Assessing the Utility of Mobile Computing Devices at Work: the Information Processing Support Index

Completed Research Paper

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Abstract

Mobile computing device adoption in organizations is proliferating with the rapid development of mobile computing technology. In this paper, we proposed a new construct, the Information Processing Support Index (IPSI), to capture how well these devices support employees' job-required information processing activities. The instrument yields scores that measure perceptions about mobile devices' capabilities and job requirements in terms of the two major types of information processing activities at work: content generation and content consumption. We use both qualitative and quantitative methods to demonstrate that the IPSI framework exhibits acceptable levels of reliability, content validity, convergent validity, and discriminant validity. Theoretical and practical contributions are also discussed.

Keywords

Content consumption, content generation, information processing, instrument development, mobile computing device adoption, confirmatory factor analysis.

Introduction

In recent years, mobile computing technology has gone through a period of rapid development. Mobile computing devices are becoming an essential part of people's lives. Employees are beginning to adopt various mobile devices not only for their personal uses, but also for work-related purposes. The proliferation of these devices also marks a radical change in organizations' computing environments (Holtsnider and Jaffe, 2012). Consequently, IT departments are shifting some of their focus from managing their organizations' IT resources to providing personal device support for the employees. This trend of employees using their own mobile devices at workplaces presents new challenges and opportunities for organizations in many areas such as information security, communication management, operation efficiency, etc. (Hayes, 2012; Messmer, 2012). For example, the increasing number of different types of mobile computing devices at workplace put a larger burden on the IT department since they now have to provide support for more types of mobile computing devices with a variety of operating systems.

The current Bring Your Own Device (BYOD) trend is considered as part of a larger phenomenon of IT consumerization (Harris et al.,2012). Some new characteristics distinguish mobile computing devices from Personal Computers (PC): these devices are extremely easy to personalize, they are compact in physical dimensions, and their operating systems differ greatly from each other (Pitt et al., 2011). Therefore, the same set of factors that influenced PC adoptions will not be sufficient to explain the current BYOD trend. To date, there is a shortage of research in the MIS field to help guide companies deal with this trend effectively. Furthermore, there is a lack of consensus among researchers about why employees want to bring their own devices to workplaces, and why they choose to use different devices for work.

In the Management Information Systems (MIS) discipline, researchers have historically focused on design features, mobile value-added services, or cognitive factors when studying mobile computing device adoptions (Rahmati and Zhong, 2013; Sarker and Wells, 2003). There is a need to systematically examine the more fundamental factors that influence employees' mobile-computing-device-adoption intentions at work. Understanding the fundamental reasons behind employees' adoption behaviors will help managers provide more effective support to their employees and will also help them develop more relevant strategies about mobile computing device usage.

This paper proposes the Information Processing Support Index (IPSI) framework to explain the increasing utility of mobile computing devices at work by capturing employees' perceptions about how well these devices support their job-required information-processing activities. This study provides some initial insights about the following research question: How can we use an information processing perspective to capture why employees choose to adopt different mobile computing devices at work? We utilize both qualitative and quantitative methods to generate, refine, test, and validate a set of survey instruments to measure the IPSI framework. This is the first step toward developing a new model that explains employees' mobile device adoption intentions.

Theoretical Background

Previous studies have approached issues in mobile-computing-device adoption and management from different perspectives, e.g., End-User Computing (EUC) (Moore et al., 2007), Consumerization of IT (Harris et al., 2012), and Human-Computer Interactions (HCI) (Hayes and Truong, 2013). However, most studies in marketing and behavioral sciences focused on users' adoption behaviors (Schepman et al., 2012), users' satisfaction with mobile devices/services (Kuo et al., 2009), and design-related issues (Morris and Aguilera, 2012). These studies viewed mobile computing devices as 1) another high-tech consumer product; 2) a media through which customers are consuming content such as mobile apps, news, video and music contents; and 3) a communication tool through which businesses can gain operating efficiency. However, few scholars have examined why employees want to bring their own mobile devices to work from the information processing perspective.

