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Keywords:

Smartphone dependency, Social networks, Loneliness, Personality traits, Gender differences

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Abstract

This study sought to determine the effects of personality traits on smartphone dependency and loneliness, controlling for the effects of students' self-perception towards instant messaging (IM) and email dependency, and compared them among social networks formed through face-to-face (FTF), IM and email. A total of 216 university students in Japan completed a questionnaire measuring their degree of personality traits (shyness and sociability), use of smartphones and computers, self-perceptions of IM/email dependency, and degree of smartphone dependency and loneliness. The results of factor analysis showed that students' self-perception of IM/email dependency was composed of the three factors of self-perception of text messages that Igarashi et al. (2008) indicated (namely, perception of excessive use, emotional reaction and relationship maintenance). The results of structural equation modeling showed that students' shyness and sociability influenced their self-perception of emotional reaction, which had the largest effects on smartphone dependency. Additionally, students' sociability led them to overuse IM/email, which helped reduce their loneliness but also led them to depend on smartphones more. Furthermore, female students' social networks via FTF and IM had positive effects on decreasing loneliness, while no similar effects for email were detected. The importance of distinguishing between the shy-sociable dependency (through the process of emotional reaction) and sociable dependency (through the process of excessive use) is discussed.

1. Introduction

Over the last two decades, various media usage has influenced people's communication behaviors dramatically. According to a survey conducted by the Institute for Information and Communications Policy, which targeted 1500 people between the ages of 13 and 69 years, 68.5% of teenagers and 94.1% of people in their twenties have and use smartphones (IICP, 2015). Compared to other generations, young persons spend more time accessing the Internet through smartphones. According to another survey targeting high school students, those with a higher level of dependency on smartphones tend to exhibit poor etiquette in their Internet usage and more inappropriate communication behaviors (IICP, 2014). The problems related to inappropriate smartphone usage among young people have attracted a substantial amount of attention.

Internet dependency, or Internet addiction, is defined as the loss of control over one's Internet use and is considered an impulse control disorder (Young, 1999). Previous studies have shown that Internet addiction and mobile/smartphone dependency relate to problems such as academic failure (e.g., Lepp et al., 2014); depression, anxiety and stress (e.g., Akin & Iskender, 2011); sleeplessness (e.g., Cao & Su, 2007); loneliness (e.g., Casale & Fioravanti, 2011); and so on. Among these, loneliness seems to be one of the most serious symptoms. As Worland (2015) argued, loneliness is a potential pandemic "on par with obesity and substance abuse," and many researchers have established that loneliness is related to serious health risks from children to adolescents and adults (Pittman & Reich, 2016). Thus, this study examines the relationship between smartphone dependency and loneliness

and factors that influence them, to identify both consistencies and inconsistencies compared to reported outcomes.

2. Literature review

2.1. Relationship between Internet addiction, mobile/smartphone dependency and loneliness

There are two main theories regarding the effects of Internet use on loneliness. The first is the *social augmentation hypothesis*, which suggests that social communication on the Internet increases the total social resources available to individuals by providing additional possibilities for interaction with others (Bessiere et al., 2004). This has been supported by Shaw and Gant (2002) and Sar et al. (2012) among college students and elderly people. Additionally, Davis (2001) proposed a cognitive-behavioral model of Pathological Internet Use (PIU), with psychosocial issues such as loneliness and depression serving as precursors to PIU. The model demonstrates that individuals with poor face-to-face (FTF) interactions and communication skills may prefer computer-mediated communication (CMC) to interact with others. Therefore, CMC provides a less risky and more anonymous arena in which to communicate with more confidence than FTF interactions, which may be especially enticing for people with higher levels of loneliness or depression (e.g., Morahan-Martin & Schumaker, 2000).

On the other hand, the *displacement hypothesis* states that time spent using a particular medium replaces time spent using other media, such as FTF interaction (Huang, 2010). As a result, using the Internet replaces FTF communication in individuals' lives. The Internet operates as a more attractive but ultimately leaner and less

satisfying medium for human interaction, thus leading users to feel an increased sense of loneliness. This has been supported by many studies (e.g., Esen et al., 2013; Kose et al., 2016).

Compared to conventional CMC, people today form more intimate relationships by sending text messages and making phone calls via various instant messaging (IM) applications, and/or by sending emails based on FTF interactions, than by relying only on FTF interactions (Cleemput, 2010; Kim et al., 2007). This suggests that the boundary between FTF and online has become smaller. Therefore, the relationship between smartphone use and loneliness might be more complicated due to the different relationships between FTF and online interactions.

