Making Sound Adoption Decisions: A Longitudinal Study of Mindfulness in Technology Adoption and Continued Use

Completed Research Paper

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Abstract

A lot of research has been conducted to study what drives people to adopt technologies. Yet, an equally, if not more, important question is how to make sound adoption decisions. This research investigates this question from a mindfulness perspective. Based on the mindfulness literature, this research defines mindfulness in the context of technology adoption and conceptualizes it as a multi-faceted formative factor. A research model of mindfulness is developed to delineate how mindfulness influences the soundness of technology adoption decisions, including the influence of mindfulness at both the adoption and post-adoption stages. The model was examined by a longitudinal empirical study and the data largely supported the model. The results suggest that mindfulness can help individuals make sound adoption decisions, which are somewhat crystallized at the post-adoption stage through high (i.e., positive) disconfirmation, user satisfaction, modified beliefs, and intention to continue. The results have implications for IS research and practices.

Keywords: Mindfulness, technology adoption and continuance, longitudinal study, survey

Introduction

A lot of effort has been put into studying what drives people to adopt a technology (e.g., Davis 1989; Thompson et al. 1991; Venkatesh and Davis 2000; Venkatesh et al. 2003). Yet, an equally important topic that has been under-investigated is how to make *sound* adoption decisions. People usually need to invest time, resources, and computing resource when making the decision to adopt a technology. Sometimes, such investments could be substantial and irreversible (i.e., sunk costs). However, limitations in time, experience, and knowledge make it hard to correctly evaluate a technology. Moreover, the benefits of a technology may be uncertain at the time of its adoption and the soundness of the adoption decision often takes time to unfold (Walden and Browne 2009). As a result, it is not uncommon for people to adopt inefficient technologies, which later turn out to be disappointing and unsatisfactory (Abrahamson 1991). Making a wrong decision also means opportunity costs: the missed opportunity to reap the benefits of a more efficient technology. Thus, it is important to understand how to make sound adoption decisions, often crystallized at the post-adoption stage.

This research investigates the soundness of technology adoption from a mindfulness perspective. Mindfulness has been defined as a state of alertness and lively awareness (Langer 1989b). It has been shown in various areas that mindfulness is needed for making sound decisions and for achieving long-term benefits (Shapiro et al. 2006). Existing information systems (IS) research has studied mindfulness primarily at the organizational level (e.g., Butler and Gray 2006; Fichman 2004; Goswami et al. 2009; Swanson and Ramiller 2004). Yet, mindfulness has rarely been applied to studying individuals' technology adoption. Thus, this research aims to understand how mindfulness helps individuals to make sound adoption decisions. Specifically, this research attempts to answer two research questions: **(1) how does mindfulness influence user technology adoption? and (2) how does mindfulness influence the soundness of the adoption decisions that is crystallized at the post-adoption stage?**

To answer the research questions, this research will develop a research model, integrating mindfulness into the Cognition Change Model (Bhattacherjee and Premkumar 2004). The research model will then be examined by an empirical longitudinal study. The results show how mindfulness influences the adoption decision-making process and post-adoption system use.

Answering these two research question is important for several reasons. First, as mentioned above, answering these questions can help understand how to make sound adoption decisions and thus has great implications for practice. Second, answering these questions has implications for addressing the limitations of the efficient-choice assumption, which posits that people make the best possible decision based on all available information (Abrahamson 1991). People do not always make the best possible adoption decisions; sometimes, people may make decisions mindlessly. Third, answering these questions enriches our understanding of post-adoption system use, a topic that is receiving more and more attention from IS researchers. This research shows that mindfulness at the adoption stage can have distal effects on post-adoption system use.

Theoretical Background

Mindfulness

A widely used definition of mindfulness is offered by Langer (1989a). According to Langer, mindfulness is "a state of alertness and lively awareness, which is specifically manifested in typical ways" (Langer 1989b, p.138) More recently, Dane (forthcoming) summarized existing research on mindfulness and defined mindfulness as a state of consciousness in which attention is focused on present-moment phenomena occurring both externally and internally. Usually, mindfulness is conceived of as a psychological state. Most people can be in a mindful state at one point or another. Nevertheless, it is easy to imagine that, due to dispositional tendencies, some people may be in a mindful state more often than others (Brown and Ryan 2003; Dane forthcoming). So mindfulness can sometimes be assessed at the trait level as well (Dane forthcoming). This research conceives of mindfulness as a psychological state.

To delineate how mindfulness functions, i.e., the mechanisms of mindfulness, Shapiro et al. (2006) specified three axioms of mindfulness: intention (reasons for being mindful), attention, and attitude (the

quality of attention). Specifically, "intentionally (I) attending (A) with openness and non-judgmentalness (A) leads to a significant shift in perspective" (Shapiro et al. 2006, p.377). They labeled this process as *reperceiving*. Consistent with Shapiro et al.'s axioms of mindfulness are the four facets of mindfulness that have been widely referred to: *active information seeking and processing, constant creation of new categories, awareness of local specifics,* and *openness to multiple perspectives* (Langer 1989a; Langer 1997). These four facets can be viewed as four dimensions of mindfulness that jointly depict it.

Mindfulness has been traditionally limited to philosophy and religious studies. More recently, more and more research applies the concept of mindfulness to other fields such as clinical research, education and learning, management, and organizational behavior, among others (Fiol and O'Connor 2003; Jett and George 2003; Langer et al. 1989; Langer 1989a; Levinthal and Rerup 2006; Reger and Palmer 1996; Shapiro et al. 2006; Weick et al. 1999). In general, mindfulness is believed to lead to a fundamental shift in perspective which often results in *positive outcomes* through self-regulation, values clarification, cognitive, emotional, and behavioral flexibility, and exposure (Shapiro et al. 2006). For example, in clinical and medical research, mindfulness has been argued to have positive influences on physical and psychological well-being (Baer 2003; Brown and Ryan 2003). Mindfulness in learning can help students develop creative thinking (Langer et al. 1989). Mindful lawyers can better deal with the dynamic nature of trials by attending to a wide range of phenomena such as the reactions of the judge, jury members, and opposing lawyers (Dane 2008). At the group level, situated cognition as manifested by mindfulness is the basis for reliable performance (Butler and Gray 2006). Mindfulness can help create intergroup harmony because people are more likely to realize the different roles of sub-groups (Fiol et al. 2009).

Mindfulness in Technology Adoption

Consistent with Dane's (forthcoming) definition, this research defines mindfulness as a psychological state of consciousness in which a person focuses on and is aware of the issues surrounding a technology adoption decision and occurring both internally and externally.

