Accordingly, data were pooled across the two studies when we tested our research model. Inter-construct correlations were presented in table 3.

Table 2 Descriptive statistics

	Pooled		**Study 1**		**Study 2**	
	Mean	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
INN	2.7131	.74855	2.7891	0.75166	2.6155	0.73733
INS	3.5437	.54167	3.5322	0.53563	3.5584	0.55207
OPT	3.6940	.51141	3.6394	0.53654	3.7642	0.47093
PEOU	3.3806	.79964	3.7765	0.5876	2.8722	0.74856
PU	3.3781	.76080	3.3496	0.75114	3.4148	0.77579
BI	3.9378	.82756	4.2212	0.70374	3.5739	0.83577
SN	3.6045	.65881	3.5619	0.6585	3.6591	0.65892

Table 3 Inter-Construct Correlations

	COM_EXP	AGE	INN	INS	OPT	SN	PEOU	PU	BI
COM_EXP	1								
AGE	.102	1							
INN	.258**	.054	1						
INS	-.066	-.112	-.158*	1					
OPT	.193**	.182**	.176*	.083	1				
SN	-.015	.092	-.095	-.013	.236**	1			
PEOU	.137	-.105	.284**	-.106	.019	.128	1		
PU	.046	.116	.119	-.117	.329**	.269**	.289**	1	
BI	-.006	-.118	.162*	.042	.111	.150*	.530**	.475	1

Note:

1) COM_EXP=Years of Computer experience, INN=Innovativeness, INS=Insecurity, OPT=Optimism, SN=Subjective Norm, PEOU=Perceived Ease of Use, PU=Perceived Usefulness, BI=Behavior Intention;

2) * Correlation is significant at the 0.05 level (2-tailed), ** Correlation is significant at the 0.01 level (2-tailed).

Results

Arnold distinguished between differential validity and differential prediction as definitions of moderation (Arnold 1982; Arnold 1984). If the degree of relationship between variables varies with a third variable a situation of differential validity obtains while if the form of relationship varies with the third variable a situation of differential prediction obtains. The definition of moderation used in this study is that of differential prediction since we explored the question of whether personal traits, specifically technology readiness, and perceptions interact to determine behavior intention. Moderation defined as differential prediction has appeared in IS literature (Carte and Russell 2003).

To obtain the path coefficients required to test the research model, iterations of multiple linear regressions were performed. The three demographic variables, i.e. age, gender (0=female, 1=male), and years of computer experience served as control variables in all regression analysis so that the conclusions on technology acceptance wouldn't be confounded by demographics. To reduce the threat of multicollinearity in regression models, all variables were standardized. The interaction terms were calculated by multiplying the standardized scores of the two variables concerned. Several steps were used to test the moderating effects of optimism, innovativeness, and insecurity. First, behavior intention was regressed on perceived usefulness, perceived ease of use, subjective norm, optimism, innovativeness, and insecurity. The model served as main effect model with which various interaction models were compared. Then, multiple regression was run with the interaction effect. The results were presented in table 4. Effect size f^2 was calculated in the same way as it was in the paper by Chin et al. (1996).

$$f^2 = [R^2 \text{ (interaction model)} - R^2 \text{ (main effects)}] / R^2 \text{ (interaction model)}.$$

Table 4 Multiple Regression of Main Effect model and Interaction Model

(a)

	Main Effect	Main Effect + Interaction		Main Effect	Main Effect + Interaction
Intercept	0.0000	0.0022	Intercept	0.0000	0.0398
OPT	.101+	.121*	OPT	-0.0507	-0.0436
PEOU	.528***	.574***	PU	.492***	.485***
OPT × PEOU		-.112+	OPT × PU		-.122*
R^2	0.291	0.305	R^2	0.228	0.244
Δ R^2		0.014	Δ R^2		0.016
Effect size		0.0459	Effect size		0.066

(b)

