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Does Screen Size Matter for Smartphones? Utilitarian and Hedonic Effects of Screen Size on Smartphone Adoption

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Abstract

This study explores the psychological effects of screen size on smartphone adoption by proposing an extended Technology Acceptance Model (TAM) that integrates an empirical comparison between large and small screens with perceived control, affective quality, and the original TAM constructs. A structural equation modeling analysis was conducted on data collected from a between-subjects experiment ($N = 130$) in which users performed a web-based task on a smartphone with either a large (5.3 inches) or a small (3.7 inches) screen. Results show that a large screen, compared to a small screen, is likely to lead to higher smartphone adoption by simultaneously promoting both the utilitarian and hedonic qualities of smartphones, which in turn positively influence perceived ease of use of—and attitude toward—the device respectively. Implications and directions for future research are discussed.

Introduction

WHILE SMARTPHONES HAVE BECOME NEAR-UBIQUITOUS tools for communication with a rapid adoption rate,[1,2] there has been increasing evidence of user preference for smartphones with large screens in recent years. For example, the trend in newer phones by leading manufacturers, such as Samsung Galaxy Note 3 (5.7 inch screen), LG Optimus G Pro (5.5 inch screen), and HTC One Max (5.9 inch screen), suggests that large screens are preferred over small screens. Recent polls on smartphone adoption and usage reveal that the screen size of smartphones has steadily grown from 2008 to the present, and nearly one-third of smartphones sold in 2012 had a screen size larger than 4.5 inches.[3,4] Screen size is now regarded as a key choice factor among smartphones, equally as important as brand reputation, price, and operating system. However, the essential question of whether screen size indeed significantly contributes to shaping user perceptions and acceptance of smartphones has not been sufficiently addressed in empirical research. Does screen size really matter? Are there psychological factors other than the intuitive notion of ''the bigger the better'' that explain the role of screen size? To answer these and related questions, this study explicates the process through which screen size determines user acceptance of smartphones by examining perceived control and perceived affective quality as key utilitarian and hedonic factors that are closely associated with screen size and integrating them with the Technology Acceptance Model (TAM).

Theoretical Background

Technology acceptance model (TAM)

TAM has frequently been utilized as a theoretical framework that allows systematic predictions of user acceptance of information and communication technologies. The original TAM features perceived usefulness (PU) and perceived ease of use (PEOU) as the primary determinants of technology adoption. A particular technology is perceived to be useful if users believe that the operation of the technology is easy and convenient. Both PU and PEOU, along with external factors surrounding unique affordances and characteristics of the technology (e.g., screen size), are then believed to determine user attitude (AT) toward the technology. When positive attitude is formed by enhanced PU and PEOU, users are more likely to show stronger behavioral intention (IU) to use the technology.[5–7]

This TAM framework has been extensively replicated and validated by numerous studies that attempt to predict user acceptance of novel technologies, systems, or services, thereby confirming ''the significant explanatory power and parsimony of TAM (p. 907).''[8] For example, prior studies have established the validity of TAM as an effective

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theoretical model especially in exploring user acceptance of various mobile-based technologies and services, including smartphones,[9,10] e-book readers,[11] mobile TV,[12] Internet,[13,14] games,[15,16] learning,[17] banking,[18] chatting,[19] and long-term evolution (LTE) services.[20] Therefore, TAM is a logical framework for empirically studying the role played by screen size in determining user acceptance of smartphones.

This study defines PU and PEOU as the degrees to which users believe that their job performance can be enhanced by using smartphones and that using smartphones is free of physical and mental effort. AT and IU refer to users' positive feelings and evaluations of using smartphones and their intentions to (continue to) use smartphones, respectively. Based on these definitions and the earlier TAM literature that provides documented evidence for the closely connected, interdependent relationship among PU, PEOU, AT, and IU,[5–20] the current study intends to verify the following hypotheses related to TAM, in an attempt to explicate the underlying process of smartphone adoption:

H1: Positive attitude will lead to stronger intention to use smartphones.

H2: Perceived usefulness will lead to stronger intention to use smartphones.

H3: Perceived usefulness will lead to a more positive attitude toward smartphones.

