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Information Technology Usage and Cognitive Engagement: Understanding Effects on Users' Cognitive Processes

Himanshu Agarwal¹ and Gaurav Dixit¹

¹ Department of Management Studies, Indian Institute of Technology Roorkee, Roorkee, India
gaurav.dixit@ms.iitr.ac.in

Abstract. Ubiquitous access to the Internet and digitalization has led to people completing many of their activities online using a smartphone or other handheld devices such as a tablet. Regular usage of information technology could potentially affect their cognitive processes. In this research, we investigate how different types of online activities influence people's cognitive engagement. Further, we also examine the role of various key mediators such as personal innovativeness, playfulness, and self-efficacy in explaining the effect of information technology use on cognition. Data was collected from 351 Indian users, and the structural equation modeling technique was employed to test and analyze the research model. The results show that online activities associated with content delivery positively affect cognitive engagement, while online activities associated with entertainment negatively affect cognitive engagement. Familiarity with information technology has a positive effect on cognitive engagement. We also find that personal innovativeness, playfulness, and self-efficacy mediate the effect of information technology usage on cognition. The results of the study have both theoretical and practical implications.

Keywords: Cognitive Engagement, Information Technology Usage, Personal Innovativeness, Playfulness, Self-efficacy.

1 Introduction

The rapid increase in the usage of smartphones and other handheld devices has changed the mindsets of users and their ways to perform many of their routine activities (Agarwal & Dixit, 2017). As a consequence, the cognitive processes related to users' perceptions, learning ways, and reasoning mechanisms are potentially changing. Information systems (IS) researchers have studied the issues related to users' cognitive aspects before, such as flow experience, cognitive absorption, and cognitive engagement (Scott & Walczak, 2009; Agarwal & Karahanna, 2000; Webster & Ahuja, 2006; Fan et al., 2017; Koufaris 2002; Zhou & Lu, 2011). However, these studies primarily study cognitive aspects in the pre-adoption and usage context of information technology (IT). In this research article, our focus is on examining the effects of the regular and continued usage of IT on cognitive aspects in the post-adoption context.

Previous studies examining the effect of regular and continued IT usage on cognitive aspects are very scarce. We discuss a few studies which are closer to our research problem. For example, Su et al. (2016) studied flow experience in mobile gaming and found that human-computer interaction can positively affect the perceived enjoyment and attention focus dimensions of flow experience. Leung (2020) studied smartphone usage for the hedonic activities (e.g., watching online videos, playing online games, and sharing pictures or videos online) and eudaemonic activities (e.g., reading news online, seeking information from the Internet or online social media, and using an online dictionary). He found that these activities lead to the flow experience. Both of these studies were concerned with the scenarios and activities related to the utilization of free time. In this research, we focus on the m-commerce scenario and associated activities. IT usage activities in our research are based on the categorization suggested by Mahatanankoon et al. (2005). Specifically, we examine the effect of IT usage related to different types of online activities on cognitive engagement.

IS studies on cognitive aspects have also explored the role of various key mediators such as personal innovativeness, playfulness, and self-efficacy. For example, Agarwal and Karahanna (2000) found personal innovativeness and playfulness to have a significant effect on cognitive absorption. Agarwal et al. (2000) found self-efficacy to affect the perceived cognitive effort associated with IT usage. In this study, we examine the role of personal innovativeness, playfulness, and self-efficacy in understanding the impact of IT usage on cognitive engagement.

We derive the theoretical lens for our study using the prior research on three cognitive variables cognitive engagement, cognitive absorption, and flow experience in the information technology contexts. These three variables conceptualize overlapping aspects of the cognitive involvement of users with IT artifacts. We briefly review the relevant past studies to discuss it.

2 Theoretical Background

Cognitive engagement, cognitive absorption, and flow experience have been defined in the existing literature using overlapping or embedded subconstructs, as shown in Table 1. IS researchers have tried to capture the holistic experiences of users with IT artifacts using these constructs.

