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Information and communication technology overload and social networking service fatigue: A stress perspective

Ae Ri Lee [a], Soo-Min Son [b], Kyung Kyu Kim [b, *]

[a] Barun ICT Research Center, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Republic of Korea
[b] Graduate School of Information, Yonsei University, 50 Yonsei-ro, Seodaemun-gu, Seoul 120-749, Republic of Korea

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ABSTRACT

In an always connected communication environment, users of social networking services (SNSs) need to pay continuous attention to the overwhelming volume of social demands from SNSs. These increased energy requirements may cause SNS fatigue, which can lead to physical and psychological strain. Using the transactional theory of stress and coping as the overarching theory, this study regards overload (i.e., stressors) as a core determinant of SNS fatigue (i.e., strain) and identifies three dimensions of overload – information overload, communication overload, and system feature overload. It also includes SNS characteristics as the antecedents of overload.

The data used in this study were collected from 201 individuals through online and offline surveys. Our results show that all three dimensions of overload were significant stressors that influence SNS fatigue. Regarding the predictors of overload, the characteristics of the SNS system significantly influenced the features of system overload, while information equivocality positively influences information overload. However, information relevance was not a significant predictor of information overload and information equivocality was not a significant predictor of communication overload.

1. Introduction

Much has been written about the value of social networking services (SNSs) in the academic literature. Indeed, SNSs provide a new channel for self-expression and connectivity (Jang, Lee, & Kim, 2013; Takahashi, 2010) and promote resilience that helps people successfully adapt to changes (Collin, Rahilly, Richardson, & Third, et al., 2011). Further, SNS users can enhance their social capital such as civic and political participation, social trust, reciprocal relationships, and life satisfaction (Valenzuela, Park, & Kee, 2009). Also, SNSs can provide users with the benefits of psychological wellbeing including improvement in self-esteem and quality of life (Ellison, Steinfield, & Lampe, 2007). Inspired by these values, SNSs have become deeply embedded in our daily lives (Boyd, 2008).

However, there can be unintended consequences from SNS overuse that might not always be apparent. One important consequence is SNS fatigue, which refers to a subjective and self-evaluated feeling of tiredness from SNS usage. The widespread use of SNS produces a perpetual obsession and creates expectations that people are obligated to respond to others' postings in a timely fashion (Hind, 1998). To meet these expectations, people need to pay continuous attention to their SNSs and are exposed to an overwhelming volume of social demands. These increased energy requirements cause SNS fatigue, which can lead to physical and psychological strain. A survey by Gartner Inc. (2011) demonstrated that 31% of survey respondents got tired from SNS and 24% had reduced their SNS usage due to fatigue.

Although SNS fatigue is obviously an important issue, scant studies have systematically investigated SNS fatigue. Among the few studies that have been performed on SNS fatigue, Ravindran, Kuan, Chua, and HoeLian (2014) investigated antecedents (e.g., social dynamics, immersion, content, and platform related factors) and consequences of SNS fatigue (e.g., taking a break, cutting back, or suspending SNS activities). In addition, Coklar and Sahin (2011) analyzed whether the stress level of an SNS user is related to mental fatigue and physical symptoms. While these trailblazing studies have made preliminary steps to better understand SNS fatigue, their focus was mainly on the direct impact of social (e.g., social dynamics, power struggles) and/or technological aspects of SNS (e.g., platform characteristics, technology environment) on SNS

* Corresponding author.
E-mail addresses: arlee12@naver.com (A.R. Lee), soomin4496@gmail.com (S.-M. Son), kyu.kim@yonsei.ac.kr (K.K. Kim).

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fatigue, but not on the impact of internal psychological processes causing the fatigue.

Considering that fatigue is a subjective, self-evaluated feeling of tiredness and an outcome of stress, it is pertinent to investigate SNS fatigue from a psychological stress perspective. In the current literature, there is a growing consensus that stress is viewed as a transactional process between an individual and her environment (Edwards, 1991; Lazarus, 1990). The person–environment (P–E) fit model asserts that stress results from an imbalance between demands placed by the environment and an individual's perceived ability to cope with the demands (Lazarus & Folkman, 1984). In other words, the misfit between environmental demands and the person's coping abilities causes overload that is considered an important immediate predictor of strain (Ayyagari, Grover, & Purvis, 2011). However, it is not clear in the extant literature what constitutes "overload" in relation to stress from SNS usage. Further, few studies have looked into SNS characteristics that cause various types of overload. Thus, this study attempts to answer the following unanswered questions:

> Research Question 1: What are the dimensions of overload that cause SNS fatigue?
> Research Question 2: What SNS characteristics are related to each dimension of overload?

In examining these research questions, this study uses the P–E fit model and the transactional theory of stress and coping (Lazarus, 1966) as reference theories. Our theories view stressors and strain as the core components of the stress process: stressors are environmental demands, and strain is an individual's behavioral and psychological response to the stressors (Cooper, Dewe, & O'Driscoll, 2001). SNS fatigue is a form of strain as an outcome of the stress process (Ragu-Nathan, Tarafdar, Ragu-Nathan, & Tu, 2008). Further, this study identifies three overload factors as stressors: information overload, communication overload, and system feature overload. It also describes which SNS characteristics are antecedents of the overload.

2. Theoretical background

2.1. Person–environment fit model of stress

The P–E fit model provides a framework of stress and has been widely referenced in stress research (Edwards, 1991; Edwards & Cooper, 1990). The P–E fit model asserts that when the equilibrium relationship between an individual and her surrounding environment is broken, it can generate stress and lead to strain (Cooper et al. 2001). The misfit between the person and the environment is based on subjective evaluation. Individuals assess whether demands required by the environment exceed their resources or abilities (Kristof-Brown, Zimmerman, & Johnson, 2005; Lazarus, 1991). Also, when supply attributes provided by the environment are not in accord with individual's interest, values, or preferences, P–E misfit can occur (Edwards, 1996; French, Caplan, & Van Harrison, 1982). In SNS, a gap between a user's abilities and the demands from the SNS environment can exist. The proliferation of information and communication technologies (ICT) has engaged people in a heavy use of SNS in daily life. ICT provides convenience to people and business innovation, but too much use and steep evolution of ICT can put people under stress.