Mindfulness is important in such situations where uncertainty abounds (Dane forthcoming). This makes mindfulness an important issue in user technology adoption and continued use, where users are often uncertain about what a technology is, how and how well it works, and how it would fits into local use contexts, among other issues (Sun and Fang 2010). The benefits of a technology usually take time to unfold, making the uncertainty high at the time when it is adopted (Walden and Browne 2009). Also, information technologies are in general complex, often including a large number of features that are unknown to the user at the time they are adopted. The complexity of technology further enhances the uncertainty of adoption. Mindfulness is crucial to make sound judgments in such uncertain situations.

Existing IS research on mindfulness is primarily at the organizational or team level (e.g., Butler and Gray 2006; Goswami et al. 2008; Swanson and Ramiller 2004; Vidgen and Wang 2009). Swanson and Ramiller (2004) studied how organizations mindfully attend to the innovation based on their own facts and specifics. Vidgen and Wang (2009) investigated the mindfulness of software development teams. Fichman (2004) developed a framework to depict how mindfulness can be leveraged to ensure high innovation quality and positive performance outcomes. Goswami et al. (2008; 2009) studied the mechanisms through which managers' mindfulness influences organization's adoption of technology.

Little is known with regard to the influence of mindfulness in individuals' adoption and continued use of technology. Goswami et al. (2008; 2009) studied managers' mindfulness. However, they conceptualized managerial mindfulness in relation to organizations' adoption of technology. Sun and Fang (2010) conceptualized mindfulness at the individual level and developed a model of mindfulness in technology adoption. In that model, mindfulness is argued to reduce uncertainty and influence users' perceived usefulness of and intention to use a technology. Their model, however, does not include how mindfulness influences post-adoption system use and thus yields little insight into how mindfulness influences the soundness of the adoption decision.

Consistent with the mindfulness literature, this research conceives of mindfulness in technology adoption as multi-faceted. Specifically, it has four dimensions: actively looking for information, comparing the technology with existing technologies, being aware of one's own needs and local use contexts, and realizing alternatives to the technology (Sun and Fang 2010). First, being mindful, a person actively looks for information about the technology being considered, from such sources as the user manual, public

media, websites, and expert reviews, to name a few. Second, mindfulness in technology adoption means one compares a technology with others so that he/she is more aware of the uniqueness of it. For example, instead of interpreting an iPad as a smaller laptop, a mindful adopter is more likely to realize how an iPad differs from a laptop and create a new category for it. Third, being mindful means one thinks about how the technology fits his/her local specifics, no matter how popular it seems to be. A technology useful for and thus being used by others is not necessarily useful for a particular user. It is thus important to consider one's local specifics when adopting a technology. A person's local specifics are often complex, including his/her own needs and learning ability, the availability of technical support, compatibility with existing technologies, and whether the adoption of this technology will meet resistance from other people, among other issues. This aspect of mindfulness explains why it helps overcome the bandwagon effects, i.e., following others' choice (Fiol and O'Connor 2003). Finally, when being mindful in adopting a technology, a person is aware of the disparate views regarding this technology, e.g., both advantages and drawbacks of it and alternative technologies. The four dimensions of mindfulness do not necessarily co-vary (e.g., actively looking for information does not necessarily mean one is aware of his/her own needs), making it a formative factor (Jarvis et al. 2003) (Figure 1).

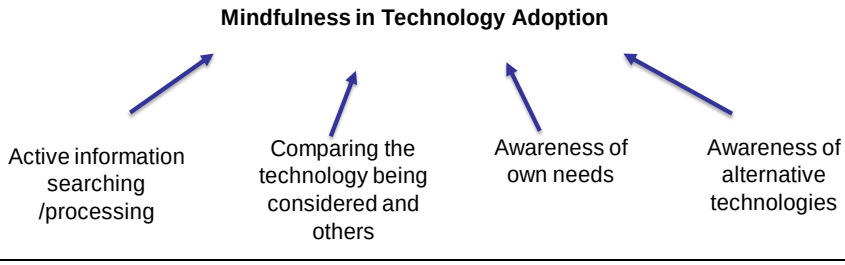

Figure 1. Mindfulness as a Formative Factor

Mindfulness is essentially different from two similar concepts that have been studied previously in IS research: cognitive absorption and flow (Agarwal and Karahanna 2000; Finneran and Zhang 2003; Koufaris 2002). Similar to mindfulness, cognitive absorption and flow are about how individuals are involved in the present moment. However, one attribute that distinguishes mindfulness from cognitive absorption and flow is the breadth of attention (Dane forthcoming). Specifically, cognitive absorption and flow means one is deeply engaged in an event while largely ignoring environmental stimuli; mindfulness, in contrast, means one is aware of a wide range of stimuli, both internal and external.

Research Model and Hypotheses

The Cognition Change Model (CCM) (Bhattacherjee and Premkumar 2004) serves as the theoretical framework for this research. According to the CCM, one's initial beliefs about a technology determine his/her intention to use a technology. Later, initial beliefs can be disconfirmed due to the availability of new information and experience. Such disconfirmation influences user satisfaction and modified beliefs about this technology, which in turn influence intention to continue to use the technology. CCM provides a convenient vehicle for this research. The longitudinal nature of CCM is necessary for studying the soundness of adoption decisions because the benefits of information technology often take time to unfold. Moreover, the constructs in CCM such as disconfirmation and satisfaction can be used as indicators of the soundness of the adoption decision. It is important to note that attitude was dropped from the original CCM because of its conceptual closeness to satisfaction[1]. Also, a new relationship between intention to use and intention to continue was added to reflect the habitual use of technology (Kim and Malhotra 2005).

[1] Satisfaction and attitude are highly correlated (Bhattacherjee and Premkumar 2004). Also, removing attitude is consistent with prior research on technology acceptance. For example, Venkatesh et al. (2003) excluded attitude in their unified theory of acceptance and use of technology (UTAUT), arguing that attitude is not a significant antecedent of behavioral intention when performance expectancy and effort expectancy are present.

The research model (Figure 2) includes two additions to the CCM. First, mindfulness is integrated into the CCM and connected with factors at both the adoption and post-adoption stages. Mindfulness is argued to influence beliefs, intention to use, or the strength of their relationship, at the adoption and post-adoption stages. The rationale for this is that mindfulness is a psychological state, which in general antecedes behaviors (Edwards 2011). Second, giving that mindfulness may reduce one's tendency to follow others (Fiol and O'Connor 2003), the research model includes subjective norm as one type of influence from others. The discussion on the hypotheses regarding the new relationships concerning mindfulness follows.

