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How does Nomophobia Impact Life Satisfaction? Exploring the Mediating Effect of Psychological Disorders

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Research paper

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Abstract

Several studies have highlighted the adverse consequences of information system (IS) excessive use. To expand the knowledge on this heated topic, this paper aims among the first to explore the association between nomophobia and life satisfaction mediated by psychological disorders. A big-scale systematic random sampling of over 10 thousand responses is implemented to test the established model empirically. The survey questionnaire collected demographic information, as well as responses to scales, including the nomophobia, psychological disorders (consisted of perceived stress, depression, and loneliness), and life satisfaction. Our results revealed that smartphone usage positively contributes to the development of nomophobia among college students. Noticeably, the relationship between nomophobia and life satisfaction is mediated by psychological disorders. This study offers a flexible reference to understand the occurrence of smartphone usage-related adverse effects through internalization, therefore facilitating future studies designed to discover more comprehensive effecting mechanisms of IS use.

Keywords: Smartphone usage, Nomophobia, Psychological disorders, Life satisfaction.

1 Introduction

Smartphone, as the latest IS evolution, has not only taken the place of cellular phone but also substituted other mobile devices by right of its property of mobility and integration, becoming an indispensable component of human beings. For instance, the latest data from China Internet Network Information Centre presents that as of December 2018, the number of Internet users in China has been 829 million, with a penetration rate of 59.6%. More importantly, among them, the number of mobile Internet users was 817 million, accounting for 98.6% of Internet users (CNNIC, 2019). Meanwhile, smartphone ownership among Chinese users increased by 4.7% compared to that of 2017 (CNNIC, 2019). Besides, in terms of online time, the average weekly online time of Chinese netizens was 27.6 hours, 0.6 hours higher than that at the end of 2017 (CNNIC, 2019).

Nomophobia is one of the profoundly adverse consequences of smartphone usage, conceptually similar to phone addiction (Billieux *et al.*, 2015). Nomophobia was defined as "a situational phobia related to agoraphobia and includes the fear of becoming ill and not receiving immediate assistance" (King *et al.*, 2014, p. 28), derived from *"no mobile phobia"* (Yildirim and Correia, 2015), which has been considered as a psychiatric disorder involving new-tech (King et al., 2013). Additionally, several scholars have explored the association between addiction and video game dependency, as well as relative implications (Hawi, Blachnio and Przepiorka, 2015). Also, the work of predecessors has so far manifested that compulsive use of smartphones makes psychological disorders happen (Lee *et al.*, 2014).

Many studies on the dark side of smartphone usage are available, many of which focus on the relationship between smartphone usage and physical & psychological wellbeing (Agogo and Hess, 2017;

Tams, Legoux and Pierre-majorique, 2018). On the other hand, many scholars have explored the relationship between smartphone addiction and life satisfaction (Samaha and Hawi, 2016), as well as smartphone usage and life satisfaction (Chui, 2015). Also, there exist some studies considering the association between psychological factors like stress and life satisfaction (Samaha and Hawi, 2016). Even though several studies explored how nomophobia was triggered by problematic mobile phone usage (Billieux *et al.*, 2015), to the best of our knowledge, there is a lack of research that considers the adverse consequences of nomophobia. Also, the study is scarce that associated nomophobia with psychological disorders and life satisfaction simultaneously in one integrated conceptual framework. Albeit smartphone usage has been empirically evidenced leading to psychological disorders, will nomophobia also trigger psychological disorders? Although the previous study shows that smartphone usage has a positive direct relationship with life satisfaction (Chui, 2015), is the effect of nomophobia, resulting from smartphone usage, mediated by psychological disorders? This study aims to answer these questions. Specifically, it explores how nomophobia, which results from excessive smartphone use, shape life satisfaction by applying psychological disorders as critical mediator.

2 Literature Review

2.1 The dark side of smartphone usage on psychological wellbeing

Some scholars have emphasized that smartphone usage can result in strong psychological attachments, thus getting into addiction (Wu *et al.*, 2013; Lee and Shin, 2015). Nomophobia has been considered to be a manifestation of excessive phone use (Billieux, Linden and Rochat, 2008; King *et al.*, 2013; Billieux *et al.*, 2015), dubbed as the equivalence of smartphone addiction (Bragazzi and Puente, 2014). Following extant studies, using smartphone apps such as social media, mobile games, and entertainment would induce nomophobia (Jeong *et al.*, 2016; Lin *et al.*, 2018).