	Main Effect	Main Effect + Interaction		Main Effect	Main Effect + Interaction
Intercept	0.0000	0.0276	Intercept	0.0000	0.0151
INN	0.0127	0.0173	INN	.107+	.108+
PEOU	.526***	.520***	PU	.463***	.434***
INN × PEOU		-0.0975	INN × PU		-.127*
R^2	0.281	0.29	R^2	0.237	0.252
Δ R^2		0.009	Δ R^2		0.015
Effect size		0.031	Effect size		0.06

(c)

	Main Effect	Main Effect + Interaction		Main Effect	Main Effect + Interaction
Intercept	0.0000	-0.0036	Intercept	0.0000	-0.0076
INS	0.0987	0.0975	INS	0.0985	0.103
PEOU	.540***	.545***	PU	.487***	.493***
INS × PEOU		-0.0345	INS × PU		-0.065
R^2	0.29	0.292	R^2	0.235	0.24
Δ R^2		0.002	Δ R^2		0.005
Effect size		0.007	Effect size		0.021

Note:

1) Numbers in the table represent B coefficients. + p<0.10, * p<.05, ** p<0.01, *** p<0.001
2) Dependent variable: behavior intention

Table 5 summarized the results from the multiple regressions (see details in table 4). Further

examination of the several sets of hypotheses suggested that technology-related optimism moderated the relationship between perceived usefulness and behavior intention and that technology-related innovativeness also moderated the relationship. However, no contingencies were found for the perceived ease of use and behavior intention prelateship.

Table 5 Results for Hypotheses 1 to 4

Hypothesis	Hypothesized direction of moderation	Results
Hypothesis 1a	Optimism weakens the PU-BI relationship	Supported
Hypothesis 1b	Optimism weakens the PEOU-BI relationship	Not Supported
Hypothesis 2a	Innovativeness weakens the PU-BI relationship	Supported
Hypothesis 2b	Innovativeness weakens the PEOU-BI relationship	Not Supported
Hypothesis 3a	Discomfort strengthens the PU-BI relationship	
Hypothesis 3b	Discomfort strengthens the PEOU-BI relationship	
Hypothesis 4a	Insecurity strengthens the PU-BI relationship	Not Supported
Hypothesis 4b	Insecurity strengthens the PEOU-BI relationship	Not Supported

Note: the effects of discomfort were not examined due to low reliability of the construct

Moderating role of Optimism

As is shown in table 4(a), optimism moderates the relationship between perceived usefulness and behavior intention. Specifically, optimism will weaken the perceived usefulness-behavior intention relationship as the interaction term coefficient was -0.122. The interaction effect has an effect size of 0.07. The sample was split based on the median of optimism. Multiple linear regressions were run separately for the two groups. Perceived usefulness was found insignificant for the high-optimism group, which further confirms the moderating effect of optimism on perceived usefulness-behavior intention relationship. Table 6 presents the results. Thus the hypothesis 1a was supported.

On the other hand, the interaction of perceived ease of use and optimism adds lightly to the variance explained (as shown by the improvement over the R^2 without the interaction). However,

the interaction effect was more likely to be a chance effect (at p<0.10 level).Thus, optimism seems not to moderate the relationship between perceived ease of use and behavior intention. Thus the hypothesis 1b was not supported.

Table 6 Multiple Regression between groups

	group with very low innovativeness	Group with very high innovativeness	group with low optimism	group with high optimism
(Constant)	-0.031	-.137	-0.033	-0.030
SN	0.055	0.075	0.014	0.055
PEOU	.420***	.317*	.428***	.398***
PU	.422***	-0.069	.460***	.154
SEX	0.044	.617+	0.098	.180
AGE	-.138	-.320*	-.157+	-.175
COM_USA	-0.073	0.033	-0.051	-0.021

Note:

1) Numbers in the table represent B coefficients. + p<0.10, * p<.05, ** p<0.01, *** p<0.001.
2) COM_USAG=Years of Computer experience, SN=Subjective Norm, PEOU=Perceived Ease of Use, PU=Perceived Usefulness
3) Groups were divided based on innovativeness and optimism separately

Moderating role of innovativeness

The results in table 4(b) showed that the interaction of "innovativeness × perceived usefulness" was significant at the 0.05 level with effect size of 0.03, which means innovativeness interacts with perceived usefulness to influence behavior intention. The hypothesis 2a was supported.