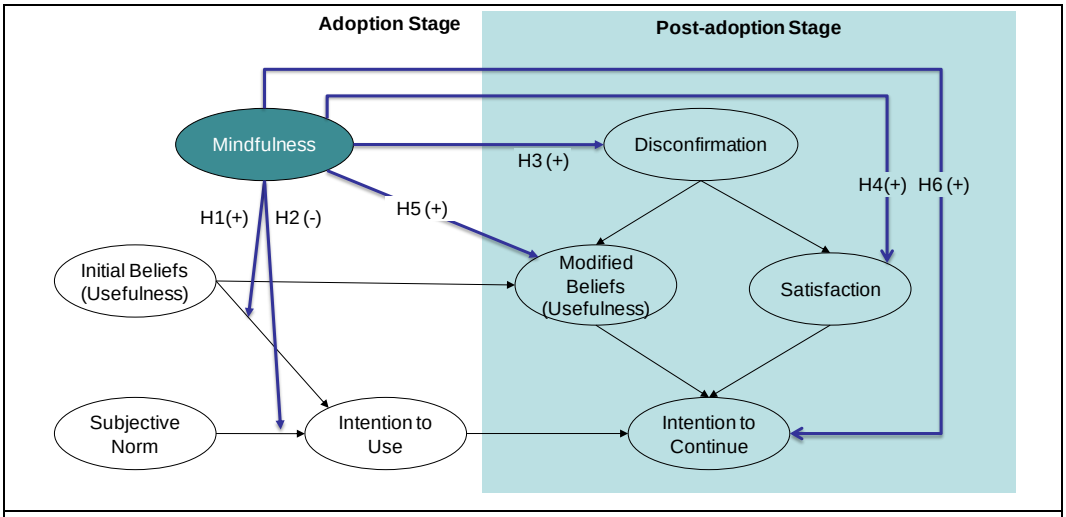

Figure 2. Research Model (the new relationships related to mindfulness are highlighted)

Hypotheses

Impact of mindfulness at the adoption stage

Consistent with the CCM, this research focuses on user beliefs about the usefulness of a technology. Accordingly, initial beliefs are defined as the degree to which a person believes that using a particular technology will enhance his performance. It has been well understood that one's perceived usefulness of a technology has a significant influence on his/her intention to use that technology (Davis 1989; Venkatesh and Davis 2000; Venkatesh et al. 2003).

This research posits that mindfulness can moderate the impact of perceived usefulness on intention to use. The information integration theory suggests that the weight of a piece of information is a function of credibility of the information such that people give more weight to credible information (Anderson 1971; Anderson 1981; Littlejohn 2002). Being mindful, one looks for more information, is acute to his/her own needs and local use contexts, and realizes alternative solutions. Accordingly, mindfulness leads to more accurate perceptions of the target (Langer and Imber 1980). Being mindful, a person forms his/her beliefs about a technology based on more and better-balanced, and thus more credible, information from both external and internal (e.g., intuition) sources. According to the information integration theory, such beliefs carry more weight in making the decision regarding whether to adopt a technology.

H1: Mindfulness will positively moderate the relationship between initial beliefs and intention to use so that this relationship is stronger when mindfulness is higher.

People are often influenced by subjective norm (Davis et al. 1989; Thompson et al. 1991; Venkatesh et al. 2003). Norms are "self-instructions to do what is perceived to be correct and appropriate by members of a culture in certain situations" (Thompson et al. 1991; Triandis 1980, p.126). Accordingly, subjective norm is 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" (Fishbein and Ajzen 1975 p.320). Existing IS research has shown that subjective norm often influences the adoption decision; although, such influence is contextual and attenuates over time (Venkatesh and Davis 2000). For example, a person may be influenced by his/her

perceptions of what his/her peers and supervisors may think about him/her using a particular technology (Taylor and Todd 1995a; Thompson et al. 1991).

This paper contends that people will give less weight to social norm when being mindful. Fiol and O'Connor (2003) argued that when being mindful, people are less likely to follow the bandwagon effects, i.e., doing what others do. Although the influence of subjective norm is essentially different from the bandwagon effects, this research argues that in general the influence from others is less salient for mindful decision makers. Prior IS research has shown that the influence of subjective norm is diluted when direct experience with the technology accumulates, indicating that people tend to rely on their own information when such information is available rather than on others' opinions (Venkatesh 2000; Venkatesh and Morris 2000). The rationale is that in the absence of direct experience and resulting knowledge about a technology, people rely on general/abstract criteria including subjective norm at the adoption stage; such reliance on subjective norm is diluted over time when specific/concrete criteria are available–e.g., from direct experience with the technology (Venkatesh 2000; Venkatesh and Morris 2000). In the same vein, mindfulness makes available more specific/concrete criteria. When being mindful, a person collects and processes a lot of information about the technology, how it meets his/her own needs and fits into his/her local use context, and its uniqueness and alternatives. Such information is processed in the working memory. As a result, the general criteria, e.g., how others think about his/her use of this technology, are likely to receive less attention for making the adoption decision, given the limitation of the working memory (Anderson 1981; Kim 2009).

H2: Mindfulness will *negatively* moderate the relationship between subjective norm and intention to use so that this relationship is weaker when mindfulness is higher.

Impact of mindfulness at the post-adoption stage

As mentioned earlier, it has been widely believed that mindfulness has positive influences on various types of activities. Similarly, in the context of technology adoption, this paper posits that mindfulness can help in making sound decisions at the adoption stage, which become crystallized at the post-adoption stage through high (i.e., positive) post-adoption disconfirmation, user satisfaction, modified beliefs about the usefulness of the technology, and intention to continue use of the technology.

Disconfirmation refers to "the extent to which subjects pre-usage expectation of technology usage is contravened during actual usage experience" (Bhattacherjee and Premkumar 2004, p.237). It can be positive or negative. A positive disconfirmation means one's experience is better that his/her expectation; a negative disconfirmation means one's experience turns out to be worse than expected.

Mindfulness is argued to positively associate with disconfirmation: a high level of mindfulness is likely to result in a high–i.e., positive–disconfirmation. The rationale is that mindfulness can help the user to form more realistic beliefs at the adoption stage; such realism of initial user beliefs helps enhance post-adoption disconfirmation (Bhattacherjee and Premkumar 2004). Fiol and O'Connor (2003) argued that mindful managers are more likely to cognitively scan contradictory information. So being mindful, a person is more likely to scan information about both the advantages and drawbacks of a technology. Such a realistic understanding of the technology helps form a more accurate and context-relevant adoption decision, which is less likely to be negatively disconfirmed (Abrahamson 1991; Fiol and O'Connor 2003). In contrast, if a person forms an unrealistic belief about the usefulness of a technology, he/she is likely to be disappointed by this technology and experience "postdecision regret" (Rao et al. 2001). Similarly, Parthasarathy and Bhattacherjee (1998) also argued that later adopters, who often mindlessly follow predecessors, tend to be "vulnerable to disappointment and dissatisfaction" (p.366).

H3: Mindfulness is positively related to post-adoption disconfirmation.