Problematic smartphone use has been claimed to induce psychological unease. Earlier research has concluded the adverse consequences of smartphone usage on individual psychological wellbeing (Rotondi, Stanca and Tomasuolo, 2017; Hughes and Burke, 2018). Previous studies revealed that smartphone excessive use may have deleterious effects on psychological wellbeing (Yang, Asbury and Griffiths, 2018; Horwood and Anglim, 2019a; Tangmunkongvorakul *et al.*, 2019a), and might trigger stress (Ragu-Nathan, Tarafdar and Ragu-nathan, 2008; Samaha and Hawi, 2016; Vahedi and Saiphoo, 2018), anxiety (Lee *et al.*, 2014; Darcin *et al.*, 2016; Hawi and Samaha, 2017), distress (Griffiths, 2012; Alam and Wagner, 2013), loneliness (Darcin *et al.*, 2016), depression and somnipathy (Thomée *et al.*, 2007; Thomée, Härenstam and Hagberg, 2011; Rozgonjuk *et al.*, 2018).

2.2 Impacts of psychological disorders on life satisfaction

Life satisfaction is depicted as *"a judgmental process in which individuals assess the quality of their lives on the basis of their own unique set of criteria"* (Wu, Hu and Yang, 2016, p. 164), which was deemed as prediction of multitudinous life outcomes covering physical and psychological wellbeing, marital satisfaction, social capital, to name but a few (Pavot and Diener, 1993, 2008).

Life satisfaction has so far been found associations with smartphone usage (Lepp, Jacob E. Barkley and Karpinski, 2014). Also, Dienlin et al. (2017)'s work indicated that conversing via SNSs, as well as instant messenger, has a mainly reinforcing effect, while communicating via SNSs enables to increase life satisfaction several months later, appearing to be plausible as SNSs have been viewed as the perfection of attaining informational support (Trepte, Dienlin and Reinecke, 2015).

Many studies have demonstrated the relationships of specific psychological factors and lower life satisfaction (Samaha and Hawi, 2016), such as perceived stress (Hamarat *et al.*, 2001; Coffman and Gilligan, 2002; Matheny, Roque-Tovar and Curlette, 2008; Extremera, Durán and Rey, 2009). Noticeably, Abolghasemi et al. (2010) reported that without considering academic success or failure, students perceived positive stress have a positive relation to their life satisfaction. Among the individuals with

spinal cord injury, there were significant adverse impacts of loneliness on life satisfaction, while loneliness demonstrated reciprocal relationships with life satisfaction over time (Tough et al., 2018).

It is worth noting that earlier studies on smartphone usage show mixed results concerning its influence on life satisfaction. On the one hand, some studies claimed that excessive and problematic smartphone usage or smartphone addiction enables them to cause psychological problems such as low life satisfaction (Lepp, Jacob E Barkley and Karpinski, 2014; Samaha and Hawi, 2016). On the other hand, Chui (2015) shows the evidence that smartphone usage positively associates with life satisfaction. In this light, a possible mediating effect of psychological disorders may exist to change the overall association between nomophobia and life satisfaction.

3 Theoretical Background

3.1 Theories of internalization

Internalization can be described as a process of transforming external activities into internal ones (Kaptelinin, Kuutti and Bannon, 1995), being a transition that external material objects were modified into the interior that takes place on the mental plane (Kaptelinin, Kuutti and Bannon, 1995). During the process, the external gets exceeded the boundaries of the possibilities of external activity. In this vein, internalization gives a chance for people to establish psychological traits with individual activities by performing actual manipulations on specific objects in reality.

External social requests can be conveyed into personally endorsed identification via the process of internalization (Ohly and Latour, 2014). Likewise, the external application like using smartphone enables to be internalized into psychological traits as well. For instance, daily long-time smartphone usage can trigger adverse impacts like nomophobia (Anshari *et al.*, 2016). Worth to mention, nomophobia can be an intrinsic psychological symptom, given it conceptually refers to fear or anxiety of being distant from mobile devices like smartphones (Mendoza *et al.*, 2018). Accordingly, we propose the argument that smartphone usage contributes to a kind of external personal activities that, via internalization, is transformed into internal psychological disorder later.