Information Processing Support Index Framework

In previous literature, researchers used the information processing view of firms to explain why organizations have different structures and communication channels (Galbraith, 1974). Information systems can help firms' performance at an organization level by eliminating the need to process information or increase the capability to process information (Daft and Lengel, 1986). On the other hand, studies about technology adoptions such as the Technology Acceptance Model (TAM) (Davis, 1989; Davis et al., 1989) and Task-Technology Fit (TTF) theory (Goodhue and Thompson, 1995) have focused on organization level technology adoptions in more mature technologies (Gebauer, 2008). The perceived usefulness, perceived ease of use, and the fit between task and technology are strong predictors about people's technology adoption behaviors. However, there is a lack of research on identifying the antecedents of these predictors and how people develop their technology adoption intentions.

The current study tries to fill this gap by adopting the information processing view at the individual level to explain employees' mobile-computing-device-adoption intentions at workplaces. We define the IPSI as an indicator of the perceived levels of information processing support mobile devices provide for employees. By examining how employees process information in workplaces, the IPSI framework utilizes the Content Generation Score (CGS) and Content Consumption Score (CCS) to measure employees' perceptions about how well the mobile computing devices support the two types of information-processing activities in their working environments.

As suggested in the literature about scale development and domain sampling model (Churchill, 1979; Nunnally and Bernstein, 1994), this study utilizes both qualitative and quantitative approaches to develop a new survey instrument to measure IPSI. The following sections discuss the IPSI model specification of and the steps of the instrument development process including generating items in the instrument, refining the item list, and assessing the reliability and validity of the instrument.

IPSI Model Specification

First, we introduce the IPSI framework and the formulas used to calculate the IPSI score. The fundamental concept behind the IPSI calculation is that people utilize mobile computing devices at work to fulfill their information processing needs. There are two major types of information processing activities, content generation and content consumption. Different mobile devices have different capabilities to support these activities. Different job positions require employees to engage in different levels of these activities as well.

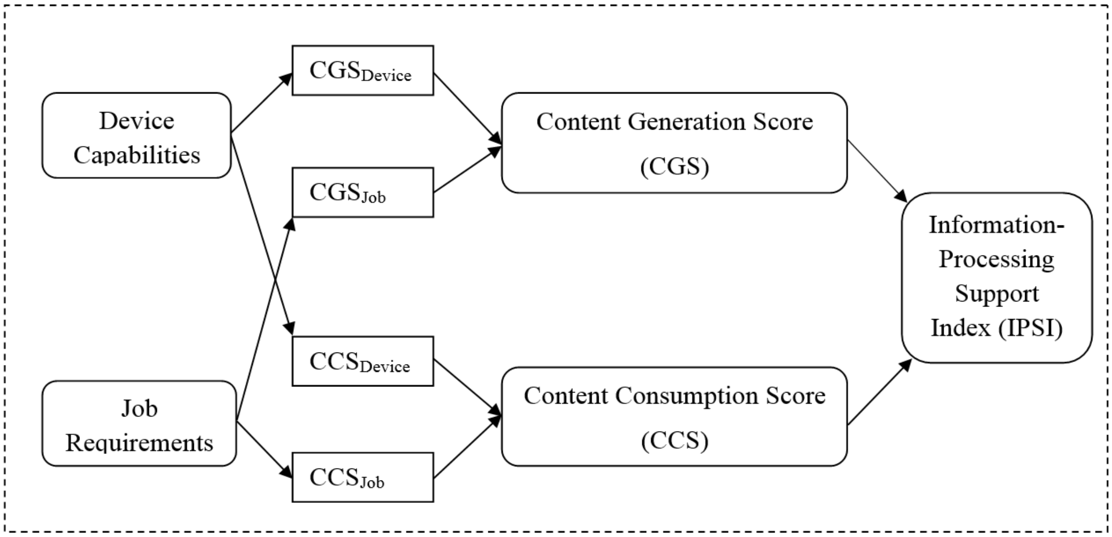

Figure 1. IPSI Framework

As indicated in Figure 1, the IPSI framework uses two sets of device-related and job-related scores (CGS_{Device}, CCS_{Device}, CCS_{Job}, and CGS_{Job}) to measure employees' perceptions about the mobile devices' capabilities and the employee's job requirements in terms of content generation and consumption.