The soundness of an adoption decision made through mindful thinking is also reflected by higher post-adoption user satisfaction. The rationale is that mindfulness can better prepare a person to be more flexible and adaptive when encountering unexpected events at the post-adoption stage and such flexibility and adaptability leads to higher user satisfaction.

At the post-adoption stage, users often encounter unexpected events and thus face the need to modify their use of system features (Barki et al. 2007; Hiltz and Turoff 1981; Jasperson et al. 2005). Triggers for

such modifications abound: new tasks, unexpected outcomes of system use, and system failures, to name a few (Ahuja and Thatcher 2005; Jasperson et al. 2005; Leonard-Barton 1988; Sun and Zhang 2008). Such triggering events, more or less unexpected, are often conceived of as unpleasant problems or additional burden, changing the nature and routine of work (Boudreau and Robey 2005; Morris and Venkatesh 2010). People may feel overloaded by such changes; such overload often results in negative reactions such as anxiety or burnout (Ahuja and Thatcher 2005; Jackson et al. 1987).

Mindfulness can facilitate more adaptive and flexible responses to unexpected events —in contrast with a rigid reflexive activity resulting from previous experience and existing beliefs— and thus reduce anxiety and burnout and increase satisfaction (Shapiro et al. 2006). For example, Langer et al. (1989) showed that when taught in conditional methods, students can develop creative thinking and are later able to apply what they learned in different conditions. Similarly, mindful organizations can better manage the implementation and assimilation process of a technology along with their response to unexpected events, which also contributes to increasing user satisfaction (Butler and Gray 2006; Swanson and Ramiller 2004). Mindfulness can lead to positive responses to unexpected discrepancies at work such as recognition of the need for change, which can be reasonably argued to lead to higher satisfaction (Jett and George 2003). Similarly, Vidgen and Wang (2009) argued that mindfulness is desired for achieving the agility of software development teams. In summary, mindfulness means one is aware of both the success and failure associated with using a technology. Such preoccupation with failure is helpful in avoiding unpleasant surprises, a major source of dissatisfaction (Swanson and Ramiller 2004; Weick et al. 1999).

By contrast, if the decision is made mindlessly, a person is more likely to develop "premature cognitive commitment" (Chanowitz and Langer 1981). Such premature cognitive commitment results in "single-minded reliance on information without an active awareness of alternative perspectives or alternative uses to which the information could be put" (Langer et al. 1989, p.140). A person with a premature cognitive commitment to certain ways of using a technology is poorly prepared for unexpected needs or problems. For example, unexpected outcomes of using some features of a technology can be a challenge for one's premature cognitive commitment about this technology and thus lower satisfaction.

H4: Mindfulness is positively related to post-adoption user satisfaction.

This research contends that mindfulness can also influence post-adoption modified beliefs. Modified beliefs refers to the degree to which one perceives that a technology is useful at the post-adoption stage (Bhattacherjee and Premkumar 2004). It is reasonable to argue that when one adopts a technology mindfully, he/she is more likely to use the technology for a broader range of tasks and thus perceive the technology to be useful at the post-adoption stage. Mindfulness is characterized by wide external and internal attentional breadths (Dane forthcoming). Being mindful, a person is likely to know more about a technology in terms of its functionalities. This enlarges his/her features in use: features that are ready to be used by this particular user (Sun and Zhang 2008). The more features of a technology a person is aware of, the more likely the technology is used to fit new tasks. Such adaptive use of a technology leads to better alignments between the system and its context (Ahuja and Thatcher 2005; Barki et al. 2007; Boudreau and Robey 2005; Jasperson et al. 2005; Saga and Zmud 1994). These alignments will increase users' perceived usefulness of the technology (Goodhue and Thompson 1995).

Moreover, mindfulness is a reperceiving process that is characterized by "intentionally cultivating nonjudgmental attention" (Shapiro et al. 2006). Mindfulness means reluctance to simplify and thus helps one to attend to details and understand the value of the technology (Weick et al. 1999). It frees one from being controlled by the impulse to join a herd of a technology mindlessly and gives one more freedom to think about how this technology can actually meet his/her own needs and fits into his/her own local use contexts (Fiol and O'Connor 2003). Characterized by openness to multiple perspectives, mindfulness also helps one to see the connections between events seemingly not relevant to each other (Fiol and O'Connor 2003). This suggests that when being mindful, a person is more likely to be aware of a wide spectrum of opportunities to combine a technology being considered and existing technologies to accomplish tasks, which increase the breadth of the application of this technology. Such preparedness equips him/her better for achieving actual fit between tasks and the technology at the post-adoption stage.

It is also expected that mindfulness can have a direct effect on intention to continue use of a technology. Being mindful when adopting a technology, a person is more confident about the long-term benefits of a technology and thus is more likely to have the intention to continue his/her use of it, even if the benefits

of this technology have not been apparent yet. On the contrary, when one mindlessly follows others to adopt a technology, he/she is more likely to abandon this decision later (Banerjee 1992; Bikhchandani et al. 1992; Lieberman and Asaba 2006; Rao et al. 2001).

H5: Mindfulness is positively related to post-adoption modified beliefs about a technology.

H6: Mindfulness is positively related to post-adoption intention to continue.

Methodology

A longitudinal study on user adoption and continued use of PBwiki, an online wiki system, was conducted to examine the research model. The study included two surveys, with an eight-week interval in between. The first survey was administrated at the adoption stage. Only those who did not have prior experience with PBwiki were invited to participate. In the beginning of the survey, a situating task was conducted. Specifically, subjects were asked to go through a list of features of PBwiki and were then asked to report an example about what PBwiki could do for their work. This task situated subjects in the context of adopting PBwiki. Based on that task, the subjects answered questions about mindfulness, subjective norm, user beliefs, and intention to use[2]. The second survey was conducted eight weeks after the first survey and included the measures for disconfirmation, user satisfaction, modified beliefs, and intention to continue. Two items adapted from (Kim and Malhotra 2005) were used to measure system use during the past eight weeks such that only the subjects who actually used PBwiki after the first survey were included.

The longitudinal study was conducted at a large northeast university in the United States. An administrative staff member sent the recruitment email to a listserv of approximate 1,600 undergraduate and graduate students at an information school. A reminder email was sent to the same listserv four days later. As a result, a total of 374 responses to the first survey were collected, representing an overall response rate of 23.4%. Eight weeks later, these 374 respondents were invited to participate in the second survey. After removing those who did not use PBwiki after the first survey, this research obtained a final sample of 206 valid responses. Table 1 shows the demographic information about the sample. A wave analysis was conducted to test the nonresponse bias (Armstrong and Overton 1977). The results indicated that non-response bias should not be a concern for this study.