3.2 Activity theory

Activity theory was designed to depict and understand people's mental processes concerning their external circumstances by analyzing personal activities in reality (Ettema, 2018). The core notion lies in that psychological traits intrinsically tie to everyday practical activities. Accordingly, psychological processes do depend on people's daily practices and vice versa. Therefore, based on the principles of activity theory, people's personal experience of activities, such as smartphone usage in our context, will influence their life attitudes and psychological status.

Activity theory suggests both the frequency of participation and the degree of intimacy associated with the activities influence life satisfaction. Previous research has shown a positive relationship between life satisfaction and involvement in personal activities (Melin, Fugl-Meyer and Fugl-Meyer, 2003; Leung and Lee, 2005; Schnohr *et al.*, 2005). In this line, we argue that smartphone usage, as a kind of personal activity, could be internalized into psychological disorders and then associates with life satisfaction.

4 Research Model and Hypotheses

4.1 The development of nomophobia

The smartphone is playing an integral role in student communities, leading to the prevalence of nomophobia among college students (Sharma *et al.*, 2015; Tavolacci *et al.*, 2015; Yildirim *et al.*, 2016). For instance, Kuroki et al. (2015) revealed that approximately one-third of college students have nomophobia. Consistently, Çakir et al. (2016) gave the evidence that nomophobia level among college stu-

dents is beyond a moderate level of the average score, through investigating the prevalence of nomophobia among college students. The work of Yildirim et al. (2016) also revealed a high level of nomophobia prevalence in the young-adult group.

Smartphone use is a prerequisite to developing nomophobia, while excessive smartphone use could be a possible precursor to nomophobia (Billieux et al., 2015; Billieux, Van der Linden, & Rochat, 2008). A frequent smartphone user, having higher familiarity for various benefits offered by smartphones, in more likely to develop greater dependence on a smartphone in daily problem-solving issues, after that cultivating the fertile ground for nomophobia. Gokçearslan et al. (2016) found that the duration of smartphone usage has a positive effect on the occurrence of smartphone addiction, which was verified by Geng et al. (2018) that long period of mobile phone usage would trigger individual fatigue, in turn, self-control decline or loss, thus elevating the possibility of mental dependency on mobile phone. From the standpoint of internalization, using a smartphone for a long session can result in a higher likelihood of developing a psychological dependence on a smartphone, cultivating nomophobia. Hence, we postulate:

H1: Smartphone usage positively influences the development of nomophobia.

4.2 Mediating effect of psychological disorders

Several studies have identified problematic smartphone usage as a cause of unfavorable psychological attachments, becoming nomophobic, thereby getting into psychological disorders. For example, compulsive smartphone usage is proved to be positively associated with technostress, which is stress caused by information and communication overload (Ragu-Nathan, Tarafdar and Ragu-nathan, 2008). Additionally, the findings of Mallya (2018) indicate an increasing trend toward nomophobia, as well as the emergence of relative psychobehavioral problems, such as compulsiveness, annoyance, and stress.

Psychological factors are of high importance for people's life satisfaction. Researchers have demonstrated a strong causality between psychological unease and lower life satisfaction (Tough et al., 2018). For instance, Matheny et al. (2008) confirmed the negative relationship between perceived stress and life satisfaction of college students through a cross-cultural study. Swami et al. (2007) claimed that life satisfaction was negatively linked to suicidal attitudes, loneliness, and depression.

Given the fact that existing studies manifest the relationships between problematic smartphone usage and psychological disorders (Horwood and Anglim, 2019b; Tangmunkongvorakul *et al.*, 2019b), as well as specific psychological symptoms and life satisfaction (Extremera, Durán and Rey, 2009; Tough *et al.*, 2018), we argue that nomophobia, as a manifestation of excessive smartphone use, exerts an indirect impact on life satisfaction through the mediating effect of psychological disorders. Hence, we postulate:

H2: psychological disorders mediate the relationship between nomophobia and life satisfaction.

