



# The dark side of smartphone usage: Psychological traits, compulsive behavior and technostress



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## ABSTRACT

Smartphones have become necessities in people's lives. Along with its obvious benefits, however, the smartphone has other effects that are not all that glorious. This study investigates the dark side of the smartphone trend. We examine the link between psychological traits and the compulsive behaviors of smartphone users, and look further into the stress caused by those compulsive behaviors. We conducted an empirical study consisting of 325 participants and compared Structural Equation Modeling with competing models. The results suggest that compulsive usage of smartphone and technostress are positively related to psychological traits including locus of control, social interaction anxiety, materialism and the need for touch. Gender differences are also found in the aforementioned relationships. The results have practical implications to user-oriented smartphone design and operation companies as well as government agencies as they combat the social ills brought on by smartphones.

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## 1. Introduction

*"The smartphone revolution is under-hyped, more people have access to phones than access to running water. We've never had anything like this before since the beginning of the planet."* – Marc Andreessen, founder of Netscape

*"Technology is changing our world more than ever before. The catalyst now is the Smartphone."* – Larry Rosen, author of *iDisorder*

Recent market survey revealed an average smartphone penetration rate of 44.6% in 47 countries, and this number is expected to grow at a fast pace (International Data Corporation, 2013; Our Mobile Planet, 2013). Smartphones are no longer cutting-edge communication gadgets, but are now necessities in peoples' lives. For smartphone users, their phone is the first thing they look at in the morning, and the last thing they look at before going to sleep. Oulasvirta, Rattenbury, Ma, and Raita (2012) actually found that their subjects check their phones 34 times a day not necessarily because they really need to check that many times, but because it has simply become a habit. Excessive usage and habitual checking on missed calls or messages may result in compulsive usage and

even lead to mobile phone addiction for smartphone users (Bianchi & Phillips, 2005; Oulasvirta et al., 2012; Takao, Takahashi, & Kitamura, 2009).

People use smartphone for entertainment or to relieve stress. Such use can yield immediate gratification, but it can also be accompanied by a diminished sense of volitional control and induce persistent activity (Thomé, Hårenstam, & Hagberg, 2011). Compulsive usage leads to mental health symptoms such as sleep disturbance and depression (Thomé, Eklöf, Gustafsson, Nilsson, & Hagberg, 2007; Thomé et al., 2011). Ongoing use of technology also links to heightened psychological distress (Chesley, 2005). Medical literature also suggests that the electromagnetic radiation of smartphones may affect biological systems by changing the antioxidant defense systems of human tissues, leading to oxidative stress (Ozguner et al., 2005). Therefore, compulsive smartphone usage elevates user stress for psychological and biological reasons.

Technostress is "a modern disease of adaptation caused by an inability to cope with the new computer technologies in a healthy manner" (Brod, 1984), and is incorporated in this study to pinpoint the stress related to smartphone usage. Technostress is the phenomenon of end users experiencing stress due to information and communication overload (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). The explosive growth of end-user computing and networking technologies enhances the severity of technostress (Brillhart, 2004). We thus expect that the smartphone user's increased experience of technostress will cause greater feelings of stress for that user. Charles, Piazza, Mogle, Sliwinski, and Alemida (2013) discovered that daily exposures stressors have

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long-term negative effects on users' mental health. Since the smartphone is a major information technology device and people feel the urge to adapt to it in order to "keep up with the times", overdependence on smartphone may lead to compulsive usage and enhance user technostress.

Recent studies indicated the importance of personality and psychological variables in compulsive consumption in technology (e.g., Mueller et al., 2011; Roberts & Pirog, 2013; Takao et al., 2009). Previous research also found that certain psychological traits could influence ability to withstand stress or make a person vulnerable to stress (e.g., Ebstrup, Eplov, Pisinger, & Jørgensen, 2011). In addition, gender differences are found in psychological traits (Feingold, 1994), mobile phone usage (Leung & Wei, 2000), and compulsive behavior (O'Guinn and Faber, 1989). This article contributes to these evolving streams of research by investigating whether and how psychological traits result in compulsive smartphone use and whether this compulsive usage results in a user's technostress level while gender differences are considered in the relationships between psychological traits and compulsive usage of smartphones. In the following section, a series of hypotheses are proposed through an extensive review of appropriate literature in the fields of psychology, psychiatry, sociology, consumer behavior and mobile commerce.

## 2. Conceptualization and hypotheses

This research adopts the view of personality theories to explain compulsive behavior since personality theories emphasize on the relationships between personality trait and compulsive behavior (Hirschman, 1992). Previous studies have considered problematic mobile phone use as addiction-like behavior, and examined from perspectives of personality traits (Bianchi & Phillips, 2005; Takao et al., 2009). In this research, we attempt to explore more traits. Four traits including locus of control, social interaction anxiety, materialism and the need for touch were selected as four antecedents for compulsive usage of smartphone. Locus of control and materialism are recognized as two important personality traits to explain compulsive behavior (e.g., Chak & Leung, 2004; Haynes & Ayliffe, 1991; Rindfleisch, Burroughs, & Denton, 1997; Iskender & Akin, 2010). Social interaction anxiety and the need for touch are both related to the motivations of smartphone usage and pleasure from such use, which increase reliance on smartphone. Social interaction anxiety has been discussed as a driving force behind phone use and it has recently received a lot of media coverage, particularly for young adults (Atchley & Warden, 2012). Compulsive behavior serves as an anxiety reliever and a source of gratification for people (Hirschman, 1992; O'Guinn & Faber, 1989; Roberts & Pirog, 2013; Takao et al., 2009). Need for touch relates to compulsive smartphone usage because the majority of smartphone comes with a touch screen (Allied Business Intelligence, 2011), which also makes touching inevitable in smartphone usage. Therefore, it is conceivable that social interaction anxiety and need for touch can serve as new predictors of compulsive smartphone use and technostress. In the following, hypotheses regarding influences of each psychological trait are developed.