2.2. Relationships between social networks and loneliness, and the effects of personality traits on these relationships

Levin and Stokes (1986) have suggested that there are two processes that can explain why loneliness occurs: the social network mediation model and the cognitive bias model. The former suggests that certain personality traits make it difficult to form and maintain social relationships with others; consequently, social networks are sparse, leading to loneliness. The latter suggests that negative perceptions toward the self and others lead people to underestimate their social networks; consequently, they feel lonely regardless of the reality of the social networks. Stokes (1985) and Levin and Stokes (1986) have shown that extroversion, depression and attitudes toward others relate to both of the models. Based on these, Igarashi (2002) indicated that in terms of FTF, both the social network mediation model and the cognitive bias model are supported when considering the effects of social skills, while the

cognitive bias model can only be supported in terms of CMC. Additionally, Ye (2016) suggested that shyness only had direct effects on loneliness but had no mediating effects on their social networks, regardless of FTF, IM or email. Currently, people transmit information to a large number of people via social media, while also sending text messages and/or making voice/video calls to a specific person using “messengers.” These allow us to suppose that if individuals’ social networks via IM are large enough as a result of FTF interactions, this will help them decrease loneliness. On the other hand, as younger people seldom send emails to connect with intimate friends (Lenhart et al., 2005), social networks via email might have weaker effects than those developed via IM.

2.3. Relationship between perception of text message dependency and personality traits

In Japan, before smartphones became popular, mobile phones had been used since 1999 not only as traditional telephones but also to access the Internet, to send and receive text messages, and to use the short message service (SMS). Because of the immediacy and the few temporal and physical restrictions of text messages, they were considered equivalent to conventional CMC and were therefore widely used, especially among the younger generations. Thus far, extensive research has indicated that young generations prefer text messages via mobile phones to other communication media (Matsushita, 2012). Based on the implications of Internet dependency/addiction via computers, Igarashi et al. (2008) developed a scale for self-perception of text message dependency and conducted a survey on Japanese high school students, examining the

relationship between personality traits and dependency on text messages, and how these affected their daily lives. As a result, it was found that text message dependency was composed of three factors—emotional reaction, perception of excessive use and relationship maintenance—and this text message dependency may occur through two different processes. The first is extroverted dependency, which is concerned with the process by which extroversion increases the *perception of excessive use* of text messages and the consequent occurrence of psychological/behavioral symptoms. The other is triggered by neuroticism, which intensifies students’ *relationship maintenance* and thus increases psychological/behavioral symptoms. However, as smartphone dependency refers to behavioral symptoms while loneliness refers to more psychological symptoms, it is necessary to measure them separately. Furthermore, as Igarashi et al. (2008) indicated, the self-perception of relationship maintenance also includes interpersonal relationships through text messages. Therefore, we believed that individuals’ self-perception of relationship maintenance influences their social networks via IM/email based on their FTF interactions.

Regarding the relationship between shyness and sociability, as Cheek and Buss (1981) indicated, shy people are not necessarily unsociable; there are also nonshy-unsociable, nonshy-sociable and shy-unsociable people. In general, when communicating in person, shy-sociable people have a strong motivation to be with others, while also realizing that they are fearful and inhibited about mixing socially. This type of individual tries to avoid interactions in person. However, this type of individual can form and maintain a large number of intimate social

networks through online communications without interacting in person. Thus, these shy-sociable individuals would depend more on smartphones.

2.4. Gender differences

Gender differences have been frequently reported in patterns of Internet/smartphone use and addictive behaviors. As IICP indicated (2014, 2015), female students spend twice as much time as male students on accessing the Internet through smartphones. Additionally, compared to male students, female students have higher levels of social anxiety, which leads them to talk with others online more (especially via IM) and to feel more comfortable using only text (Piece, 2009). Liang et al. (2016) indicated that, in the case of children in grades 6-8 in China, male students’ depression leads them to Internet addiction, while female students’ Internet addiction makes them have higher levels of depression. Furthermore, Igarashi et al. (2005) indicated that in Japan, female students tend to be more active than male students in forming larger and more intimate social networks by sending more text messages via mobile phones. Based on these, we believe that female students will depend on smartphones more than males.

In sum, the present study aims to examine the process illustrated by Figure 1. Here, self-perception of IM/email dependency includes the three factors of emotional reaction, excessive

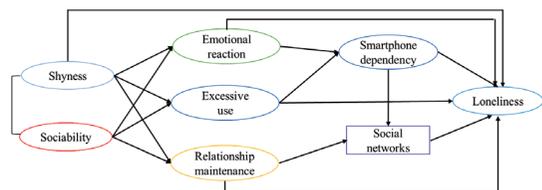


Figure 1. The analyzed model in this study

use and relationship maintenance, and we examined their effects on behavioral symptoms (smartphone dependency) and psychological symptoms (loneliness).