Accordingly, a conceptual framework was established, as shown in Figure 1.
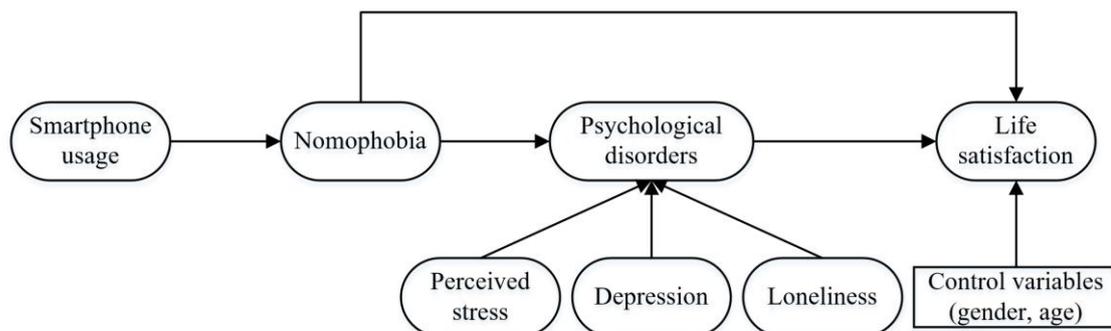

Figure 1. Conceptual framework

5 Method

5.1 Measurement

As shown in Appendix A, nomophobia is developed and validated from existing literature (Yildirim and Correia, 2015). Based on the work of Kraut et al. (1998), we treat psychological disorders as a second-order formative construct, which is measured using three first-order reflective variables including perceived stress (Cohen, Kamarck and Mermelstein, 1983), depression (Radloff, 1977), and loneliness (Russell, Peplau and Cutrona, 1980). The items of life satisfaction derive from Pavot and Diener (2008). Additionally, smartphone usage is measured by smartphone usage before sleep and overall smartphone usage. Noticeably, the reason why smartphone usage before sleep has been included as a unique dimension because that pre-sleep mobile usage exerts substantial adverse wellbeing-related impacts highlighted in recent studies (Chang *et al.*, 2015; Christensen *et al.*, 2016). The respondents were required to answer items for all the variables using a 7-point Likert scale ranging from 1 (strongly disagree) to 7 (strongly agree), and fill in their demographic profile (age, gender, and smartphone usage experience) using categorical scales, as shown in Appendix A. The descriptive statistics for key variables are presented in Appendix B.

5.2 Sample and data collection

This study data was derived from a large-scale survey distributed from 12th November 2017 to 18th January 2018, the research instruments of which was approved by the university administration. Before the formal investigation being officially issued, pre-testing was conducted, and the questionnaire was revised according to the feedback of pilots-stage so that to promote readability and validity. When students log in to the university official website with their username and password, they would see the notification for filling the questionnaire. Permission to distribute the survey was sought from each participant before filling the questionnaire. A total of 10352 respondents filled out the online survey through the student portal of university website. Cases with invalid responses, including incomplete responses with missing values or unmindful responses such as choosing almost the same scales were removed from the dataset, which reduced the sample size to 9062.

Table 1 shows the demographic breakdown of all the participants in the current study. Of 9,062 respondents, 57.57% are male respondents. Approximately three froths of the students approached for this survey use a smartphone for more than 2 hours per day. What is worth to mention is that 43.59% of the respondents reported that their late sleep frequency is 6-7 times per week, which means they go to bed after 23 o'clock almost every day. Notably, 23 o'clock is the regulated lights-off time of student dormitory in the surveyed university. Paradoxically, only 10.61% in the sample reported that they never or seldom (1-2 times per month) late sleep at night.