Table 1. Mapping of Cognitive engagement, cognitive absorption, and flow experience

Cognitive engagement	Cognitive absorption	Flow experience
<i>Attention focus:</i> user narrows himself to a limited stimulus	<i>Focused immersion:</i> user ignores other attentional demands	<i>Total absorption:</i> nothing else matters for the user
<i>Intrinsic interest:</i> the user is involved for pleasure and enjoyment	<i>Heightened enjoyment:</i> a pleasurable experience for the user	<i>Pleasure and enjoyment:</i> a deep sense of exhilaration and enjoyment for the user
<i>Curiosity:</i> user experiences arousal of sensory	<i>Curiosity:</i> user experiences arousal of sensory	
	<i>Control:</i> the user is in charge of the interaction	<i>Control:</i> user feels a sense of being in control
	<i>Temporal dissociation:</i> user	<i>Transformation of time:</i>

inability to register the passage of time	loss of self-consciousness for user
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Adapted from Scott and Walczak (2009)

The first construct of cognitive engagement is a playful state of mind reached by the user during interactions with an IT artifact. It is typically characterized by subconstructs attention focus, curiosity, and intrinsic interest (Webster & Ho, 1997). Cognitive absorption seems to be an expanded version of cognitive engagement. It adds two subconstructs control and temporal dissociation. It has been conceptualized as a state of mind reached by the user, which exhibits deep involvement during interactions with an IT artifact (Agarwal & Karahanna, 2000). Flow experience seems to be an expanded version of both cognitive engagement and cognitive absorption. It has been conceptualized as an optimal state of mind reached by the user, which exhibits control, mastery, exhilaration, and a deep sense of enjoyment during interactions with an IT artifact (Webster et al., 1993). Therefore, the existing conceptualization of these constructs in the literature measure experiential states where flow experience is a higher-level abstraction of cognitive absorption, which in turn is a higher-level abstraction of cognitive engagement. It is reflected in the hierarchical layers in the conceptualization, inclusion, and removal of subconstructs for these constructs. As we move higher in the cognitive involvement levels from the layer of cognitive engagement to the layer of cognitive absorption, we gain a subconstruct of control and reach higher intensity for other subconstructs. The user seems to move higher from a playful state of mind to a controlled state of mind or from playful interaction to meaningful interaction. Similarly, as we move higher in the cognitive involvement levels from the layer of cognitive absorption to the layer of flow experience, we lose a subconstruct of curiosity and reach higher intensity for other subconstructs. The user seems to move higher from a controlled state of mind to an optimal state of mind or from conscious interaction to subconscious interaction. In this research, we study the cognitive engagement, since it is the lowest layer that can be reached by IT usage. For most of the users, it is the cognitive engagement that can be reliably measured, since higher layers might yet not be in their perceptions.

Prior studies have examined the role of personal innovativeness, playfulness, and self-efficacy on cognitive aspects in IS research since users' capability manifested through these variables can be important in explaining the effects of regular and continued IT usage. Agarwal and Karahanna (2000) defined self-efficacy as an individual characteristic, which reflects a user's confidence in his ability to perform a particular activity. Webster and Martocchio (1995) defined playfulness as the degree of cognitive spontaneity in a user's interactions with IT artifact. Agarwal and Prasad (1998) conceptualized personal innovativeness as an individual trait, which reflects a user's willingness to experiment with a new IT artifact.

In this research, we study the effect of online activities, which users perform in the m-commerce context on cognitive engagement. We consider four types of IT usage activities suggested by Mahatanankoon et al. (2005): content delivery, transaction-based, location-based, and entertainment related. The effect of online activities asso-

ciated with these different types of IT usage on cognitive engagement is investigated. We also study users' familiarity with IT to determine the impact on cognitive aspects.

3 Hypotheses Development

Online activities associated with content delivery, such as searching for desired information, sending or receiving emails, browsing news, blogs, and social media, require users to spend more time interacting with their smartphones. Users might eventually become more specific in the content activities, narrowing their focus to a limited set of items. Reading important emails marked starred in Gmail, a breaking news story recommended by Google news, and an interesting trend suggested for the user by Twitter are few examples. It is typically followed by the consumption of the content, which might take some time and more interactions. Frequent interactions between users and smartphones for content can be due to pleasurable and sensory experiences. All this can enhance their relevant cognitive abilities, and therefore, the user's state of cognitive engagement will improve. Thus, we posit the following hypothesis:

H1. Online activities associated with content delivery services will positively affect cognitive engagement during interactions with an IT artifact.