### 2.1. Influence of locus of control

*Locus of control* refers to an individual's perceptions about the cause of events in his/her life, and is defined as the extent to which an individual believes that he/she has the ability to affect the outcome through his/her own actions (Rotter, 1966). Internal locus of control suggests that the cause of an event or behavior depends on one's internal force, and personal decisions and efforts can decide or influence what will happen in one's life (Lefcourt, 1991).

Compared with their "external" counterparts, "internals" (people with an internal locus of control) are more likely to engage in problem-focused coping behaviors, and reduce or eliminate possible stressors (Ng, Sorensen, & Eby, 2006; Qiang, Bowling, & Eschleman, 2010). On the other hand, individuals with an external locus of control believe that events are not within their control but in the hands of some external force. They tend to believe that their lives are influenced or controlled by fate, luck and other people. This belief leads to a sense that nothing can be done to change or improve the current situation. Locus of control influences how one copes with stress (Qiang et al., 2010). Internals engage in problem-focused coping behaviors to reduce stressors by making and following plans (Ng et al., 2006). Researchers suggest that externals' passive tendencies increase the likelihood that externals will exhibit compulsive behaviors such as drug and alcohol addiction (Haynes & Ayliffe, 1991), Internet addiction (Chak & Leung, 2004; Iskender & Akin, 2010), and credit card misuse (Watson, 2009). Given the externals' diminished sense of self-control, we expect that individuals with an external locus of control are more likely to experience compulsive usage of smartphones than their counterparts with an internal locus of control.

**H1.** Smartphone users with a stronger tendency toward an external locus of control demonstrate more compulsive usage of smartphones.

### 2.2. Influence of social interaction anxiety

*Social interaction anxiety* is an excessive fear of social situations or interactions with others, and of being evaluated or scrutinized by other people, particularly when encountering strangers in public settings (Schlenker & Leary, 1982). The need to reduce anxiety motivates socially anxious people to minimize their chances of making undesired impressions on others (Caplan, 2007). Acute social anxiety leads to social withdrawal and isolation (Leary, 1983). Researchers have shown that lonely and anxious individuals positively benefit from on-line interaction (Morahan-Martin & Schumacher, 2003; Yen et al., 2012). Because social anxiety is lower when interacting online than when interacting in real life, interacting online rather than face-to-face has proven to be a useful alternative, fulfilling the need to interact in a less direct way (Reid & Reid, 2007; Yen et al., 2012). However, this group of people is likely to develop problematic or excessive Internet use behavior (Caplan, 2002). Problematic Internet use and smartphone use may share the same properties because they are both related to communication tools and interpersonal interaction (Takao et al., 2009). Since 83% of smartphone users use their phone for communication (Our Mobile Planet, 2013), it is plausible that people with high social interaction anxiety will be more disposed to depend on their smartphones than those with low social interaction anxiety.

**H2.** Smartphone users with a higher level of social interaction anxiety demonstrate more compulsive usage of smartphones.

### 2.3. Influence of need for touch

*Need for touch* is defined as a preference for the extraction and utilization of sensory information obtained through touch or the haptic system (Peck & Childers, 2003a; Peck & Childers, 2003b). Individuals who have a stronger need for touch enjoy touching the groceries in supermarkets and cannot help touching the other person's arm or shoulder during conversations (Peck & Childers, 2003a). Need for touch has been identified as a multidimensional construct with two primary dimensions: instrumental and autotelic

touch. Since smartphone sales are growing rapidly and 75% of smartphone comes with a touchscreen (Allied Business Intelligence, 2011), touching the screen when using a smartphone becomes a handy source of satisfaction for the need for touch (Power, 2010). Oulasvirta et al. (2012) also indicated that 35% of phone usage sessions are touching behaviors. For example, smartphone users enjoy turning off the screen saver by touching the joystick and/or unlocking the screen. Peck and Childers (2003a) suggested that autotelic touch is hedonic with a compulsive need to engage in an exploratory search for variety. Thus, autotelic need for touch is emphasized in this research since the more hedonic satisfaction the smartphone brings, the more users with a stronger need for touch may become compulsively dependent on the smartphones than would those with less need for touch.

**H3.** Smartphone users with a stronger need for touch demonstrate more compulsive usage of smartphones.

#### 2.4. Influence of materialism

*Materialism* is a person's beliefs about the importance of material possessions in his/her life (Richins & Dawson, 1992), and is conceptualized as a value (Burroughs & Rindfleisch, 2002). An individual with a high level of materialism, described as "materialistic", considers material possessions to be central to his/her life and identity (Belk, 1985). Compared with their non-materialistic counterparts, materialistic individuals usually desire a higher level of income, place a greater emphasis on financial security and are less satisfied with their lives. When interacting with others, materialistic individuals tend to care less about interpersonal relationships, preferring to spend more on themselves (Richins & Dawson, 1992).