Given the lack of literature on SNS fatigue, existing studies on stress in the context of general ICT can be used as references. These studies have investigated the concept of "technostress" (Sahin & Coklar, 2009; Tarafdar, Tu, Ragu-Nathan, & Ragu-Nathan, 2007). Technostress refers to "stress experienced by individuals due to the use of ICT" (Ragu-Nathan et al., 2008, p. 418). When ICT offers too complicated and diverse functions, changes rapidly, has a steep learning curve, and/or enables complex multitasking, it can cause a misfit between the person and the ICT environment, thereby leading to an increase in stress (Ragu-Nathan et al., 2008). For example, Ayyagari et al. (2011), in a study on technostress, claimed that an individual's perceived gaps between personal abilities and ICT attributes (or demand placed by ICT) are important causes of stress in a work setting. The P–E fit model of stress has been applied primarily in an organizational work environment so far (Edwards & Cooper, 1990; Eulberg, Weekley, & Bhagat, 1988; Heo & Cheon, 2009). The study herein applies the P–E fit model of stress to the SNS environment.

2.2. Transactional theory of stress and coping: stressors and strain

Scholars in social psychology have adopted the transactional theory of stress and coping (TTSC) to understand the causal relationships between stress factors and outcomes in the context of organizational and occupational environments (Barley, Meyerson, & Grodal, 2011; Cooper et al., 2001; Kahn & Byosiere, 1992; Sparks, Faragher, & Cooper, 2001). TTSC incorporates the concepts of P–E fit as the underlying theory (Edwards & Cooper, 1990). For example, McGrath (1976), in a study on the transaction-based approach of stress, explained the term "under stress" as "a state experienced by an individual when there is an environmental situation that is perceived as presenting a demand which threatens to exceed the person's capabilities and resources for meeting it" (p. 1351).

The transaction-based approach explains the phenomenon of stress as a combinative interaction (or transaction) of "a stimulating condition" and "the individual's response to it" (Ragu-Nathan et al., 2008, p. 419). That is, *stress* is a transactional process in which *stressors* are the stimuli that encounter an individual and *strain* is the individual's response to the stressors (Cooper et al., 2001). *Stressors* are demands, conditions, events, or situations in the environment that can generate stress (Ragu-Nathan et al., 2008). Extant studies on technostress of an ICT workforce identify overload (work overload) as a representative stressor (Karr-Wisniewski & Lu, 2010). Overload is a situation where ICT forces people to work much faster and longer than their capabilities and arouses increased demands on individuals who use ICT (Moore, 2000). Meanwhile, *strain* can be considered a negative outcome of stress. In SNS, strain can take the form of exhaustion, discomfort, dissatisfaction, and unfriendly attitudes toward ICT use (Fuglseth & Sorebo, 2014; Salanova, Llorens, & Cifre, 2013). This study adopts TTSC as the overarching theory to understand SNS fatigue.

2.3. Overload in SNSs

According to previous studies on excessive technology use, overload is a core factor that results in negative consequences from the use of ICT (Ahuja, Chudoba, Kacmar, McKnight, & George, 2007; Moore, 2000). Misra and Stokols (2011) noted that advanced ICT tends to burden people behaviorally and psychologically. Specifically, Karr-Wisniewski and Lu (2010) explained that "technology use, once exceeding the optimum level, can actually incur negative outcomes (a curvilinear relationship)" (p. 1062). The proliferation of Internet and SNS introduces new types of overload, including too much information, involuntary extensions of social networking, and rapid changes in technological features of SNS. In SNS, the energy requirements necessary to deal with these overloads can be associated with fatigue (Ravindran et al., 2014).

Meanwhile, the meaning of overload can be different depending on the research context. Karr-Wisniewski and Lu (2010), in a study of the ICT-productivity paradox, proposed a comprehensive definition of "technology overload" that has three components: information, communication, and system features. Information overload occurs when people are exposed to more information than they can accommodate in their capacity for information processing (Eppler & Mengis, 2004; Farhoomand & Drury, 2002). Communication overload refers to a state when communication demands from ICT channels such as SNS (e.g., emails, instant messaging, and news feeds) exceed users' communication capacities (Cho, Ramgolam, Schaefer, & Sandlin, 2011). System feature overload can occur when "the given technology is too complex for a given task" or "the addition of new features is outweighed by the impact on technical resources and the complexity of use" (Karr-Wisniewski & Lu, 2010, p. 1062). In SNS, various types of overload can occur, leading to negative consequences from SNS usage (e.g., SNS fatigue). This study adopts these three dimensions of technology overload and applies them to the context of SNS.

2.4. SNS fatigue

Studies on fatigue have been conducted in various disciplines such as psychology, health science, medicine, and occupational domains (Chandler, Newsom, Sumners, & Crews, 1993; Cho & Tsay, 2004; Hart, Freel, & Milde, 1990; Yu, Lee, & Man, 2010). Fatigue is a complex concept and scholars have defined it in different ways. For example, Hart et al. (1990) defined it as a subjective feeling of discomfort, decreased motivation, and increased physical lassitude. Piper, Lindsey, and Dodd (1987) defined fatigue as "a subjective, unpleasant feeling of tiredness that has multiple dimensions" (Piper et al., 1987, p. 19). Other studies have viewed fatigue as a self-evaluated feeling of exhaustion that is induced by compositive interactions of physical and psychological factors (Potempa, Lopez, Reid, & Lawson, 1986; Yu et al., 2010). Fatigue is an individual's feeling based on subjective experiences in nature (Hardy, Shapiro, & Borrill, 1997; Yu et al., 2010). Thus, the intensity of fatigue individuals experience in the same situation could vary from a mild feeling of tiredness to a state of exhaustion (Ravindran et al., 2014). For example, an SNS user might have difficulties in managing a certain level of communication loads with other SNS members and feel fatigued, while another user may efficiently deal with the same level of communication loads. By referring to the previous studies on fatigue, this study defines SNS fatigue as a subjective and self-evaluated feeling of tiredness from SNS usage. As a consequence of SNS fatigue, it can impact SNS usage in negative ways such as breaks in SNS activities or withdrawal from stress-causing environments (Ravindran et al., 2014; Walker, 1986).