Location-based online activities require users to interact with apps such as Google maps to explore routes and places, analyze traffic, and find new or shortest ways. When driving, users might eventually start experimenting with different possible routes and learn by experiences from the Google maps-aided navigation. For example, planning the trip to a place based on the typical traffic information, sharing of the current location or live location with someone through WhatsApp, and sending the link of the location of a meeting or event are few examples. Similarly, Internet platforms such as Justdial.com, Zomato.com, and Swiggy.com also offer location-based services, which require exploration of available choices and interaction with users. Activities on these platforms can enhance the cognitive abilities of users, and therefore, cognitive engagement will improve. Thus, we posit the following hypothesis:

H2. Online activities associated with location-based services will positively affect cognitive engagement during interactions with an IT artifact.

Similarly, transaction-based online activities like finding a suitable train ticket, bus or flight seat, or seat in the best or nearby multiplex require more interaction due to increased choices. Users might spend more time exploring and browsing e-commerce websites such as Amazon.com and Flipkart.com or associated mobile apps, which offer various products for users. These websites offer many features to aid in online shopping, such as the comparison tool and recommendations based on items or user profiling. Therefore, during these types of online activities, users' cognitive engagement with the smartphone might be higher. Thus, we posit the following hypothesis:

H3. Online activities associated with transaction-based services will positively affect cognitive engagement during interactions with an IT artifact.

Websites such as Youtube.com, Netflix.com, Amazon's Primevideo.com, and Hotstar.com and associated mobile apps offer entertainment services such as movies, tv-series, and web series covering different genres and languages. Youtube has a large collection of user-uploaded videos as well. However, once a user selects a particular item for entertainment, further exploratory interaction with the smartphone might not be required for days. The smartphone will be treated as a portable, miniature tv screen, which might lead to a lower level of cognitive engagement. Thus, we posit the following hypothesis:

H4. Online activities associated with entertainment services will negatively affect cognitive engagement during interactions with an IT artifact

User interaction with the smartphones might depend on the familiarity of the user with IT. A higher level of familiarity with IT artifacts might help the user in performing online activities. Many websites and associated mobile apps offer advanced features that can enrich user interactions with smartphones. Therefore, familiarity with IT might affect the ability of users to explore and interact using smartphones. Thus, we posit the following hypothesis:

H5. Familiarity with the use of IT for performing online activities will positively affect cognitive engagement during interactions with an IT artifact.

As users become relatively regular in performing online activities associated with content delivery, location-based, and transaction-based services, their personal innovativeness or willingness to experiment with newer aspects of the IT artifact is expected to improve. However, in the case of entertainment services, chances of experimentations are minimal, rather passively watching videos might lead to a decrease in the personal innovativeness of users. Further, familiarity with IT will help in performing experiments. Thus, we posit the following hypotheses:

H6. Online activities associated with content delivery services will positively affect personal innovativeness during interactions with an IT artifact.

H7. Online activities associated with location-based services will positively affect personal innovativeness during interactions with an IT artifact.

H8. Online activities associated with transaction-based services will positively affect personal innovativeness during interactions with an IT artifact.

H9. Online activities associated with entertainment services will negatively affect personal innovativeness during interactions with an IT artifact.

H10. Familiarity with the use of IT for performing online activities will positively affect personal innovativeness during interactions with an IT artifact.

Improved willingness to experiment during interactions with IT artifacts might lead to increased cognitive spontaneity and confidence. Cognitive spontaneity can also have a direct effect on a user's ability to perform an activity and hence, self-efficacy. Increased confidence can boost cognitive engagement due to more assertive use of IT artifacts. Thus, we posit the following hypotheses:

H11. Personal innovativeness has a positive effect on playfulness during interactions with an IT artifact.

H12. Personal innovativeness has a positive effect on self-efficacy during interactions with an IT artifact.

H13. Playfulness has a positive effect on self-efficacy during interactions with an IT artifact.

H14. Self-efficacy has a positive effect on cognitive engagement during interactions with an IT artifact.

The research model is depicted in Figure 1.

