THE IMPACTS OF SOLOMO SERVICES TECHNOSTRESS ON ANXIETY

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ABSTRACT

Any technology service is not always positive but might accompany with something negative. Past studies have documented the dark side of technology such as technostress. Current technostress research reveals that individuals may experience technostress as a result of their use of information and communication technologies (ICTs), and consequently may have symptoms of anxiety and tension. At the level of individuals, this study tries to understand anxiety caused by modern ICT technostress such as SoLoMo (social-local-mobile) services in daily life. Accordingly, we propose the SoLoMo services stress as a specific technostress of SoLoMo services and identify five stressors including information overload, social message overload, social support overload, perceived surveillance, and services usage cost. The results reveal that three stressors, information overload, social message overload, and perceived surveillance have significant impacts on users' anxiety, but social support overload and services usage cost have no significant impacts. Meanwhile, it is interesting to find that users of different features have different influential stressors of anxiety.

Keywords: SoLoMo services technostress; Anxiety; Perceived surveillance; Social message overload; Social support overload;

1. Introduction

Information and communication technologies (ICTs) have become more powerful, real-time and ubiquitous. ICTs enable users to communicate immediately and continually for making their life easier, but also cause users to be reached anywhere at any time. One current outstanding example is SoLoMo (social-local-mobile) services, which are the integration of social network services and location-based services via mobile devices to fulfill users' immediate needs. Users can share information about their whereabouts and local offers to their friends by SoLoMo services. This interaction is no longer time-delayed but shared in real time [Heinemann et al., 2015]. On the other hand, even if users want to be alone, their friends still can contact users at anytime and anyplace. Past researchers agreed that the "dual nature" of ICTs would have both positive and negative effects on users [Tarafdar et al., 2007]. The negative effects of ICTs may lead to unintended consequence such as *stress*. Clinical psychologist Brod [1984] coined the term *technostress*, which is described as "a modern disease caused by individual's inability to cope or deal with ICTs in a healthy manner". Subsequently, Weil et al. [1997] extended the definition of technostress as "any negative impact on attitudes, thoughts, behaviors or body psychology caused directly or indirectly by technology". Further research indicated that technostress inversely affects productivity, satisfaction and commitment in organization [Tarafdar et al., 2007; Tarafdar et al., 2010].

Recently, technostress has become an important research issue of information system research [Ayyagari et al., 2011; Maier et al., 2014; Maier et al., 2015; Tarafdar et al., 2010]. Stressors are the events or properties of events (stimuli) encountered by individuals [Ayyagari et al., 2011]. While prior technostress research has investigated technostress stressors, most of them focused on the organizational contexts. However, we consider that technostress would not only caused by organizational usage but also evoked by personal usage in daily life. Meanwhile, it should be noted that the modern ICTs are very different from the earlier ICTs such as mobile, social and localized capability. Thus the technostress stressors of modern ICTs may be different. For example, SoLoMo services are mostly installed on mobile devices which own characteristics such as small screen size, LTE mobile network, connected social network

and mobile locating. These characteristics may cause inefficient information processing, overextended social interaction, unaffordable mobile network fee and uncomfortable privacy invasion. Furthermore, in organizational usage context, there are several stimuli such as technical system changes in tasks and processes, and social system changes in roles, reward systems and authority structures [Tarafdar et al., 2007]. These stimuli can be significant sources of stress for employees in organization. However, in personal usage context, the above situations do not exist. In personal daily usage, while users have undesirable experience, they can discontinue to use a specific ICT as they wish. Namely, the use of technology is voluntary; users pursue personal benefits such as functional and social benefit instead of business benefits such as productivity and performance. Accordingly, the formulation of technostress stressors in personal usage may be different from organizational usage.

Besides, most existing technostress research focuses on the negative relationship between technostress and employee productivity in organization [Tarafdar et al., 2007; Tarafdar et al., 2010]. There is limited research empirically to investigate the relationship between technostress stressor and psychological outcome. At the level of individuals, Brod [1984] elaborated that the primary symptom of technostress is anxiety. Strain is the individual's psychological response to the stressors [Sharma et al., 2014]; technostress stressors will induce users' anxiety (psychological response). Technostress is most frequently confused with anxiety, although there are differences. In general, technostress refers to a kind of fallout of an individual's inability to deal with constantly evolving ICTs and the changing cognitive and social requirements related to their use [Tarafdar et al., 2007; Tarafdar et al., 2010]. Technostress represents the direct and indirect impacts of ICTs. By contrast, anxiety usually is defined as the fear of using a specific object, for instance, fear of using computers is conceptualized as computer anxiety [Venkatesh et al., 2003]. It is an emotional reaction toward using a specific object. In the information system research, the feeling of anxiety has been demonstrated as one of the significant determinants of usage intention [Compeau et al., 1995; Venkatesh et al., 2003; Yang et al., 2013]. People would avoid to use information technology that invokes anxious feelings. Accordingly, it is important to understand what will cause personal users' anxiety for SoLoMo services' providers to prevent and minimize the impact.

There are many famous examples of SoLoMo services such as Facebook, Instagram, Twitter, LINE, WeChat, Waze, etc. These SoLoMo services have been very popular and deeply integrated into our lives. Recently, researchers have started to address the issues of SoLoMo services. For example, Hsieh [2016] explored the critical determinants of SoLoMo technology acceptance based on technology acceptance model. Lee [2016] investigated the factors affect attitudes toward SoLoMo advertising from social capital perspective. However, there is limited research to address the potential unintended consequences of SoLoMo services such as technostress. Accordingly, this study focuses on the anxiety induced as the users' negative psychological outcome of SoLoMo services. The primary objectives of this research are to identify possible technostress stressors of voluntarily using SoLoMo services and understand their impacts on anxiety in the context of individual daily life.