3. Method

A questionnaire survey was conducted at a national university in the Kanto Region, Japan. A total of 228 university students submitted their responses. We excluded 12 respondents who did not use smartphones and/or had incomplete responses (Table 1).

The questionnaire had four parts—Part A, Part B, Part C, and Part D—with the content in each part as follows.

Part A gathered demographic data, such as gender, age, living situation, and so on. The 12 items for shyness were chosen from Sakurai and Sakurai (1991) based on Factor loadings from the three factors. The 5 items for sociability were chosen from Cheek and Buss (1981). Respondents were asked to answer using a 5-point scale (5. Strongly agree; 3. Neither/either; 1. Strongly disagree) for each of the items.

Part B measured the students' media usage including computers and smartphones. Regarding the self-perception of IM/email dependency, we revised some expressions based on the scale for self-perception of text message dependency from Igarashi et al. (2008) (Table 2). They were asked to rate the 15 items by using a 5-point scale (5. Strongly agree; 3. Neither/either; 1. Strongly disagree).

In addition, we used a short version of the smartphone dependency scale developed for high school students in Japan (IICP, 2014). There were 20 items in the original version, but we excluded those with low scores and those that

were not typical for university students. As a result, 10 items were used in the present study and the students were asked to answer by rating on a 5-point scale (5. Very true; 3. Neither/either; 1. Definitely not the case).

Part C gathered information about the students' FTF, IM, and email social networks. As in the study of Ye (2016), we asked students to list UP TO 10 people they had met FTF or sent IMs and emails to in the previous three months for important conversations. Here, students were asked to provide information, for each social network, about their social contacts' genders, ages, relationships, and frequency of contact (from 4. Almost every day to 1. Less than once per month), and the main content of the communication and importance of the person in their lives (from 5. Very important to 1. Not important at all). Additionally, the students were asked to answer whether the person(s) listed in the social network via IM and email were also listed via FTF, and so on.

Part D measured students' degree of loneliness. The 20 items were chosen from Moroi (1992) and used a 5-point scale (from 5. Strongly agree to 1. Strongly disagree).

4. Results

4.1. Relevant information for analyzed students

Relevant information for the 216 students is shown in Table 1. According to the results, 94% personally owned a computer (either desktop or laptop), and 71.3% accessed the Internet via smartphones for over 2 hours per day. In particular, they accessed the Internet via smartphones for longer than they did via computers. We conducted *t*-test (independent

example) to examine gender differences in time spent on accessing the Internet via computers and smartphones. The results indicated significant differences for both: Male students accessed the Internet via computers longer than females ($t(213)=2.14, p<.05$, male vs female: 3.35 h vs 2.83 h), while female students accessed the Internet via smartphones longer than male students ($t(214)=2.19, p<.05$, male vs female: 3.29 h vs 3.79 h).

Regarding the types of IM platforms used, 96.3% used LINE, 81.9% used Twitter, and so on. However, there were no differences due to gender among these preferences.

4.2. Internal reliability for each scale

We confirmed each scale’s internal reliability by calculating its Cronbach’s α coefficients. As a result, α for the shyness scale was .89, α for the sociability scale was .90, α for the smartphone dependency was .89, and α for the loneliness was .90. These all showed high internal reliability. Therefore, we used the total score for each scale in the following analysis. We conducted a t -test (independent sample) to confirm whether there was any difference due to gender. As a result, no

significant differences among these scales were found except for the smartphone dependency ($t(214)=2.12, p<.05$, male vs female: 28.21 vs 30.69).

4.3. Factor analysis of the self-perception of IM/email dependency scale

We conducted an exploratory factor analysis on the self-perceptions of IM/email dependency to test the factor structure. Table 2 shows the results of a maximum-likelihood exploratory factor analysis with oblique rotation, including the mean score and standard deviation (SD) for each item. The results show the same structure as Igarashi et al. (2008) with regard to the self-perception of text message dependency (namely, emotional reaction, relationship maintenance and self-perception of excessive use). The Cronbach’s α coefficients were .86, .80, and .76 for emotional reaction, relationship maintenance and excessive use, respectively, and were almost the same as the results of Igarashi et al. (2008).