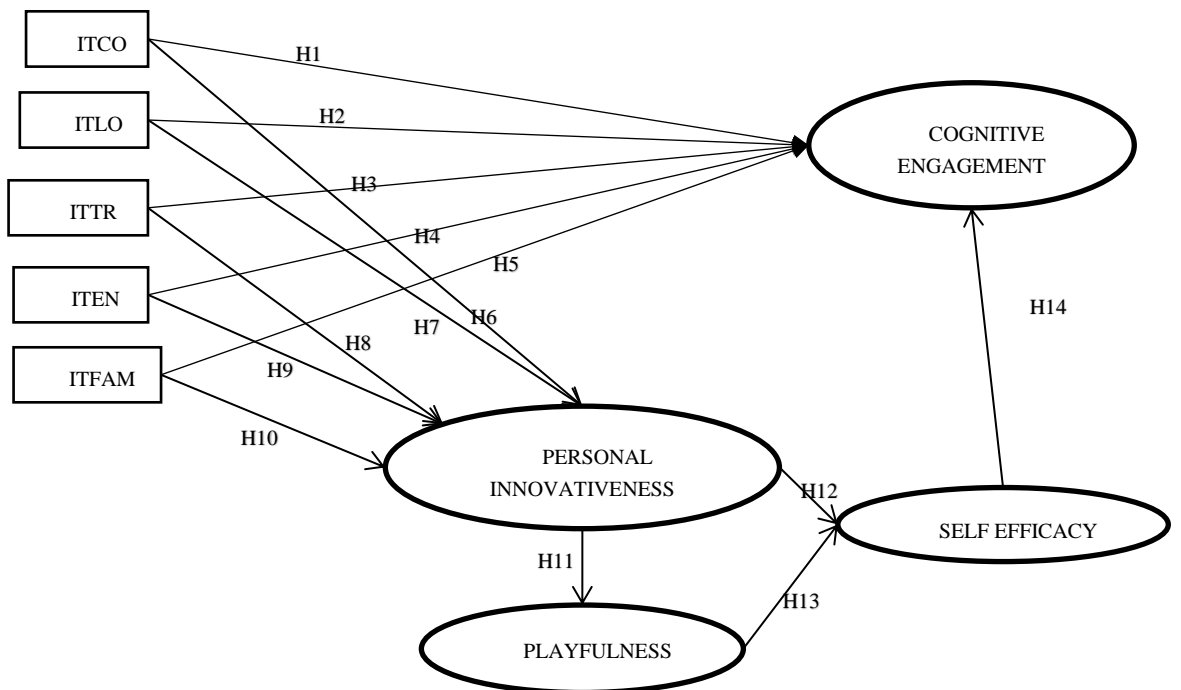


Fig. 1. Research Model

4 Methods

We conducted a field study to test the hypothesized relationships depicted in the research model empirically. Data was collected using the survey method, and the mobile app version of the survey was used to expedite the process. We collected data from 351 Indian smartphone users. Survey participants were fairly distributed across gender, mostly from age groups between 20-50. Other important details of the participants, such as their PC experience, Web experience, and work experience, are shown in Table 2.

We measured the established constructs using multi-item scales (refer Appendix). We adopted Webster and Ho's (1997) six-item scale for cognitive engagement. For self-efficacy, we adopted the ten-item scale used by Agarwal and Karahanna (2000). For playfulness, we adopted the seven-item scale used by Webster and Martocchio (1995). We used the four-item scale developed by Agarwal and Prasad (1998) to measure personal innovativeness. Further, we measure the observed variables, such as all IT use variables and control variables using single-item (refer Appendix). IT use variables are IT use of content delivery services, IT use of transaction-based services, IT use of location-based services, IT use of entertainment-related services, and familiarity with IT.

Table 2. Profile of Respondents

Variable	Scale	Frequency	Percentage
Gender	Male	166	47.3
	Female	185	52.7
Age (years)	20-30	104	29.6
	31-40	132	37.6
	41-50	109	31.1
	50-60	4	1.1
	60-70	2	.6
PC Exp (years)	01-05	10	2.8
	06-10	60	17.1
	11-15	108	30.8

	16-20	164	46.7
	21-25	9	2.6
	01-05	14	4.0
	06-10	82	23.4
Web Exp (years)	11-15	182	51.9
	16-20	73	20.8
	01-05	127	36.2
	06-10	37	10.5
	11-15	121	34.5
Work Exp (years)	16-20	52	14.8
	21-25	8	2.3
	26-30	4	1.1
	31-35	2	.6

We employed SPSS AMOS to test and analyze the research model using the structural equation modeling (SEM) technique. SEM analysis helped us determine the statistical significance of the model and hypothesized relationships.