Although the personal daily usage of ICTs is voluntary, ICTs have become necessities for modern younger generations. Researchers have noticed the negative relationship between technology usage and psychological health, a new psychological malady referred to as "iDisorder" by Rosen et al. [2012]. For example, Rosen et al. [2013] discovered that having anxiety about not checking in Facebook would cause the increased symptoms of narcissism, antisocial and compulsive. Lee et al. [2014] mentioned that overdependence on smartphone may lead to compulsive usage and enhance user technostress. However, past researchers have not explored the possible stressors from the characteristics of SoLoMo services. Thus, this study contributes to these evolving streams of research by investigating possible technostress stressors underlying personal daily SoLoMo services usage instead of organizational usage on the literature. Based on prior related research and characteristics of SoLoMo services, we propose the concept of SoLoMo service stress and identify five stressors from operational and social perspectives. The results indicate information overload, social message overload, and perceived surveillance have significant impacts on users' anxiety, but social support overload and services usage cost are insignificant. In addition, we provide a further post-hoc results by users' different features such as usage purpose (information acquiring vs. social interaction), job (student vs. non-student), and frequently used app (Facebook vs. LINE) for better exploring possible differences.

The remaining part of the paper is organized as follows. Section 2 presents the research model and hypotheses. The measurement development and data collection are described in Section 3. The research results are presented in Section 4 and discussions are provided in Section 5. Finally, the implications and conclusions are given in Section 6.

2. Research model and hypotheses

SoLoMo services integrate social network services, location-based services and mobile devices. This synthetic nature facilitates social interaction and accelerates information dissemination, but might also lead to social overload and information overload [Koroleva et al., 2010; Maier et al., 2014], and then cause users' strain. According to Ayyagari et al. [2011], stress would arise when an individual evaluates the demands placed by the environment

exceeding the individual's resources, thereby threatening the individual's well-being. Stressors are the stimuli encountered by an individual, and strain would be brought as an individual's psychological response to the stressors. In a similar vein, we propose the concept of *SoLoMo services stress* and define it as negative impacts from SoLoMo services which exceed what users can cognitively handle.

In this study, we are interested in the anxiety as the psychological response of SoLoMo services. Epstein [1972] indicated that the most basic source of anxiety is primary overstimulation. It involves feelings of being overwhelmed or bombarded with information/message stimulation to the upper limits of tolerance. Torkzadeh et al. [1992] suggested that anxiety could be viewed from the social perspective and the operational perspective. Maier et al. [2012; 2014] also pointed out the social support overload in the context of social network sites based on social support theory. For the operational perspective, privacy is often considered as an important intangible cost and tangible cost includes financial fee for subscribing location-based services [Smith et al., 1996; Xu et al., 2009; Yang et al., 2012; Yun et al., 2013]. Accordingly, this study identifies five stressors of SoLoMo services stress: information overload, social message overload, social support overload, perceived surveillance, and services usage cost. In literature, some previous studies [Maier et al., 2015; Tarafdar et al., 2007; Tarafdar et al., 2010] treated technostress as the second-order construct including different stress creators. In this study, we try to explore the separate impact of each stressor. Thus, we propose the research model for explaining SoLoMo services users' anxiety as shown in Figure 1. The variables and justifications of the research hypotheses are addressed as follows.
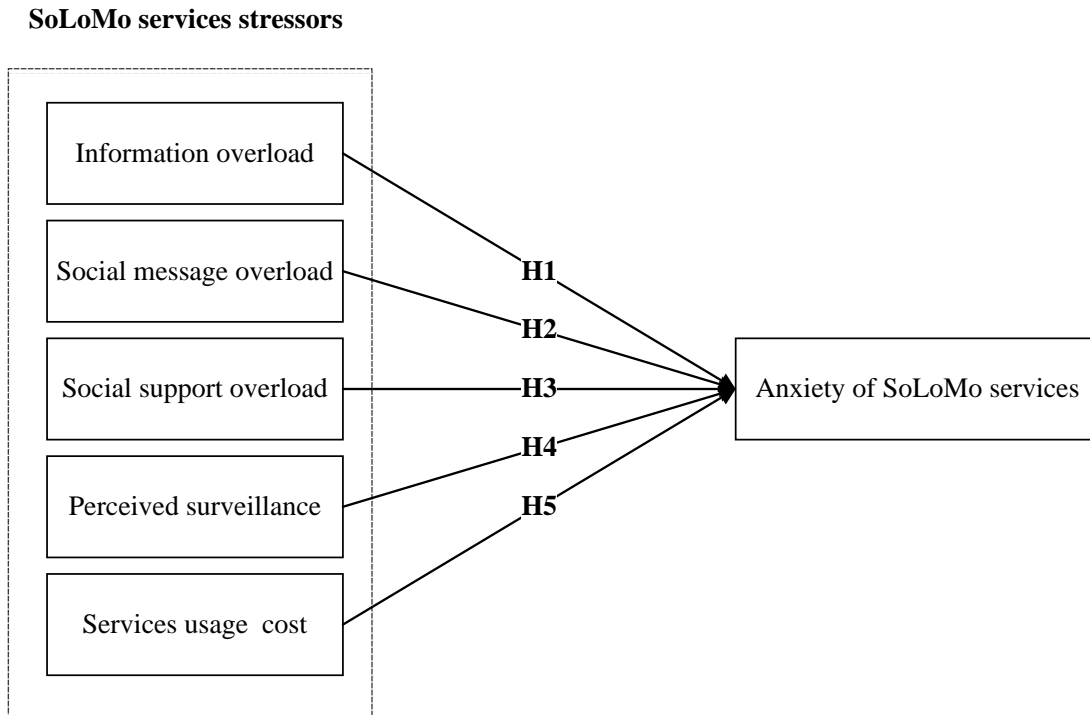

Figure 1: Research model

2.1. Information overload

According to Miller [1956], people have limited cognitive processing capacity. Once the received information surpasses the processing capacity, users may be overloaded by the processing of information and hence lead to dysfunctional consequences [Jacoby et al., 1974]. In general, this phenomenon is called information overload, which is resulted from too much information received by users so that they have to make much effort and time to process it. Nowadays, SoLoMo services are presented as the form of a mobile "app" (the abbreviation of "application") that provides easy and intuitive operation for users. However, SoLoMo services deliver many contents, such as product information, discount information and store location, which also contain a lot of unrelated contents such as advertisements. Unless service providers could intelligently pre-process these contents so as to tailor, customize or personalize to specific users, users would need to make much effort to pick up their target information from huge and imprecise information. The extensive and diverse information of SoLoMo services would increase processing complexity and consume more users' efforts. Furthermore, while using SoLoMo services, the large amount of

information has to be displayed on a small size screen. It is difficult for users to open a lot of windows to make alternative comparisons as they did on traditional computers. Without a proper arrangement, the diverse and intensive information/advertisement, such as hardware limitation, may lead to information overload.