Materialism affects consumers' reasoning when evaluating purchases, and influences their post-purchase satisfaction (Richins, 2004). For example, materialism may strengthen brand connections (Rindfleisch, Burroughs, & Wong, 2009), and is positively related to the preference for luxury goods (Tatzel, 2002; Wong & Ahuvia, 1998). Materialism leads to problems such as drug dependency (Haynes & Ayliffe, 1991), compulsive consumption (Rindfleisch et al., 1997), and addiction (Chang & Arkin, 2002). Because individuals consider the latest smartphone model to be a symbol of material possessions (Chan, 2008) and develop an emotional attachment to their phones (Wehmeyer, 2008), we predict that materialism may result in compulsive usage of smartphone.

**H4.** Smartphone users with a higher level of materialism demonstrate more compulsive usage of smartphones.

#### 2.5. Relationship between compulsive usage and technostress

Compulsive behavior is defined as "a response to an uncontrollable drive or desire to obtain, use, or experience a feeling, substance, or activity that leads the individual to repetitively engage in behavior that will ultimately cause harm to the individual and/or others" (O'Guinn and Faber, 1989). Its major feature (e.g., compulsive eating, shopping, gambling, and substance misuse) is a pattern of repetitive, senseless behavior (Parylak, Koob, & Zorrilla, 2011). Extreme compulsive behavior is an obsessive-compulsive disorder which induces symptoms such as distress.

The smartphone's ability to quickly access rewards like social networking and communication induces users to check their phones more often. Repetitive checking of mobile phones is considered a compulsive behavior (Oulasvirta et al., 2012). People who use their phones excessively experience difficulty controlling

the time they spend on the device and are easily distracted by phones (Bianchi & Phillips, 2005). Excessive users exhibit such signs as: (1) preoccupation with the phone, (2) increasing amounts of time spent using the phone in order to achieve the same level of satisfaction, (3) repeated, unsuccessful efforts to control, cut back, or stop the use; (4) feelings of restlessness when attempting to reduce the use; (5) jeopardizing significant relationships, jobs, or educational or career opportunities because of phone use; and (6) using the phone as a way to relieve a dysphonic mood (e.g., a feeling of hopelessness, guilt, anxiety, and depression). Since users' top priority is getting connected (Sanfilippo, 2007) and technological advancements augment the over-attachment of users to their phones (Takao et al., 2009), the signs above may become more serious as smartphone adoption becomes more prevalent. When compulsive behaviors are perceived to be inescapable, adverse consequences of psychological distress such as depression and stress are more likely to be induced as well (Matusik & Mickel, 2011). In the smartphone context, technostress can serve as a useful indicator of stress. It is thus predicted that compulsive usage of smartphone will result in technostress.

**H5.** Higher compulsive usage of smartphone leads to higher technostress.

#### 2.6. Gender differences in the relationship between psychological traits and compulsive usage of smartphones

Different genders perceive technology differently. Males are stereotypically expected to be task-oriented users who incorporate technological competence and know-how, skills and interests, while females use a people-oriented style to satisfy their social motives (Claisse & Rowe, 1987). Females use a telephone more than males; "gossip" is a word often used to describe what females do on the phone (Claisse & Rowe, 1987). Females also maintain close personal relationships, even with others who are at a distance. Pawłowska and Potembska (2012) also found that females have a stronger attachment to their mobile phones. Such gender differences are also observed in the context of smartphones. Males tend to use their smartphone more for agentic purposes while female use it for communal purposes (Lenhart, Purcell, Smith, & Zickuhr, 2010). In the following, arguments are developed to propose that gender differences will moderate the relationships between psychological traits and compulsive usage of smartphone.

Although males embrace technology and hold more positive attitudes, they tend to become problematic users more than females (Morahan-Martin & Schumacher, 2000; Rotsztein, 2003; Takao et al., 2009). Rotsztein (2003) found that females are more likely to recognize their problematic Internet use and attempt to cut back or stop their use more than males. The results imply that, compared with females, males have less self-control over such technology. In the smartphone context, it is expected that males are more likely to be compulsive users than females, especially when the males are with external locus of control.

**H6.** The effect of external locus of control on compulsive usage of smartphone will be stronger for males than for females.

Females value social functionality of the mobile phone higher than males and tend to use the phone more as medium for personal and emotional exchange (Bianchi & Phillips, 2005; Lenhart et al., 2010). Female adults are more active in sending text messages and write longer texts than males (Pawłowska & Potembska, 2012). Previous literature also indicated that females tend to be more anxious in social situations such as public speaking, meeting strangers, and speaking to a small group of familiar persons

(Turk et al., 1998). To reduce social anxiety, females may rely on smartphones more than males. The relationship between social interaction anxiety and compulsive usage of smartphone (stated in H2) will thus be stronger for females.

**H7.** The effect of social interaction anxiety on compulsive usage of smartphone will be stronger for females than for males.

Prior research concerning gender differences in need for touch found that females showed more needs for tactile input compared to males in product evaluation (retail shopping: Citrin, Stem, Spangenberg, & Clark, 2003; functional products: Schifferstein, 2006; clothing: Workman, 2010). For example, Schifferstein (2006) examined the importance of five sensory modalities during product use and found that the scores of all modalities were rated higher among female respondents than male ones. In a recent study, Workman (2010) found that females showed higher scores both on autotelic and instrumental dimensions of need for touch than males for clothing products. Thus a positive relationship between need for touch and compulsive usage of smartphone (predicted in H3) is expected to be enhanced.

**H8.** The effect of need for touch on compulsive usage of smartphone will be stronger for females than for males.

Although previous research examining the interaction between materialism and gender differences produced mixed results, it is commonly agreed that males could have higher levels of materialism than females (Kilbourne & LaForge, 2010; Mueller et al., 2011). The concept of materialism includes not only striving for money and material objects, but also a comparison of material possessions between oneself and others. Hence, mobile phones have become a materialistic representation of the self (Walsh, White, & Young, 2007). With a stronger focus on achievement, power, or self-enhancement, males with high materialism are expected to use smartphone more as a means of self-expression than females. The hypothesis is proposed as follows.