5 Results and Discussion

We performed a confirmatory factor analysis to examine the discriminant and convergent validity of the constructs. The average variance extracted (AVE) method was used to determine the discriminant validity.

Table 4 shows the loading and cross-loadings of the constructs used in the research model. Table 3 depicts the correlation among variables in the study.

Table 3. Pearson Correlations

	ITCO	ITTR	ITLO	ITEN	ITFAM	PI	PFS	SE	CE
ITCO	1								
ITTR	.071	1							
ITLO	.156**	.378**	1						
ITEN	.165**	.233**	.289**	1					
ITFAM	-.023	.130*	.324**	.099	1				
PI	.224**	.391**	.480**	.346**	.132*	1			
PFS	.228**	.384**	.477**	.343**	.128*	.997**	1		
SE	.147**	.090	.183**	.118*	.003	.397**	.465**	1	
CE	.152**	.032	.104	-.021	.088	.218**	.251**	.441**	1

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

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

All loadings are greater than 0.7 except for two items, where it is almost 0.7. The results of the structural models are shown in Figure 2.

Table 4. Loadings and cross-loadings

	CE	SE	PFS	PIIT
CEAF1	0.822			
CEAF2	0.866			
CEC1	0.754			
CEC2	0.829			
CEII1	0.89			
CEII2	0.829			
SE1C		0.93		
SE2C		0.783		
SE3C		0.882		
SE4C		0.911		
SE5C		0.85		
SE6C		0.953		
SE7C		0.964		

SE8C	0.909	
SE9C	0.954	
SE10C	0.877	
CPS1		0.697
CPS2		0.893
CPS3		0.809
CPS4		0.724
CPS5		0.735
CPS6		0.698
CPS7		0.744
PIIT1		0.794
PIIT2		0.772
PIIT3		0.823
PIIT4		0.764

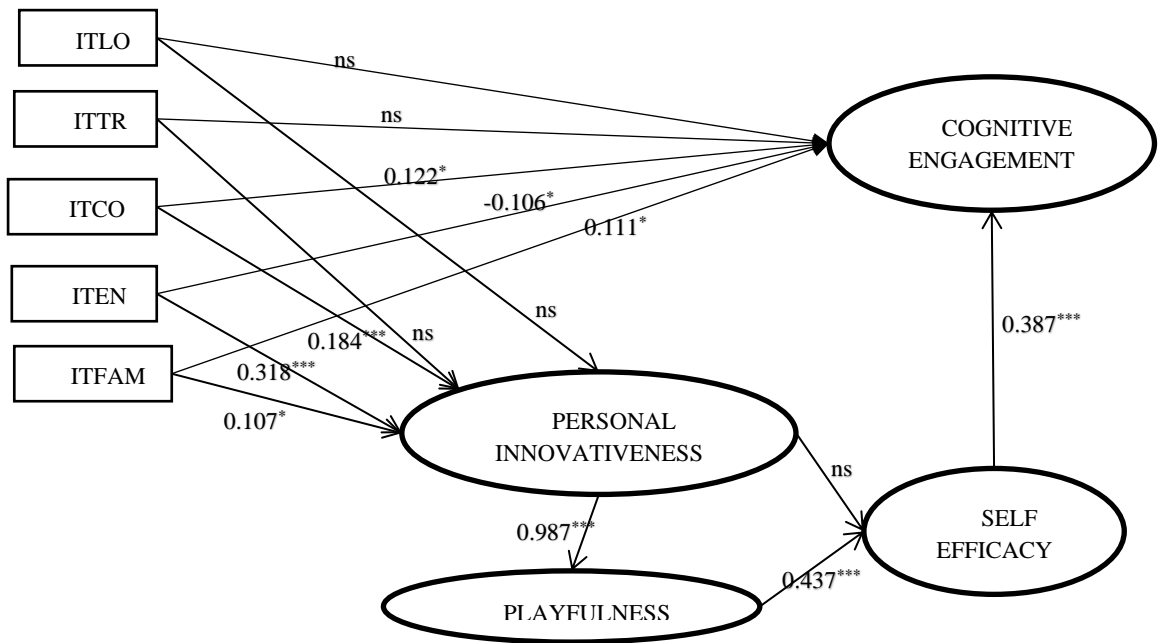


Fig. 2. Results of SEM

6 Conclusion

The results show that online activities associated with content delivery positively affect cognitive engagement, while online activities associated with entertainment negatively affect cognitive engagement. Familiarity with information technology has a positive effect on cognitive engagement. We also find that personal innovativeness, playfulness, and self-efficacy mediate the effect of information technology usage on cognition. The results of the study have both theoretical and practical implications.