Information overload is often associated with a loss of control over the situation, feeling of being overwhelmed and causes anxiety of users [Bawden et al., 2009; Koroleva et al., 2010]. Thus, while most of the current SoLoMo services are provided with the ineffective information management, the diverse and intensive information such as advertisement interruptions would exhaust the processing ability of users, and thereby they may feel full of frustration and anxiety. Tarafdar et al. [2010] also pointed that information overload is an important stressor of technostress. Therefore, we consider information overload as a stressor of SoLoMo services stress and hypothesize the following:

H1. *Information overload of SoLoMo services has a positive effect on users' anxiety.*

2.2.　　Social message overload

Social message overload refers to the situation that the amount of social message, which users have to engage with, exceeds their communicative and cooperative capacities [Laumer et al., 2013]. For example, users may have many friends in SoLoMo services, so they may receive many messages, news feeds, notifications and announcements from their friends. Because the nature of ubiquity, messages from friends can be delivered by SoLoMo services at anytime and anyplace. Consequently, users are constantly connected to their social network, any friend can contact them immediately. Unlike general information, social messages imply social activities or communication so that users might not ignore easily. Further, social communication is two-way, users' friends might be waiting for their responses. Especially, the messages from intimate friends are highly important and users have to deal with them. Nevertheless, in some situations, e.g., driving car, or meeting with others, it is not convenient for users to communicate with friends. In those inconvenient situations, the incoming social messages from families or friends would make users anxious. While the amount of social message exceeds users' communicative and cooperative capacity, they may be tired of SoLoMo social activities or feel uneasy about how to handle everyday social situations properly. Laumer et al. [2013] also indicated that social message overload is an important stressor of technostress underlying social networks. Therefore, we consider social message overload as a stressor of SoLoMo services stress and hypothesize the following:

H2. *Social message overload of SoLoMo services has a positive effect on users' anxiety.*

2.3.　　Social support overload

Social support overload refers to the situation that users need to give too much social support to other individuals embedded in their social networks [Maier et al., 2014]. In SoLoMo services, users may receive many social support requests such as emotional support, material assistance and so on and further may feel that they take too much care of their friends. For example, message posting may be like "I am planning to visit Taipei, can anyone recommend me a hotel?", or "I am sick", or "how to solve this problem?", etc. Those posts are very general social requests on SoLoMo services. While users saw the posts of their friends, they may consider that they are responsible for taking care of friends and addressing their questions. Thus, no matter what time and place, users may be confronted with a lot of social requests. Namely, SoLoMo services may force users to respond to their friends faster and also take more time to deal with their requests. Hall et al. [2011] indicated that users might feel pressured that they have to be available to their friends. While the social support requests become more than what users are comfortable in offering, they would experience social support overload. Maier et al. [2015] found that social support overload is an important stressor of social networking services. Prior research also argued that social support overload would induce users' stressful feeling [Laumer et al., 2013; Maier et al., 2015]. Owing to the ubiquitous nature of SoLoMo services, users may take too much effort to respond to their friends' requests so that they may feel tired, worried or even fear using SoLoMo services. Therefore, we consider social support overload as a stressor of SoLoMo services stress and hypothesize the following:

H3. *Social support overload of SoLoMo services has a positive effect on users' anxiety.*

2.4.　　Perceived surveillance

SoLoMo services might be a double-edged sword offering both advantageous and disadvantageous consequences. Through these services, users can lower searching costs so as to access their needed information easily. However, users' friends, considerate service providers or even intended strangers can also easily track and monitor users. Thoughtful, attentive, meticulous and intelligent services are welcome. However, users might become nervous or paranoid if they suddenly recognize that some strangers already knew anything users did before --- friendships, conversation messages, secrets, internet browsing records, footprints in real world, and even their future schedules, etc. While the SoLoMo services offer more precise contents, some users might recognize that they have been being surveilled. For example, if users search for specific clothes information through a SoLoMo app service, their browsing activities might be recorded stealthily. After that, while the users are walking on the street, they might receive a "nice message" from the app reminding that the advertisement of the nearest store is going to perform a big sale on the specific clothes related to their previous searches. Some of users might become uncomfortable because they could not

figure out about how the SoLoMo services could provide the specific clothes information at current location. They might be worried that their personal life details are being surveilled secretly and someone can watch them at anytime and anyplace, and thereby feel uncomfortable for using SoLoMo services.

Several studies have noticed users' perception of surveillance about technology. Lyon [2001] pointed out that in a surveillance society everyday life is subject to monitoring, checking, and scrutinizing; it is hard to find a place or an activity, which is shielded or secure from some purposeful tracking, tagging, listening, watching, recording or verification device. Solove [2008] defined surveillance as the watching, listening to, or recording of an individual's activities. Xu et al. [2012] proposed the concept of perceived surveillance about mobile users for information privacy. Sharma et al. [2014] adopted perceived surveillance to understand its effect on perceived risk in social commerce environment.