As SNS fatigue is attracting more and more attention, several studies have recently investigated the determinants and consequences of SNS fatigue. For example, Ravindran, Chua, and Hoe-Lian (2013), Ravindran et al. (2014) examined factors such as social dynamics and effects of SNS fatigue using qualitative research methods. Also, Cherubini, Gutierrez, De Oliveira, and Oliver (2010) argued that SNS users may be overloaded by overwhelming content and constantly changing feeds, thereby needing an effective solution to reduce fatigue. Coklar and Sahin (2011) investigated the stress level of SNS users. Most recently, Yao, Phang, and Ling (2015) examined the influence of trend-seeking tendencies and SNS fatigue on an intention to switch from one SNS to another. However, these studies primarily investigated the effects of external factors surrounding SNS users, not the internal aspects of human psychology. Considering that stress is a transactional process between an individual and her environment, studies are needed that incorporate theoretical frameworks of internal psychological processes. Thus, this study attempted to investigate SNS fatigue using TTSC.

3. Research model and hypothesis development

Based on the stress perspectives of the P–E fit model and TTSC, we built a research model comprising three sets of constructs: (1) SNS characteristics as antecedents of overload, which can cause the P–E misfit; (2) overload as stressors; and (3) SNS fatigue as a strain, which is an outcome of the stress process.

3.1. SNS characteristics and overload in SNSs

Referring to previous studies on technostress and overload (Edmunds & Morris, 2000; LaRose, Connolly, Lee, Li, & Hales, 2014; Pennington & Tuttle, 2007), this study identifies SNS characteristics as precursors that can cause overload from SNS. We considered information characteristics and system characteristics as specific dimensions of SNS that may cause a P–E misfit and lead to overload from SNS.

In SNSs, there are diverse types of information. For example, there is information about personal lives, news, expertise, gossip, and events. Users are expected to pay attention to such information, regardless of their interest, when connecting via SNSs. When SNS users are impeded by too much information and it exceeds a user's information processing capacity, information overload is likely to occur (Cherubini et al., 2010; Edmunds & Morris, 2000; Pennington & Tuttle, 2007). Two of the many dimensions of information, relevance and equivocality, have received much attention in the literature. First, when a user receives information that is relevant to their interests, chances of experiencing overload is low (Ayyagari et al., 2011). That is, users don't have to deal with content that is irrelevant to their interests, unimportant, or petty. If a user is exposed to irrelevant information frequently, she may experience at least one of two distinct types of P–E misfit: (1) misfit between environmental supplies and personal motives, goals, and values; and (2) misfit between environmental demands and personal skills and abilities (Edwards & Cooper, 1990). Thus, the higher the information relevance, the less P–E misfit and hence the lower levels of information overload a user may experience from SNS usage (Edwards, 1996; French et al., 1982). Second, information equivocality means the extent to which information has several meanings and can be interpreted in various ways (Huber & Daft, 1987). When the meaning of a posted message in SNS is highly equivocal, users need to exchange more information to clarify the meaning of the message. Hence, it is expected that the more frequently equivocal messages are seen, the higher are the chances of experiencing information overload. Accordingly, we propose the following hypotheses:

Hypothesis 1a. Information relevance negatively influences information overload from SNS.

Hypothesis 1b. Information equivocality positively influences information overload from SNS.

In SNSs, multiple channels of electronic communication with online friends and followers generate a large amount of shared information (LaRose et al., 2014). When users encounter equivocal messages and content from SNS members, they will make every effort to resolve the equivocality through exchanging each individual's views and deducing the correct interpretation of the information (Lampe, Ellison, Vitak, Wohn, & Wash, 2010; Lampe, Wohn, Vitak, Ellison, & Wash, 2011). Thus, high information equivocality may require more communication among SNS users and it may cause an imbalance between communication demands from SNS and a user's communication capacities. This situation can lead to communication overload in an always-connected communication environment (Rainie, Smith, & Duggan, 2013; Richtel, 2010). Hence, we propose the following hypothesis:

Hypothesis 2. Information equivocality positively influences communication overload from SNS.

Changes and the introduction of new technical features in SNSs have been made frequently to improve services by SNS providers. Ayyagari et al. (2011) noted that ICT characteristics such as the system's complexity and system's pace of change can influence stress caused by the ICT. System complexity is the degree of effort required to use the technology, while system pace of change refers to the extent to which a user perceives the frequency of changes to be high in her ICT environment. Changes in the functions of the SNS system may require adaptation and efforts to learn the new functions, and these changes can lead to various degrees of stress to the user. In addition, the pace of change of the system can cause system feature overload for users, creating strain in SNS usage (Coklar & Sahin, 2011). Meanwhile, system complexity resulting from many features may increase the burden of learning how to use them and may make users feel frustrated (Ayyagari, 2012). Hence, the pace of system change and system complexity can lead to system feature overload in SNS.

Hypothesis 3a. System pace of change positively influences system feature overload from SNS.

Hypothesis 3b. System complexity positively influences system feature overload from SNS.

3.2. Overload and SNS fatigue

As for the types of overload affecting SNS fatigue, this study adopts the model developed by Karr-Wisniewski and Lu (2010) that includes three dimensions of technology overload. First, information overload can lead to dysfunctional consequences such as stress as well as distract users from other important activities in their daily lives (Eppler & Mengis, 2004; Meyer, 1998). These negative consequences become inflated because the speed of producing and diffusing information has been growing enormously with the development of ICT (Evaristo, Adams, & Curley, 1995; Hiltz & Turoff, 1985). Specifically, the pace of information proliferation in SNS accelerates as the number of SNS users increases exponentially. Too much information in an SNS could quickly drive SNS users to cognitive limits in processing information and make them feel overwhelmed (Karr-Wisniewski & Lu, 2010). In summary, an explosion of digital information can lead to information overload, which negatively affects human behavior, feelings, and health (Jackson, Zhao, KolenicFitzgerald, Harold, & Von Eye, 2008; Stokols, Misra, Runnerstrom, & Hipp, 2009; Stokols & Montero, 2002). Thus, we generated the following hypothesis:

Hypothesis 4. Information overload positively influences SNS fatigue.

Communication overload may interrupt users' daily tasks (Cho et al., 2011; McFarlane & Latorella, 2002). Frequent interruptions make it hard to concentrate and could force people to discontinue their activities at hand (McFarlane, 1997; O'Conaill & Frohlich, 1995). Such interruptions can negatively influence work productivity in terms of accuracy, efficiency, and performance (McFarlane & Latorella, 2002; Van Bergen, 1968). Furthermore, communication overload can make users feel fatigued, leading to more serious mental or physical diseases (Deutsch, 1961; Klapp, 1986). For example, when SNS users have to deal with unwanted human networks and/or too much communication from SNSs while performing primary tasks, users can get overwhelmed because they cannot effectively deal with the situation, and thereby get fatigued from SNS usage. If the situation persists, users' stress levels as well as their risk for certain diseases (e.g., hypertension) can increase. Thus, we propose the following hypothesis:

Hypothesis 5. Communication overload positively influences SNS fatigue.