Negative coefficient of the interaction term (-0.123) means that innovative will attenuate the relationship between perceived usefulness and behavior intention. Thus, it can be expected that for those people with certain level of innovativeness, whether a new technology is useful is not important for them to accept the new technology. To check whether perceived usefulness will change into non-significant to explain behavior intention, respondents were divided into two groups based on whether their innovativeness scores are higher than median or not. Multiple regression with behavior intention regressing on perceived usefulness, perceived ease of use,

subjective norm, age, computer experience, and gender. Perceived usefulness was found significant in both groups at the 0.05 level. To check whether perceived usefulness has different roles in explaining behavior intention for those with *very* high innovativeness and those without, subjects were then divided into two groups based on 75% percentile of innovativeness. Multiple linear regressions were run for these two groups respectively. Results were reported in table 6. As can be seen from the table, perceived usefulness was not significant for those with very high technology innovativeness.

Unfortunately, innovativeness dose not interact with perceived ease of use to influence behavior intention. Thus, the hypothesis 2b was not supported.

Role of Insecurity

Insecurity was found not to interact with either perceived ease of use or perceived usefulness to determine behavior intention as was shown in table 4(c). Actually, adding interaction term "Perceived Ease of Use × Insecurity" does not increase R^2. And adding interaction term "Perceived Usefulness × Insecurity" only slightly increases R^2. Therefore, hypotheses 4a and 4b were not supported.

Discussions and conclusions

Motivated by the need to better understand the role of personal trait in people's acceptance of new technologies, the study incorporated a set of variables (innovativeness, optimism, insecurity, and discomfort) that were combined to measure a person's general attitude toward new technologies into technology acceptance model. In TAM literature, perceived usefulness has been consistently found a significantly determinant of behavior intention (Agarwal and Karahanna 2000; Davis et al. 1989; Venkatesh and Davis 2000; Venkatesh et al. 2003). However, in this research it was demonstrated that for people with certain personal traits to accept new

technologies perceived usefulness does not matter. Specifically, for those people who are highly innovative and optimism with respect to new technologies, whether they accept a new technology or not is regardless of their perceptions of whether the technology is useful for their work.

This study partially supports Agarwal and Prasad's (1998) predictions. They predicted that of personal innovativeness in the domain of information technology (PIIT), a construct similar to innovativeness within TRI, will moderate the relationship between perceived ease of use and behavior intention as well as the relationship between perceived usefulness and behavior intention. However, in their study, they failed to find moderating effects of PIIT on the two relationships. They provided a possible explanation that people quite well know the ease of use and usefulness of World Wide Web renders the moderating effects of PIIT as nonsignificant. In case of a technology new to people as it is in this study, technology innovativeness will play a moderate role in the relationships between perceptions and behavior intention. However, since this study still fails to find moderating effect between perceived ease of use and behavior intention, Agarwal and Prasad's predictions were only partially supported.

Out of the six hypothesized moderation only two were supported. However, it should be noted that this does not simply mean that moderations of the other six do not exist. In fact, researchers have demonstrated that the ability to detect a true moderating effect will always be lower than anticipated when the measure of the independent variables is not perfectly reliable (Arnold 1982; Busemeyer and Jones 1983). As was illustrated by Arnold, with the sample size of 200 and with the reliability of the independent variable at 0.7, the probability to detect a moderating effect when it exists is below 0.7 (Arnold 1982). Considering that the construct of insecurity has a little bit low reliability, insecurity may actually interact with perceived ease of use and perceived

usefulness to determine behaviors intention to adopt new technologies, and we simply do not have the power to detect the moderating effects. The same may be true for our hypothesized moderating effect of optimism on the PEOU-BI relationship.