In the context of this study, perceived surveillance is defined as the perception that users perceive their life details might be surveilled ubiquitously and stealthily by SoLoMo services. Solove [2006] indicated that continuous monitoring as surveillance has problematic effects, which can create feelings of anxiety and discomfort. Kallman [1993] argued that continual monitoring puts pressure on employees to work and leads to anxiety, fatigue and apprehension. Xu et al. [2012] indicated that users' perceptions of surveillance can be very salient due to aggressive data collection activities by mobile apps. One might argue the causal relationship between perceived surveillance and anxiety. Cambre et al. [1985] indicated that there are two types of anxiety: trait anxiety and state anxiety; the first is relatively stable and permanent personality characteristic; the second is a transitory condition which fluctuates over time and treatment. Thus, people whose personality characteristic are more anxious can be more worried about information privacy and feel being monitored. However, the possible antecedents of stressors such as personality characteristics are out of our research scope. In this study, anxiety is adapted from computer anxiety [Venkatesh et al., 2003] as the state anxiety, which would be induced by the feeling of perceived surveillance. We therefore consider perceived surveillance as a stressor of SoLoMo services stress and hypothesize the following:

H4. *Perceived surveillance of SoLoMo services has a positive effect on users' anxiety.*

2.5.   Services usage cost

While using SoLoMo services, users have to constantly pay the financial cost to acquire convenient and ubiquitous services, that is, services usage cost. These financial costs include initial investment for the proper device, the subscription fee for mobile data usage and additional charges for value-added services. For example, while a SoLoMo service provides a new function that needs 3D Touch (only supported by iPhone 6s or later), users may have to purchase a new iPhone for the new function if they really like it. Another example, SoLoMo services can provide real-time and media-rich information for users via the mobile network; but users have to pay a subscription fee of the 3G/4G mobile network. While users enjoy SoLoMo services, they may be also worried about the subscription fee. Prior studies indicated that services cost negatively influences users' behavioral intention in mobile services [Cheong et al., 2005; Kuo et al., 2009; Luarn et al., 2005; Yang et al., 2012]. Similarly, if users cannot afford services usage cost, they would be no longer have convenient and useful SoLoMo services, thus causing anxiety. We therefore consider services usage cost as a stressor of SoLoMo services stress and hypothesize the following:

H5. *Services usage cost of SoLoMo services has a positive effect on users' anxiety.*

3.   Research methodology

3.1.   Measurement development

Table 1 lists the operational definitions and sources of variables of the proposed model. Except for perceived surveillance, all the questionnaire measures were adapted from previous research. Perceived surveillance was developed by the process suggested by Hinkin [1998]. The detailed procedures are reported as follows. Step 1, we created a set of initial six items based on the definition of perceived surveillance. Step 2, the items were reviewed by a focus group of three information systems experts to detect any ambiguities. Two ambiguous items were deleted. Next, for preventing the possible common method concerns while collecting data from a single sample source, we invited twenty students who might not have usage experience of SoLoMo services to participate in our pretest. Step 3, we performed a reliability test before exploratory factor analysis (EFA). Inter-item correlations of all item were above 0.74, item-to-total correlations of four items were above 0.79 and the Cronbach's alpha was above 0.94. The results of EFA depicted that only one eigenvalue (3.449) greater than 1 and 86.2% of variance was explained. All of the factor loadings were larger than 0.88. Step 4, a confirmatory factor analysis was implemented and results showed satisfactory fitness of measurement model (GFI=0.997, AGFI=0.987, CFI=1.000, RMSEA=0.000), all factor loadings were higher than 0.81. All the statistical results were fulfilled the recommended values of Hinkin [1998]. Thus, we finally developed the four items as our measures of the following pilot study.

All the constructs in Table 1 were measured using multiple items and a seven-point Likert scale ranging from strongly disagree (1) to strongly agree (7). To ensure the content validity, we invited information system faculties to

identify any potential errors about wording and content of the items. To further refine the instrument, a pilot study was also deployed among sixty experienced users of SoLoMo services. The reliability of the instrument was tested; the Cronbach's alpha of each variable was above the acceptable level, that is, above 0.70. Besides, the opinions of pilot test respondents were used to refine the instrument. The final questionnaire items are listed in Appendix 1. The questionnaire translation procedure as follows. A native Chinese researcher translated the items into Chinese. It was then back translated from the Chinese into English by another researcher independently. There were few discrepancies, and all were resolved before disseminating the questionnaire.

Table 1: Operational definitions and sources of variables

Constructs	Operational definitions	Numbers of items	References
Information overload	The amount of product, location, and other non-social-related information received by users exceeds their processing capacities while using SoLoMo services.	2	Adapted and revised from Chen et al. [2009]
Social message overload	The amount of social message, which users have to engage with, exceeds their communicative and cooperative capacities while using SoLoMo services.	3	Adapted and revised from Laumer et al. [2013]
Social support overload	Users give too much social support to other individuals embedded in their social network while using SoLoMo services.	3	Adapted and revised from Maier et al. [2014]
Perceived surveillance	Users feel that their life details may be surveilled ubiquitously and stealthily by SoLoMo services.	4	New scale developed based on Solove [2008]
Service usage cost	The financial cost for using SoLoMo services include devices fee, communication subscription fee, and value-added service fee.	4	Adapted and revised from Cheong et al. [2005]
Anxiety	Users feel apprehensive, worried or even fear, while using SoLoMo services.	3	Adapted and revised from Venkatesh et al. [2003]

3.2.   Data collection

The target population of this study was SoLoMo services experienced users. Empirical data were collected via an internet survey. Announcements were released on several channels include PTT (the largest Bulletin Board System in Taiwan) and Facebook to invite those with SoLoMo services experiences. To make sure that participants could truly understand the survey target, we listed the definition of SoLoMo services and several examples at the beginning of the questionnaire. The examples include using LINE app on mobile devices to share users' location information to friends, using Facebook app on mobile devices to check in and share to friends, using parking apps to find and assist navigating to available parking lot, looking for a nearby restaurant, etc. We also highlighted the participants should answer the instrument based on their mobile experience of using SoLoMo services ubiquitously.