A higher CGS_{Device}/CGS_{Device} score indicates that employees have better perceptions about the device's capabilities in performing content generation/consumption-related tasks. Similarly, a higher CGS_{Job}/CCS_{Job} score indicates that employees think their jobs require them to engage more frequently in content generation/consumption activities. The CGS and CCS scores are then calculated by comparing the device-related scores to the job-related scores. Therefore, the CGS and CCS scores capture employees' perceptions about how well these devices support their job-required content-generation/consumption activities. If a device has CGS/CCS scores that match or exceed the job-related scores, the perceived device capability is equal to/greater than the perceived job-required content generation/consumption activities. Equation 1 to 3 demonstrate how these scores are calculated.

Equation 1: $$CGS' = 1 - \frac{CGS_{Job} - CGS_{Device}}{MAX(CGS_{Job} - CGS_{Device})} \qquad CGS = \begin{cases} CGS' & if\ CGS' \geq 1 \\ CGS'^2 & if\ CGS' < 1 \end{cases}$$

Equation 2: $$CCS' = 1 - \frac{CCS_{Job} - CCS_{Device}}{MAX(CCS_{Job} - CCS_{Device})} \qquad CGS = \begin{cases} CCS' & if\ CCS' \geq 1 \\ CCS'^2 & if\ CCS' < 1 \end{cases}$$

Equation 3: $$IPSI = CGS \times W_{cgs} + CCS \times W_{ccs}$$

In Equation 1 and 2, the CGS' and CCS' scores were computed as the differences between device-related and job-related sub scores scaled by their maximum differences. The resulting scores range from zero to two, in which a score of one indicates the neutral point (the device-related scores equal the job-related scores) and a higher score means better perceived device support. The CGS' and CCS' are the raw scores. As suggested by the prospect theory (Kahneman and Tversky, 1979), when evaluating the value of choices, people discount the losses more than they value the gains. Therefore, when the perceived device capability falls below the perceived job requirements, the perceived support of mobile device will decrease faster. To reflect these effects, when calculating the CGS and CCS, the IPSI framework penalizes the raw scores less than one by squaring the CGS' and CCS' if they are less than one, reflecting the effect that losses loom larger than gains.

Finally, the IPSI score is calculated by equation 3. The W_{cgs} and W_{ccs} are weights that indicate the perceived importance of the two types of job-required information processing activities. By incorporating these weights, the IPSI formula is able to account for the differences in job requirements across different positions. Next, we discuss the instrument development process using both qualitative and quantitative approaches.

Item Generation

In order to measure the CGS and CCS, this paper develops a set of new instrument items asking employees about their perceptions of the capabilities of a mobile device in performing job-related content generation/consumption activities, and the degree to which their jobs require them to perform these activities. As indicated in the Theory of Planned Behavior (TPB) (Ajzen and Fishbein, 1980; Ajzen, 1991), attitudes have great impact on people's behavior. In addition, using perception measures can avoid device/job specific issues. Mobile computing devices are evolving rapidly, therefore, any measures based solely on device characteristics such as processing speed, display size, and etc. will soon become outdated. By utilizing the perception measures, we successfully solve the problem that there are too many device-specific measures and achieve a high level of parsimony and generality in the resulting instrument.

The Morgan Stanley Research Global study (2011) used content creation and consumption to distinguish two information-processing activities. Although focused on consumer usage of tablet computers, the study revealed several work-related activities in the content creation category (communication, and general/specific work-related content creations) and the content consumption category (general web browsing, and communication-related content consumptions). In addition, as suggested by the Information Technology Associates' (ITA) dictionary of occupational titles (DOT) (1991), every job requires a person to function to some degree in relation to data, people, and things. Based on these notions, we generated a list of job-required content-generation/consumption activities. There are three major categories of information processing activities at workplaces: communication, work-related, and networking activities. Table 1 below shows some of the sample activities in these categories.

