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The Development of a Scale to Measure Smartphone Dependency

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Abstract

The purpose of this study is to develop a scale to measure users' social interaction on smartphone toward dependency. Smartphone dependency refers to users' compulsive behaviors resulting from overuse of the social interaction function pertaining to smartphone. This article constructs the smartphone dependency scale and its development, reliability, exploratory factor analyses, structure, and validity. The research instrument was pilot tested and necessary modifications were made. The reliability and validity of the instrument are determined using Exploratory Factor Analysis. Further, Confirmatory Factor Analysis using AMOS 20.0 is carried out for the scale. Confirmatory Factor Analysis model-fit indicators were found acceptable in this study. A five-dimension scale of smartphone dependency was developed. The five subscales are social connection of smartphone, compulsive behavior, salient behavior, pleasure to engage interpersonal interaction, and withdrawal.

Keywords: SMARTPHONE DEPENDENCY, SCALE DEVELOPMENT.

1. Introduction

According to ITU (International Telecommunication Union), the number of mobile phone users worldwide will reach a record high of 7 billion by the end of 2014, with the total market penetration rate being at a high of 96% [1]. Specifically in Ameri-

ca, according to Pew Research Center's Internet & American Life Project, 91% of the population used mobile phone, with smartphone popularity rate being as high as 56% [2]. Presently, smartphone functions as a micro computer. People communicate with others by calling, text messaging and emailing. Ad-

ditional functions include surfing the Internet, navigation, renewing community websites and providing online shopping. Using smartphone to communicate with others has become an integral part of our daily life. Indeed, smartphone with its high mobility and portability is more competitive than PC or traditional mobile phone. The communication technology unit is no more computer-based. Rather, it has become mobile phone-based.

Millward Brown conducted a global survey of how much time (by minutes per day) users spend on electronic appliances, including smartphone, TV and PC. Users, according to the survey, averagely spent 147 minutes on smartphone, 113 minutes on TV, and 108 minutes on PC. Using smartphone to access the Internet provides an alternative way to interact with others [3]. Indeed, smartphone with its high mobility and portability has become an integral part of daily life. Over dependency on smartphone, however, has caused a variety of psychological and physical problems.

A variety of modes of interaction, including voice-calling, communication & social networking Apps, and community websites, are mainly to blame for users' dependency on smartphone. The present study refers to smartphone dependency as a compulsive behavior resulting from overuse of the social interaction function pertaining to smartphone. Overuse of social interaction may exert negative influence on users' daily life. Based on this definition, the present study develops a scale of smartphone dependency, aiming to measure to what extent users' dependency of smartphone is.

2. Literature Review

Katz, Blumer, & Gurevitch proposed a theory of uses and gratifications. According to the theory, a person uses one form of media based on personal motivation and needs, and is gratified in the process of using it [4]. To the end, the psychology and behavior of the person can be changed. Papacharissi & Rubin identified the motivations of using the Internet as interpersonal utility, passing time, information seeking, convenience, and entertainment [5]. These motivations are found to be similar to those of smartphone use. Individuals, who use smartphone to meet different needs, are also satisfied in the process of using smartphone. Smartphone is equipped with different modes of communication such as voice calling, messaging, communication APPs, and community websites. In the process of gratification, users' motivation and behavior of using smartphone may be enhanced. If an individual overuses a media, he or she might develop over-dependency.

"Smartphone dependency" is derived from "Internet dependency." Young first proposed a definition of Internet dependency [6]. By Internet dependency is meant Internet-related compulsive behaviors, which exert negative impact on users' psychology or behaviors in daily life. According to Kandell, Internet dependency refers to psychological dependency with four characteristics: 1) more investment on Internet-related activities; 2) distress or anxiety upon logging off; 3) incremental on-line tolerance; 4) tendency to deny having problems [7]. Davis mentioned Internet dependency in general refers to users' maladjustment to and misconception of Internet use [8]. Users tend to hold the misconception that they are highly welcome and valued on websites. Once they are off line, they almost inevitably feel meaningless, distressful, socially alienated and devoid of social resources. To cope with this problem, they spend a large amount of time building up network socializing for support. Caplan also suggested that on-line interpersonal relations can elevate users' feeling of pleasure or happiness, which is regarded as one of the factors leading to Internet dependency [9]. Consequently, searching for on-line interpersonal interaction is the major cause of the Internet dependency.