A total of 454 responses were collected in this study. After removing invalid responses (missing data or respondents had no SoLoMo services experience), the final valid sample consisted of 451 respondents who frequently used SoLoMo services including Facebook, LINE, and other social interaction or information acquiring apps. The demographic information of these respondents is shown in Table 2. We evaluated the non-response bias by comparing the subjective variables between early and late respondents, which were arranged based on their submission time [Armstrong et al., 1977]. The late respondents served as a proxy for non-respondents. No significant differences were found between these two groups in all subjective variables. Therefore, we believed that non-response bias was unlikely a major problem in this study.

Table 2: Demographic information for respondents

Profiles	Items	Frequency	Ratio (%)
Gender	Male	258	57.21%
	Female	193	42.79%
Age	≤ 20	129	28.60%
	$21 - 30$	278	61.64%
	≥ 31	44	9.76%
Education	Below Senior High School	70	15.52%
	College	291	64.52%
	Above Graduate	90	19.96%
Job	Government-related	33	7.32%
	Service	57	12.64%
	Manufacturing	15	3.33%
	Information Industry	17	3.77%
	Student	324	71.84%
	Other	5	1.11%
The most frequently used SoLoMo services	Facebook app	170	37.69%
	LINE app	127	28.16%
	Others	154	34.14%
The primary purpose for using SoLoMo services	Social interaction	142	31.49%
	Information acquiring	152	33.70%
	Both of above	157	34.81%
Average using SoLoMo services per day	$\leq$ 1hr	77	17.07%
	1hr $<$ to $\leq$ 3hrs	206	45.68%
	3hrs $<$ to $\leq$ 5hrs	84	18.63%
	5hrs $<$ to $\leq$ 7hrs	40	8.87%
	$>$ 7hrs	44	9.76%

3.3.   Common method bias

Since the data were collected from the same source by using the same method, common method variance was deemed a potential concern [Podsakoff et al., 2003]. We implemented the Harman's single-factor test to examine the common method variance. Podsakoff et al. [2003] claimed that if all the items load on a single factor or one factor explains the majority of the variance, common method variance may be a problem. In this study, since six factors explained about 75.94% variance, and the largest variance explained by an individual factor was 35.95%, the common method variance was not significant. Another CFA was conducted by loading all items as the indicators on one factor. The results indicated a poor fitness (GFI=0.631, AGFI=0.535, CFI=0.570, RMSEA=0.169). Thus, the common method variance should not be a significant problem in this study.

4.   Data analysis and results

We applied the covariance-based technique of structural equation model (SEM) for data analysis using AMOS 21.0. Following the two-step approach recommended by Anderson et al. [1988], the measurement model was first assessed using CFA to test the fit and construct validity. Then, the structural model was tested for the significance of relationships.

4.1.   Measurement model

A confirmatory factor analysis was conducted with 451 respondents. As shown in Table 3, the fit indices showed that satisfactory fitness of measurement model. The values of all fit indices were better than the recommended values. As shown in Table 4, all of the average variance extracted (AVE) and the composite reliability (CR) also exceeded the recommended level 0.5 and 0.7, respectively. AVEs ranged from 0.556 to 0.708 and CRs ranged from 0.781 to 0.906. Also, as shown in Appendix 1, all of the standardized loadings were significantly larger than 0.7, ranging from 0.701 to 0.905, and thus ideally acceptable [Hair et al., 2010]. Thus, convergent validity was assured. The constructs and correlation matrix is listed in Table 5 that indicates the diagonal square root of AVE of each construct was higher than

the corresponding correlation values. Thus, the discriminant validity was assured. Overall, the results assured the construct validity of the measurement model. In addition, in Table 4, all the variables of the model were significantly higher than the middle value 4 in terms of 1-7 Likert scale, thus indicating those stressor perceptions did exist.

Table 3: Fit indices for the research model

Fit indices	Recommended value	Research model
χ^2 (p-value)	-	239.307 ($p = 0.000$)
df	-	136
χ^2/df	< 3	1.760
GFI	> 0.9	0.949
AGFI	> 0.9	0.929
CFI	> 0.9	0.977
RMSEA	< 0.05	0.041

Table 4: AVE, CR and mean of constructs

Construct	AVE	CR	Mean
Information overload (IO)	0.640	0.781	4.436***
Social message overload (SMO)	0.603	0.819	4.380***
Social support overload (SSO)	0.556	0.789	4.106#
Perceived surveillance (PS)	0.708	0.906	4.539***
Service usage cost (SC)	0.618	0.865	4.442***
Anxiety (AN)	0.662	0.854	4.111#

Note: # and *** indicate that the mean significantly larger than the middle level 4 (with scale 1 - 7) at $p < 0.1$ and 0.001, respectively.

Table 5: Correlation of constructs and square root of AVE

Constructs	IO	SMO	SSO	PS	SC	AN
Information overload (IO)	**0.800**					
Social message overload (SMO)	0.565	**0.777**				
Social support overload (SSO)	0.365	0.549	**0.746**			
Perceived surveillance (PS)	0.424	0.430	0.425	**0.841**		
Service usage cost (SC)	0.374	0.309	0.321	0.368	**0.786**	
Anxiety (AN)	0.594	0.577	0.428	0.560	0.371	**0.814**

Note: The values in bold type shown along the diagonal are respectively a square root of the AVE of a specific construct, while all other values are correlation coefficients between two constructs, respectively.

4.2.   Structural model

After adequate measurement and construct validity were established, we estimated the structural model using maximum likelihood method with 451 respondents. Table 3 indicates that structural model had reasonably good overall model fit (GFI=0.949, AGFI=0.929, CFI=0.977, RMSEA=0.041). Figure 2 depicts the standardized path coefficients, path significances, and explained variances (R^2) of each path. Three constructs, information overload (**H1**) ($\beta = 0.295$, $p < 0.001$), social message overload (**H2**) ($\beta = 0.242$, $p < 0.001$), and perceived surveillance (**H4**) ($\beta = 0.288$, $p < 0.001$) had significant impacts on anxiety. However, social support overload (**H3**) and services usage cost (**H5**) had no significant effects on anxiety. In addition, the results indicated that structural model accounted for 51.9% of the variance in anxiety of SoLoMo services. The standardized path coefficients and hypotheses testing results are summarized in Table 6.