Implications for theory and research

The study contributes to TAM research in the following ways. First, the research identifies important individual traits and examines their effects on behavior intentions so that we can better understand technology adoption. Second, this research furthers our understanding of technology acceptance by mapping out major contingency factors. Our study also contributes to TRI research as it is among the first studies combining TRI and TAM and it demonstrates the implications of TRI for both IS and marketing research.

Managerially, new technology vendors could customize their services to their targeting market segments based on different degrees of technology readiness of their users. This model proves that the drivers of technology acceptance differ for people with different personal traits. Accordingly, managers should employ different marketing strategies based on characteristics of target customers of a new technology. Specifically, in case that the potential customers of a new technology are those who are highly innovative or optimistic, managers should not emphasis much on the usefulness of the new technology to its potential customers. Rather this research demonstrates that they should emphasize on how the new technology can be used without much effort. Researchers always recommend that practitioners should emphasize on the utility that new system can bring to its customers regardless personal traits of customers. Implication from this study is that ease of use is equally important. Furthermore, in certain cases, the effect of perceived ease of use renders perceived usefulness unimportant! As for software engineers, well before they develop a new system, this research shows that it is critical to make clear who are the

potential customers and what are their characteristics. If potential users of a system are technology innovators or optimists, even from the stage of system design on, system engineer should emphasize on decreasing the efforts needed to use the system. Even in the first stage of system development —system analysis, this study suggests one more job for system analysts: to understand the individual traits of the potential customers of the new system if system analysts want the system to be accepted.

Limitation and Future research

Incorporating the technology readiness index is the first step toward better understanding technology acceptance across people with different traits. Future research should continue to explore the contingencies within TAM. First of all, due to low reliability, discomfort was not examined in the study. Future study should explore the effects of discomfort. Second, the data for this study were collected from students. Future studies should try to validate the findings of this study in organizational setting. Last, Zeithaml et al. (2002) predicted that TRI will moderate the relationship between e-service quality and e-shopping behavior. According to Zeithaml et al. (2000), perceived e-Service Quality has the component of perceived ease of use as represented in "ease of navigation" and the component of perceived usefulness as represented in "price knowledge" and "customization/personalization". Thus, future research would examine the predicted moderating effects of TRI on relationships between perceived ease of use and online shopping behaviors as well as on that between perceived usefulness and online shopping behaviors.

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Reference

Agarwal, R., and Prasad, J. "A conceptual and operational definition of personal innovativeness in the domain of information technology," *Information Systems Research* (9:2) 1998, pp 204-215.

Agarwal, R., and Prasad, J. "Are individual differences germane to the acceptance of new information technologies?" *Decision Sciences* (30:2) 1999, pp 361-391.

Agarwal, R., and Karahana, E. “Time files when you’re having fun: cognitive absorption and beliefs about information technology usage,” *MIS Quarterly* (24:4) 2000, pp665-694

Ajzen, I., and Fishbein, M. *Understanding attitudes and predicting social behavior.* Prentice Hall, Englewood Cliffs, NJ, 1980.

Arnold, H.J. "Moderator variables: a clarification of conceptual, analytic, and psychometric issues," *Organizational Behavior and Human Performance* (29:2) 1982, pp 143-174.

Arnold, H.J. "Testing moderator variable hypotheses: a reply to Stone and Hollenbeck," *Organizational Behavior and Human Performance* (34:2) 1984, pp 214-224.

Baron, R.M., and Kenny, D.A. "The moderator-mediator variable distinction in social psychological research: conceptual, strategic, and statistical considerations," *Journal of Personality and Social Psychology* (51:6) 1986, pp 1173-1182.