Activities	Content generation	Content consumption
Communication activities	Creating email messages, and IM/social network messages	Reading email messages, and IM/social network messages
Work-related activities	Creating work-related documents, editing work-related documents	Browsing the Internet, reviewing work-related documents
Networking activities	Creating content on social network and other web pages	Reading content on social network and other web pages

Table 1. Sample information processing activities

The instrument item list was created using activities from these categories. Initially, five survey items per construct were generated. An instrument refinement process was conducted to ensure the content validity, convergent validity, and discriminant validity of the initial IPSI instrument item list.

Instrument Refinement Process

To assess how well these items represented their underlying constructs, the instrument refinement process utilized a Q-sort technique. This technique, discussed by various researchers (Segars and Grover, 1998; Storey et al., 2000; Straub et al., 2004), is useful in evaluating both content validity and construct validity. In general, a Q-sort test involves having participants group items according to their similarity. Convergent validity was demonstrated if items representing the same constructs are grouped together. On the other hand, discriminant validity was evident if items representing different constructs are grouped into different sets. Finally, content validity was ensured if most of the items are grouped into their underlying constructs.

The Q-sort test was conducted with 30 undergraduate students from a large southern public university in the U.S. Four content generation activities and four content consumption activities were included in the Q-sort test. The reasons that undergraduate students are appropriate participants for the instrument refinement process and subsequent tests are: 1, most of the undergraduate students are familiar with multiple types of mobile computing devices (smartphones, tablet computers, and laptop computers); 2, they all have adopted these mobile devices in their study-related activities; 3, they are viewed as future employees and their perceptions are more relevant to the younger generations in the workforce. However, students have limited professional employment experience. They cannot entirely represent how employees view their job-required content generation/consumption activities without special instructions. Based on these factors, the Q-sort test showed the participants only the eight activities that were used to construct the instrument's items. By not revealing the actual items, we were able to avoid potential confusion about work-related situations among the participants. In the later test, a scenario was created in which the participants were asked to view their classroom as their work environment. By using the "classroom as workplace" and "pursuing your degree as your job" analogy, we were able to reduce the lack of work experience effect of our student sample through positioning them with a familiar setting.

The Q-sort test randomly assigned participants to either a categorizing task or a ranking task. The categorizing task asked them to categorize eight activities into content-generation and content-consumption categories. The ranking task asked them to rank the same set of activities according to their relevance to content-generation and consumption. No definitions of content generation and consumption were given in these tasks. Table 2 and Table 3 show the results of these tasks.

Items	Content-Generation (# of responses)	Content-Consumption (# of responses)
Creating email messages	12	3
Creating IM/Social network messages/posts	12	3
Creating work-related documents	12	3
Editing work-related documents	12	3
Reading email messages	4	11
Reading IM/social network messages/posts	6	9
Browsing web pages	6	9
Reading/reviewing work-related documents	6	9

Table 2. Categorizing task results

Content Generation Activities	Rank	Content Consumption Activities	Rank
Creating work-related documents	1	Reading email messages	1
Creating email messages	2	Browsing web pages	2
Creating IM/social network messages/posts	3	Reading/Reviewing work-related documents	3
Reading email messages	4	Creating email messages	4
Reading IM/social network messages/posts	5	**Reading IM/social network messages/posts**	5
Browsing web pages	6	Creating work-related documents	6
Reading/Reviewing work-related documents	7	**Editing work-related documents**	7
Editing work-related documents	8	Creating IM/social network messages/posts	8

Table 3. Ranking task results

Overall, these results showed that the initial item list demonstrated acceptable levels of content validity, convergent validity, and discriminant validity. In the categorizing task, most participants were able to group the activities into appropriate categories. The ranking task also showed that most of the items were ranked properly.

Figure 2 below demonstrates the rankings changes of these activities across the two categories. As these changes indicate, the item "Editing work-related document" was ranked low in the content generation category. Given that students had limited work experience, one possible explanation was they cannot relate this item to their own experience very well. In addition, the participants might not be able to distinguish between editing and creating documents. Another potentially problematic item was "Reading

IM/social network messages/posts". The rankings were in the middle range and the same across the two categories. This item also had some overlap with the items concerning email. It was possible that the students were confused between this item and other items such as reading email and browsing web pages.