It would be interesting to explore the differences of users who have specific purposes. Thus, we further classified our samples into three groups based on the respondents' self-reported major usage purposes (information acquiring, social interaction and both of above), and then implemented the cluster analysis to explore the differences among users with specific purposes. For the "information acquiring group", information overload and perceived surveillance were significant stressors inducing users' anxiety. For the "social interaction group", social message overload was the only significant stressor raising users' anxiety. For the "both of above group", the results were similar to overall sample model. The group analysis of purpose is summarized in Table 7.

In addition, as shown in Table 8, we also implemented two cluster analyses based on other respondent features in Table 2. The first classification was based on the respondents' job: for the "student group", information overload,

social message overload and perceived surveillance were significant stressors; for the "non-students group", information overload and perceived surveillance were significant stressors. The second classification was based on the respondents' most frequently used SoLoMo services: for "users who most frequently used LINE", social message overload and perceived surveillance were significant stressors; for "users who most frequently used Facebook", information overload and perceived surveillance were significant stressors. LINE and Facebook were two most frequently used SoLoMo services in the survey; other respondents used most frequently used other mobile social interaction apps (e.g., BeeTalk, WeChat) or information acquiring apps, and had the same significant stressors as the Facebook group.
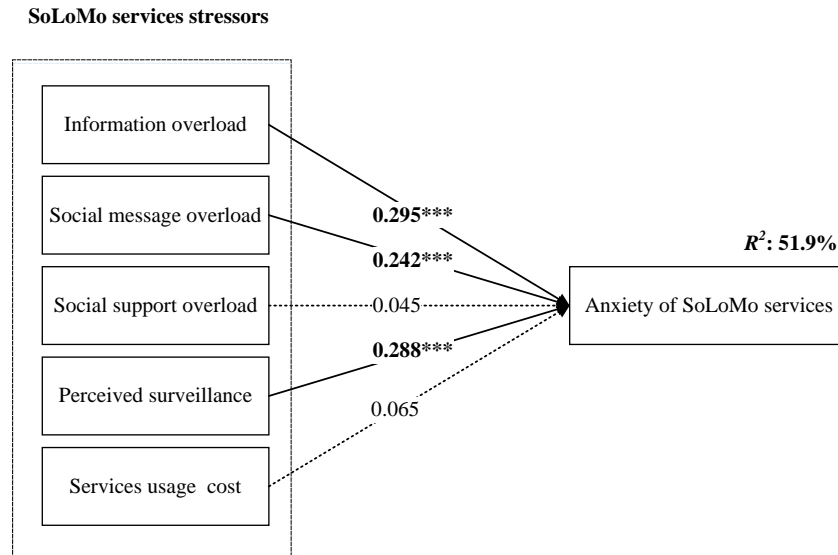
SoLoMo services stressors

Figure 2: The structural model
(*** indicates significant at $p < 0.001$)

Table 6: Hypothesis testing results and path coefficients of overall sample

Hypothesis	Path estimate	t value	Supported
H1. Information overload → Anxiety	0.295***	4.537	Yes
H2. Social message overload → Anxiety	0.242***	3.532	Yes
H3. Social support overload → Anxiety	0.045	0.743	No
H4. Perceived surveillance → Anxiety	0.288***	5.428	Yes
H5. Services usage cost → Anxiety	0.065	1.350	No

Note: *** indicates significant at $p < 0.001$.

Table 7: Path coefficients of groups of different purposes

Hypothesis	Information acquiring (N=152)	Social interaction (N=142)	Both of above (N=157)
	Path estimate	Path estimate	Path estimate
H1. Information overload → Anxiety	0.344**	0.167	0.355**
H2. Social message overload → Anxiety	0.047	0.374*	0.267**
H3. Social support overload → Anxiety	0.149	0.187	-0.138
H4. Perceived surveillance → Anxiety	0.296**	0.187	0.370***
H5. Services usage cost → Anxiety	0.119	-0.028	0.115

Note: *, ** and *** indicate significant at $p < 0.05$, 0.01, and 0.001, respectively.

Table 8: Path coefficients of groups of different jobs and frequently used services

Hypothesis	Classified by "job"		Classified by "most frequently used services"		
	Student (N=324)	Non-student (N=127)	LINE (N=170)	Facebook (N=127)	Others (N=154)
	Path estimate	Path estimate	Path estimate	Path estimate	Path estimate
H1. Information overload → Anxiety	0.250**	0.381***	0.160	0.322*	0.499***
H2. Social message overload → Anxiety	0.250**	0.171	0.357***	0.219	0.067
H3. Social support overload → Anxiety	0.047	0.041	0.102	0.140	-0.078
H4. Perceived surveillance → Anxiety	0.282***	0.317***	0.275***	0.219*	0.305***
H5. Services usage cost → Anxiety	0.059	0.077	0.107	0.017	0.011

Note: *, ** and *** indicate significant at $p < 0.05$, 0.01, and 0.001, respectively.

5. Discussions

The statistical results suggest that SoLoMo services stress does exist in modern ICT environment. The research model indicates that approximately 51.9% of the variances in anxiety (strain) can be explained by proposed stressors. The most influential stressor of anxiety in overall sample is information overload. The next influential stressors are perceived surveillance and social message overload. Contrary to expectations, we were unable to detect the significant impacts of social support overload and services usage cost on users' anxiety.