H4: Perceived ease of use will lead to a more positive attitude toward smartphones.

H5: Perceived ease of use will lead to greater perceived usefulness of smartphones.

Effects of screen size: utilitarian and hedonic perspectives

A large corpus of work in the fields of psychology and communication has consistently found that an increase in screen size positively influences various cognitive and affective domains of user perceptions, including presence, enjoyment, satisfaction, immersion, and realism.[21–24] Increased screen size is believed to lead to greater sensory richness by increasing the number of perceptual channels that process information, thereby providing users with a more apparent reality and natural experience than that of a small screen.[24–26] Given these documented effects in shaping user perceptions, screen size is likely to serve as a salient technological affordance of smartphones that influences psychological determinants of smartphone adoption and usage. More specifically, this study intends to demonstrate that user acceptance of the technology can be better understood by explicating the effects of screen size in utilitarian and hedonic terms.

In terms of the utilitarian aspect, screen size is likely to affect perceived control (PC) of smartphones, i.e., the degree to which users believe that they have control over the device. Given that smartphones are equipped with touch-based interfaces that allow intuitive and dynamic interactions, an increase in screen size offers a larger surface for interactions and a greater sense of controllability. Large screens also enable the utilization of various communication modalities.[27] Exchanging and accessing information become more comfortable and convenient as smartphone screen sizes increase. Higher quality and quantity of information can now be delivered by large screens that are capable of simultaneously utilizing different modalities (e.g., text, audio, video, haptic) more effectively than earlier small screen devices using text as their primary modality. That is, the increased number of modalities provides users with greater convenience and interactivity than do smartphones with small screens.

Furthermore, users who believe that they have strong control over a technology are more likely to perceive that the technology is easier to use for completing and satisfying their tasks and expectations.[16,28–30] One explanation is that perceived control is positively related to a sense of connectedness, readiness, and accessibility that enhances users' ability to complete tasks and their confidence (i.e., self-efficacy) in reaching goals by using the technology.[30,31] In accordance with the literature reviewed thus far, this study proposes the following hypotheses pertaining to the utilitarian effects of screen size:

H6: A large screen will lead to greater perceived control of smartphones.

H7: Perceived control will lead to greater perceived ease of use of smartphones.

In terms of the hedonic aspect, large screens enhance perceived affective quality (PAQ) of smartphones by triggering the ''bigger is better'' heuristic.[32] Heuristics are judgment-based mental shortcuts that allow an easy, immediate evaluation of—and formation of attitude toward—an object, person, or event.[33] The physical size of large screens serves as a salient technological cue that triggers heuristic-based judgments related to the habitual notion that large objects are generally more affective, appealing, and pleasing.[32] Substantial research in the fields of psychology, behavioral science, and design has indicated that individuals rely heavily on this size-based judgment when interacting with others as well as technologies.[32,34,35] Larger screens are believed to be particularly more effective in eliciting affective responses because users can more easily recognize affection-eliciting stimuli projected on large screens than on small screens.[36,37]

Affective quality is especially relevant in human–computer interaction and user acceptance of a technology due to its ability to induce positive feelings and evaluations of the technology.[38–40] For example, research has demonstrated that Websites and web-based services with greater affective quality typically elicit positive reactions toward using the technology.[40–42] Extending this literature to smartphones, this study defines PAQ as the degree to which smartphones influence user affect, feelings, and moods, and posits the following hypotheses pertaining to the hedonic effects of screen size:

H8: A large screen will lead to greater perceived affective quality of smartphones.

H9: Perceived affective quality will lead to a more positive attitude toward smartphones.

Method

A between-subjects experiment with two conditions representing two levels of smartphone screen size (large vs. small) was conducted in Seoul, Korea. Data from 130 undergraduate students (65 males, 65 females) who signed up for the experiment through an online registration page were analyzed. Participants ranged in age from 18 to 27 years, with a mean age of 22.49 years ($SD = 2.05$). A power analysis for the not close model fit ($\alpha = 0.05$, null root mean square error of approximation [RMSEA] = 0.05, alternative RMSEA = 0.01)[43] using online R software[44] confirmed that the current sample size had an adequate level of statistical power (0.90) to test the hypotheses.