4.4. Configurations of social networks

Prior to examining the relationship between the students’ personalities, self-perception of IM/email dependency, smartphone dependency and loneliness, we needed to investigate the configurations of each social network. Table 3 shows the average number of people in each social network and their relationships. As mentioned earlier, we asked the respondents to list up to 10 persons for each social network, so the maximum number for each social network is 10. As Table 3 indicates, the largest social network was still via FTF, while that via email was the smallest. In addition, we also analyzed how students’ social networks related to each other. For instance, “IM & FTF” means that those

Table 1. Information for analyzed students

Items	Distributions		
Gender	Male: 41.2%	Female: 58.8%	
Age	Mean: 20.2 years ($SD=1.49$)		
Academic standing	Freshman: 31.0%	Sophomore: 40.3%	
	Junior: 19.4%	Senior: 9.3%	
	Others: 0.0%		
Living Situation	Alone: 78.8%	With a family/relatives: 17.9%	
	With friends: 2.4%	Others: 0.9%	
	Others: 0.0%		
Possession rate of computer	Personally own: 94.0%		
Internet via computer (per day)	0-1hour: 24.2%	1-2 hours: 20.0%	2-3 hours: 22.3%
	3-4 hours: 14.0%	4-5 hours: 6.0%	5-6 hours: 7.4%
	Over 6 hours: 6.0%		
	Others: 0.0%		
Internet via smartphone (per day)	0-1hour: 7.4%	1-2 hours: 21.3%	2-3 hours: 26.4%
	3-4 hours: 17.6%	4-5 hours: 13.4%	5-6 hours: 5.6%
	Over 6 hours: 8.3%		
	Others: 0.0%		
Types of IM (multiple choices)	LINE: 96.3%	Twitter: 81.9%	Facebook: 25.0%
	Skype: 24.5%	Kakao Talk: 1.4%	Others: 5.1%
	Others: 0.0%		
	Others: 0.0%		

people who were listed under IM were also listed under FTF. From Table 3, it was found that for both males and females, approximately 60% to 70% of the contact persons listed under IM were also people with whom the students communicated in person (male: 3.42/4.94; female: 3.18/5.61). In contrast, most of the contact persons listed under email had not been met in person or communicated with via IM. Furthermore, it was found that female students' social networks with males via FTF, IM and email were all larger than male students' social networks with females.

We also analyzed with whom the students communicated in each social network, including the effects of gender differences. As Table 4 shows, for both males and females, over half of the contact persons in their social networks via FTF and IM were "friends," and over 30% were at the same university. Furthermore, although those friends who were "at other universities" were not included in social networks via FTF, they were included in social networks via IM. On the other hand, emails were used to communicate with academic advisors and family members/relatives, rather than with friends, for both males and females.

4.5. Personality traits' effects on self-perception of IM/email dependency, smartphone dependency and loneliness

We conducted SEM analysis to test the effects of personality traits on self-perception of dependency towards IM/email, and the effects of both on smartphone dependency and loneliness among the three social networks (FTF, IM and email), as shown in Figure 1. Additionally, we also conducted multi-group SEM to detect gender differences; however, no model for males could

be adopted regardless of the social networks via FTF, IM or email. Therefore, the following results were about the entire group and females. All the indexes and the parameter estimates are shown in Figures 2-7.

We found that they share the following commonalities: (a) Smartphone dependency had no relationship with social networks or loneliness. (b) Self-perception of excessive use and emotional reaction had strong effects on smartphone dependency, while only excessive use had effects on decreasing loneliness. (c) Shy-sociable students showed the strongest emotional reaction, and also relationship maintenance for IM/email, while their self-perception of excessive use was influenced by sociability only. (d) Shy people felt lonelier.

Meanwhile, we found that, overall, their self-perception of relationship maintenance had effects on increasing loneliness regardless of the social networks of FTF, IM or email, while the females' social networks via FTF and IM had positive effects on decreasing loneliness.

5. Discussions

5.1. Key findings

There were three main purposes of this study. First, we completed an analysis of the predictive relationships between self-perception of IM/email dependency, smartphone dependency and loneliness among the three social networks (FTF, IM and email). Second, we conducted an analysis of personality traits' effects on their self-perception of IM/email dependency. Finally, we examined gender's effects on the above associations.

Igarashi et al. (2008) showed that self-perception of excessive use had the strongest