Variable	Measurement	Samples	Variable	Measurement	Samples
Gender	Male	5217 (57.57%)	Stay up frequency	Never	394(4.35%)
	Female	3845 (42.43%)		1-2 times per month	567 (6.26%)
Age	Below 19	435 (4.80%)		1-2 times per week	1978 (21.83%)
	19-22	6073 (67.02%)		3-5 times per week	2173 (23.98%)
	23-25	2500(27.59%)		6-7 times per week	3950 (43.59%)
	Above 25	254(2.80%)	Daily smartphone in hours	Less than 0.5 hour	305 (3.37%)
Internet experience	Less than 0.5 year	261 (2.88%)		0.5-1 hour	518 (5.72%)
	0.5-1 year	450 (4.97%)		1-2 hours	1452 (16.02%)
	2-3 years	1346 (14.85%)		2-4 hours	2830 (31.23%)
	4-5 years	1570 (17.33%)		4-6 hours	2349 (25.92%)
	More than five years	5435 (59.98%)		7-8 hours	694 (7.66%)
				More than 8 hours	914 (10.09%)

Table 1.   Demographic characteristics of respondents (N = 9062)

6   Data Analysis and Result

Structural Equation Modelling (SEM) was opted to validate the measurement model and structural model via smartPLS3.0. According to a previously recommended procedure (Hulland, 2015), we first assess the reliability and validity of all latent variables, and then, path analysis accompanied by the relative significant level was assessed.

6.1   Reliability and validity

Reliability, reflecting consistency and stability of a tested measurement (Cook and Campbell, 1979), can be assessed by evaluating Cronbach's alpha, composite reliability (CR), and average variance extracted (AVE) (Fornell and Larcker, 1981). As shown in Table 2, the smallest value of Cronbach's Alpha was 0.899, CR values for all the constructs were more significant than 0.9, and all AVE values were higher than 0.8, exceeding the suggested threshold points of 0.7, 0.7 and 0.5, respectively (Fornell and Larcker, 1981; Fornell and Bookstein, 1982; Chin, 1998), indicating reliable measurements.

	Cronbach's alpha	Composite reliability (CR)	Average variance extracted (AVE)
Nomophobia	0.906	0.941	0.842
Perceived stress	0.905	0.941	0.841
Depression	0.937	0.960	0.889
Loneliness	0.899	0.937	0.832
Life satisfaction	0.931	0.956	0.878

Table 2.   Reflective-variable reliability

	NOM	PS	DEP	DON	LS
Nomophobia (NOM)	**0.918**				
Perceived stress (PS)	0.421	**0.943**			
Depression (DEP)	0.294	0.017	**0.937**		
Loneliness (DON)	0.426	0.850	0.043	**0.912**	
Life satisfaction (LS)	0.425	0.801	0.112	0.762	**0.917**
Smartphone usage (SU)	0.346	0.134	0.059	0.130	0.109

Table 3.   Correlation coefficients

Note: ① The boldfaced numbers in the diagonal row are the square roots of the average variance extracted (AVE) values; ② Smartphone usage is a first-order formative variable.

Convergent validity was assessed by checking loadings to see whether items within the same construct correlate highly with one another, while discriminant validity of the constructs was evaluated by examining the factor loadings; items should be loaded higher on their intended constructs than on other constructs (Cook and Campbell, 1979). The approach to calculating discriminant validity is to compare the square root of the average variance extracted for a construct and the correlation coefficients related to that construct. As shown in Table 3, the square roots of AVE values for all the constructs were higher than the correlation coefficients, suggesting that all constructs had good discriminant validity (Bock *et al.*, 2005). Besides, the item loadings on their respective constructs were mostly higher than 0.70, suggesting that these constructs had excellent convergent and discriminant validity (Comrey, 1995), as shown in Appendix C,

Psychological disorders, as a second-order formative construct, was measured using three first-order reflective variables (perceived stress, depression, and loneliness). The formative variable was examined by checking their weights, loadings, and variance inflation factors (VIF) (Petter, Straub and Rai, 2007). As shown in Table 4, three weights for perceived stress, depression and loneliness are highly

significant at $p < 0.001$ level (Cenfetelli and Esearch, 2009). In addition, multicollinearity among the first-order reflective variables was examined, revealing that multicollinearity is not a severe issue because all VIF were below 5.0 (Hair *et al.*, 1998).

First-order reflective variables	Weights	t-statistics	p-value	VIF
Perceived stress	0.346	258.216	< 0.001	3.039
Depression	0.378	255.027	< 0.001	4.532
Loneliness	0.348	269.626	< 0.001	3.915

Table 4.   Weights and t-statistics of psychological disorderS

Smartphone usage, as a first-order formative variable, the weights and associated *p*-values for the measurement items contributing to the formative variable are provided below in Table 5. All weights are significant at $p < 0.001$ level, indicating that the measurements are reliable.