Two Android-platform-based smartphones with 5.3 inch and 3.7 inch screens (16:9 ratio) were prepared in a laboratory. The brand logo and exterior features of each smartphone were masked to minimize the potential influence of familiarity and brand reputation. The smartphones' default home screens and user interfaces were replaced with an Android application called Apex Launcher so that both smartphones offered identical user interfaces.

During the experiment, participants were randomly assigned to one of the two smartphones, and told that their experimental task was to visit a Website (a pseudo mobile Website of a student organization created by the experimenter) and find the nearest departure time of the university shuttle bus from the laboratory at Campus A to the organization office at Campus B. (The university has two main campuses located in two cities about 60 minutes apart by bus, and students occasionally commute between the campuses.) When participants raised their hands to indicate that they were finished with the experimental task, they were asked to complete an online questionnaire on a desktop computer, which included items on their assessments of the measured variables included in the proposed research model.

All variables were measured on 7-point Likert scales with anchors of 1 = ''strongly disagree'' and 7 = ''strongly agree.'' Questionnaire items for PU, PEOU, AT, and IU were adopted from previously validated TAM studies.[5,6,45–47] Items measuring PAQ and PC were adopted from the Mobile Phone Usability Questionnaire.[48] Words and phrases from the original questionnaires were modified to fit the context of general smartphone use and the experimental task in this study. The complete list of questionnaire items used in this study can be found in the Appendix.

Results

Measurement model

A confirmatory factor analysis (CFA) using AMOS 20 with a maximum likelihood estimation method confirmed that the overall measurement model fit indices were satisfactory: ratio of chi-square to the degrees of freedom (χ^2/df) = 1.127, RMSEA = 0.031, comparative fit index (CFI) = 0.988, goodness-of-fit index (GFI) = 0.866, normed fit index (NFI) = 0.907, incremental fit index (IFI) = 0.989, Tucker-Lewis index (TLI) = 0.986, relative fit index (RFI) = 0.889, parsimony goodness-of-fit index (PGFI) = 0.669, parsimony comparative fit index (PCFI) = 0.832, and parsimony normed fit index (PNFI) = 0.763. Researchers agree that measurement and structural models with values of $\chi^2/df < 5$; RMSEA < 0.08; CFI > 0.92; GFI, NFI, IFI, TLI, and RFI > 0.90; and PGFI, PCFI, and PNFI > 0.50 are considered statistically acceptable model fits.[49–53]

The measurement model also showed good internal reliability and convergent and discriminant validity. As reported in Tables 1 and 2, the factor loadings of individual items were well over 0.70 (except PU2) and significant at $p < 0.001$. The average variance extracted (AVE) and the Cronbach's alpha for every construct were over 0.50 and

Table 1. Internal Reliability and Convergent Validity of the Measurements

Observed variable	*Item*	*Factorloading**	*Cronbach's alpha*	*Composite reliability*	*Average variance extracted*
Attitude	AT1	0.86	0.88	0.88	0.64
	AT2	0.87			
	AT3	0.77			
	AT4	0.70			
Intention to use	IU1	0.70	0.90	0.90	0.70
	IU2	0.87			
	IU3	0.92			
	IU4	0.83			
Perceived ease of use	PEOU1	0.94	0.97	0.97	0.87
	PEOU2	0.96			
	PEOU3	0.92			
	PEOU4	0.92			
Perceived usefulness	PU1	0.82	0.91	0.89	0.68
	PU2	0.69			
	PU3	0.83			
	PU4	0.94			
Perceived affective quality	PAQ1	0.71	0.87	0.88	0.72
	PAQ2	0.86			
	PAQ3	0.95			
Perceived control	PC1	0.75	0.86	0.87	0.62
	PC2	0.83			
	PC3	0.78			
	PC4	0.79			

*All item loadings were significant at $p < 0.001$.