The information overload has a significant impact on anxiety. Because users' cognitive processing capacity is limited. If a large amount of information and irrelevant advertisements are delivered to mobile devices on the small screens, users would have to make more effort to identify what they need and deal with many interruptions of irrelevant advertisements. Thus, the processing ability of users may be exhausted and then lead to anxiety of users.

The emergence of perceived surveillance as a strong stressor of anxiety implies a worried truth that users believe they would be surveilled at anytime and anyplace; namely, someone may be always monitoring on them. SoLoMo services provide powerful surveillance means so as to allow others to track users possible; any activities can be collected stealthily via SoLoMo services. Although collecting data can be applied for providing better and intelligent services, collecting users' activities without permission may cause their concerns about why services know about users' needs exactly, where providers get users' private information, and how much private information was already collected stealthily; and thus it would evoke users' anxiety.

Similarly, the positive relationship between social message overload and anxiety indicates that users actually receive too much social message. In the social communication field, the number of messages do exceed the communicative and cooperative capacity of users and whereby induce users social message overload. Too many irrelevant notifications from connected friends such as game invitations, life news sharing, group chat messages would put heavy burdens on users. The more connected friends, the more social messages may be posted. While the social message volume exceeds the communicative and cooperative capacity that users can bear, the feeling of anxiety would be induced.

However, there is a lack of support for the significant effect of social support overload on anxiety. The possible reason is that most of social support requests might be public in forums or group chats. When users see such a request, they might feel no oppressive obligation to respond it. Thus, on the average, the perception of social support overload is not very high; the mean is 4.106 in Table 4. While the requests are sent as private messages, the specific receivers usually have close relationships with the senders. When users are confronted with such social support requests, they would just do what they can do for their friends and would not have anxious emotion. In addition, psychological and psychosomatic medicine research indicated that giving social support to friends would be beneficial for evoking happiness and reinforcing caregiving behavior [Brown et al., 2003; Inagaki et al., 2012]. Even if users feel social support overload, they may consider that giving social support to friends are beneficial for mental and physical well-being. That is, users giving social support may receive positive emotion feedback. Therefore, social support overload does not have a significant impact on anxiety.

Services usage cost is not a significant stressor of anxiety. The mean 4.442 of services usage cost is relatively high in Table 4. It indicates that users do perceive high financial cost including acquiring proper devices for new functions, subscription fees of high-speed internet connection, and various charges of value-added services from service providers. However, such high cost is deemed as necessary for achieving ubiquitous and convenient SoLoMo services. Thus, services usage cost would not cause users' anxiety significantly.

We also tried alternative models. One possible model is to combine information overload and social message overload into one variable since both are related to message overload and may potentially overlap. First, we combined the items of information overload and social message overload into a single factor, the results indicated poor factor loadings of certain items (IO1, IO2 and SMO3 were lower than acceptable level 0.7). Then, we formulated information overload and social message overload as a second-order factor, the results indicated a satisfactory fitness of measurement model (GFI = 0.946, AGFI = 0.927, CFI = 0.975, RMSEA = 0.043). Its structural model depicted that the second-order factor ($\beta = 0.730$, $p < 0.001$) and perceived surveillance ($\beta = 0.188$, $p < 0.001$) had significant impacts on anxiety. The second-order factor model revealed similar results of original research model. However, we did not adopt this parsimonious model because we think information overload and social message overload are two different constructs, the simplifying model would lose some interesting findings as discussed below.

Table 7 provides a further understanding of SoLoMo services users with distinct purposes. These findings indicate that distinct purposes users have different weighting and influential stressors. That is, different purposes of people have different focuses on SoLoMo services. Once if their purposed goals are hindered or possibly endangered, they would become anxious. Information acquiring users are looking for information and knowledge. Thus, they would feel anxious because information overload may not allow them to process information effectively and efficiently. Meanwhile, they are also worried about the possibility of being surveilled. Social interaction users apply SoLoMo services mainly for social intercourse. Thus, they would feel anxious because social message overload may not allow them to communicate important persons properly. However, although they do have the perception of being surveilled (the mean of this group is still high as 4.511), they may not care possibly because they think that their daily whereabouts and even mood conditions are already known to their families and lots of friends. Thus, the surveillance feeling would not cause them anxious.

Table 8 reveals the differences for other classifications of users. First, these results indicate that different job users also have different influential stressors and focuses on SoLoMo services. Both students and non-students feel information overload and perceived surveillance as significant stressors. However, it is interesting to find that students feel anxious owing to social message overload but the non-students do not. It can be conjectured that non-students need to engage in a lot of social interaction with familiar/unfamiliar people for meeting job requirements, and thus they would tolerate high social message overload without anxiety.

From Table 8, we also found another interesting phenomenon: different apps would give users different stressors. LINE users are worried about social message overload; Facebook users are worried about information overload. People most frequently using LINE would feel that there are too many messages and push notifications from others, especially if they participate in many "groups". In addition, while using LINE, sent messages would be tagged as "read" so that users could realize their messages were read by others. Users may become stressful for social messages because "reading without responding" might be treated as an impolite behavior. Further, photo and video messages in LINE will be deleted automatically after a period of time. Neither is a useful searching mechanism provided in LINE. Thus, too heavy social message overloading would induce users' anxiety. On other hand, the platform of Facebook is original designed for sharing users' self-status and help others know about users. Users would not know who read their posted messages unless others respond to the messages actively. Meanwhile, all of the messages on Facebook are preserved almost forever. Many users are also accustomed to post long texts with rich media on Facebook. Consequently, a huge mass of information would be accumulated on Facebook. Further, the search function of Facebook is not working well for helping find the information precisely. Thus, the information overload might become the main stressor for Facebook users.

Since there are the above interesting findings about the different groups in the post-hoc analyses, we also tried to test another alternative model by inserting "purpose", "job", "frequently used app" as three moderating variables. However, all of the chi-square differences ($\Delta\chi^2$) between models were insignificant[1]. The results suggested us to keep the original model.