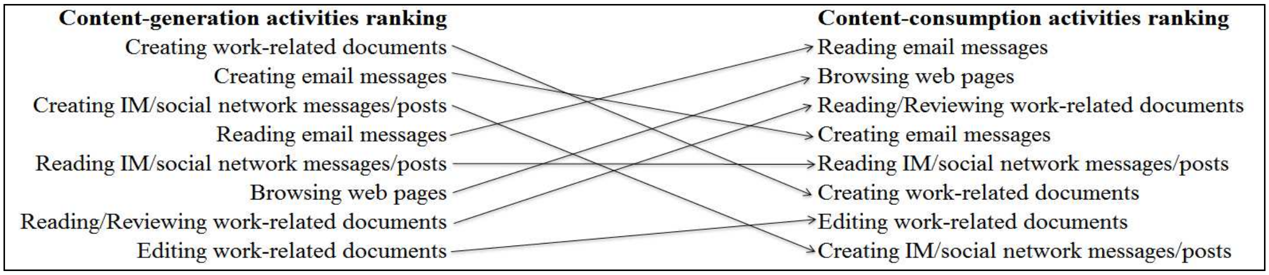

Figure 2. Ranking changes among items

Based on these results, potentially problematic items were revised. As a result, the revised instrument has four items each to measure the component scores of IPSI. Table 4 below shows the revised item list.

Content Generation	Content Consumption
Creating or Editing email and other messages	Reading email and other messages
Creating or Editing work-related documents	Reading work-related documents
Creating or Editing content on social network and other web pages	Reading content on social network and other web pages
Overall content generation item	Overall content consumption item

Table 4. Revised CGS/CCS items list

Next, we collected quantitative data to assess the reliability and validity of the revised instruments.

Reliability and Validity Assessments

To assess the reliability and validity of the instrument, survey questionnaires were distributed to 283 undergraduate students in a large southern public university in the U.S. Participants were randomly assigned with one of the three types of mobile devices: smartphone (69 responses), tablet computer (70 responses), and laptop computer (68 responses) for the CGS_{Device} and CCS_{Device} measures. By the survey closing time, 212 responses were received, yielding a response rate of 74.91%. To alleviate the potential problem of the lack of working experience, we used the classroom to simulate the students' "work environment". Participants were asked to consider their jobs as obtaining their college degree and to view their classroom, classmates, and professors as the organization, coworkers, and supervisors respectively. In this way, the students could better relate the job-required information processing activities to their own course of study, which will provide more accurate and relevant data for the analysis. After removing incomplete data, there were 182 responses in the final analyses.

Cronbach's alpha was used to assess the reliability of each IPSI sub constructs. Table 5 shows that all coefficient alphas were greater than 0.70. As subsequent analyses show, if the items that have low factor loadings in the CFA were removed, the coefficient alphas would be all above 0.75.

Scale Name	CGS_{Device}	CCS_{Device}	CGS_{Job}	CCS_{Job}
Cronbach's alpha	0.788	0.810	0.741	0.748

Table 5. Cronbach's alpha for all scales

These results demonstrated that the revised instrument items measuring the four component scores of IPSI all had acceptable levels of reliability. Next, various validity issues were assessed utilizing the Confirmatory Factor Analysis (CFA) technique.

As suggested by Torkzadeh et al. (2003), convergent validity was assessed by examining the standardized factor loadings of all measurement items. If the items measuring the same underlying construct have standardized factor loadings that are greater than 0.50, convergent validity was demonstrated. On the other hand, discriminant validity was partially supported if all items have the highest standardized factor loadings on their own constructs (no cross-loaded items).

Latent Variable	Indicators	Standardized Loadings (16 indicators)	Standard Errors	t Values
CGS_{Device}	CGSD1	0.821	0.039	21.302
	CGSD2	0.631	0.053	11.824
	CGSD3	0.732	0.045	16.218
	CGSD4	0.594	0.057	10.514
CCS_{Device}	CCSD1	0.906	0.023	40.322
	CCSD2	0.797	0.032	24.764
	CCSD3	0.863	0.026	33.346
	CCSD4	***0.413***	***0.065***	***6.304***
CGS_{Job}	CGSJ1	0.863	0.029	29.398
	CGSJ2	0.810	0.034	24.186
	CGSJ3	***0.385***	***0.068***	***5.629***
	CGSJ4	0.529	0.059	8.978
CCS_{Job}	CCSJ1	0.894	0.025	36.273
	CCSJ2	0.859	0.027	31.421
	CCSJ3	***0.345***	***0.070***	***4.964***
	CCSJ4	0.573	0.054	10.540