System feature overload in SNS occurs when demands for using the SNS system features exceed the users' capabilities to handle them (Karr-Wisniewski & Lu, 2010; Thompson, Hamilton, & Rust, 2005). According to the cognitive load theory, human cognitive overload arises when the amount of an individual's cognitive resources required to complete a task exceed the amount of resources that are retained in cognitive structures (Sweller, 1988). In SNS, system features can influence SNS usage positively up to a certain point. However, if there are frequent changes in system features and functions are highly complex for users, system feature overload could arise and lead to negative consequences including SNS fatigue. When SNS users perceive the costs of learning and using the system's features to outweigh the benefits of them, they may get tired of SNS usage and feel fatigue. Hence, we propose the following hypothesis.

Hypothesis 6. System feature overload positively influences SNS fatigue.

In addition to the main research variables described above, we included demographic variables – gender, age, and SNS usage duration – as covariates. Fig. 1 presents the research model.

4. Research methods

4.1. Measurement development

To evaluate our research model, we developed a measurement instrument and then conducted a survey. In developing the instrument, we adapted existing scales validated in previous studies to the context of this study. Existing instruments were developed mainly in the context of general websites or organizational environments utilizing ICT. SNSs in this study have distinct characteristics from these environments in that they are basically friends' networks and not primarily work-related. Thus, SNS contexts were made explicit in our instrument and questions were rephrased to suit the SNS context. All items were measured on a 7-point Likert scale.

Regarding the measurement of specific variables, information relevance was operationalized as the extent to which information in an SNS is helpful and applicable to an SNS user (Yi & Jiang, 2007) and the measurement items were adapted from McKinney, Yoon, and Zahedi (2002). Information equivocality was operationalized as the extent to which information in an SNS can be interpreted in various ways (Huber & Daft, 1987) and the measurement items were adapted from Daft and Macintosh (1981). System pace of change was measured as the frequency of change in the technological environment in SNSs, and system complexity was measured as the degree of user's efforts required to use the technology in SNSs (Ayyagari et al., 2011).

Information overload was operationalized as the extent to which users are exposed to more information than their information processing capacities in SNSs, while communication overload was measured as the extent to which excessive communication in SNSs interrupts the users' primary tasks. System feature overload was operationalized as the extent to which efforts required to use system features in SNSs outweigh any benefits of them (Karr-Wisniewski & Lu, 2010). The items for information overload and system feature overload were adapted from Karr-Wisniewski and

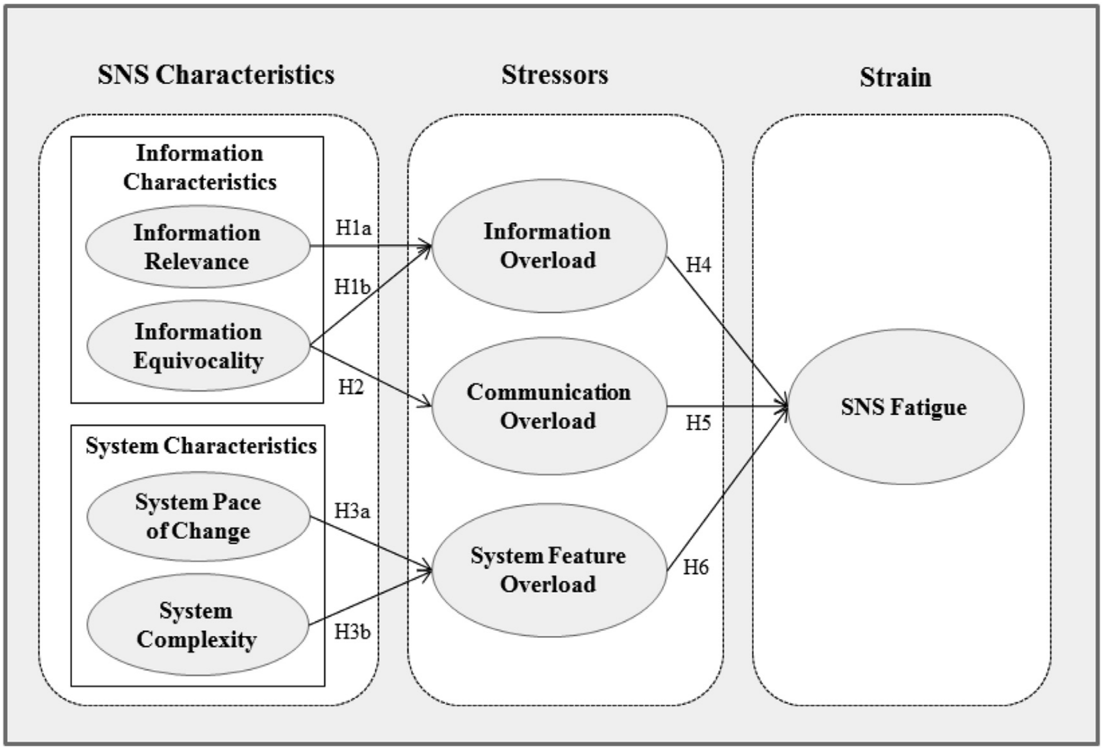

Fig. 1. Research model.

Lu (2010), while the items for communication overload were adapted from Cho et al. (2011). SNS fatigue was operationalized as the degree of user's subjective and self-evaluated feelings of tiredness from SNS usage (Hart et al., 1990; Van Yperen & Hagedoorn, 2003) and the measurement items were adapted from Karasek (1979) and Van Yperen and Hagedoorn (2003).

To confirm the face validity of the measurement items, we performed a pilot test using 68 graduate students at a major Korean university who regularly used SNSs. These students were not part of the final sample. As a result of the pilot test, some questions were modified to be clearer. Our measurement items and their sources are presented in Table 1.