First-order reflective items	Weights	t-statistics	p-value	VIF
Overall smartphone use	0.446	13.515	< 0.001	1.400
Smartphone usage before sleep	0.688	23.683	< 0.001	1.400

Table 5.   Weights and t-statistics of smartphone usage

6.2 Hypotheses tests

Previous studies indicated that gender and age might affect life satisfaction (Stoeber and Stoeber, 2009; Moksnes and Espnes, 2013). Therefore, we included gender and age as control variables in this research model. This effort helps determine that the covariation of those demographic features does not cause the significant results obtained in the current study among the respondents. Both gender and age had no significant impact on life satisfaction, as shown in Figure 2. Hence, the results of the tests of the hypotheses were revealed to be stable and independent of control variables.

Smartphone usage significantly contributes to the development of nomophobia ($\beta = 0.346$, $p < 0.001$), thereby corroborating H1. Nomophobia has positive effect on psychological disorders ($\beta = 0.454$, $p < 0.001$), which in turn negatively impacts life satisfaction ($\beta = -0.093$, $p < 0.001$).

We employed the three-step approach introduced by Baron & Kenny (1986) to test the mediating effect of the psychological disorders in this study. As shown in Figure 3, firstly, the independent variable significantly affects the mediating variable (path a); secondly, the mediating variable significantly affects the dependent variable (path b); thirdly, controlling the paths of above two steps, we detect path c, if it is reduced to zero, we can conclude that psychological disorder acts as a full mediator between nomophobia and life satisfaction. However, if it is not zero, it indicates that psychological disorder acts as a part mediator. In this case, the first step was to test the direct effect of nomophobia on life satisfaction. The results (as shown in Table 6) showed that the direct effect of nomophobia on life satisfaction was significant ($\beta = 0.293$, $p < 0.001$). Nomophobia's direct effect on life satisfaction was significant either when the psychological disorders were included ($\beta = 0.336$, $p < 0.001$), suggesting a partial mediating effect for psychological disorders, supporting H2.
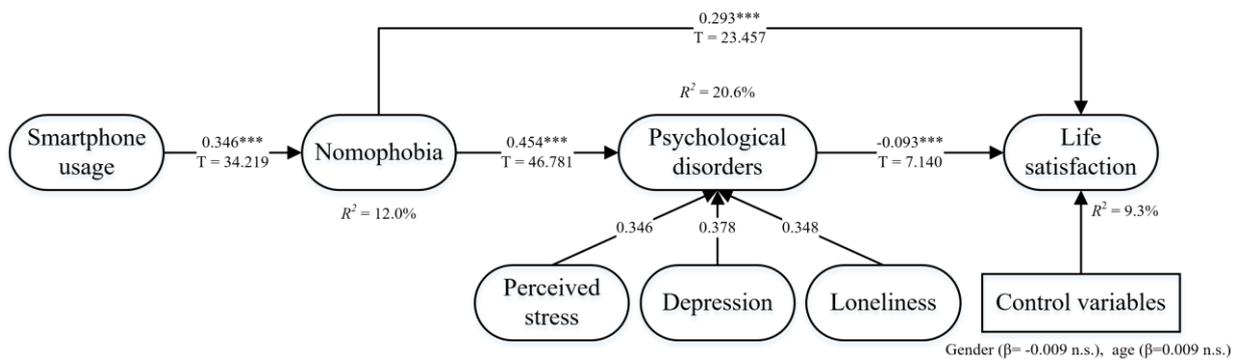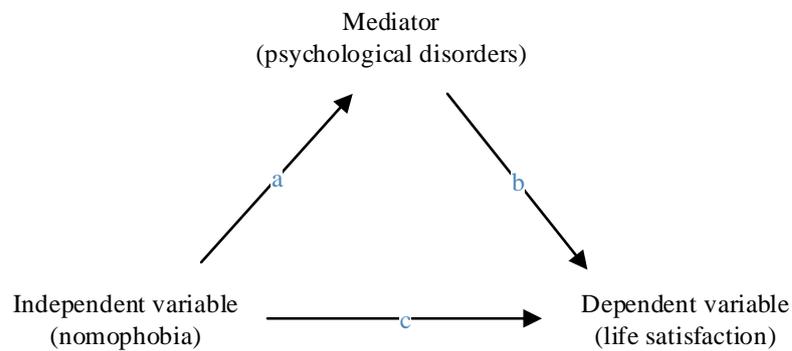
Figure 2.   The Revised Research Model