Table 2. Exploratory factor analysis on self-perception of IM/email dependency

Exploratory factor analysis on self-perception of IM/email dependency						
<i>Emotional reaction</i>	I	II	III	Communality	<i>M</i>	<i>SD</i>
1. After sending a message/email, I check my mailbox repeatedly to see if I had received a response	.70	.05	.21	.51	2.94	1.10
2. I feel disappointed if I don't get a reply to my message/email immediately	.83	.17	.06	.72	2.45	1.05
3. I feel anxious when people don't immediately reply to my message/email	.74	.08	.06	.56	2.76	1.11
4. I often check my mailbox to see if I had a new text message/email	.67	.20	.20	.53	2.78	1.09
5. I feel disappointed if I don't receive any text-messages/email	.66	.30	.06	.53	2.27	1.14
<i>Perception of excessive use</i>						
6. I sometimes send message/email while engaging in a conversation with other people	.05	.04	.84	.71	2.74	1.15
7. I sometimes spend several hours on sending messages/email continuously	.17	.22	.46	.29	2.96	1.18
8. I often exchange many messages/emails in a short period of time	.24	.19	.43	.28	3.14	1.07
9. I send messages/emails even while I am talking with friends	.09	.06	.82	.69	2.38	1.09
10. I consider myself a quick-typist on smartphones	.04	.18	.37	.17	3.06	1.20
<i>Relationship maintenance</i>						
11. I cannot maintain new friendships without messages/emails	.21	.81	.20	.74	2.11	.96
12. I can't form any new relationships without sending messages/emails	.15	.86	.18	.79	2.03	.91
13. I think my relationships would fall apart without messages/emails	.15	.79	.15	.67	1.96	.92
14. Without messages/emails, I would not be able to contact friends whom I cannot meet often on a daily basis	.04	.39	.07	.16	3.12	1.28
15. Without messages/emails, I can't say what is on my mind	.24	.48	.13	.31	1.76	.85
Factor Contribution	2.82	2.70	2.13			
Cumulative Contribution Rates	18.78	36.81	50.94			

Table 3. Configurations of each social network and their relationships

Number of each social network	Male			Female		
	Entire	Same	Cross	Entire	Same	Cross
FTF	6.57	4.53	1.91*	6.68	4.21	2.46*
IM	4.94	3.45	1.49*	5.61	3.64	1.98*
email	2.57	1.60	.98*	2.99	1.47	1.52*
<i>Relationship between networks</i>						
IM & FTF	3.42	2.45	.97	3.18	2.06	1.12
Email & FTF	.81	.60	.21	.66	.39	.28
Email & IM	.62	.43	.19	.65	.43	.22

Note: * for significant differences between males and females ($p < .05$).

Table 4. The contact persons in each pair of social network

Social networks	Male			Female		
	a.	b.	c.	a.	b.	c.
FTF	3.4%	61.0%	10.4%	4.7%	50.2%	13.3%
	1.0%	30.1%	4.6%	2.7%	35.5%	4.8%
	1.5%	6.7%	2.7%	1.5%	7.0%	2.4%
IM	3.9%	71.4%	9.5%	4.6%	53.9%	15.8%
	1.1%	24.1%	10.0%	0.4%	33.8%	12.2%
	0.0%	3.0%	1.8%	0.4%	2.5%	2.5%
email	1.7%	33.2%	15.7%	0.8%	27.5%	31.4%
	9.6%	16.6%	2.6%	21.8%	28.9%	3.9%
	8.7%	8.3%	6.6%	9.5%	6.3%	11.3%

Note: a: Lover; b: Friend; c: Family member/Relative; d. Advisor; e. Student at the same university; f: Student at other university; g. Other faculty member/staff; h. People at part-time job; i. Others.

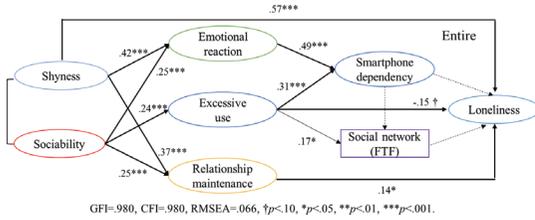


Figure 2. Results for FTF (Entire)

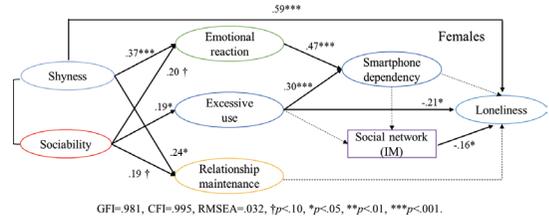


Figure 5. Results for IM (Female)

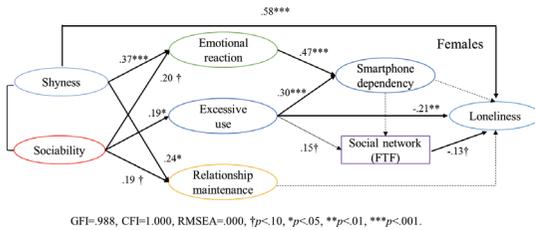


Figure 3. Results for FTF (Female)

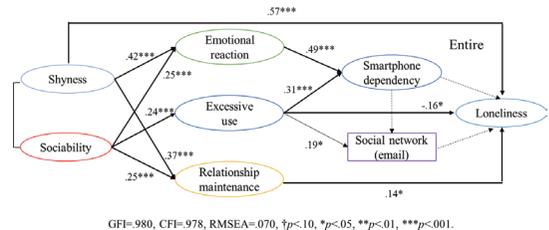


Figure 6. Results for Email (Entire)