**H9.** The effect of materialism on compulsive usage of smartphone will be stronger for males than for females.

Fig. 1 presents an integrated model which jointly covers both the direct and indirect effects caused by researched variables, and summarizes the predicted relationships between the variables.

### 3. Method

#### 3.1. Country selection

We conducted this empirical study in Taiwan for two reasons. First, Taiwan is one of the countries leading the world in smartphone penetration (Ahonen & Moore, 2011). Second, the smartphone penetration rate in Taiwan (50.8%) is closest to the average (49%) of developed countries among all the 47 countries studied (Our Mobile Planet, 2013; The World Factbook, 2013).

#### 3.2. Measures

The constructs were adopted from various pieces of literature and were measured by multiple items. Compulsive usage of smartphones was measured by incorporating various works (Ehrenberg, Jukes, White, & Walsh, 2008; Jenaro, Flores, Gomez-Vela, Gonzalez-Gil, & Caballo, 2007; Koo, 2009; Meerkerk, Van Den Eijnden, Vermulst, & Garretsen, 2009) and consisted of sixteen items. The dimensions included withdrawal symptoms, loss of

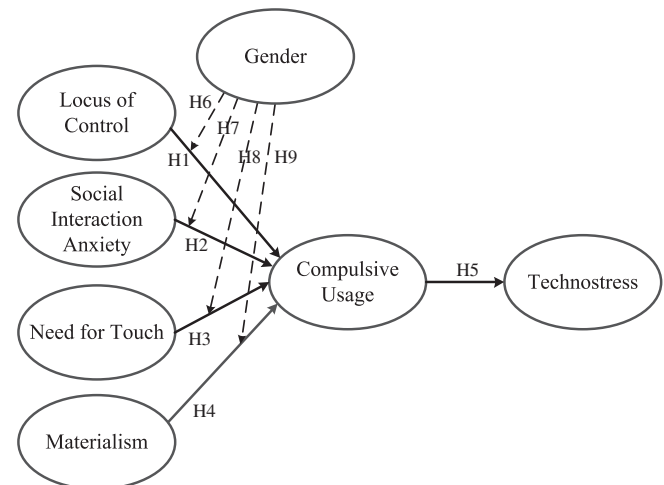


Fig. 1. The proposed model and hypotheses.

control, salience, life dysfunction, conflict, and compulsion/persistence. Technostress was modified from Ragu-Nathan et al. (2008) with eight items. Locus of control was measured with a 9-item scale by Sapp and Harrod (1993) and this scale was constructed from the original Levenson's 24-item scale. Reliability, construct validity, and predictive validity proved to be satisfactory in the brief version of Sapp and Harrod (1993). Social interaction anxiety was measured with 15 items from the Social Anxiousness Scale (Leary, 1983), focusing on interpersonal concern in actual interactions (Leary & Kowalski, 1993). The 6-item autotelic need for touch scale was adapted from Peck and Childers (2003a). The scale was reported to support reliability and convergent, discriminant and nomological validity. Materialism was measured with Richins' (2004) updated 9-item Materialism Value Scale consisting of three components: acquisition centrality, acquisition as the pursuit of happiness, and possession-defined success. Richins (2004) revealed that the scale possesses acceptable psychometric properties. All the aforementioned measures were assessed on 7-point Likert scales from *strongly disagree* to *strongly agree*.

The translation and back-translation procedure (Van De Vijver & Leung, 1997) was adopted to create the Chinese version of each measure. First, to translate the materials into Chinese, we hired a bilingual PhD student (English and Chinese) who had survey experience. Second, we used help from a bilingual English professor (living in Taiwan for more than 20 years) to translate them back to English. After the back-translation, the original and back-translated instruments were compared and points of divergence were noted. The translation was then corrected to accurately reflect the intent of the wording in the original language.

#### 3.3. Pre-tests

We adopted the procedure suggested by Churchill (1979) for scale development (Parasuraman, Zeithaml, & Berry, 1988). Initially, we generated 63 items for the six constructs above. Then we used a convenience sample of undergraduate students in marketing classes to assess the internal consistency of the measurement scales (by means of coefficient alpha estimates). We conducted this procedure iteratively until the measure items showed acceptable properties. There were 52 items for six constructs in the final survey (i.e., fourteen questions for compulsive usage, eight questions for technostress, seven questions for locus of control, ten questions for social interaction anxiety, six questions for need for touch, and seven items for materialism).



### 3.4. Participants and procedures

Following the Research tradition in addictive consumption of technology (e.g., Caplan, 2007; Chak & Leung, 2004; Reid & Reid, 2007; Roberts & Pirog, 2013; Takao et al., 2009), a sample without purposely identifying compulsive consumers before the surveys is appropriate. The study was conducted in mid 2013 using an adult sample in Kaohsiung, the second largest city in Taiwan. Trained interviewers recruited participants using an intercept technique at various locations (e.g., shopping malls, fast food restaurants, supermarkets, cultural centers, libraries, department stores, train and bus stations, and movie theaters) throughout the city to capture a broad representation of the population. When approaching potential respondents, interviewers introduced themselves as university researchers investigating smartphone usage behavior. All of the participants in this study own and use a smartphone on a daily basis. The interviewers assured participants that their responses would be confidential, anonymous, and used only in aggregate form. The questionnaire contained questions on smartphone usage and switching behavior, measures for the six constructs, and demographics. The survey took 10–15 min on average to complete.