4.2. Study sample and data collection

The data used in this study were collected from a major university in South Korea where there are noticeable characteristics in the usage of Internet and SNSs. The penetration rate of broadband Internet in South Korea amounts to 100.6%, which is much higher than the OECD's average of 54.3% (CNET., 2012). It is the only country in the world where the entire population has access to 4G mobile network (Bock, Field, Zwillenberg, & Rogers, 2015). Further, more than 73 percent of the population owns a smartphone (Bock et al., 2015) and average daily time spent on SNSs amounts to 72.8 min, which is longer than in the U.S. (KISDI, 2013). These characteristics of South Korea provide an interesting research context for this study.

Online and offline surveys were conducted in parallel during a 3-day period in November 2014. We used both online and offline survey methods in order to capitalize on the strengths of each method. Online survey has strengths such as reachability to the target audience and transcendence of location and time, while offline survey has strengths such as more control over respondents' survey environments (e.g., helping respondents understand questions correctly). Then, we conducted the two-sample Kolmogorov–Smirnov (K–S) test to check whether the two samples come from the same distribution.

A total of 250 survey responses were received. After eliminating outliers and incomplete responses, 201 responses were selected for the final sample. The results of two sample K–S test show that both samples came from the same population. Thus, we combined the two samples into one. Table 2 shows the profile of the final sample.

5. Data analysis and results

The proposed model was tested using structural equation modeling (SEM) supported by Partial Least Squares (PLS), SmartPLS v.3.2.0. PLS allows a simultaneous test of the psychometric properties of each measurement scale (measurement model) and the analysis of the strength and direction of relationships among constructs (structural model) (Chin, Marcolin, & Newsted, 1996; Pee, Kankanhalli, & Kim, 2010). PLS is also suitable during the early stage of theory development and enables the modeling of latent variables, even for small-to-medium size samples (Chin, 1998; Yoo & Alavi, 2001).

5.1. Instrument validation

The measurement items were drawn from multiple sources and adapted to this research context, and thus we conducted a two-step approach for factor analysis (Anderson & Gerbing, 1988). We first performed an exploratory factor analysis (EFA) using VARIMAX rotation in SPSS 21. EFA has been used to check the quality of measurement instrument when the reference sources are multiple and the instrument has new combinations (Steelman,

Table 1
Measurement of the variables.

Variables	Items		Sources
Information relevance (IFR)	IFR1	Information in SNSs is applicable to me	(McKinney et al., 2002)
	IFR2	Information in SNSs is related to my interest	
	IFR3	Information in SNSs is pertinent to me	
	IFR4	In general, information in SNSs is relevant to me	
Information equivocality (EQV)	EQV1	Information in SNSs can be interpreted in several ways	(Daft & Macintosh, 1981)
	EQV2	In spite of having the same content, information in SNSs can have more than one morph (or form)	
	EQV3	Information in SNSs can mean different things to different people	
System pace of change (POC)	POC1	I feel that there are frequent changes in the features of SNSs	(Ayyagari et al., 2011)
	POC2	I feel that system characteristics (e.g., screen composition elements) of SNSs change frequently	
	POC3	I feel that the requirement for technical capabilities for using SNSs change often	
	POC4	I feel that the way to use the SNS changes often	
System complexity (COP)	COP1	The functions of SNSs are not easy to use	(Ayyagari et al., 2011)
	COP2	It is not easy to get the results that I desire when using SNSs	
	COP3	Learning to use SNSs is not easy for me	
Information overload (IFO)	IFO1	I am often distracted by the excessive amount of information in SNSs	(Karr-Wisniewski & Lu, 2010)
	IFO2	I find that I am overwhelmed by the amount of information that I process on a daily basis from SNSs	
	IFO3	I feel some problems with too much information in SNS to synthesize instead of not having enough information	
Communication overload (CO)	CO1	I receive too many messages from friends (or acquaintances) through SNSs	(Cho et al., 2011)
	CO2	I feel like I have to send many more messages to friends through an SNS than I would want to send	
	CO3	I feel that I generally get too many notifications of new postings, push messages, news feeds, etc. from SNSs while performing other tasks	
	CO4	I often feel overloaded with communication from SNSs	
	CO5	I receive more communication messages and news from friends on SNSs than I can process	
System feature overload (SFO)	SFO1	I am often distracted by software features that are included in SNSs but are not necessary	(Karr-Wisniewski & Lu, 2010)
	SFO2	I am often less productive in my daily activities because SNSs have a poor user interface design	
	SFO3	I find that most of the system features in SNSs handle too many tasks poorly instead of too few tasks very well	
	SFO4	Many software applications of SNSs tend to try to be too helpful which makes performing my task even harder	
	SFO5	The system features of SNSs that I use are often more complex than I need	
SNS fatigue (SFG)	SFG1	I find it difficult to relax after continually using SNSs	(Karasek, 1979; Van Yperen & Hagedoorn, 2003)
	SFG2	After a session of using SNSs, I feel really fatigued	
	SFG3	Due to using SNSs, I feel rather exhausted	
	SFG4	After using SNSs, it takes effort to concentrate in my spare time	
	SFG5	During SNS use, I often feel too fatigued to perform other tasks well	

Hammer, & Limayem, 2014). Through EFA, the best item combination can be found to construct main factors (i.e., principal component). Then CFA is used to check the accuracy of item-factor matching and prepare for factor–factor relationship analysis. The EFA results are presented in Table 3. We checked whether the items were loaded on their intended factors and their factor loadings were above 0.50 (Hair, Anderson, Tatham, & Black, 1998). The factor loading values of all items were greater than the cut-off value of 0.50.

Next, we conducted a confirmatory factor analysis (CFA) using PLS. The reliability and convergent validity of the measurement model were evaluated by examining item-construct-loading, composite reliability (CR), Cronbach's alpha, and the average variance extracted (AVE) (Gefen, Straub, & Boudreau, 2000). Table 4 presents the results of the convergent validity tests. All standardized factor loadings were greater than 0.6 (Hess, Fuller, & Campbell, 2009); CR and Cronbach's alpha for all constructs exceeded 0.7, and the AVE for each construct was greater than 0.5; these threshold

Table 2
Sample characteristics.

Category		Frequency	Percent (%)
Gender	Male	119	59.2
	Female	82	40.8
Age (years)	29 or below	186	92.5
	30–39	12	6.0
	Above 40	3	1.5
Survey sample	Online	86	42.8
	Offline	115	57.2
Average daily time spent on SNS usage	Less than 30 min	75	37.3
	30 min–1 h	78	38.8
	1 h–2 h	38	18.9
	2 h–3 h	5	2.5
	More than 3 h	5	2.5
Social networking sites	Facebook	136	67.6
	Instagram	37	18.4
	Kakao Story	16	8.0
	Twitter	8	4.0
	Pinterest	2	1.0
	Tumblr	2	1.0

Table 3
EFA results.