Table 2. Descriptive Analysis and Discriminant Validity of the Measurements

Construct	*Mean*	*SD*	*AT*	*IU*	*PEOU*	*PU*	*PAQ*	*PC*
AT	4.64	1.11	**0.80**					
IU	4.96	1.19	0.54	**0.84**				
PEOU	4.77	1.09	0.41	0.43	**0.94**			
PU	4.74	1.11	0.43	0.30	0.52	**0.82**		
PAQ	3.65	1.39	0.39	0.34	0.42	0.32	**0.85**	
PC	4.77	1.06	0.32	0.41	0.47	0.47	0.56	**0.79**

Diagonal elements in boldface represent the square roots of the average variance extracted.

AT, attitude; IU, intention to use; PEOU, perceived ease of use; PU, perceived usefulness; PAQ, perceived affective quality; PC, perceived control.

0.70, respectively. The square roots of the AVEs were also larger than the intercorrelations between the factors.

Structural model

Structural equation modeling (SEM) analysis using AMOS 20 was employed to validate the hypothesized relationships in the proposed research model. As summarized in Table 3 and Figure 1, the SEM results supported all hypotheses except H3 and indicated that the structural model had acceptable fit indices: χ^2/df = 1.274, RMSEA = 0.046, CFI = 0.973, GFI = 0.845, NFI = 0.886, IFI = 0.973, TLI = 0.969, RFI = 0.869, PGFI = 0.676, PCFI = 0.846, and PNFI = 0.771.

Consistent with H1 and H2, user attitude toward ($\beta = 0.47$, $p < 0.001$)—and perceived usefulness of ($\beta = 0.24$, $p < 0.01$)—the smartphone had positive effects on intention to use the device. However, H3 was not supported: perceived usefulness of the smartphone did not significantly affect user attitude toward the device ($\beta = 0.17$, $p = 0.09$) when the PAQ → AT path was added, indicating that the portion of AT's variance explained by PAQ and PU are roughly the same. As predicted in H4 and H5, perceived ease of use of the smartphone had positive effects on attitude toward ($\beta = 0.29$, $p < 0.01$)—and perceived usefulness of ($\beta = 0.57$, $p < 0.001$)—the device.

H6 and H8 were also supported: screen size (dummy coded: 1 large, 0 small) was found to be a significant factor that influences perceived control ($\beta = 0.56$, $p < 0.001$) and perceived affective quality ($\beta = 0.59$, $p < 0.001$) of the smartphone, confirming the superiority of a large screen over a small screen. As predicted in H7 and H9, perceived control of the smartphone had positive effects on perceived ease of use ($\beta = 0.59$, $p < 0.001$), while perceived affective quality of the smartphone had positive effects on user attitude ($\beta = 0.25$, $p < 0.001$).

Table 3. Summary of Hypothesis Tests

Hypotheses	*Standardized coefficient*	*SE*	*CR*	*Supported*
H1: AT → IU	0.47**	0.87	4.64	Yes
H2: PU → IU	0.24*	0.08	2.68	Yes
H3: PU → AT	0.17	0.11	1.69	No
H4: PEOU → AT	0.29*	0.12	2.61	Yes
H5: PEOU → PU	0.57**	0.09	6.54	Yes
H6: LS → PC	0.56**	0.17	6.03	Yes
H7: PC → PEOU	0.59**	0.11	5.83	Yes
H8: LS → PAQ	0.59**	0.20	6.33	Yes
H9: PAQ → AT	0.25*	0.09	2.76	Yes

*$p < 0.01$; **$p < 0.001$.

SE, standard error; LS, large screen.

Discussion

The main contribution of this study is the two-dimensional conceptualization of the effects of screen size in terms of utilitarian and hedonic perspectives. A large screen, compared to a small screen, was found to enhance both utilitarian (i.e., perceived control) and hedonic (i.e., perceived affective quality) qualities of smartphones, suggesting that smartphones are convergent media that appeal to both task-oriented and affect-oriented needs and motivations of users.[2] The significant path coefficients from large screen to PC ($\beta = 0.56$, $p < 0.001$) and PAQ ($\beta = 0.59$, $p < 0.001$) confirm that these two psychological domains are largely and simultaneously affected by screen size, thereby playing a critical role in predicting overall smartphone adoption.