## 4. Results

### 4.1. Preliminary analysis

We received 325 completed surveys from the 347 we distributed. The participants' demographics were comparable to national averages (as per National Statistics of Taiwan, 2011), thus producing a nationally representative sample in terms of age and gender. The sample appeared more educated, however, and contained proportionately more females than the population from which it was drawn. Overall, 55.7% of participants were female. Ages ranged from 17 to 67 years ( $M = 28.98$ ,  $SD = 9.34$ ). Within the sample, 90.3% had achieved a college diploma or higher. Furthermore, 30.2% had used the smartphone less than 6 months, and 45.2% had used them for more than one year. In addition, approximately half of participants had changed their phones during the past two years (i.e., 31.4% changed once, and 14.7% changed twice or more).

### 4.2. Measurement model

A two-step approach (Anderson & Gerbing, 1988) was employed to test the proposed hypotheses. We first checked the quality of the measurement model and then assessed the structural model for hypotheses testing. These models were estimated using LISREL 8.80 software. For scale purification, we eliminated the measures with low factor loadings ( $<.50$ ) from the survey's original items by conducting a confirmatory factor analysis (CFA). We deleted one item from compulsive usage, two items from technostress, one item from locus of control, two items from social interaction anxiety, and one item from materialism. Appendix A presents the CFA results of the final set of items. Our measurement model fit the data well using the same criteria as Hu and Bentler (1995) ( $\chi^2_{(930)} = 2415.82$ ; Comparative Fit Index [CFI] = .95; Non-Normed Fit Index [NNFI] = .94; Root Mean Square Error of Approximation [RMSEA] = .07; Standardized RMR [SRMR] = .06). In addition, the convergent validity of the measures was supported since the factor loadings of the indicators were all significant ( $p < .05$ ) and greater than .50 (Anderson & Gerbing, 1988).

Table 1 shows summary statistics, internal consistency estimates, and intercorrelations among the six constructs. Based on Nunnally and Bernstein (1994), the reliability of the measurement model was supported by testing Cronbach's  $\alpha$  (from .83 to .93) and composite reliability (CR) (from .83 to .93). Furthermore, we examined the discriminant validity among the constructs by determin-

**Table 1**

Summary statistics, internal consistency estimates, and correlations among constructs ( $N = 325$ ).

Construct	1	2	3	4	5	6	Mean	SD	$\alpha$	C.R.
1. CU	1.00						3.38	1.18	.90	.90
2. TS	.72	1.00					3.21	1.29	.86	.87
3. LOC	.55	.56	1.00				3.70	1.15	.83	.84
4. SIA	.44	.36	.46	1.00			3.98	1.12	.86	.86
5. NFT	.42	.45	.29	.30	1.00		3.86	1.53	.93	.93
6. MAT	.63	.54	.53	.42	.48	1.00	4.01	1.23	.82	.83

Notes: CU = compulsive usage, TS = technostress, LOC = locus of control, SIA = social interaction anxiety, NFT = need for touch, MAT = materialism. All correlations are significant at  $p < .05$ .

ing whether the confidence interval for the correlation parameter of each pair of constructs excluded the value of 1 (Anderson & Gerbing, 1988). We obtained no confidence interval for any correlation parameter containing the value of one. Our measurement model met all psychometric property requirements when we tested reliability and convergent and discriminant validity collectively.

### 4.3. Structural model

Structural Equation Modeling (SEM) was employed to evaluate the structural model. Table 2 summarizes the results of standardized structural path estimates and fit indices. The results indicated that the structural model fit the data well ( $\chi^2_{(934)} = 2441.92$ ; CFI = .95; NNFI = .94; RMSEA = .07; SRMR = .07). We predicted that people who have a stronger tendency toward an external locus of control would be more likely to compulsively use smartphones. A significant positive relationship between locus of control and compulsive usage was observed ( $\gamma_{1,1} = .27$ ,  $p < .001$ ). H1 was supported. For social interaction anxiety, H2 suggested that social interaction anxiety positively affected the compulsive usage of smartphones. As expected, a significant, positive path between social interaction anxiety and compulsive usage was obtained ( $\gamma_{1,2} = .12$ ,  $p < .05$ ), supporting H2. H3 predicted that people who have a stronger need for touch tended to use smartphones compulsively. A significant, positive path from need for touch to compulsive usage was confirmed ( $\gamma_{1,3} = .14$ ,  $p < .01$ ), supporting H3. For materialism, H4 indicated that people with a higher degree of materialism would have a greater likelihood of using smartphones compulsively. The path between materialism and the compulsive usage estimate was significant and positive ( $\gamma_{1,4} = .38$ ,  $p < .001$ ). H4 was supported. H5 hypothesized that a higher level of compulsive usage of smartphones would lead to a higher level of technostress. The path estimate displayed in Table 2 was consistent with the prediction ( $\beta_{2,1} = .74$ ,  $p < .001$ ). H5 was thus confirmed.

### 4.4. Moderating effects of gender differences

We further examined gender differences in the relationships among the four psychological traits (i.e., locus of control, social

**Table 2**

Summary of all standardized structural path estimates.