Bhattacherjee, A. "Understanding information systems continuance: an expectation-confirmation model," *MIS Quarterly* (25:3) 2001, pp 351-370.

Busemeyer, J.R., and Jones, L.E. "Analysis of multiplicative combination rules when the causal variables are measured with error," *Psychological Bulletin* (93) 1983, pp 549-562.

Carte, T.A., and Russell, C.J. "In pursuit of moderation: nine common errors and their solutions," *MIS Quarterly* (27:3) 2003, pp 479-501.

Chin, W.W. "The partial least squares approach for structural equation modeling," in: *Modern methods for business research,* G.A. Marcoulides (ed.), Lawrence Erlbaum Associates, 1998, pp. 295-336.

Chin, W.W., and Gopal, A. "Adoption intention in GSS: relative importance of beliefs," *DATABASE for Advances in Information Systems* (26:2-3) 1995, pp 42-64.

Chin, W.W., Marcolin, B.L., and Newsted, P.R. "A partial least squares latent variable modeling approach for measuring interaction effects: results from a Monte Carlo simulation study and voice mail emotion/adoption study," Proceedings of the Seventeenth International Conference on Information Systems, Cleveland, Oh, 1996, pp. 21-41.

Dabholkar, P.A., and Bagozzi, R.P. "An attitudinal model of Technology-based self-service: moderating effects of consumer traits and situational factors," *Journal of the Academy of Marketing Science* (30:3) 2002, pp 184-201.

Davis, F.D. "Perceived usefulness, perceived ease of use, and user acceptance of information technology," *MIS Quarterly* (13:3) 1989, pp 319-340.

Davis, F.D., Bagozzi, R.P., and Warshaw, P.R. "User acceptance of computer technology: a comparison of two theoretical models," *Management Science* (35:8) 1989, pp 982-1003.

Gefen, D., Karahanna, E., and Straub, D.W. "Trust and TAM in online shopping: an integrated model," *MIS Quarterly* (27:1) 2003, pp 51-90.

Gentry, L., and Calantone, R. "A comparison of three models to explain shop-bot use on the web," *Psychology & Marketing* (19:11) 2002, pp 945-956.

Lee, C., Ashford, S.J., and Jamieson, L.F. "The effects of type A behavior dimensions and optimism on coping strategy, health, and performance," *Journal of Organizational Behavior* (14: 2) 1993, pp 143-157.

Lee, D., Park, J., and Ahn, J. "On the explanation of factors affecting e-commerce adoption," Proceedings of the twenty-second International Conference on Information Systems, New Orleans, Louisiana, 2001.

Leonard-Barton, D., and Deschamps, I. "Managerial influence in the implementation of new technology," *Management Science* (34:10) 1988, pp 1252-1265.

Parasuraman, A. "Technology Readiness Index (TRI): a multiple-item scale to measure readiness to embrace new technologies," *Journal of Service Research* (2:4) 2000, pp 307-320.

Parasuraman, A., and Colby, C.L. "Correlates and consequences of consumer attitudes toward new technologies: implications for marketing technology bases services," Paper presented at 1997 Frontiers in Services Conference, Nashville, TN, 1997.

Tan, M., and Teo, T.S.H. "Factors influencing the adoption of Internet banking," *Journal of the Association for Information Systems* (1:5) 2000, pp 1-51.

Taylor, S., and Todd, P.A. "Understanding information technology usage: a test of competing models," *Information Systems Research* (6:2) 1995, pp 144-176.

Venkatesh, V., and Davis, F.D. "A model of the antecedents of perceived ease of use: development and test," *Decision Science* (27:3) 1996, pp 451-480.

Venkatesh, V., and Davis, F.D. "A theoretical extension of the technology acceptance model: four longitudinal field studies," *Management Science* (45:2) 2000, pp 186-204.

Ventatesh, V., Gorris, M. G., Davis, G.B., and Davis, F.D. "User acceptance of information technology: toward a unified view," *MIS Quarterly* (27:3) 2003, pp 425-478.