Table 1. Demographic characteristics of the sample

Demographic		Total
Age	18-24	49
	25-34	76
	35-44	37
	45-54	22
	55-64	22
	65 years or older	0
Gender	Male	65
	Female	141
Education Level	High school	8
	Associate degree	2
	Some college, no degree	15
	4 year college degree	12
	Some graduate school, no degree	63
	Master degree	89
	PhD, MD, JD or other advanced degree	17

[2] This first survey includes more measures that those examined in this research.

The measures can be found in Appendix A. Kim and Malhotra's (2005) instruments were adapted to measure initial beliefs and modified beliefs. Intention to use, satisfaction, disconfirmation, and intention to continue were measured by the original measures from CCM (Bhattacherjee and Premkumar 2004). Two items were adopted from prior research to measure subjective norm (Taylor and Todd 1995b; Venkatesh and Davis 2000). Necessary revisions were made to fit into the context of this research. Four items for measuring mindfulness, corresponding to the four facets of mindfulness discussed above (i.e., active information searching, awareness of own specifics, comparing the technology with others, and awareness of alternative technologies), were adapted based on Sun and Fang's work (2010). But different from Sun and Fang's work, this research conceives of mindfulness as a formative factor because its four dimensions do not necessarily co-vary (Jarvis et al. 2003).

Data Analysis and Results

Partial Least Square (PLS) was utilized to accommodate the complexity of the model and the presence of moderating and formative factors (Chin et al. 2003; Fornell and Bookstein 1982; Lohmoller.J. 1989). PLS can readily handle formative factors (i.e., mindfulness) and can avoid the problem of identification of such factors (Chin 1998a; Petter et al. 2007). To test the moderating effects of mindfulness, this research referred to the product-of-sums approaches (Goodhue et al. 2007). Specifically, the variable scores of the moderating factor (Mindfulness) and independent variables (SN and IB) were multiplied to generate two interaction factors: Mindfulness x SN and Mindfulness x IB. They were then linked to the dependent variable (IU).

Measurement Model

To assess the measurement model, the reliability, convergent validity, and discriminant validity were examined. The reliability of the scales was evaluated by the composite reliability and Cronbach's alpha; both need to be 0.70 or higher in order to demonstrate sufficient reliability (Bagozzi and Yi 1988; Bearden et al. 1993; Nunnally and Bernstein 1994). Table 2 shows that all composite reliability values meet this criterion, indicating that the scales were reliable.

To assess the convergent validity, items loadings and average variance explained (AVE) were examined. Item loadings should be greater than 0.707 and AVEs should be larger than 0.5 (Barclay et al. 1995; Chin 1998b; Fornell and Larcker 1981). Appendix B shows the items loaded well on their associated factors. Table 2 shows that all AVEs in this study were larger than 0.5, suggesting that most variances in the constructs are captured by the indicators rather than denoting measurement errors (Barclay et al. 1995).

Two criteria were examined to assess the discriminant validity. First, the square root of the average variance extracted (AVE) should be greater than the variance shared among the construct and other constructs (i.e., correlations) (Chin 1998b; Compeau et al. 1999). This is satisfied, as shown in Table 3. Second, items should load more highly on their associated factors than on other factors. Appendix B showed that this criterion was also met.

Table 2: Descriptive Statistics

	N. of Items	Mean	Std. Dev	Composite Reliability	Cronbach's Alpha	Average Variance Extracted
1. Mindfulness	4	4.40	1.10	N/A	N/A	N/A
2. Initial Beliefs	4	4.38	1.23	0.96	0.95	0.87
3. Subjective Norm	2	3.60	1.48	0.96	0.92	0.93
4. Intention to Use	3	4.31	1.48	0.97	0.95	0.91
5. Modified Beliefs	4	4.17	1.28	0.98	0.97	0.93
6. Disconfirmation	4	4.39	0.93	0.97	0.95	0.88
7. Satisfaction	4	4.53	0.98	0.97	0.96	0.90
8. Intention to Continue	3	3.54	1.89	0.99	0.99	0.98

Table 3: Square Roots of AVEs and Correlations †								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1. Mindfulness	N/A							
2. Initial Beliefs	0.35	**0.93**						
3. Subjective Norm	0.23	0.30	**0.96**					
4. Intention to Use	0.39	0.67	0.34	**0.95**				
5. Modified Beliefs	0.44	0.35	0.25	0.32	**0.96**			
6. Disconfirmation	0.48	0.17	0.26	0.20	0.53	**0.94**		
7. Satisfaction	0.50	0.15	0.20	0.25	0.52	0.83	**0.95**	
8. Intention to Continue	0.47	0.30	0.25	0.45	0.52	0.58	0.68	**0.99**
† The diagonal Elements (in bold) are the square roots of the variance shared between the constructs and their measurement (AVE).								

A high correlation between disconfirmation and satisfaction was observed (Table 3). Their cross-loadings are also high (Appendix B). High correlations and cross-loadings indicate that items may measure more than one factor in the model and thus may threaten the discriminant validity of a study. However, no factors/items were dropped for several reasons. First, the high cross-loadings in this research still met Gefen and Straub's (2005) criterion of a minimum difference of .10 between item loadings and cross-loadings. In addition, other statistics (e.g., the comparison between AVEs and correlations) were satisfactory, suggesting that the overall discriminant validity was still acceptable. Second, the items with high cross-loadings were retained to ensure content validity. Third, the highly cross-loaded items are from the original CCM. The new measures for mindfulness, which are the primary focus of this study, did demonstrate high discriminant validity. Moreover, high correlations at the same or higher levels have been observed and accepted by prior IS research. For example, Wixom and Todd's research (2005) reported several correlations ranging from 0.70 to 0.85. In short, high correlations/cross-loadings should be considered with other statistics in mind. If the other statistics are satisfactory and content validity is a concern, highly correlated factors or highly cross-loaded items can be retained. Nevertheless, for a robustness check purpose, this paper will present a post hoc analysis that to some degree addresses the problem of high correlations and cross-loadings between disconfirmation and satisfaction.

The longitudinal nature of the research model is helpful to overcome the possible common method bias. In addition, a Harman's single-factor test—which is one of the most widely used approaches for assessing common method bias in a single-method research design (Podsakoff et al. 2003)—was conducted to further assess the common method bias. This test loads all variables into an exploratory factor analysis and then examines the unrotated factor solution to determine the number of factors necessary to account for the variance in the variables. Common method bias may exist if (1) a single factor emerges from the unrotated factor solution or (2) one general factor accounts for the majority of the covariance in the variables (2003 p. 889). Neither occurred in this study: no single factor accounted for a majority of the covariance, indicating that common method bias should not be a concern for this study.