Path	$\beta$	t-Value
Locus of control → compulsive usage	.27***	3.85
Social interaction anxiety → compulsive usage	.12*	1.98
Need for touch → compulsive usage	.14**	2.54
Materialism → compulsive usage	.38***	4.74
Compulsive usage → technostress	.74***	8.83
$\chi^2 = 2441.92$ ; d.f. = 934; CFI = .95; NNFI = .94; RMSEA = .07; SRMR = .07		

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

interaction anxiety, need for touch, and materialism) and compulsive usage through multi-group analysis. Before conducting the multi-group analysis, we checked whether the proposed model fit the male sample as well as female sample. The acceptable fit indices were obtained (males:  $\chi^2 = 1810.71$ , d.f. = 934, CFI = .95, NNFI = .94, RMSEA = .08, SRMR = .07; females:  $\chi^2 = 2046.07$ , d.f. = 934, CFI = .91, NNFI = .91, RMSEA = .08, SRMR = .08). We then tested a model that enabled all paths of the structural model to be estimated freely across males ( $N = 144$ ) and females ( $N = 181$ ). In turn, we constrained each path to be equal between males and females and examined the differences in chi-square values between the freely estimated model and the constrained model. Table 3 presents the results for the separate structural model estimations in terms of path coefficients and chi-square values.

H6 predicted that the effect of locus of control on compulsive usage was stronger for males. As shown in Table 3, the relationship between locus of control and compulsive usage was stronger for male participants ( $\gamma_{1,1} = .40$ ,  $p < .001$ ) compared to the same relationship for female participants ( $\gamma_{1,1} = .06$ , n.s.). The significant chi-square difference ( $\chi^2_{diff} = 4.87$ ,  $p < .05$ ) supported gender as a moderator. H6 was supported. H7 predicted that the positive relationship between social interaction anxiety and compulsive usage was greater for females. As expected, the coefficient was larger in the female group ( $\gamma_{1,2} = .31$ ,  $p < .01$ ) than in the male group ( $\gamma_{1,2} = -.02$ , n.s.), with a significant chi-square difference ( $\chi^2_{diff} = 7.55$ ,  $p < .01$ ). H7 was thus confirmed. In H8, it was expected that the relationship between need for touch and compulsive usage was stronger for females. The results showed a significant chi-square difference (male:  $\gamma_{1,3} = .04$ , n.s.; female:  $\gamma_{1,3} = .32$ ,  $p < .01$ ;  $\chi^2_{diff} = 4.92$ ,  $p < .05$ ). H8 was thus supported. For the relationship between materialism and compulsive usage, H9 suggested that this relationship was stronger for males. However, the test of chi-square difference was not significant ( $\chi^2_{diff} = .57$ , n.s.). H9 was not supported.

#### 4.5. Relative effects of locus of control, social interaction anxiety, need for touch, and materialism

In addition to examining the relationships among the researched constructs and the moderating effects of gender differences, this study further investigated which factor had the strongest impact on compulsive usage of smartphone. Chi-square difference tests were conducted. Since we constrained the two paths of interest to be equal in one model, the degree of freedom for that model was set to a value of one (1). In the other model, the paths of interest were estimated freely. First, we tested the relative effects of materialism ( $\gamma_{1,4} = .38$ ) and locus of control ( $\gamma_{1,1} = .27$ ) on compulsive usage. The results of chi-square difference testing indicated that both materialism and locus of control equally affected compulsive usage ( $\chi^2_{diff} = .08$ , n.s.). We then

compared the direct effects of materialism and social interaction anxiety ( $\gamma_{1,2} = .12$ ) on compulsive usage. The significant chi-square difference between the constrained model and the totally free model ( $\chi^2_{diff} = 4.90$ ,  $p < .05$ ) indicated that materialism had a stronger effect on compulsive usage than did social interaction anxiety. Finally, we went onto compare the path between materialism and compulsive usage with the path between need for touch and compulsive usage ( $\gamma_{1,3} = .14$ ). The direct effect of materialism was stronger than that of need for touch ( $\chi^2_{diff} = 6.00$ ,  $p < .05$ ).

## 5. Discussion

Our research goal was to incorporate compulsive usage of smartphone and technostress in the examination of how a smartphone user's characteristics affect his/her stress levels. Four characteristics are found to increase an individual's risk of developing problematic smartphone habits. Except for H9, all the hypotheses were empirically supported via SEM and the results also contribute to the international literature on smartphone behavior. The following observations are noteworthy.

First, the reasons behind the compulsive usage of smartphones are related to an external locus of control, materialism, social interaction anxiety, and the need for touch. The first two factors are found to be more influential. Because of their passive tendencies and reduced powers of self-control, individuals with an external locus of control are more likely to use their smartphones compulsively. Our findings also prove that compulsive behavior under smartphone context share similarities with other forms of compulsive behaviors such as drug and alcohol addiction (Haynes & Ayliffe, 1991), credit card exploitation (Watson, 2009), and Internet dependency (Chak & Leung, 2004; İskender & Akin, 2010). The first of two quotes at the beginning of this paper indicates the role of materialism by describing how smartphones have become such an important possession. Actually, many people use expensive and prestigious phones as a form of social performance, simply to show off (Caronia & Caron, 2004). The influence of social interaction anxiety on the compulsive usage of smartphones suggests that individuals may rely on their phones to reduce feelings of discomfort during social contacts. Recent smartphone designs may have been influenced by users' need for touch. Known as "touch phones", the newest phones (especially smartphones) feature high-resolution touch screens which allow tasks to be accomplished tactilely with the fingers. Such autotelic touch (Peck & Childers, 2003a) provides instant gratification to phone users and can potentially create a compulsion.

Second, gender differences play a moderating role in the relationships between various psychological traits and compulsive usage, including need for touch, locus of control, and social interaction anxiety. In terms of need for touch, female exhibits stronger relationship with compulsive usage than males. Our result is

**Table 3**

Comparison of gender differences in the relationships between psychological traits and compulsive usage of mobile phone.