Table 6. CFA standardized loadings

Table 6 shows the standardized loadings produced during the CFA using SAS 9.3. Overall, most of the items have appropriate factors loadings (greater than 0.50) on their underlying constructs except CCSD4, CGSJ3, and CCSJ3. The items that had low factor loadings are examined below. Table 7 shows the wordings of these items.

Item	Wordings in the survey instrument	Factor loadings
CCSD4	The [mobile device] is capable of performing content-consumption-related tasks at work.	0.413
CGSJ3	My job frequently requires me to create/edit content on social network and other web pages.	0.385
CCSJ3	My job frequently requires me to read content on social network and other web pages.	0.345

Table 7. Items that had lower factor loadings

One possible explanation for the low factor loadings of the "overall" item measuring the content generation/consumption scores (CCSD4) is the wording issue. The initial item used terms that were abstract and passive in nature. The wording may have caused some confusion among the student participants. The CGSJ3 and CCSJ3 items had some problems that were related to the term “social network”. According to the comments gathered from the participants, a large portion of them mentioned that “using mobile devices may cause distractions in work such as getting on social media, always on Facebook, etc.” Therefore, the term social network needed to be clarified and restricted to professional social networking. Appendix A shows the complete IPSI instrument.

Discussions

Table 8 presents the summary statistics produced in this study by using the IPSI framework.

Mean Score	CGS_{Device}	CCS_{Device}	CGS_{Job}	CCS_{Job}	CGS	CCS	IPSI
Smartphone (S)	21.754	24.508	19.377	22.016	1.099	1.104	12.550
Tablet computer (T)	25.705	25.705	21.000	22.230	1.196	1.145	13.824

Laptop computer (L)	23.450	24.350	20.433	22.100	1.126	1.094	12.797
All	23.637***	24.857***	20.269***	22.115***	1.140**	1.114**	13.059
S-T	-3.951***	-1.197**	-1.623*	-0.213	-0.097***	-0.041	-1.274***
S-L	-1.696**	0.158	-1.056	-0.084	-0.027	0.010	-0.247
T-L	2.255***	1.355**	0.567	0.130	0.070*	0.051	1.027**
Range	**CGS_{Device}**	**CCS_{Device}**	**CGS_{Job}**	**CCS_{Job}**	**CGS**	**CCS**	**IPSI**
Smartphone	8-28	15-28	6-26	8-28	0.75-1.63	0.63-1.71	7.44-18
Tablet computer	4-28	16-28	4-28	4-28	0.50-1.83	0.92-1.96	3.79-19.25
Laptop computer	12-28	7-28	6-28	8-28	0.79-1.92	0.54-1.83	4.73-18
All	4-28	7-28	4-28	4-28	0.50-1.92	0.54-1.96	3.79-19.25

Table 8. IPSI framework statistics (* p<0.01 ** p<0.05, * p<0.10)**

A comparison of the means on these scores showed that the three types of mobile devices differed in their CGS_{Device} and CCS_{Device} measures. In terms of the perceived content-generation capabilities, the results showed that the mean scores for tablet computers were the highest and the mean scores for smartphones were the lowest. In terms of perceived content-consumption capabilities, the tablet computers had the highest and the laptop computers had the lowest mean scores. The mean scores were significantly different from each other for all three types of mobile devices in content generation. In content consumption, the mean score of the tablet computer was significantly different from the other two types of devices.

Overall, the means of CGS and CCS were significantly different from each other, indicating that the IPSI framework can distinguish between the two underlying constructs and can reflect the different perceived device capabilities and job requirements. As shown in Table 10, the mean scores of CGS_{Device} and CCS_{Device} are essentially the same for the tablet computers. In other words, on average the participants thought tablet computers had similar capabilities to perform both types of activities. The final IPSI scores showed that on average, the participants thought the tablet computers provide the highest level of support to their information processing activities. This result is consistent with the rapid development of tablet computers and increasing adoptions of these devices in classrooms.