Structural Model

The weights of the formative indicators of mindfulness were first examined. Among the four weights, MF4 is insignificant (b=0.18, t=1.16). Given the importance of content validity for formative factors (Bollen and Lennox 1991; 2001; Petter et al. 2007), this item was retained. Interestingly, a negative weight of MF2 was found (b= -0.20, t=2.01). A closer examination of this item suggested that it can be considered a reversed item of mindfulness: when a subject said that he/she "will look for additional information about PBwiki from sources other than its own website," he/she might imply that he/she has not yet been active in information seeking. So MF2 was retained as a reversed item.

The results of the structural model are presented in Figure 3. The statistical significance of the path coefficients was estimated using the bootstrapping method (Chin 1998b). Mindfulness positively

moderates the influence of initial beliefs on intention to use (b=0.43, t=4.08, p<0.01), supporting H1. However, the moderating effect of mindfulness on the relationship between subjective norm and intention to use was, albeit in the predicted direction, not significant (b=-0.10, t=0.38). Thus, H2 was not supported. Mindfulness was shown to have significant distal effects on post-adoption disconfirmation (b=0.48, t=8.55, p<0.01), satisfaction (b=0.13, t=3.24, p<0.01), and modified beliefs (b=0.17, t=2.46, p<0.05). Therefore, hypotheses 3 through 5 were confirmed. Hypothesis 6 about the impact of mindfulness on intention to continue was not confirmed (b=0.05, t=0.82). The model explained a significant portion of the variance in intention to use (R^2=0.52), modified beliefs (0.37), disconfirmation (0.23), satisfaction (0.69), and intention to continue (0.57).

An examination of the means of initial beliefs and modified beliefs and those of intention to use and intention to continue (Table 2) suggests that subjects in this study became less favorable of using PBwiki over time. Initial Beliefs has a higher mean (4.38) than Modified Beliefs (4.17); Intention to Use has a higher mean (4.31) than Intention to Continue (3.54). When juxtaposed with the above finding that mindfulness influences disconfirmation positively, this suggests that mindfulness is crucial for leading to positive disconfirmation even when people in general become less favorable of using this technology.

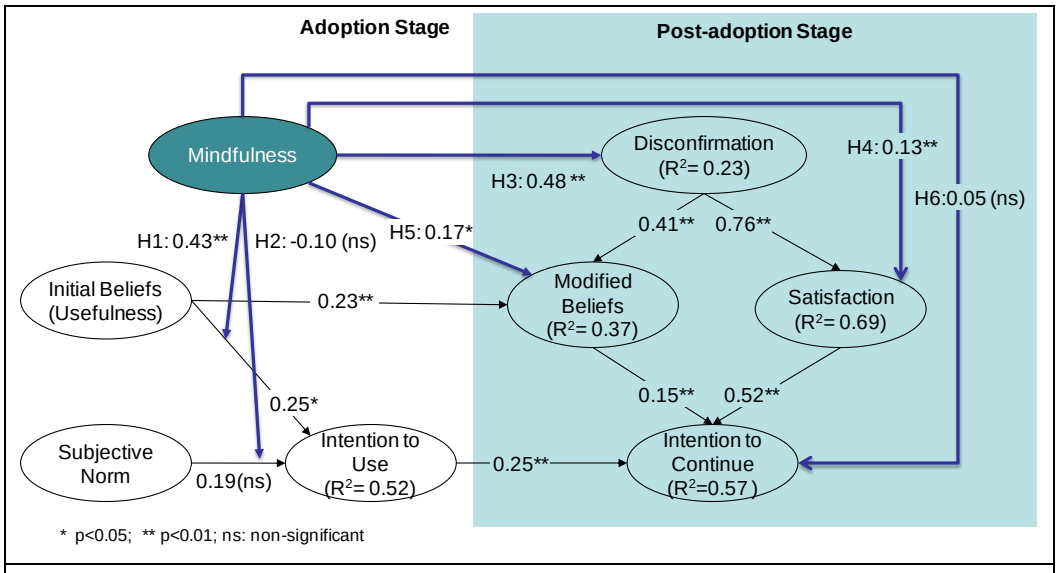

Figure 3. Results of the Structural Model

Post Hoc Analysis

As shown above, there exist uncomfortably high correlations and cross-loadings between Disconfirmation and Satisfaction. The lack of discriminant validity of their measures indicates that Disconfirmation and Satisfaction may be related to the same thing. A reflection upon their definitions and measures suggested that they both reflected positive experience of using a technology. Therefore, a revised model (Figure 4) was examined as a robustness check. Specifically, Disconfirmation and Satisfaction were re-conceptualized, following the procedure set forth by Wetzels et al. (2009), as two reflective first-order factors of a new second-order factor, namely *positive experience*. Consistent with its components (i.e., disconfirmation and satisfaction), positive experience is believed to be influenced by mindfulness and in turn affects modified beliefs and intention to continue. The results are summarized in Figure 4. Both disconfirmation and satisfaction load well on the new positive experience construct. The relationships are generally consistent with the original research model. This gives more confidence in the results of this study despite the high correlations between disconfirmation and satisfaction [3].

[3] Another approach to deal with multicollinearity is to delete one of the highly correlated variables. Therefore, two additional analyses were conducted to examine models excluding Disconfirmation and Satisfaction respectively. Similar results were observed, further supporting the findings.