Path	Standardized estimates		Subgroup comparison (unconstrained $\chi^2_{(1868)} = 3863.11$ )		Results
	Males ( $N = 144$ )	Female ( $N = 181$ )	Constrained $\chi^2_{(1869)}$	$\Delta\chi^2_{(1)}$	
LOC → CU	.40***	.06	3867.98	4.87*	M > F
SIA → CU	-.02	.31**	3870.66	7.55**	F > M
NFT → CU	.04	.32**	3868.03	4.92*	F > M
MAT → CU	.22**	.34**	3863.68	.57	NS

Notes: CU = compulsive usage, LOC = locus of control, SIA = social interaction anxiety, NFT = need for touch, MAT = materialism. M = Males, F = Females, NS = not significant.

\*  $p < .05$ .

\*\*  $p < .01$ .

\*\*\*  $p < .001$ .

consistent with previous research in product evaluation (Citrin et al., 2003; Schifferstein, 2006; Workman, 2010). The moderating role of gender between locus of control and compulsive behavior is stronger among males than females. Despite the fact that females exhibit stronger relationship between social interaction anxiety and compulsive usage than males, one thing to notice is such relationship is not significant for males. Lenhart et al. (2010) found that males tend to use smartphone for business or professional networking more (i.e. LinkedIn et al.) and females tend to use it for general networking (i.e. Facebook et al.). Therefore, online networking through smartphone tend to be an enhancement for males' career but not a getaway from socially anxious situations and males are less likely to develop overdependence on smartphone due to social interaction anxiety.

Third, gender does not moderate the relationship between materialism and compulsive usage. Males tend to use their phones for business or professional purpose, while females rely on smartphone for social networking (Lenhart et al., 2010). Smartphone usage for the aforementioned purposes enhances self-centered traits (Twenge & Campbell, 2009) which associate with the spirit of materialism (Campbell, Brunell, & Finkel, 2006; Van Boven, Campbell, & Gilovich, 2010). This may explain why no moderating role of gender was found between materialism and compulsive smartphone usage.

This article makes theoretical contributions to human behavior, compulsive consumption, and addiction literature. Previous research used single personality traits such as locus of control and materialism to explain behavioral addictions (e.g., Chak & Leung, 2004; Haynes & Ayliffe, 1991; Roberts & Pirog, 2013; İskender & Akin, 2010). As personality theories in addiction literature focus on the dimensions or cluster of personality traits (West & Hardy, 2006), study multiple traits simultaneously can provide a better understanding of compulsive behavior. DeSarbo and Edwards (1996) identified materialism and locus of control with compulsive buying, but did not mention the relative strength of the associations. To our best knowledge, this research is the first to examine the influences of social interaction anxiety and need for touch on compulsive behavior. Our results contribute to the personality theories in addiction literature by proving that psychological traits related to motivation (i.e., need for touch) and interaction (i.e., social interaction anxiety) can also play a role in behavioral addiction research and the role of psychological traits are moderated by biological factors (i.e. gender). Moreover, we go beyond simple demonstrations of four psychological traits as predictors of compulsive usage of smartphone, and to clarify *which traits* are more influential and *when* gender differences are likely to be effective or eliminated in the relationships between psychological traits and compulsive usage of smartphone.

Our findings also provide practical implications. The relationship between compulsive usage and technostress suggests that overdependence on smartphones leads to user stress and compulsive usage of smartphone. Compulsive usage of smartphone can be an indicator of user's stress induction. Since smartphones is an indispensable part of life for people and some might even feel irritation, frustration and impatience without a smartphone, the increased smartphone usage could also damage relationships with others or result in psychological distress for users (James & Drennan, 2005) which can become a source of social problems. The de facto market segmentation based on psychological traits may offer potential payoffs to social marketers who strive to discover and take advantage of the diversity of audience characteristics. Our results also present implications for intervention management to be implemented in the educational fields. If people with these psychological traits are discovered during screening,

they should be informed of their inclination toward compulsive usage and be educated about the accompanying stress so they can learn self control for proper smartphone usage. Such actions would help them avoid the dark side of smartphones (e.g., compulsive usage and technostress). Education interventions held by government agencies or non-profits for social marketing will thus become essential.

## 6. Limitations and directions for future research

We should note a few limitations of this study. This research depended exclusively on participants' self-reports. The results may thus have been vulnerable to the effects of common-method variance. However, the problems attributed to common-method variance may be overstated (Spector, 2006). In our case, self-reports may be the most accurate means of assessing psychological characteristics, given that individuals should have better insight into their own beliefs than would outside observers. Furthermore, since the mean score of compulsive usage of smartphone ( $M = 3.38$ ) and that of technostress ( $M = 3.21$ ) were not above the mid-point 4 in our 7-point scale, suggesting that the participants were not serious compulsive users. Researchers should thus be cautious in the result interpretation. Future research should replicate by using compulsive users with objective criteria for participant screening (e.g., frequency of daily smartphone use and frequency of checking). An additional limitation is the cross-sectional and correlational nature of the study. Although personality theorists recognize personality traits as causes of behavior rather than the reverse (e.g., McCrae & Costa, 1999), the current research alone does not provide sufficient evidence of causal relationships.