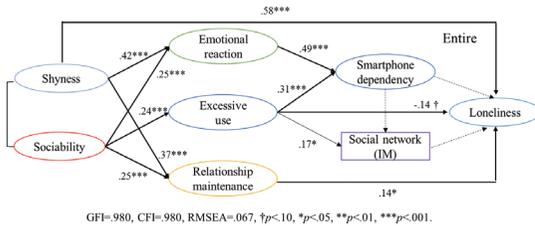


Figure 4. Results for IM (Entire)

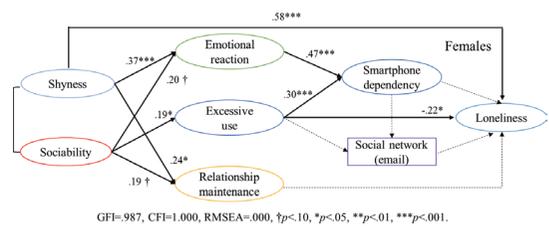


Figure 7. Results for Email (Female)

effects on psychological/behavioral symptoms, followed by relationship maintenance, while emotional reaction had the weakest influence. However, the current research indicated that emotional reaction had the strongest effects on smartphone dependency, whereas relationship maintenance increased loneliness when including both genders. There are some possible reasons for these differences.

First, this study measured behavioral symptoms (smartphone dependency) and psychological symptoms (loneliness) separately. Our results suggest that emotional reaction might have the largest effects on behavioral symptoms, while self-perception of excessive use has effects on psychological symptoms. Interestingly, students' self-perception of

excessive use had effects on both smartphone dependency and loneliness. This might also help to explain why self-perception of excessive use had the largest effects in Igarashi et al. (2008)'s findings, as they measured psychological symptoms and behavioral symptoms together.

Second, the factor of emotional reaction involves a strong urge to receive immediate replies from the recipient of a message. When using mobile phone text messages previously, users (especially younger generations) tended to reply immediately, even though text messages are asynchronous. This means that text messages had become synchronous tools for users, especially younger generations. There are now many applications with functions to show whether the recipient has already read a text message. We

believe that these functions have influenced students to depend on smartphones more. In contrast, the factor of relationship maintenance did not lead to smartphone dependency but rather to loneliness when including both males and females. This factor is concerned with motivation for perpetual contact via IM/email and therefore has the potential for interpersonal dependency. As Igarashi et al. (2008) suggested, interpersonal dependency implies a central need to stay close to others and to maintain nurturing and supportive relationships, and people who receive less social support tend to feel lonelier and use more social media to compensate for the lack of FTF interactions (Song et al., 2014).

Third, the effects of the self-perception of excessive use seemed to be more complicated. Although using IM/email helped students decrease loneliness, it also led them to depend on smartphones. This factor contains the items regarding the perception of socially inappropriate behavior in Japanese culture, such as typing messages while having FTF communications with others. However, targets in our research are members of the so-called “digital native generations,” who might have different perceptions of inappropriate behaviors because they started using mobile devices in elementary school or middle school and therefore might consider certain behaviors to be natural or acceptable. This would be one of the main reasons why they had higher levels of self-perception of excessive use while feeling less lonely. Still, we should note that these individuals need to send messages frequently and actively in order to form and maintain these intimate social relationships.

Out of our hypotheses, it was found that only females’ social networks via FTF and IM had

positive effects on decreasing loneliness (Figures 3 and 5). As Table 4 shows, students sent IM to communicate with friends, especially those at the same university. Compared to male students, female students communicated with more cross-gender people, who helped them decrease loneliness as Argyle (2001) suggests. On the other hand, female students also sent email to advisors and family members (Table 4), who are less intimate and, therefore, had no effects on decreasing their loneliness.

With regard to personality factors and self-perception, shyness affected emotional reaction and relationship maintenance, whereas sociability contributed to emotional reaction, excessive use and relationship maintenance. On the basis of these, smartphone dependency may occur through two different processes. The first is social dependency, concerned with the process by which sociability increases the perception of excessive use of IM/email and the consequent occurrence of smartphone dependency. This is similar to extroverted dependency, as Igarashi et al. (2008) indicated. We found that social students, especially females, also tended to overuse IM/email to decrease their loneliness, so these two processes would seem to continue in the future.

The other type of smartphone dependency is triggered by shyness and sociability. As mentioned above, shy-sociable people have a strong motivation to be with others while also avoiding interactions in person because they are afraid of using appropriate non-verbal cues and how they will be interpreted (Check & Buss, 1981). However, they are able to form and maintain social networks using IM/email without communicating with others in person. Among the three factors of self-perception in IM/email dependency, emotional reaction had the strongest

effects on smartphone dependency and was strongly influenced by shyness and sociability. These suggest that shy-sociable dependency (through the process of emotional reaction) may occur more easily than the social dependency (through the process of excessive use).