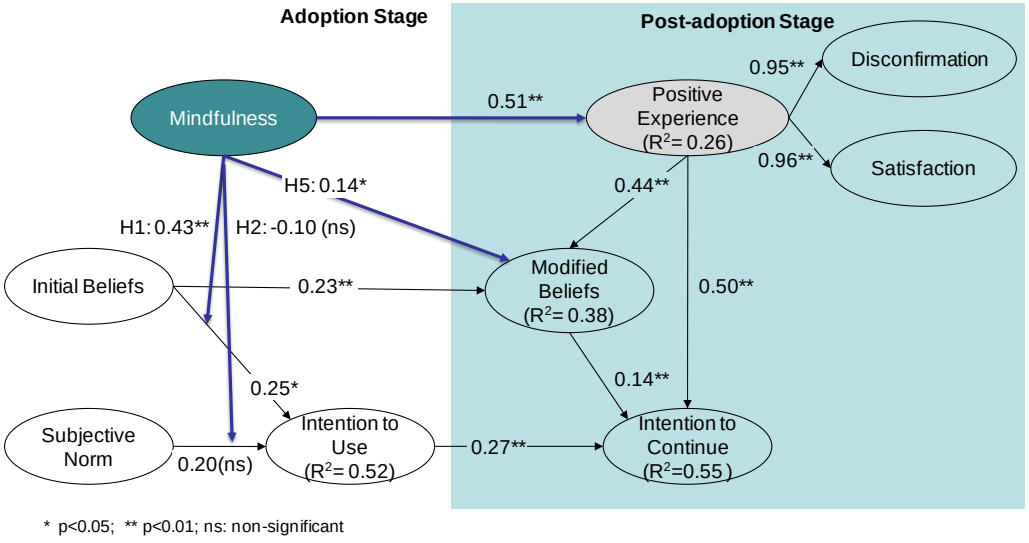

Figure 4. Post Hoc Analysis of the Revised Model

The hypothesized direct relationship between mindfulness and post-adoption intention to continue was found to be non-significant. Therefore, post hoc analyses were conducted to examine how this relationship may be mediated by disconfirmation, satisfaction, and modified beliefs. To do so, this research utilized the Preacher and Hayes (PH) method (2008). The bias-corrected (BC) bootstrap algorithm was employed. The results showed that mindfulness has a significant total effect on intention to continue (effect=0.354, t=5.56, p<0.001). After the mediators (i.e., disconfirmation, satisfaction, and modified beliefs) were introduced, the direct effect of mindfulness on intention to continue is non-significant (effect=.054 t=0.92, p=.357). The total indirect effects through the mediators are 0.300, with a BC bootstrap 95% confidence interval (CI) of 0.214 and 0.408. Since this CI did not contain zero, the indirect effects were significantly different from zero. A closer examination of the three mediators indicate that the relationship between mindfulness and intention to continue are mediated by modified beliefs (effect=0.055, CI of 0.016 and 0.114) and satisfaction (effect=0.246, CI of 0.138 and 0.393) but not by disconfirmation (effect=-0.001, CI of -0.090 and 0.106). In summary, the influence of mindfulness on intention to continue is fully mediated by modified beliefs and satisfaction.

Discussion

Although a lot of research has been conducted to study what drives people to adopt technologies, an equally, if not more, important question is how to make *sound* adoption decisions. This research approaches this question from a mindfulness perspective. Based on the mindfulness literature, this research conceives of mindfulness as a multi-faceted formative factor. A research model of mindfulness has been developed to delineate how mindfulness influences user adoption of technology and how mindfulness leads to sound adoption decisions reflected by high disconfirmation, satisfaction, modified user beliefs, and intention to continue at the post-adoption stage. The model was examined by a longitudinal study of 206 users of PBwiki. The data largely supported the model.

This paper yields several interesting findings. At the adoption stage, mindfulness positively moderates the impact of user beliefs on intention to use, indicating that while being mindful a person gives more weight to his/her own beliefs. This research also hypothesized that mindfulness can reduce one's reliance on subjective norm. However, this hypothesis was not confirmed. The results also show that mindfulness has distal effects on post-adoption disconfirmation, satisfaction, and modified user beliefs, supporting the motif of this paper that mindfulness helps make sound adoption decisions.

This research contributes to the contemporary IS research in several ways. First, this research proposes a new conceptualization of mindfulness in technology adoption. Different from previous research (e.g.,

Goswami et al. 2009; Sun and Fang 2010), this research conceived of mindfulness as a formative factor. Second, the research model suggests new mechanisms through which mindfulness influences technology adoption. Specifically, mindfulness does not influence initial user beliefs and intention to use directly, as suggested by Sun and Fang's work (2010), but instead moderates their relationship. Third, it is probably the first time that the distal influences of mindfulness on post-adoption system use are investigated.

Limitations and Future Topics

The measures for mindfulness are limited. Each dimension of mindfulness is measured by only one item. The weight of one item was non-significant. Therefore, the content validity of the measurement is somewhat limited. Developing a more comprehensive and robust instrument for mindfulness should receive the priority in future IS research to further study mindfulness. One way of doing this is to conceive of mindfulness as a high-order formative construct that has four dimensions, each representing one facet of mindfulness and measured by multiple items (Wetzels et al. 2009).

The measures adapted from the CCM proved to be limited. Specifically, this research observed a high correlation and cross-loadings between disconfirmation and user satisfaction. The post hoc analysis suggested that they may reflect the same construct of positive experience. Future research can either develop better instruments for measuring disconfirmation and user satisfaction or instead re-conceptualize them as two facets of the same construct.

A promising topic is to investigate mindfulness as a personal trait (Brown and Ryan 2003). Also related to this, future research may investigate how individual factors, such as personal innovativeness in IT (Agarwal and Karahanna 2000; Agarwal and Prasad 1999) and computer self-efficacy (Compeau and Higgins 1995a; Compeau and Higgins 1995b), may influence mindfulness.

This research did not find a significant moderating effect of mindfulness on the relationship between subjective norm and intention to use. However, it is important to note that previous research has argued that mindfulness can help overcome the bandwagon effects, i.e., doing what others do (Fiol and O'Connor 2003). Subjective norm is only one type of social influences and is essentially different from bandwagon effects (Sun 2009). Future research can study how mindfulness influences the impact of other types of social influences, e.g., behavioral modeling (Compeau and Higgins 1995b) and herding effects (Sun 2009; Walden and Browne 2009).

Apparently, how to induce mindfulness is a promising topic given the positive consequences of mindfulness as demonstrated in this work. Langer (1989b) pointed out several conditions for mindfulness to occur. Jasperson et al. (2005) also discussed triggers for people to actively think about their system use. One factor of particular interests is the attributes of a technology. For example, a highly restrictive technology constrains people to specified structures of using the technology and may force individuals to be in a mode of using the system less mindfully (Silver 1988; Weick et al. 1999). Such design features associated mindfulness or mindlessness should receive attention, given their apparent practical implications.

Finally, a promising topic is *mindful system use*, which is essentially different from mindful adoption studied in this research. Mindfulness can be a continuous practice (Shapiro et al. 2006). After adoption, people can be mindful in using the system. Studying post-adoption mindful use may have implications for IS research on active as well as automatic and habitual system uses (Kim et al. 2005; Limayem et al. 2008). It may also have implications for studying the performance impact of system use.

Research Implications

More attention is needed to investigate the soundness of technology adoption. Differing from positive performance impact of system use that has been studied in IS research, the soundness of a technology adoption is more or less determined at the adoption stage and crystallized at the post-adoption stage. Studying the soundness of technology adoption is of great implications in that many investments in information technologies are not reversible such that making sound adoption decisions is crucial. This paper provides one way for studying the soundness of technology adoption. Specifically, people differ in the level of mindfulness when adopting a technology; this difference in mindfulness accounts for the soundness of the adoption decision.

This research has implications for studying post-adoption system use. A significant amount of attention has been paid to studying post-adoption system use from various perspectives (e.g., Bhattacherjee 2001; Burton-Jones and Straub 2006; Guinea and Markus 2009; Jasperson et al. 2005; Kim 2009; Kim et al. 2005; Limayem et al. 2008). It is especially appealing to study the connection between factors at the adoption and post-adoption stages respectively, such that we can predict post-adoption system use as early as at the adoptive stage. Previous research has suggested several mechanisms —e.g., the memory (Kim 2009) and expectation-confirmation (Bhattacherjee and Premkumar 2004)— through which factors at the adoption stage influence post-adoption system use. This research proposes another one: mindfulness. Those people who made the adoption decision mindfully are more likely to positively disconfirm their initial beliefs and have higher satisfaction and perceived usefulness at the post-adoption stage, which lead to continued use of the technology.