Dependency of text message is defined as text message-related compulsive behavior which leads to psychological or behavioral syndrome and exerts negative impact on one's daily life [10]. They focused on the relations between users' psychological and social factors and their psychological or behavioral syndromes. They developed the scale of Self-perception of text-message dependency to measure the extent to which users depend on text messages on the one hand and what attitude they adopt toward text message on the other hand. The scale includes three factors, namely emotional reaction, perception of excessive use and relationship maintenance. They found that overuse of text message is positively correlated to psychological or behavioral dependency. Interacting with others and maintaining relationship via text messaging is one of the causes leading to mobile phone message dependency.

Bianchi and Phillips explored problems with mobile phone use from psychological perspectives [11]. They developed a Mobile Phone Problem Use Scale (MMPUS), which contains 27 items, including users' tolerance, withdrawal, escape and other negative psychological impacts on life. The scale, with Cronbach's α (reliability or consistency test) posing at .93, is highly reliable. According to the study, those with extraverted personality score higher on the MMPUS. They regard mobile phone as a basic means of com-

municating with other people. As a result, they tend to overuse and addict to mobile phone. Those with lower self-esteem seek for sense of security and use mobile phone mainly for the purpose of socialization. They are likely to use mobile phone at inappropriate time and become addicted. This study pointed out that despite individuals' different motivations of using mobile phone, they all manifest severe mobile phone addiction.

Walsh et al applied Mobile Phone Involvement Questionnaire, MPIQ) to investigate to what degree users' mobile phone involvement is [12]. The questionnaire was developed based on the addiction concept proposed by Brown [13-14]. It contains judgmental indices such as psychological cognition and behavioral salience, conflict between people and/or related to other activities, loss of control, tolerance, withdrawal, and relapse and reinstatement. High degree of mobile involvement indicates users regard mobile phone as an integral part of daily life. Users are likely to become panicked in case of power break down or signal reception failure. They even manifest addiction syndrome.

As smartphone can access the Internet, over dependency on smartphone may be regarded as a syndrome similar to Internet addiction. Both of them refer to being addicted to virtual reality on the Internet. Therefore, both smartphone addiction and mobile phone addiction mean exactly the same thing as Internet addiction does. As a consequence, mobile phone addiction scale is developed for the purpose of self diagnosis. Kwon et al developed Smartphone Addiction Scale (SAS) by modifying Korean self-diagnostic program for Internet addiction (K-scale) [15]. The scale contains 48 items, which are categorized into 6 factors, including daily-life disturbance, positive anticipation, withdrawal, cyberspace-oriented relationship, overuse, and tolerance. The scale is found to be highly reliable and is significantly correlated to K-scale and Y-scale.

By referring to Chen Internet Addiction Scale (CIAS), Mobile Phone Problem Use Scale (MMPUS) by Bianchi and Phillips [11], Lin et al developed Smartphone Addiction Inventory (SPAI) [16]. This scale consists of 4 factors, namely compulsive behavior, functional impairment, withdrawal, and tolerance. The 4 sub-scales are highly correlated.

By applying random sampling, Suki & Suki collected 200 valid questionnaires [17]. Their survey aims to investigate how social needs, social influences and convenience of smartphone exert influence on students' smartphone dependency and purchase behavior. It undergoes factor analysis and

model fit analysis in terms of structural equations model. Questions include "I'm totally dependent on my smartphone," "I cannot do anything with my job without the smartphone," "I will feel insecure when my smartphone is not with me." The result shows the model satisfies Goodness-of-fit. Social needs, social influences and convenience of smartphone can effectively predict smartphone dependency, which again effectively predicts purchase behavior.

Over the past few years most mobile phone-related research has been concerned about psychological well being, self-esteem and personality trait [11-12]. In Japan, there have been studies dealing with users' psychological dependency word messaging and emailing via mobile phone [10].

As of now, there has been no commonly accepted definition of smartphone dependency. Neither have scales for measuring users' smartphone dependency been well developed. Obviously, modern people use smartphone much more frequently than they use other electronic appliances [3]. Higher frequency of smartphone use is very likely to lead to addiction. An understanding of users' psychological factors of smartphone dependency can help prevent users from excessive dependency on or addiction to smartphone. Therefore, it is very important to develop an instrument for measuring smartphone dependency.

3. Methodology

3.1. Sampling

Taiwanese smartphone users (18 years old and above) are the targeted respondents of the present research. Part of the survey was conducted at public sites, including railroad station squares and several fast food restaurants, where passers-by were randomly selected to solicit their on-site answers to the questionnaire. Other part of the survey was conducted online for answers. The survey was conducted during the 3-month period, beginning with March 1 and ending in May 31. In all, a total of 639 valid returned questionnaires were collected. Of the respondents, 312 (48.8%) were males, and 327(51.2%) were females. The respondents are divided into 4 age groups. Of all 639 respondents, 228(35.7%) fall on the 18~30 age group; 177(27.7%), 31~40 age group; 142 (22.2%), 41~50 age group; 92(14.4%), 51~ above age group.