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APPENDIX

Scales and Items

IT Use Variables

ITCO: Extent to which I used mobile or other handheld devices for online content delivery activities

ITTR: Extent to which I used mobile or other handheld devices for performing transactions online

ITLO: Extent to which I used mobile or other handheld devices for online location-based services

ITEN: Extent to which I used mobile or other handheld devices for online entertainment

(1 – Never, 2 – Rarely, in less than 10% of the chances when I could have, 3 – Occasionally, in about 30% of the chances when I could have, 4 – Sometimes, in about 50% of the chances when I could have, 5 – Frequently, in about 70% of the chances when I could have, 6 – Usually, in about 90% of the chances I could have, 7 – Every time)

ITFAM: Extent to which I am familiar with the use of mobile or other handheld devices

(1 – Not at all familiar, 2 – Slightly familiar, 3 – Somewhat familiar, 4 – familiar, 5 – Moderately familiar, 6 – Very familiar, 7 – Extremely familiar)

Cognitive Engagement

CEAF1: Online activity on mobile or other handheld devices keeps me totally absorbed.

CEAF2: Online activity on mobile or other handheld devices holds my attention.

CEC1: Online activity on mobile or other handheld devices excites my curiosity.

CEC2: Online activity on mobile or other handheld devices arouses my imagination.

CEII1: Online activity on mobile or other handheld devices is fun.

CEII2: Online activity on mobile or other handheld devices is intrinsically interesting.

(1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neither agree nor disagree, 5 – Somewhat agree, 6 – Agree, or 7 – Strongly agree)

Self-Efficacy

For each of the conditions, please indicate whether you think you would be able to complete the online activity on a mobile or other handheld device. Circle either “Yes” or “No.”

Then, for each condition that you answered “Yes,” please rate your confidence about your first judgment, by writing in a number from 1 to 10 (1 – Not at all confident, 2 –, 3 –, 4 –, 5 –, 6 –, 7 –, 8 –, 9 –, or 10 – Totally confident).

S.No.	I could complete the online activity on a mobile or other handheld device...	Yes/No	Confidence (1-10)
SE1	..if there was no one around to tell me what to do as I go.	Yes No	
SE2	..if I had never used a mobile or other handheld device like it before.	Yes No	
SE3	..if I had only the software manuals for reference.	Yes No	
SE4	..if I had seen someone else using it before trying it myself.	Yes No	
SE5	..if I could call someone for help if I got stuck.	Yes No	
SE6	..if someone else had helped me get started.	Yes No	
SE7	..if I had a lot of time to complete the online activity on mobile or other handheld device.	Yes No	
SE8	..if I had just the built-in help facility for assistance.	Yes No	
SE9	..if someone showed me how to do it first.	Yes No	
SE10	...if I had used similar devices like this one before to perform the online activity.	Yes No	

Playfulness

CPS1. When using mobile or other handheld devices for online activity, I am Spontaneous.

CPS2. When using mobile or other handheld devices for online activity, I am Imaginative.

CPS3. When using mobile or other handheld devices for online activity, I am Flexible.

CPS4. When using mobile or other handheld devices for online activity, I am Creative.

CPS5. When using mobile or other handheld devices for online activity, I am Playful.

CPS6. When using mobile or other handheld devices for online activity, I am Original.

CPS7. When using mobile or other handheld devices for online activity, I am Inventive.

(1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neither agree or disagree, 5 – Somewhat agree, 6 – Agree, or 7 – Strongly agree)

Personal Innovativeness

PIIT1. If I heard about new information technology, I would look for ways to experiment with it.

PIIT2. In general, I am hesitant to try out new information technologies.

PIIT3. Among my peers, I am usually the first to try out new information technologies.

PIIT4. I like to experiment with new information technologies.

(1 – Strongly disagree, 2 – Disagree, 3 – Somewhat disagree, 4 – Neither agree nor disagree, 5 – Somewhat agree, 6 – Agree, or 7 – Strongly agree)