More attention is needed to investigate how system use affects job performance (Benbasat and Barki 2007). In general, mindfulness has not been sufficiently studied in performance-related behavior (Dane forthcoming). It is reasonable to expect that mindfulness can influence performance, at least indirectly, through satisfaction and post-adoption system use in light of the fact that satisfaction and system use influence the performance impact of information systems (DeLone and McLean 2003). Future research can investigate how and in what conditions mindfulness is related to performance impact of system use. It is important to note that although mindfulness has generally been considered a positive psychological state, its impact may be conditional (Dane forthcoming).

Practical Implications

For IT practitioners, user training programs should be designed in a way that can solicit users' mindfulness. To do so, it is important to highlight the uniqueness of the technology and present information about the technology from different perspectives. For IT users, being mindful is important when adopting a technology. IT users should look for more information from multiple perspectives and be aware of the advantages and drawbacks of the technology and be acute to one's own needs and local use contexts. This mindfulness will have long-term benefits.

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Appendix A: Measurements

Other than Satisfaction and Disconfirmation, whose scales are specified believed, all other factors use a seven-point Likert scale, where 1 indicates "strongly disagree," 4 indicates "neutral," and 7 indicates "strongly agree."

Measures at Time 1

Mindfulness (adapted from Sun and Fang 2010)

MF1. (Creation of category) I am aware that PBwiki seems to be different from any technologies that I had used before.
MF2. (Active information seeking) I will look for additional information about PBwiki from sources other than its own website.
MF3. (Awareness of alternatives) I am aware that there are alternatives to PBwiki.
MF4. (Awareness of own needs) I have thought about how PBwiki could match my specific needs.

Initial Beliefs (IB)(adapted from Kim and Malhotra 2005)

IB1. I think PBwiki would allow me to accomplish tasks more quickly.
IB2. Using PBwiki could help improve the quality of my work.
IB3. PBwiki would give me greater control over my work.
IB4. Using PBwiki would enhance my effectiveness in my work.

Intention to Use (IU) (adapted from Bhattacherjee and Premkumar 2004)

IU1. I plan to use PBwiki for collaboration.
IU2. I intend to use PBwiki for my future work.
IU3. It is very likely that I will use PBwiki in the near future.

Subjective Norm (SN) (adapted from Taylor and Todd 1995b; Venkatesh and Davis 2000)

SN1. People who influence my behavior think that I should use a wiki system like PBwiki.
SN2. People who are important to me think that I should use a wiki system like PBwiki.

Measures at Time 2

Modified Beliefs (MB) (adapted from Kim and Malhotra 2005)

MB1. Using PBwiki helps me to accomplish tasks more quickly.
MB2. Using PBwiki improves the quality of the work I do.
MB3. Using PBwiki gives me greater control over my work.
MB4. Using PBwiki enhances my effectiveness in my work.

Disconfirmation (DC) (adapted from Bhattacherjee and Premkumar 2004) (measured on a seven-point Likert scale, where 1 indicates "much worse than expected", 4 indicates "neutral", and 7 indicates "much better than expected.")

Compared to my initial expectations, the ability of PBwiki _____

DC1. to improve my performance was_____
DC2. to increase my productivity was_____
DC3. to enhance my effectiveness was_____
DC4. to be useful for my work or study was_____

Satisfaction (SAT) (adapted from Bhattacherjee and Premkumar 2004)

All things considered, I am _____ with my use of PBwiki

SAT1: 1 "Extremely displeased" ——— 4 "Neutral" ———7 "Extremely pleased"
SAT2: 1 "Extremely frustrated" ——— 4 "Neutral" ———7 "Extremely content"
SAT3: 1 "Extremely terrible4 ——— 4 "Neutral" ———7 "Extremely delighted"
SAT4: 1 "Extremely dissatisfied"——— 4 "Neutral"——— 7 "Extremely satisfied"

Intention to Continue (IC) (adapted from Bhattacherjee and Premkumar 2004)

IC1. I intend to use PBwiki in the next two months.
IC2. I plan to use PBwiki in the next two months.
IC3. I predict that I will use PBwiki in the next two months.

Appendix B: Loadings and Cross-loadings*

	IB	*SN*	*IU*	*MB*	*DC*	*SAT*	*IC*
IB1	**0.96**	0.27	0.65	0.32	0.16	0.14	0.29
IB2	**0.95**	0.32	0.63	0.34	0.16	0.12	0.25
IB3	**0.85**	0.22	0.57	0.29	0.13	0.15	0.29
IB4	**0.98**	0.32	0.67	0.36	0.17	0.14	0.30
SN1	0.31	**0.97**	0.36	0.26	0.24	0.20	0.23
SN2	0.27	**0.96**	0.29	0.25	0.26	0.19	0.25
IU1	0.70	0.35	**0.97**	0.32	0.20	0.23	0.41
IU2	0.63	0.29	**0.96**	0.28	0.19	0.20	0.38
IU3	0.60	0.33	**0.93**	0.31	0.18	0.28	0.49
MB1	0.36	0.31	0.33	**0.96**	0.50	0.47	0.49
MB2	0.33	0.28	0.31	**0.97**	0.51	0.47	0.50
MB3	0.34	0.21	0.27	**0.96**	0.51	0.53	0.50
MB4	0.33	0.23	0.32	**0.97**	0.51	0.51	0.50
DC1	0.17	0.25	0.21	0.47	**0.93**	0.81	0.54
DC2	0.17	0.29	0.19	0.46	**0.93**	0.74	0.53
DC3	0.13	0.23	0.17	0.53	**0.97**	0.78	0.55
DC4	0.15	0.21	0.18	0.52	**0.91**	0.76	0.56
SAT1	0.15	0.22	0.30	0.51	0.81	**0.95**	0.69
SAT2	0.09	0.18	0.20	0.45	0.74	**0.94**	0.60
SAT3	0.17	0.15	0.22	0.50	0.77	**0.95**	0.65
SAT4	0.15	0.23	0.23	0.50	0.82	**0.96**	0.66
IC1	0.32	0.24	0.45	0.53	0.58	0.69	**0.99**
IC2	0.31	0.25	0.45	0.51	0.56	0.68	**0.99**
IC3	0.27	0.24	0.43	0.50	0.58	0.66	**0.98**

* The highest loading for each measure is highlighted in bold.

IB: Initial Beliefs SN: Subjective Norm IU: Intention to Use MB: Modified Beliefs

DC: Disconfirmation SAT: Satisfaction IC: Intention to Continue