3.2. Scale of Smartphone Dependency

The scale of smartphone dependency developed by the researcher for the present study is a modified version of Mobile Phone Problem Use Scale (MMPUS) developed by Bianchi and Phillips [11], Self-perception of text-message dependency designed by Igarashi et al [10], Mobile Phone Involvement Questionnaire (MPIQ) developed by Walsh et

al [12], and other related research. It aims to measure to what extent users are dependent on or addicted to smartphone. The present study adopts Likert's 5-point scale, ranging from strongly disagree, through disagree, partially agree, agree, to strongly agree, all of which, in order of strength, respectively assume 1, 2, 3, 4 and 5 points. The total score of the scale ranges from the minimum 17 points (17x1) to the maximum 85 points (17x5). The average score of all respondents is 55.98 (SD=11.45), and the average score of each item (question) is 3.29 (SD=0.67).

4. Result

4.1. Item Analysis

This research implements item analysis and reliability analysis to measure the Goodness-of-fit of the scale of smartphone dependency. The application of internal consistency index analysis shows that the t value of each item is at the significance level ($p > 0.05$) and all t values are greater than 3.0. The internal consistency reliability of the scale of smartphone dependency is 0.936, and the average scale reliability is greater than 0.7, indicating high degree of reliability.

4.2. Explorative Factor Analysis

This research implements SPSS20.0 for explorative factor analysis of the scale of smartphone dependency. To obtain construct validity, the researcher extracts the common factors from the scale. Principal factor analysis (PFA) is implemented for factor extraction. According to Kaiser's judgmental method, factors with eigenvalues greater than 1 are kept for making up the common factors of the scale. Whereas items with factor loadings smaller than 0.5 are deleted, factors with loadings greater than 0.5 remain unchanged. The construct validity of the scale is eventually obtained. Varimax is implemented as a rotation method to distinguish the factor each question belongs to. Originally, 29 items (questions) are drafted by the researcher. After deleting items with factor loadings smaller than 0.5 and items which simultaneously belong to two constructs, only 17 items are kept for explorative factor analysis. The statistical result shows the KMO value is .895 and the test value of χ^2 of Bartlett's test of sphericity is 5198.088, both of which are at the significance level ($p > 0.05$). This means the 17 items are ready for factor analysis. The 17 items are again categorized into 5 factors, which respectively assume eigenvalues 7.169, 2.203, 1.437, 1.210 and 1.041. The five factors are social connection of mobile phone, compulsive behavior, salient behavior, pleasure to engage in interpersonal interactions, and withdrawal. The Cronbach's α 's of the five sub-scales are respectively 0.845, 0.840, 0.851, 0.845 and 0.808. The Cronbach's α of the scale is 0.903. All

degrees of reliability are greater than 0.80, indicating the overall scale and all subscales have relatively high degree of reliability (See Table 1).

4.3. Confirmatory Factor Analysis

This research processes confirmatory factor analysis of the five factors of the scale of smartphone dependency by using AMOS20.0. The researcher refers to maximum likelihood for parameter estimation and confirming consistency of the scale. Fig. 1 shows the result of analysis. All parameters and errors across the model are at the significance level. Goodness-of-fit indices are respectively: $\chi^2(109, N=639)=445.964(p < .01)$, GFI=.925, AGFI=.894, CFI=.940, RMSEA=.070 (90%CI=.063, .076) All indices are found to fall on the range of reasonable degree of Goodness-of-fit, indicating the model is reasonably fitting (See Table 2).