However, a follow-up phantom model analysis[37,54] using 10,000 bootstrap samples at 95% bias-corrected confidence intervals revealed that the overall magnitude of the hedonic path (i.e., LS → PAQ → AT → IU; $B = 0.14$, $SE = 0.06$, $p < 0.01$) was larger than that of the utilitarian path (i.e., LS → PC → PEOU → PU → IU; $B = 0.07$, $SE = 0.03$, $p < 0.01$) even though participants were given a task-oriented, rather than entertainment-oriented (e.g., gaming, movie watching), assignment during the experiment. This implies that users are likely to put greater emphasis on the affective dimension of the technology than on its utilitarian dimension, despite the practical, purposeful nature of the assigned task. Given that user affect (e.g., positive or negative feelings) toward a technology is typically attributed as the central characteristic of the technology (regardless of the accuracy of the attribution),[55] the practical implication of this finding is that smartphone manufacturers ought to take full advantage of the positive effects of the large screen on PAQ when designing their products. However, the more challenging design implication is that the optimal level of screen size that does not jeopardize the anywhere–anytime mobility of smartphones should first be identified, since screen size cannot be indefinitely increased in the mobile context. Thus, the remaining question to be addressed in future research is the optimal size of the mobile screen.

From a theoretical standpoint, the notable contribution of this study lies in the identification and integration of PAQ and PC as key predictors of adoption. Researchers argue that extended TAM frameworks that include both affective (e.g., PAQ) and rational (e.g., PC) evaluations of technology are more effective in analyzing user acceptance of convergent media, such as smartphones, than the traditional TAM alone.[2] Furthermore, this study adds to the existing TAM literature in that the integrated model demonstrates a way to circumvent the two key predictors of TAM (i.e., PEOU and PU) but still significantly affect the final outcome (i.e., IU) via the hedonic path. Therefore, our integrated model arguably has greater theoretical strength in predicting smartphone adoption than traditional TAM.

By extension, the proposed model may be further refined by adopting newer models of TAM, including TAM2 and UTAUT, which have proposed additional determinants such as performance and effort expectancy, voluntariness,

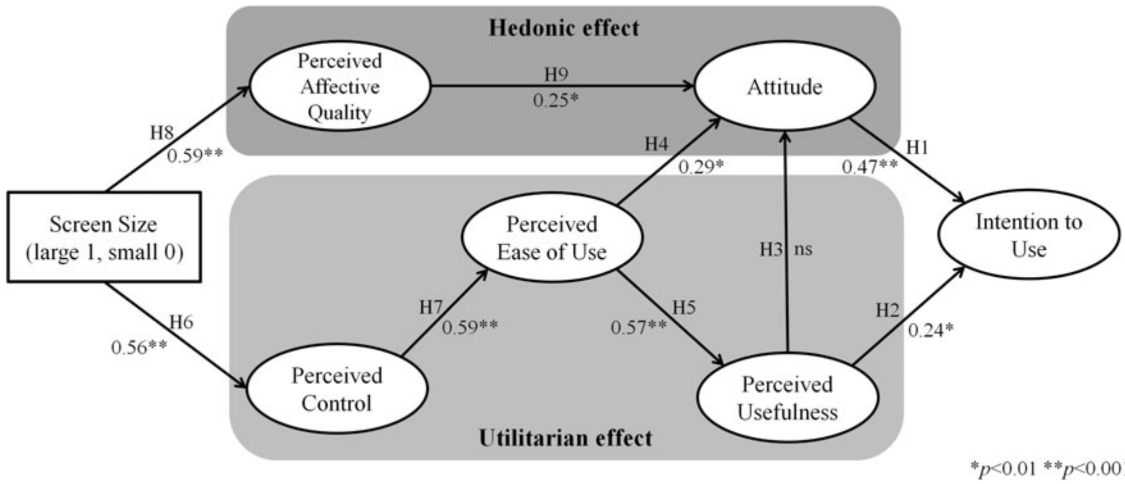

FIG. 1. Proposed research model with standardized path coefficients.

experience, and social influence.[46,56] For example, incorporating social influence variables such as perceived coolness[57] can help us examine whether social factors play an influential role in making an acceptance decision. Given that the concept of coolness is socially constructed[57] and society in general thinks of large screens as cool, PAQ resulting from the large screen could be, in part, due to the recognition of coolness surrounding large screens.