Constructs	Items	Component							
		SFG	SFO	POC	CO	IFR	IFO	EQV	COP
SNS fatigue (SFG)	SFG1	**0.74**	0.12	0.06	0.20	−0.12	0.21	0.06	0.01
	SFG2	**0.84**	0.12	0.01	0.18	−0.03	0.18	0.13	0.09
	SFG3	**0.82**	0.15	0.05	0.10	0.02	0.23	0.10	0.14
	SFG4	**0.82**	0.10	0.17	0.09	0.08	−0.03	−0.03	0.09
	SFG5	**0.80**	0.20	0.05	0.08	−0.07	0.07	0.02	0.06
System feature overload (SFO)	SFO1	0.24	**0.77**	0.00	0.11	−0.09	0.08	0.04	0.15
	SFO2	0.11	**0.82**	0.09	−0.02	−0.03	0.07	0.05	0.09
	SFO3	0.14	**0.62**	0.22	0.00	−0.01	0.10	0.05	0.27
	SFO4	0.09	**0.77**	0.16	0.18	0.03	0.19	−0.05	0.20
	SFO5	0.13	**0.77**	0.07	0.08	−0.05	0.07	0.04	0.27
System pace of change (POC)	POC1	0.04	0.09	**0.85**	0.16	0.04	0.09	0.06	0.12
	POC2	0.08	0.08	**0.85**	0.24	0.05	0.05	−0.01	0.06
	POC3	0.09	0.13	**0.85**	0.19	0.15	0.03	0.12	0.09
	POC4	0.06	0.16	**0.77**	0.04	0.07	0.10	0.11	0.11
Communication overload (CO)	CO1	0.11	0.07	0.23	**0.74**	0.21	0.07	−0.07	0.02
	CO2	0.18	0.05	0.38	**0.50**	0.01	0.01	−0.21	0.15
	CO3	0.17	0.02	0.19	**0.81**	0.14	0.03	−0.04	0.03
	CO4	0.09	0.14	0.06	**0.75**	0.01	0.21	0.11	−0.04
	CO5	0.16	0.05	0.08	**0.74**	0.10	0.13	0.14	0.16
Information relevance (IFR)	IFR1	−0.05	−0.07	0.10	0.07	**0.82**	−0.02	0.04	0.01
	IFR2	−0.02	−0.06	0.01	0.03	**0.87**	0.12	−0.13	−0.01
	IFR3	−0.02	0.03	0.04	0.11	**0.90**	−0.07	−0.10	−0.06
	IFR4	−0.01	−0.02	0.11	0.16	**0.73**	−0.12	0.06	0.04
Information overload (IFO)	IFO1	0.19	0.10	0.14	0.17	−0.13	**0.84**	0.08	−0.01
	IFO2	0.18	0.10	0.08	0.15	−0.03	**0.89**	0.04	0.03
	IFO3	0.16	0.19	0.05	0.08	0.03	**0.80**	−0.01	0.04
Information equivocality (EQV)	EQV1	0.13	0.07	0.00	0.05	−0.02	0.00	**0.83**	0.02
	EQV2	0.03	0.11	0.08	−0.01	−0.08	0.03	**0.86**	−0.03
	EQV3	0.04	−0.08	0.12	0.01	−0.01	0.07	**0.84**	0.11
System complexity (COP)	COP1	0.13	0.26	0.22	0.07	−0.01	0.07	0.01	**0.81**
	COP2	0.10	0.37	0.07	0.07	−0.06	0.00	0.06	**0.77**
	COP3	0.13	0.35	0.14	0.08	0.05	−0.01	0.07	**0.82**
Eigenvalue		7.99	3.76	2.82	2.36	2.03	1.77	1.49	1.07
% of variance		24.95	11.76	8.80	7.38	6.34	5.54	4.67	3.34
Cumulative %		24.95	36.71	45.51	52.89	59.23	64.77	69.44	72.78

The bold face shows the loading of the measurement items on the constructs to which they are assigned.

values have been recommended previously for these tests (Gefen et al., 2000). Because all conditions were met, the convergent validity of our measurement instrument was established.

The discriminant validity of the measurement model was assessed by comparing the squared root of the AVE for each construct to the inter-construct correlations (Fornell & Larcker, 1981). As shown in Table 5, the squared root of the AVE for each construct was larger than all the related inter-construct correlations, and thus the discriminant validity of all scales was established. Furthermore, to assess possible concerns of multicollinearity among constructs, the variance inflation factor (VIF) scores were examined. The resultant VIF scores ranged from 1.05 to 1.75, which were well below the recommended threshold value of 10 (Hair et al., 1998), and thus multicollinearity was not a problem in this study.

We also evaluated the extent of common method bias with Harman's one-factor test (Podsakoff, MacKenzie, Lee, & Podsakoff, 2003) because all questions on each survey were answered by the same individual. In this test, the threat of common method bias is considered high if a single factor accounts for more than 50 percent of the variance (Harman, 1976). The results showed that none of the factors significantly dominated the explanation of the variance (the most influential factor accounted for 24.95 percent of the variance). Other evidence of common method bias includes exceptionally high correlations ($r > 0.90$) among the research variables (Pavlou & El Sawy, 2006). The inter-construct correlation matrix in Table 5 shows that there were not any unusually high correlations in our sample. Thus, we concluded that common method bias was not a serious concern in this study.

In summary, the results of the instrument validity tests showed that the measurement model was adequate.

5.2. Hypothesis testing

To test the structural model, we assessed the path coefficients of the independent variables and their statistical significance (t-values[1]) using PLS and the bootstrap re-sampling method with 500 re-samples (Chin, 1998; Chin et al., 1996). The results are presented in Fig. 2. As hypothesized, information equivocality showed a weak, significant positive effect on information overload with a t-value of 1.590 (H1b, $p = 0.056$). In addition, system pace of change (H3a, $t = 2.197$, $p < 0.05$) and system complexity (H3b, $t = 11.417$, $p < 0.001$) showed significant positive relationships with system feature overload. Meanwhile, the effect of information relevance on information overload (H1a) and the effect of information equivocality on communication overload (H2) were not significant. As for the direct determinants of SNS fatigue, information overload (H4, $t = 3.646$, $p < 0.001$), communication overload (H5, $t = 3.336$, $p < 0.001$), and system feature overload (H6, $t = 3.286$, $p < 0.001$) showed significant positive effects, explaining 28.3% of the variance in SNS fatigue. None of the control variables (i.e., gender, age, and SNS usage duration) were significant in relation to SNS fatigue.