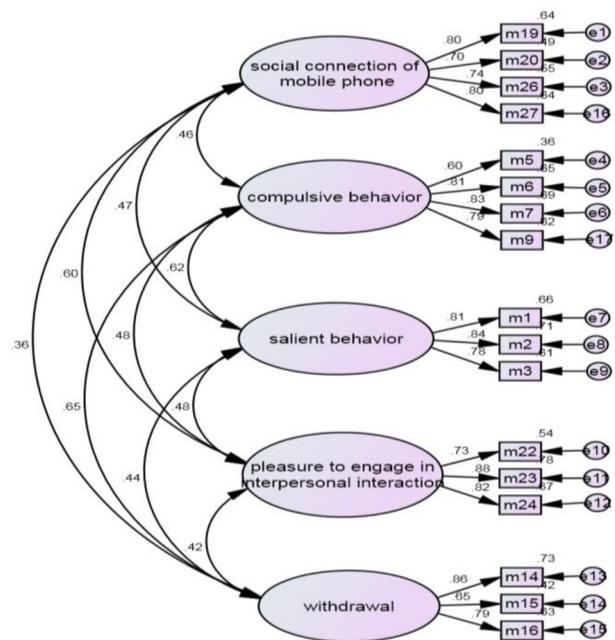


Figure (1). Confirmatory factor analysis of the scale of mobile phone dependency

Table 3 shows that the factor loadings of most items are greater than .7. As to item reliability, 16 are greater than .50, with only one (m5) being smaller than .40. Concerning composite reliability, all 5 factors are greater than .60. Average variances extracted are respectively .584, .355, .435, .449, and .369. This scale, therefore, is deemed to have acceptable convergent validity.

Table 4 indicates the average variance extracted of each factor is greater than the square of the product-moment correlation coefficient of the paired factors. This suggests this scale has acceptable discriminant validity.

Table 1. Descriptive Statistics, Factor loadings and Reliability analysis of Smartphone Dependency Scale

		Factor loadings							Eigenvalues	Variance explained	Reliability
		1	2	3	4	5	M	SD			
Factor 1: Social connections of smartphone											
m26	Keep friends posted of where I am via FB check in.	.822	.067	-.020	.199	.071	2.52	1.16	7.169	37.73	0.845
m27	Provide my updates on community websites via smartphone; share with friends my feeling and emotion.	.813	.106	.110	.226	.022	3.02	1.05			
m19	When in company of my friends, I tend to use smartphone to access community websites to provide my updates (FB check in or upload photo).	.812	.166	.170	.122	.111	2.75	1.11			
m20	I like to use smartphone to keep posted of friends' updates on community websites.	.644	.211	.242	.242	.130	3.27	1.04			
Factor 2: Salient behavior											
m6	The first thing I do in the morning is to read the message on the smartphone (calls or Apps).	.156	.832	.176	.102	.137	3.19	1.22	2.203	11.594	0.840
m7	I am used to checking calls or messages on smartphone before going to bed.	.108	.806	.181	.210	.167	3.41	1.14			
m9	I have formed the habit of checking smartphone messages (calls or Apps).	.171	.728	.207	.190	.236	3.49	1.09			
m5	I use smartphone on mass transport vehicles.	.116	.614	.216	.003	.266	3.58	1.11			
Factor 3: Compulsive behavior											
m2	Over the past three months I have accessed community websites (FB, Twitter) via smartphone more frequently than before.	.323	.150	.834	.103	.107	3.36	1.17	1.437	7.562	0.851
m1	Over the past three months I have used communication Apps (LINE, WhatsApp) more frequently than before.	.058	.262	.804	.149	.181	3.63	1.08			
m3	Over the past three months I have used smartphone to browse or search the Internet more frequently than before.	.064	.290	.782	.199	.083	3.50	1.06			
Factor 4: Pleasure to engage in interpersonal interactions											
m23	I am pleased to hear from friends or receive photo via communication App.	.181	.132	.170	.868	.147	3.28	.89	1.210	6.366	0.845
m24	I feel being valued when I receive messages or photos from friends via community Apps.	.255	.151	.149	.784	.189	3.35	.87			
m22	I become high spirited when friends reply my messages via community App.	.324	.138	.120	.747	.043	2.85	.97			
Factor 5: Withdrawal											
m15	I surely feel anxious and nervous in case my phone is missing.	-.024	.111	.138	.148	.812	4.00	1.04	1.041	5.478	0.808
m14	I feel annoyed when I leave my phone home.	.119	.356	.083	.095	.780	3.54	1.12			
m16	I tend to feel uneasy, nervous and anxious when my phone runs out of power.	.207	.247	.112	.108	.779	3.25	1.13			

Table 2. Total Goodness-of-fit indices of confirmatory factor analysis of Smartphone Dependency Scale