5.2. Future work

This study's results suggest that smartphone dependency does not necessarily lead to loneliness, which is inconsistent with previous studies. As mentioned above, smartphone dependency in this study included more behavioral symptoms, while loneliness refers to more psychological symptoms. As previous studies have reported, people who use smartphones for SNS and games are likely to depend on smartphones more, while those who use smartphones for academic purposes are not (e.g., Salehan & Negahban, 2013). This suggests that future research should investigate the different purposes of smartphone usage when examining the relationships between smartphone dependency and loneliness.

Additionally, our research results show that female students spent more time accessing the Internet via smartphones than did male students, while male students used computers longer, which is consistent with previous studies. This suggests that although smartphone dependency is obvious for female students, computer Internet dependency, like traditional addiction, might still be a serious problem for male students. Detailed research might be necessary in the future.

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Information networks of Open Data promotion in Local Governments of Japan

Keywords:

Local Governments, Open Data, Information Network, Scale-free network, Regional bond

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Abstract:

Public data collected or possessed by administrative agencies and subsequently released as Open Data is expected to bring about positive economic effects. The purpose of this study is to obtain findings contributing to the Open Data promotion in Japanese local governments. We conducted WEB questionnaire survey and obtained information networks of Open Data promotion in local governments. The network in the open data personnel had different characteristics from those of the WEB reference relationship network in the degree distribution. It shows those two networks have different structures. This result can be indicative that the regional binding plays an important role in the information network.

Introduction

Open Data, publishing public data which governmental agencies collect and hold in the form easy-to-secondary-use, are expected to have a significant economic effect. On 22th Dec 2016, the council of industrial structure in the Ministry of Economy, Trade and Industry of Japan (which is discussing the strategy of growth) has decided to consider making new mechanisms for companies to utilize big data that the central government and local governments obtain in the traffic and medical fields etc (NHK, 2016). On 20th Jan 2017, Saitama prefecture has created a common format of Open Data in cooperation with 58 municipalities in the prefecture (Nikkei Shimbun, 2017). The common format is important for both promotion and utility of Open Data (Noda et al, 2017). Japan is on the way of Open Data promotion.

In the view of network effect (Katz et al, 1985), the more local governments provide these public data, the values and utilities of each data sets will increase. Open Data initiatives in advanced municipalities bring about certain economic effects, and Open Data can spread to various places throughout the network. In this process, the following local governments get information from advanced ones. Both the estimation of economic effects and findings in the way of spread can help to promote Open Data.

With respect to economic effects by using Open Data, some estimates have been carried out by the governments including the EU Commission and private research institutions, there are also the estimates made in Japan (Jitsuzumi et al, 2013). Noda (2015) carried out a study of the relevant prior research. Subsequently, on the basis of the study results, a questionnaire survey for local governments of Japan was conducted (Yoshida et al, 2016). A comparison of the major previous studies and this study are shown in Table 1. First, this survey aims to estimate the economic effect in line with the current situation of Open Data in Japan. Second, the investigation object is the local government which is a provider of data. Third, the estimation process of the economic effects becomes clear by using a uniform question of WEB questionnaire.

The purpose of this study in the project is to obtain the knowledge how Open Data spread in municipalities of Japan by considering through the network analysis of the answers in the questionnaire how the local governments refer information of each other. Honda et al (2016) have already pointed out the role of advanced cities in Open Data promotion. Especially Sabae city in Fukui Prefecture was referred by other municipalities. In this study, total structures of information networks are analyzed. Municipalities can learn the ways of Open Data on websites by others. They can also get information about Open

Table 1 Comparison with previous researches

	Tasman(2008)	Vickery(2011)	Jitsuzumi(2013)	This Study(2016)
Area:	Oceania	EU	Japan	Japan
Investigation Object:	Use Operators	Use Operators	Use Operators	Data Provider
Data Provider:	All	Public Agencies	Public Agencies	Local Governments
Kind of Data:	Spatial Information	All	All	All
Method:	Interview	applying parameters from Tasman	applying parameters from Tasman	questionnaire(WEB)

(Noda et al, 2017)

Data from personnel in other municipalities. Therefore, this study is going to clarify the difference. It will help us to know how to promote Open Data efficiently.

Method

WEB questionnaire were requested to the persons in charge of Open Data at local governments of Japan which have already implemented Open Data. WEB site for answer were constructed and e-mails of the request for answer were delivered Using the SPIRAL of Piped Bits Co., Ltd. Period was up to 22nd February from 9th February, 2016. The investigation objects correspond with Open Data municipality list of Fukuno (2013) at the time of survey added Atsugi city, 182 local governments of Japan (Table 2). Response rate is at 57.1%, up to 63.5% excluding the administrative districts of major cities.