Contributions and Limitations

This paper made several theoretical and practical contributions to the field. First, we proposed a new construct, the IPSI, to capture the more fundamental reasons about employees' perceived utilities of mobile computing devices at work from an information processing perspective. Second, this paper developed and validated measurement instruments for the IPSI framework. Following the steps in scale development, the instrument demonstrated acceptable levels of reliability, content validity, and construct validity. Third, from the practitioners' perspectives, the IPSI scores provided a starting point to develop quantifiable means to evaluate different mobile device options, which can be useful to help organizations managing these device at work. Finally, the insights from the information processing perspective can help guide the mobile device industry to design and develop new technologies that focus on improving information processing support at work.

Since this is an exploratory study, there are several limitations. First, this study used student participants. Although students possess adequate knowledge about these devices, their experiences, ways of thinking, and decision making skills are different from people who have professional working experiences. Therefore, the IPSI needs to be further tested with participants who have adequate working experiences to further validate its measures. Second, as the validity results show, several items need to be modified and revalidated. Third, future studies are needed to connect the IPSI with employees' mobile device adoption behaviors to gain more insights about the relationship between IPSI and the adoption behaviors.

Conclusion

This study provides some important initial insights about the information processing based view of people's mobile device adoption behaviors in organizations. We propose a new construct, Information Processing Support Index (IPSI), to capture an important aspect of why people adopt different mobile computing devices at work. The IPSI framework utilizes two scores, CGS and CCS to measure the perceived levels of support that mobile devices can provide to two major types of information processing activities. Following the literature on measurement scale development, we developed, refined, and validated the measurement instrument for the IPSI construct. The data analysis showed that the IPSI scale exhibits good levels of content validity, reliability, discriminant validity, and convergent validity. Although some items may need to be adjusted for wording issues, the overall results show the IPSI scale captures the differences among three types of mobile computing devices. These results are important to further the understanding of the more fundamental reasons behind employees' mobile device adoption behaviors. Future studies are needed to further validate the construct and to examine the relationships between IPSI and employees' mobile computing device adoption behaviors.

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Appendix A: IPSI Instruments

CGS_{Device}:

CGSD1	The [mobile device][1] is capable of performing tasks related to creating/editing email and other messages.
CGSD2	The [mobile device] is capable of performing tasks related to creating/editing work-related documents.
CGSD3	The [mobile device] is capable of performing tasks related to creating/editing content on social network and other web pages.
CGSD4	The [mobile device] is capable of performing content-generation-related tasks at work.

CCS_{Device}:

CCSD1	The [mobile device] is capable of performing tasks related to reading email and other messages.
CCSD2	The [mobile device] is capable of performing tasks related to reading work-related documents.
CCSD3	The [mobile device] is capable of performing tasks related to reading content on social network and other web pages.
CCSD4	The [mobile device] is capable of performing content-consumption-related tasks at work.

CGS_{Job}:

CGSJ1	My job frequently requires me to create/edit email and other messages.
CGSJ2	My job frequently requires me to create/edit work-related documents.
CGSJ3	My job frequently requires me to create/edit content on social network and other web pages.
CGSJ4	My job frequently requires me to engage in content-generation-related tasks.

CCS_{Job}:

CCSJ1	My job frequently requires me to read email and other messages.
CCSJ2	My job frequently requires me to read work-related documents.
CCSJ3	My job frequently requires me to read content on social network and other web pages.
CCSJ4	My job frequently requires me to engage in content-consumption-related tasks.

Weights of CGS and CCS:
Please indicate the relevant importance of the following tasks:

W_{CGS}	Content-generation-related tasks (e.g., creating/editing email and other messages, work-related documents, and content on social network and other web pages)
W_{CCS}	Content-consumption-related tasks (e.g., reading email and other messages, work-related documents, and content on social network and other web pages)

[1] In this study, three types of mobile computing devices are examined: smartphone, tablet computer, and laptop computer. In the actual survey, the term mobile device was replaced with one of these devices.