6. Conclusions and implications
6.1. Conclusions
By synthesizing information, social relationships and mobile devices, SoLoMo services can provide more real-time, suitable and convenient services for satisfying users' immediate needs at anytime and anyplace. However, the

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[1] For instance, in terms of moderator "purpose", in the unconstrained model, the chi-square and degree of freedom were 668.348 and 408; in the constrained model, the path of information overload → anxiety was constrained to be equal in all groups (χ^2 = 669.769, degree of freedom = 410). The chi-square difference, $\Delta\chi^2(2) = 1.421$, indicated no significant ($p > 0.05$) difference between the two models.

integrated nature of SoLoMo services may lead to unintended consequence such as technostress. The primary goals of this research are to identify possible technostress stressors and understand their impacts on anxiety underlying the context of SoLoMo services in daily life. Based on the literature and considering the features of SoLoMo services, we propose the concept of SoLoMo services stress and identify five stressors including information overload, social message overload, social support overload, perceived surveillance and services usage cost. The empirical results reveal that information overload, social message overload, and perceived surveillance have significant impacts on SoLoMo services users' anxiety.

6.2.   Academic implications

The academic contributions of this research are as follows. First, past technostress research is mostly conducted in the organizational ICT context and the suggested stressors are suitable for understanding organizational employees. Besides, the modern ICTs are very different from the earlier ICTs. There was a lack of understanding for individual technostress of modern ICTs in the daily usage context. Accordingly, we propose the SoLoMo services stress, which is a technostress underlying the specific context of daily SoLoMo services usage, and identify the possible stressors. To the best of our knowledge, this research area has not been deeply explored. Second, this study conceptually explains and empirically validates the relationships between stressors and anxiety. We further implement a post hoc analysis to understand the differences of various groups of users and depict several interesting findings. The most important stressor of information acquiring users is information overload. For social interaction users, the most influential stressor is social message overload. Non-student users would not be worried about social message overload, but students would. LINE users are worried about social message overload; Facebook users are worried about information overload. Such findings would provide a basis to future research for investigating users who have different features in the SoLoMo service context. These research findings could extend our understanding of the effects of users' features on influential stressors of anxiety.

6.3.   Practical implications

The findings of this research also provide several insights for SoLoMo services providers. First, information overload is observed to be the most influential stressor of anxiety. We suggest that SoLoMo services providers should intelligently figure out what information is their users actually need and minimize the number of irrelevant advertisement to lower efforts paid by users. By doing this, it would help users to get required information as soon as possible and then may reduce the influence of information overload. Second, the results reveal that perceived surveillance is the second significant stressor for evoking users' feeling of anxiety. SoLoMo services providers, especially information acquisition providers, should be received such warning. Users should be respected for their privacy. It is advised that providers should only collect the user information that is necessary for services, obtain the explicit consent of customers, and also allow users opt-out their private data as they wish. Users should know how their personal data would be used, what results may be emerged, what benefits would be fed back to them, and should be relieved from the sense of surveillance. Third, for preventing social message overload, it is suggested that SoLoMo services providers may modify their filtering algorithms to allow the information of intimate friends more likely to be received by users and decrease the exposure rate of information from strangers. Another way is to provide efficient means to assist users to manage their virtual friendships. By doing this, the irrelevant social messages may not bother users intensively and thereby may decrease the social message overload. Finally, the cluster analysis results indicate that different groups of users have different crucial stressors of anxiety. Thus, SoLoMo services providers should try to understand their features and provide differentiated services for various users.

6.4.   Future research

There are several suggestions for future research. First, our data is collected in Taiwan. Further research is encouraged to be conducted in other regions. Second, although this study has identified several important stressors of anxiety, future research may attempt to explore others. Third, though our research indicates several path differences for groups of different usage purposes, the number of respondents is relatively limited. Future research may try to collect a large sample to verify our results. Fourth, our results indicate three stressors information overload, social message overload and perceived surveillance lead to users' anxiety. We suggest future research may attempt to explore how to inhibit these stressors' effects on anxiety. Fifth, most of the respondents are less than the age 30, the results may not be generalizable across age groups. Future research might try to explore the stressors of the elder people.

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Appendix 1: Items and standardized factor loading

Items	Content: **While using SoLoMo services at any time and any place, please answer the following:**	Loading
IO1	There is too much information on SoLoMo services so that I am burdened in handling it.	0.817
IO2	Because of the plenty information on SoLoMo services, I feel difficult in acquiring all of this information.	0.783
SMO1	I am overextended from the social messages, notifications and announcements from SoLoMo services.	0.799
SMO2	The amount of trivial messages from friends via SoLoMo services is too high.	0.824
SMO3	I often forget to respond to messages, notifications and announcements on SoLoMo services.	0.701
SSO1	I take too much care of my friends' well-being on SoLoMo services.	0.750
SSO2	I deal too much with my friends' problems on SoLoMo services.	0.775
SSO3	I am often too concerned for my friends on SoLoMo services.	0.710
PS1	Because SoLoMo services deeply understand my needs and timely provide services at any place, it seems that others can continue watching me.	0.872
PS2	Sometimes, I believe my life details (the details of interpersonal communications, consumer behaviors and other activities) are being monitored by others through SoLoMo services.	0.871
PS3	It seems that SoLoMo services can read my mind, as someone is continually watching my activities.	0.831
PS4	SoLoMo services may trace my locations so that others can easily monitor me.	0.789
SC1	I think that the fee for using the mobile internet is a burden to me.	0.737
SC2	I think the fee of buying value-added services (e.g., purchasing new stickers in LINE) is a burden to me.	0.774
SC3	It is expensive to buy new mobile devices for using full functions (e.g., NFC, 4G, and distinguishing fingerprint) of SoLoMo services.	0.714
SC4	I think that using SoLoMo services is expensive in overall.	0.905
AN1	I feel apprehensive about using SoLoMo services.	0.794
AN2	SoLoMo services are somewhat intimidating to me	0.837
AN3	I feel tired about using SoLoMo services.	0.809