Figure 3.   Mediator testing model (Baron and Kenny, 1986)

| IV | M | DV | IV→ DV | IV→ M | IV+M→DV | | Mediation |
					IV→DV	M→DV	
Nomophobia	Psychological disorders	Life satisfaction	0.294***	0.454***	0.336***	-0.093***	Part

Table 6.   Mediating effect of psychological disorder

7 Discussion and Conclusion

Our results show that the daily time of smartphone usage is positively associated with the cultivation of nomophobia among college students. This finding corroborates previous studies on the adverse impacts of smartphone usage that using smartphones for multiple applications such as social networking, games, and entertainment media increases the severity of smartphone addiction or nomophobia (Yildirim and Correia, 2015; Jeong et al., 2016). Worthy mentioning, pre-sleep smartphone usage associates with a more harmful impact on nomophobia than that of overall smartphone usage. These findings imply not only that, the adverse consequences of smartphone usage might get more severe taking the tendency toward increased smartphone usage into consideration if without active intervention, but also, decreasing pre-sleep smartphones usage should be efficient solutions to buffer the negative influence of smartphone usage on students' psychological wellbeing.

Nomophobia has a direct positive impact on life satisfaction, consistent with the finding of Chui (2015) that smartphone usage positively associates with life satisfaction. One plausible explanation lies in that, users with nomophobia might gain a sense of satisfaction with life through interacting with smartphones such as social networking and mobile gaming so that to escape from real life.

Nomophobia is found to cultivate college students' psychological disorders that can further lower their life satisfaction. Specifically, first, college students with a high risk of nomophobia experience higher levels of perceived stress, depression, and loneliness. Second, college students with higher levels of psychological disorders (including perceived stress, depression, and loneliness) experienced a lower level of life satisfaction. These findings shed light on some similarities between our sample and those of previous studies that Internet addiction and psychiatric symptoms can interact and precipitate each other (Beranuy et al., 2009). The above findings suggest that nomophobia not only has direct influence on life satisfaction but also, there is a significant and indirect effect of nomophobia on life satisfaction mediated by psychological disorders. The findings highlight the importance of psychological disorders in understanding the relationship between IS usage and life satisfaction. Conceivably, anything that raises the risk of nomophobia might influence an increased level of psychological disorders, which moves a student into a dangerous zone characterized by the high risk of nomophobia, a high level of psychological disorders, and a low level of life satisfaction. This pattern confirms the relationship with life satisfaction perspective and is a novel contribution to the literature.

8   Implications and limitations

The current study provides three theoretical implications. First, our study contributes to a panoramic picture including direct and indirect paths understanding the relationship between nomophobia and life satisfaction. In this line, we give empirical evidence to settle down the dispute concerning the effect of smartphone usage on life satisfaction.

Second, the results of this study contribute to altering the common understanding of nomophobia, in uniquely addressing the relationship between nomophobia and psychological disorders. Most research tackling similar topics has addressed the relationships between smartphone usage on students and mental wellbeing (Schneider and Wang, 2016; Thadani *et al.*, 2016). Given the fact that smartphones gradually overtake IT devices, and the increasingly using time of smartphones facilitates the nomophobic tendency of users. For this reason, to test nomophobia cultivated by excessive smartphone use, researchers are employing the nomophobia rather than smartphone usage to make it more context-specific for the current social occasion.

Third, this study is among the first to uniquely address how the mediating mechanism of multidimensional psychological disorders rather than a specific single variable in the association of nomophobia and life satisfaction based on theories of internalization and activity theory, responding to call for the mediating effects to interpret the black-box mechanism between nomophobia and life satisfaction. The pattern in our study yields new insights on the relationship with the perspective of life satisfaction, which is a unique novel contribution in IS literature.