The nonsignificant relationship between PU and AT ($\beta = 0.17$, $p = 0.09$) and the relatively small path coefficients from PEOU to AT ($\beta = 0.29$, $p < 0.01$) and PU to IU ($\beta = 0.24$, $p < 0.01$) are unexpected and noteworthy findings. The nonsignificant path suggests that the indirect effects of PU on AT via PEOU and IU might have reduced the direct effects of PU on AT. An implication of this finding, along with the PEOU → AT path, is that the link between the utilitarian and hedonic determinants is yet to be directly established and needs further exploration, especially in the mobile context. In addition, the weak relationship between PU and IU suggests that the level of participants' experience and familiarity with smartphones might have played a role, given that effects of PU on IU are known to increase over time and use.[7]

For future research, there are several issues that should be taken into consideration. First, the relatively small sample size ($N = 130$) for SEM is a potential limitation of this study. Researchers have recommended sample sizes larger than 200 for greater validity of structural modeling[58,59] and argued that insufficient data is a latent cause for Heywood cases in which standardized loading is larger than one and error variance is negative.[60,61] However, both the measurement and structural models yielded no such cases, and our sample size is arguably acceptable given the experimental nature of this study, which offers the ability to isolate the attribution of observed effects solely to the variation in screen size. Second, controlling for individual differences, such as gender, age, and product knowledge, could have increased the exploratory strength of the study. For example, males are more likely to use digital media as tools for information and entertainment, whereas females tend to use them as tools for communication.[62] Controlling for gender, therefore, might have enhanced the validity of the study findings by verifying that the experimental results were solely due to the variation in screen size.

The current sample of college students does not represent the entire range of smartphone users, thereby restricting the study's generalizability to other demographic groups. Likewise, the utilitarian task employed in this study does not represent the wide range of activities performed by smartphone users. The addition of a hedonic task, for example, could have enhanced the ecological validity of the experiment, given that smartphones are convergent media that are known to simultaneously influence both rational and emotional decision-making processes.[2] While the current study offers valuable insights for understanding the effects of screen size in smartphone adoption, future studies may confirm and extend our findings by investigating potential moderating effects of different types of experimental tasks and employing a survey-based, rather than laboratory-based, approach to collect data from a larger representative sample.

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Appendix

Questionnaire Items

Attitude[45–47]
AT1: Using a smartphone is a good idea.
AT2: I have a generally favorable attitude toward using a smartphone.
AT3: Overall, using a smartphone is beneficial.
AT4: I think a smartphone makes my life more interesting.

Intention to use[45–47]
IU1: I would recommend others to use a smartphone.
IU2: I predict I will use a smartphone in the future.
IU3: I plan to use a smartphone in the future.
IU4: I expect my use of a smartphone to continue in the future.

Perceived ease of use[5,6]
PEOU1: Operating the smartphone was easy for me.
PEOU2: My interaction with the smartphone was clear and understandable.
PEOU3: I found the smartphone easy to use.
PEOU4: I found it easy to get the smartphone to do what I wanted it to do.

(*continued*)

Questionnaire Items (Continued)

Perceived usefulness[5,6]
PU1: Using the smartphone today helped me productively locate the bus departure hour.
PU2: Using the smartphone helped me effectively find the bus departure hour.
PU3: The smartphone was useful in finding the bus departure hour.
PU4: Using the smartphone improved my ability to find the bus departure hour.

Perceived affective quality[48]
PAQ1: I felt excited when using the smartphone.
PAQ2: I would miss using a smartphone if I no longer had it.
PAQ3: The smartphone I used today was attractive and pleasing.

Perceived control[48]
PC1: The smartphone at some time stopped unexpectedly (reversed).
PC2: The smartphone operated consistently overall.
PC3: The smartphone allowed me to do the task with sufficiently few keystrokes.
PC4: The smartphone supported the operation of all the tasks in a way that I found useful.