The current work points to a number of opportunities for future research. *First*, to overcome the disadvantages of self-reported data regarding compulsive usage of smartphone, future research may consider a tracking study by a longitudinal logging of smartphones with custom tracking software (Oulasvirta et al., 2012). *Second*, cultural differences in our study may have been overlooked. Several dimensions by Campbell (2007) including perceptions of the mobile phone as fashion, attitudes about phone use in public settings, use of the phone for safety/security reasons, and use of the phone for instrumental/expressive purposes can be considered in future research. *Third*, objective measures of stress should be assessed in future research. For instance, modern neuro-scientific equipment including electroencephalography (EEG), event-related potentials (ERPs), magnetoencephalography (MEG), and functional Magnetic Resonance Imaging (fMRI) are able to directly translate neural activities into observable movements. Objective measures of stress will provide insights regarding how smartphones affect a person's health and wellbeing.

Although causal relationships have not been firmly established, the current study provides important insights into possible pathways through which psychological traits might facilitate the development of compulsive usage of smartphone and generate technostress. The results will help marketing personnel and researchers better understand smartphone users. The measurements of these psychological traits will be beneficial in the screening of potentially compulsive smartphone users, and aid in intervention when such users are discovered.

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**Appendix A: Results of confirmatory factor analysis**

Constructs	Factor loadings	t-Values	Sources
<i>Compulsive usage of mobile phones</i>			Ehrenberg et al. (2008), Jenaro et al. (2007), Koo (2009), Meerkerk et al. (2009)
1. The first thing I do each morning is to check my mobile phone for missed calls or messages.	.54	10.23	
2. I find it hard to control my mobile phone use.	.69	13.89	
3. I feel lost and frustrated without my mobile phone.	.57	10.70	
4. I risk an important relationship, a job, an academic opportunity or a career development opportunity because I overuse my mobile phone.	.52	9.78	
5. I try to not use my mobile phone frequently but I am unsuccessful.	.79	16.70	
6. I often anticipate my next use of my mobile phone.	.80	16.90	
7. I often get angry if someone interrupts me during my mobile phone use.	.67	13.22	
8. I can't concentrate in class because of mobile phone use.	.66	13.04	
9. I check for missed calls and messages all the time when I am awake.	.67	13.35	
10. I use my mobile phone even when talking or eating with others.	.62	11.92	
11. I feel like my mobile phone is ringing or vibrating but it isn't.	.64	12.58	
12. I prefer to use my mobile phone rather than spend time with others.	.57	10.92	
13. Others complain about me using my mobile phone too much.	.64	12.57	
<i>Technostress</i>			Ragu-Nathan et al. (2008)
1. I am forced by my mobile phone to live with very tight time schedules.	.84	18.33	

**Appendix A: Results of confirmatory factor analysis (continued)**

Constructs	Factor loadings	t-Values	Sources
2. I am forced to change habits to adapt to new developments in mobile phones.	.89	20.15	
3. I have to sacrifice my personal time to keep current on new mobile phone technologies.	.84	18.25	
4. I feel my personal life is being invaded by mobile phone technologies.	.60	11.45	
5. I do not find enough time to study and upgrade my technology skills on mobile phones.	.56	10.48	
6. I am threatened by people with newer mobile phone technology skills.	.59	11.21	
<i>Locus of control</i>			Sapp and Harrod (1993)
1. To a great extent, my life is controlled by accidental happenings.	.60	11.29	
2. My life is chiefly controlled by powerful others.	.78	15.70	
3. I feel like what happens in my life is mostly determined by powerful people.	.81	16.59	
4. When I get what I want, it's usually because I'm lucky.	.63	11.77	
5. Often there is no chance of protecting my personal interest from the occurrence of bad luck.	.59	10.89	
6. People like me have very little chance of protecting our personal interests when they conflict with those of strong pressure groups.	.65	12.42	
<i>Social interaction anxiety</i>			Leary (1983)
1. I often feel nervous even in casual get-togethers.	.66	12.63	
2. I get nervous when I must talk to a teacher or a boss.	.73	14.37	



**Appendix A: Results of confirmatory factor analysis (continued)**

Constructs	Factor loadings	t-Values	Sources
3. I sometimes feel tense when talking to people of my own sex if I don't know them very well.	.68	13.11	
4. I would be nervous if I was being interviewed for a job.	.69	13.29	
5. In general, I am a shy person.	.58	10.71	
6. I often feel nervous when talking to an attractive member of the opposite sex.	.65	12.28	
7. I often feel nervous when calling someone I don't know very well on the telephone.	.65	12.33	
8. I get nervous when I speak to someone in a position of authority.	.67	12.90	
<i>Need for touch</i>			Peck and Childers (2003a)
1. When walking through stores, I can't help touching all kinds of products.	.78	16.33	
2. Touching products can be fun.	.82	17.68	
3. When browsing in stores, it is important for me to handle all kinds of products.	.79	16.92	
4. I like to touch products even if I have no intention of buying them.	.82	17.63	
5. When browsing in stores, I like to touch lots of products.	.91	21.15	
6. I find myself touching all kinds of products in stores.	.86	18.98	
<i>Materialism</i>			Richins (2004)
1. I admire people who own expensive homes, cars, and clothes.	.69	13.33	
2. I like to own things that impress people.	.69	13.31	
3. Buying things gives	.65	12.11	

**Appendix A: Results of confirmatory factor analysis (continued)**

Constructs	Factor loadings	t-Values	Sources
me a lot of pleasure.			
4. I like a lot of luxury in my life.	.70	13.36	
5. I'd be happier if I could afford to buy more things.	.61	11.31	
6. It sometimes bothers me quite a bit that I can't afford to buy all the things I'd like.	.63	11.68	
$\chi^2 = 2415.82$ ; d.f. = 930; CFI = .95; NNFI = .94; RMSEA = .07; SRMR = .06			

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