Goodness-of-fit indices		reference standard	test statistics	result of model confirmation
Absolute fit indices	Chi square value χ^2 (CMIN)		445.964 ($p < .01$)	
	degree of freedom (df)		109	
	CMIN/df normed chi-square (NC)	≤ 3	4.091	
	standardized root mean square residual (SRMR)	$\leq .08$	.060	Accept
	root-mean-square error of a pproximation (RMSEA)	$\leq .08$	.07	Accept
	goodness-of-fit index (GFI)	$\geq .9$	.925	Accept
	adjusted goodness-of-fit index (AGFI)	$\geq .8$	.894	Accept
Incremental fit indices	normalized fit index (NFI)	$\geq .9$	.923	Accept
	NNFI (TLI)	$\geq .9$	.926	Accept
	comparative fit index (CFI)	$\geq .9$	.940	Accept
	Incremental fit index (IFI)	$\geq .9$	.941	Accept
Parsimony fit indices	parsimony normed fit index (PNFI)	$\geq .5$	.740	Accept
	parsimony comparative fit index (PCFI)	$\geq .5$	.754	Accept

Table 3. Convergent validity of Smartphone Dependency Scale

Factor	Item	Factor loading	Item reliability	Composite reliability	Average variance extracted
Social connection of smartphone	m26	.744	.554	0.849	0.584
	m27	.803	.645		
	m19	.803	.644		
	m20	.703	.495		
Compulsive behavior	m6	.809	.654	0.677	0.355
	m7	.830	.690		
	m9	.788	.621		
	m5	.601	.361		
Salient behavior	m2	.843	.710	0.697	0.435
	m1	.812	.659		
	m3	.778	.605		
Pleasure to engage in interpersonal interaction	m23	.882	.778	0.705	0.449
	m24	.821	.675		
	m22	.732	.535		
Withdrawal	m15	.645	.416	0.626	0.369
	m14	.857	.734		
	m16	.793	.629		

Table 4. Discriminant validity of Smartphone Dependency Scale

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
F1	Social connection of smartphone	.584				
F2	Salient behavior	.161	.355			
F3	Compulsive behavior	.155	.294	.435		
F4	Pleasure to engage in interpersonal interaction	.303	.167	.177	.449	
F5	Withdrawal	.092	.301	.139	.129	.369

Table 5. Correlation coefficients between 5 sub-scales and the scale

		Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
F1	Social connection of smartphone	1				
F2	Salient behavior	.402*	1			
F3	Compulsive behavior	.394*	.543*	1		
F4	Pleasure to engage in interpersonal interaction	.551*	.409*	.421*	1	
F5	Withdrawal	.304*	.549*	.373*	.359*	1
Total score of smartphone dependency		.736*	.811*	.734*	.710*	.689*

*p<.05

4.4. Analysis of Correlation

Table 5 shows correlation coefficients between 5 sub-scales and the overall scale. The correlation coefficients among the 5 subscales and the correlation coefficients between each subscale and the overall scale are all found to be greater than .30. This indicates that there is moderate correlation both between each subscale and each factor.

5. Discussion

Based on exploratory factor analysis and confirmatory factor analysis, the research result reveals that 5 factors are to blame for smartphone dependency. The five factors are identified as social connection of smartphone, compulsive behavior, salient behavior, pleasure to engage in interpersonal interaction and withdrawal. Of the 5 factors, compulsive behavior,

salient behavior and withdrawal are also found to be identified by Igarashi et al and Walsh et al [10, 12]. Individuals who are over-dependent on or addicted to mobile phone manifest compulsive behavior or withdrawal. They become upset and anxious, thus affecting their daily life. Using smartphone enables users to feel pleased or happy and become more experienced, which again motivates users to use smartphone to a greater extent. Overuse of mobile phone inevitably leads to over-dependency on it. At the prime time of PC, online interpersonal interaction enabled users to feel pleased or happy and became addicted to the Internet. It was necessary, therefore, to prevent users from running a risk of Internet addiction [18]. Likely, with its rapid development and constant renovation, smartphone has attracted individuals for its social

connection, portability and instantaneity. With smartphone, individuals can check in their FB, upload photos, share their feelings and emotions with people in other parts of the world. Smartphone, indeed, has enabled people to come to frequenter contacts with others in distant places. Users are closely linked to social websites with virtual reality.

Conclusion

Based on previous research, the researcher endeavors to explore factors of mobile phone dependency. A scale of smartphone dependency is developed by the researcher on the basis of related literature and research. The research result reveals the scale of smartphone dependency contains 5 factors, namely social connection of smartphone, compulsive behavior, salient behavior, pleasure to engage in interpersonal interaction, and withdrawal. The five subscales and the overall scale are found to manifest acceptable reliability. The confirmatory factor analysis shows there is significant correlation among 5 factors. This suggests the model satisfies goodness-of-fit. The scale of smartphone dependency developed by the researcher proves to have goodness-of-fit and therefore can serve as the judgmental index of smartphone dependency.

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