[1] In this study, all hypotheses were directional as opposed to non-directional and thus we analyzed their statistical significance in one-tailed tests.

Table 4
Results of convergent validity testing.

Construct	Item	Std. loading	t-Value	AVE	CR	Cronbach's α
IFR	IFR1	0.78	3.191	0.64	0.90	0.86
	IFR2	0.67	2.583			
	IFR3	0.88	3.762			
	IFR4	0.87	3.033			
EQV	EQV1	0.84	5.864	0.74	0.89	0.82
	EQV2	0.87	6.623			
	EQV3	0.87	5.851			
IFO	IFO1	0.92	59.279	0.80	0.92	0.87
	IFO2	0.93	75.792			
	IFO3	0.83	28.391			
CO	CO1	0.78	20.056	0.59	0.88	0.82
	CO2	0.64	9.464			
	CO3	0.85	29.627			
	CO4	0.75	16.381			
	CO5	0.79	19.459			
POC	POC1	0.88	41.422	0.77	0.93	0.90
	POC2	0.88	34.093			
	POC3	0.92	56.048			
	POC4	0.83	21.154			
COP	COP1	0.88	49.738	0.80	0.92	0.87
	COP2	0.88	43.001			
	COP3	0.92	65.222			
SFO	SFO1	0.80	27.814	0.65	0.90	0.87
	SFO2	0.79	25.109			
	SFO3	0.75	20.850			
	SFO4	0.85	34.405			
	SFO5	0.85	41.389			
SFG	SFG1	0.82	28.896	0.72	0.93	0.90
	SFG2	0.90	61.739			
	SFG3	0.89	64.902			
	SFG4	0.80	26.413			
	SFG5	0.83	30.487			

6. Discussion and conclusions

Viewing SNS fatigue as an outcome of the stress process, this study adopts TTSC as the overarching theory and applies it to SNS fatigue. Specifically, this study examined two research questions: (1) what constitutes overload that causes SNS fatigue, and (2) what SNS characteristics are related to each overload dimension. Regarding what constitutes overload, TTSC asserts that stress is experienced when environmental demands exceed a person's coping resources and some negative consequences are anticipated (Lynn, 2011). Excessive demands on human cognitive processes can cause various overloads, which are direct sources of strain (Osipow, Doty, & Spokane, 1985). This study accommodates overload as a core determinant of SNS fatigue and identifies three dimensions of overload (i.e., information, communication, and system feature overload). Our results show that all three types of overload are significant stressors influencing SNS fatigue. This is a novel approach to SNS fatigue that has not been adopted by existing literature. Previous studies on SNS primarily focused on positive aspects of SNS as they attempted to explain the recent substantial growth in SNS usage. However, unintended consequences such as SNS fatigue need to be investigated in order to get balanced perspectives of SNS as it matures. This study is a first attempt to systematically validate the causal relationships among SNS characteristics, overload, and SNS fatigue based on the widely accepted stress theory, TTSC.

Regarding the second research question, our results show that most antecedents were significant determinants of the intended overload dimensions. Contrary to our expectations, however, information relevance was not a significant predictor of information overload. We expected that the higher the information relevance, the lower levels of information overload a user may experience, because she does not have to deal with irrelevant information. However, the relationship may not be that straightforward. In SNS, too much information exchange exceeding a user's cognitive capacity can distract her from other important life activities, regardless of the level of relevance of the information (Rainie et al., 2013; Richtel, 2010). Then, the transactional process with SNS may be stressful because a user cannot control her SNS usage in the “always connected communication” environment (Richtel, 2010). This explanation suggests that there might be a “threshold” where the direction of the relationship between information relevance and information overload changes due to the information amount. In other words, a “threshold” means a “point of diminishing return”, where the addition of one more unit of *relevant* information will result in a diminishing rate of return instead of increasing it (Pasinetti, 1999). The threshold point is considered an inflection point from a non-overload state to an overload state in SNS usage. Once the amount of relevant information exceeds an individual's information processing capacity, the productivity gains would become counterproductive due to information overload (Karr-Wisniewski & Lu, 2010). In sum, before the threshold point the relationship is negative (information relevance reduces information overload), but after the threshold point it may become positive (more information increases information overload regardless of the level of relevance). Future research may investigate the location of the threshold point with an additional dimension of information amount, determinants of the threshold point, and prescriptions for how to deal with relevant but excessive information after the threshold point.

Another surprising result was the relationship between information equivocality and communication overload. This result is surprising because one of the main reasons for using SNS in some cases (e.g., SNS for a university course) is to reduce equivocality in the subjects associated with members' common interests (e.g., classroom performance) (Lampe et al., 2010, 2011). It was expected that high equivocality might require more frequent communications to resolve the equivocality, which can lead to communication overload. This unexpected result may suggest that the relationship between information equivocality and communication overload

Table 5
Descriptive statistics, correlation matrix, and squared root of the AVE.

Construct	Mean (S.D)	Min	Max	CO	COP	EQV	IFO	IFR	POC	SFG	SFO
CO	3.55 (1.20)	1.00	7.00	**0.77**							
COP	2.69 (1.16)	1.00	6.00	0.24	**0.89**						
EQV	5.66 (0.74)	1.33	7.00	0.06	0.12	**0.86**					
IFO	4.19 (1.43)	1.00	7.00	0.32	0.15	0.12	**0.89**				
IFR	2.89 (0.92)	1.00	6.00	0.24	0.01	−0.04	−0.12	**0.80**			
POC	3.45 (1.16)	1.00	6.75	0.43	0.33	0.16	0.23	0.19	**0.88**		
SFG	3.28 (1.29)	1.00	6.00	0.37	0.30	0.16	0.40	−0.04	0.22	**0.85**	
SFO	3.35 (1.20)	1.00	6.50	0.26	0.61	0.11	0.32	−0.04	0.31	0.39	**0.81**

The leading diagonal shows the squared root of the AVE for each construct.