Wold, H. "Introduction to the second generation of multivariate analysis," in: *Theoretical Empiricism,* H. Wold (ed.), Paragon House, New York, 1989, pp. vii-xi.

Zeithaml, V.A., Parasuraman, A., and Malhotra, A. "Service quality delivery through web sites: a critical review of extant knowledge," *Journal of the Academy of Marketing Science* (30: 4) 2002, pp 362-375.

Zeithaml, V.A., Parasuraman, A., and Malhotra, A. "e-service quality: definition, dimensions and conceptual model," Working paper. Marketing Science Institute, Cambridge, MA. 2000

Appendix 1: Questionnaire Items

TRI[1]

Innovativeness

INN1	Other people come to me for advice on new technologies
INN2	It seems my friends are learning more about the newest technologies than I am
INN3	In general, I am among the first in my circle of friends to acquire new technology when it appears
INN4	I can usually figure out new high-tech products and services without help from others
INN6	I enjoy the challenge of figuring out high-tech gadgets
INN7	I find I have fewer problems than other people in making technology work for me

Insecurity

INS3	If I provide information to a machine or over the Internet, I can never be sure it really gets to the right place

[1] These questions comprise the technology readiness index which is copyrighted by A. Parasuraman and Rockbridge Associates, Inc., 1999. This scale may be duplicated only with written permission from the authors.

INS4	I do not consider it safe giving out a credit card number over a computer
INS5	I do not consider it safe to do any kind of financial business online
INS6	I worry that information I send over the Internet will be seen by other people
INS7	I do not feel confident doing business with a place that can only be reached online
INS8	Any business transaction I do electronically should be confirmed later with something in writing
INS9	Whenever something gets automated, I need to check carefully that the machine or computer is not making mistakes
Optimism	
OPT1	Technology gives people more control over their daily lives
OPT3	I like the idea of doing business via computers because I am not limited to regular business hours
OPT6	Technology makes me more efficient in my occupation
OPT8	Technology gives me more freedom of mobility
Behavior Intention	
BI1	Assuming I have access to XXX[2], I intend to use it.
BI2	Assuming I have access to XXX, I predict that I would use it.
Perceived Usefulness	
PU1	Using XXX improves my performance in my studies
PU2	Using XXX in my studies increases my productivity
PU3	Using XXX enhances my effectiveness in my studies
PU4	I find XXX to be useful in my studies
Perceived Ease of Use	
PEOU1	My interaction with XXX is clear and understandable
PEOU2	Interacting with XXX does not require a lot of my mental effort
PEOU3	I find XXX to be easy to use
PEOU4	I find it easy to get XXX to do what I want it to do
Subjective Norm	
SN1	People who influence my behavior think that I should use XXX
SN2	People who are important to me think that I should use XXX

Appendix 2: Principal Component Analysis with Varimax Rotation: Pooled Across Studies (Loadings below .30 are not shown)

	Component					
	Innovativeness	**Perceived Usefulness**	**Perceived Ease of Use**	**Insecurity**	**Optimism**	**Subjective Norms**
INN1	.833					
INN7	.796					
INN4	.770					
INN3	.734					

[2] 2 XXX would be replaced with the name of the technology when the survey was conducted.

INN6	.694					
INN2*	.533					
PU2		.887				
PU3		.869				
PU4		.825				
PU1		.813				
PEOU3			.871			
PEOU2			.833			
PEOU1			.812			
PEOU4			.685			
INS5				.726		
INS4				.666		
INS8				.653		
INS7				.531		
INS3				.467		
INS6				.433		
INS9				.381		
OPT8					.741	
OPT6					.700	
OPT1					.654	
OPT3					.477	
SN2						.839
SN1						.835
Cronbach's α	0.8422	0.9168	0.8628	0.6485	0.6215	0.8305

*This item was reversed when we did the analysis.