This study also offers us several practical suggestions. First, the daily time of smartphone users should be controlled, especially smartphone usage before sleep, which would induce a more harmful impact of users' mental wellbeing. Second, educational parties, including both students and teachers, should pay close attention to the duration of using smartphones per day, as it is a significant sign of nomophobic tendency. Third, this study could also offer educational institutions guidelines about the interaction of IS use, psychological disorders, and life satisfaction.

As for the limitations, first, our study used a cross-sectional dataset which may situate an impediment in capturing dynamic associations (Rindfleisch *et al.*, 2008), thereby encouraging a longitudinal analysis on this topic in the future study. Secondly, aiming to access the connections of nomophobia, psychological disorders, and life satisfaction, we could conduct the application segmentation, the patterns of smartphone usage activity among different students still leave to be elaborated. Therefore, we suggest pattern identification of smartphone usage in the future study, so that to figure out how specific smartphone activities impact life satisfaction.

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Appendix A: Survey Items

Constructs	Description	Resource
Smartphone usage	Average daily time of using smartphone per day?	Felisoni and Godoi (2018)
	Frequency of pre-sleep smartphone usage per day?	Thompson (2013)
Nomophobia	"I feel restless, moody, depressed, or irritable when I would drop the stop part on my phone."	Yildirim and Correia (2015)
	"If I do not have a mobile phone, my friends would find it hard to get in touch with me."	
	"I feel unsettled when I forget to take my mobile phone with me."	
Perceived stress	"In the last month, how often have you felt nervous and stressed?"	Cohen et al. (1983)
	"In the last month, how often have you found that you could not cope with all the things that you had to do?"	
	"In the last month, how often have you been upset because of something that happened unexpectedly?"	
Depression	"I was bothered by things that usually do not bother me."	Radloff (1977)
	"I felt that I could not shake off the blues, even with the help of my family or friends."	
	"I had trouble keeping my mind on what I was doing."	
Loneliness	"I feel isolated from others."	Russell et al. (1980)
	"My interests and ideas are not shared by those around me."	
	"I cannot find companionship when I want it."	
Life satisfaction	"In most ways, my life is close to my ideal."	Pavot and Diener (2008)
	"I am satisfied with my life."	
	"So far, I have achieved the important things I want in life."	

Appendix B: Descriptive statistics for key variables

Items	Mean	Standard deviation	Min.	Max.
Overall smartphone use	4.339	1.432	1	7
Smartphone usage before sleep	5.499	1.861	1	7
Nomophobia1	3.970	1.896	1	7
Nomophobia2	4.107	1.912	1	7
Nomophobia3	3.759	1.927	1	7
Perceived stress1	3.159	1.749	1	7
Perceived stress2	3.286	1.784	1	7
Perceived stress3	3.257	1.768	1	7
Depression1	3.199	1.783	1	7
Depression2	2.994	1.787	1	7
Depression3	3.230	1.777	1	7
Loneliness1	3.471	1.795	1	7
Loneliness2	3.077	1.730	1	7
Loneliness3	3.008	1.759	1	7
Life satisfaction1	4.231	1.578	1	7
Life satisfaction2	4.309	1.594	1	7
Life satisfaction3	3.967	1.663	1	7

Appendix C: Loadings and cross-loadings

	Nomophobia	perceived stress	depression	loneliness	life satisfaction
Nomophobia1	0.922	0.403	0.397	0.404	0.257
Nomophobia2	0.920	0.365	0.369	0.365	0.289
Nomophobia3	0.911	0.402	0.392	0.403	0.265
Perceived stress1	0.401	0.781	0.940	0.804	0.037
Perceived stress2	0.388	0.734	0.937	0.787	0.001
Perceived stress3	0.401	0.750	0.951	0.814	0.009
Depression1	0.395	0.698	0.787	0.919	0.049
Depression2	0.371	0.725	0.797	0.925	0.036
Depression3	0.401	0.661	0.741	0.891	0.033
Loneliness1	0.404	0.893	0.747	0.696	0.080
Loneliness2	0.395	0.943	0.745	0.715	0.112
Loneliness3	0.371	0.915	0.711	0.686	0.115
Life_satisfaction1	0.296	0.104	0.016	0.037	0.950
Life_satisfaction2	0.259	0.072	-0.019	0.004	0.951
Life_satisfaction3	0.271	0.139	0.052	0.082	0.911