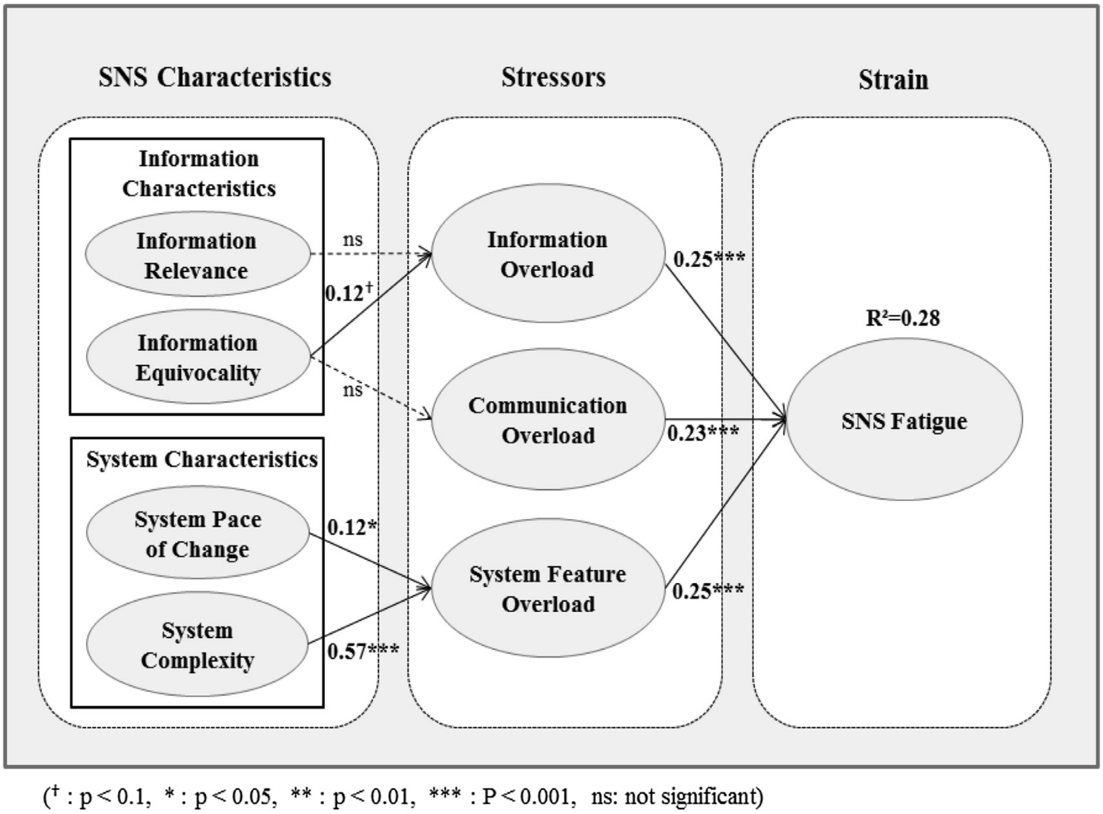

Fig. 2. Results of the structural model testing.

may not be direct, but may be mediated or moderated by other variables such as importance of the equivocal message, intensity of use, or perceptions of social capital (Lampe et al., 2010, 2011). For instance, a user who receives an equivocal message may not pursue any further clarification if it is not important to her or the relationship with the sender is not highly valued. Clearly, these explanations are speculative and should be tested by future research.

Further, future research may elucidate the unique characteristics of various SNSs because the stress process may be influenced by those characteristics. For example, Instagram excels in services to share photos and videos, while Twitter has a 140-character limit for tweets. Meanwhile, existing literature asserts that the cognition process for text-recognition is different from that of image-recognition (Belk, Germanakos, Fidas, Spanoudis, & Samaras, 2013). Cognitive factors influencing the cognition process includes working memory capacity, controlled attention, and speed of processing. Depending upon individual differences in these factors, users may have different stress experiences in various SNSs.

This study has certain limitations. First, our sample is heavily skewed towards individuals under 30 years old. However, this distribution does not highly deviate from common users of popular SNSs. For example, in some of the biggest social networks, including Facebook, Twitter, Google+, LinkedIn, and Pinterest, the largest share of the user base comes from internet users in their late 20s and early 30s (Business Insider, 2014). Nevertheless, it would be better for future research to include various age groups in order to better reflect the characteristics of a wider range of users. Second, this study focused on ICT overload as important influencers of SNS fatigue. However, other factors such as personal differences (e.g., perceived privacy concerns) and social environments (e.g., reputation management climate) can also influence SNS fatigue. Future studies may expand the research scope including these factors as other stressors or moderators between stressors and strain. Third, as mentioned above, the research context for this study, South Korea, has very high usage rate of ICT and SNSs. Due to this high penetration of ICT, Koreans are readily exposed to high demands from SNSs. Further, South Korea is characterized as a high collectivistic society which may put extra burdens on SNS users (Ji et al., 2010; Kim & Yun, 2008). For example, while most Koreans use SNSs to strengthen existing social networks for social support (Kim, Sohn, & Choi, 2011; LaRose et al., 2014), they can get more stressed due to the social norm of reciprocity that requires them to response to messages on time and to put more efforts to maintain SNS connections with friends (e.g., visiting friends' SNS sites frequently) (Kim & Yun, 2008; LaRose et al., 2014). Meanwhile, in other countries with different cultural orientations and ICT infrastructure, our findings may not apply and thus, future research may exercise some caution about the external validity of our findings.

This study produces some practical implications for SNS users and providers. First, SNS users should be aware that three types of overload are main determinants of SNS fatigue. So, users should manage their overload in order to avoid potential negative consequences (e.g., distress) from SNS fatigue. For example, they can enforce more strict control over their SNS usage or apply topic filters to reduce the number of incoming messages. Second, SNS providers may adopt strategies for helping users cope with stressors. For example, they can provide users with a more controllable environment so that users themselves can set the limits to communication requests at certain times and/or apply optional filters to content that they do not find particularly interesting. Specifically, SNS providers may equip users with optional features that allow them to deactivate the functions of real-time push notification or instant messenger during specified time periods. Meanwhile, fast-changing technologies and frequent updates of SNS systems may make existing technologies quickly obsolete, thereby leading to user overload and eventually causing users' discomforts. To reduce the overload, SNS providers may make the transition process as smooth as possible by announcing the schedule and scope in advance, and providing user guides and training to learn new features. Also, instead of providing too many complex functions to users, SNS providers may allow users to design their own SNS pages by selecting elements in design options.

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