The main questions in this survey were, percentages and progress degrees of Open Data, the cost at the time of implementation of Open Data, the reduction cost of the past business, and the feeling of personnel. In addition, the use of the data, the possibility of private use, and the network of information propagation about Open

Data in the inter-local government were asked. In the question of the information network, the 182 local governments made up of all subjects presented to the respondent by pull-down menu, to select the appropriate other local government in the order. Specific questions are as follows. If we asked them to answer all informants, it would be too much a load for respondents. It might decrease response rate. Therefore five municipalities were selected in this survey, based on the name generator method in 1985 GGS (Smith et al, 2015).

- “Do you access the following other municipalities’ WEB sites, in the reference of the state of Open Data? Please select five in the order you refer the most.” ... (A)
- “Do you get information about Open Data from personnel of public information at the following other municipalities? Please select five in the order you get the most, including the case you attended a seminar.” ... (B)

Information networks obtained from the two questions¹ of the respondents were compared by degree distributions.

Table 2 Investigation object

	All	Prefecture	City	Major City	Administrative district
All	1963	47	1721	20	175
Request for survey	182	23	115	18	26
Rate of LG with OD	9.3%	48.9%	6.7%	90.0%	14.9%
Number of respondents	104	14	75	10	5
Rate of recovery	57.1%	60.9%	65.2%	55.6%	19.2%

*Included major city in city, Number of City is 1741 (Yoshida et al, 2016)

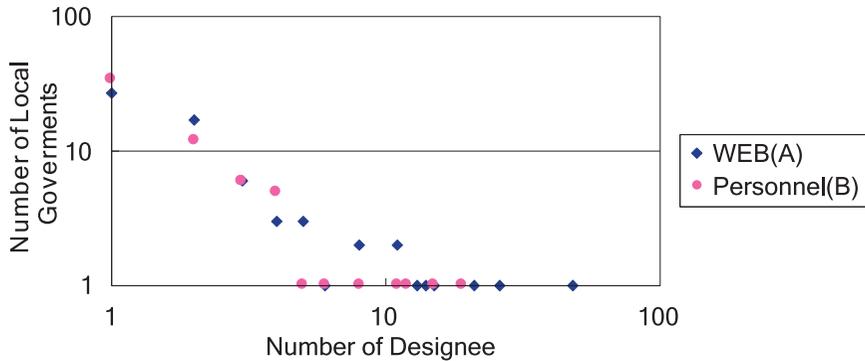


Figure 1 Degree distributions for two information networks

Results

Information networks in the WEB site (A), and in the persons in charge of public information (B) are shown as piled degree distributions (Figure 1). The horizontal axis is the number of nomination (designee) from the personnel at other local government which is incoming degree in the sense that it was chosen by others as the option of the answer, but also is outgoing degree in the sense that it originated the information. Here, it is referred to as the designee number. The vertical axis is the number of local governments. Both of the horizontal axis and the vertical axis are displayed in common logarithm to distinguish the features of distributions.

In the information network of the WEB site, the degree distribution to power approximation is $y=1.5129x^{-0.9128}$ $R^2=0.9748$ (the local governments with no designee² included in the calculation of the approximate curve as designee number 0.1). On the other hand, the information network of the persons in charge of Open Data is calculated

$y=1.898x^{-1.0794}$ $R^2=0.6727$. The coefficient of determination is approximately 0.3 lower than that of WEB network. This also can be seen in Figure 1. The number of local governments with the 5 designees is only 1. The cut-off of normal distribution seems to occur. It is also reflected in the point that the long tail becomes shorter, designee number Sabae city in Fukui Prefecture remains 19 in spite goes up to 48 in the WEB network.

Discussion

Degree distribution of the WEB site of the information network, which fit very well in power approximation with the coefficient of determination 0.9748, can be said to have the characteristics of the so-called scale-free network by Barabási et al. (1999). However, the information network of the persons in charge of public information, the coefficient of determination 0.6727 is approximately 0.3 lower, is presumed to have different properties from the scale-free network.

1 It can also be considered to use WEB reference network in their sites. But they may not link up others even if they referred to them. These ways of asking realize the comparison of the two networks.

2 Those municipalities also constitute networks by nominating others. Nomination has significance when compared with non-nomination.

What are in this back ground? As one of them, there exists a regional binding in the Open Data of the municipalities (Honda et al, 2016). Sabae city in Fukui Prefecture which won the large number of nomination in this study is a pioneering municipality in Open Data and has also grabbed nationwide attention. When other local governments are going to implement the open data, it is a very natural flow to check the WEB site of Sabae city trying to refer to the their efforts. There also would be many local governments that participated in lectures and trying to listen to the person in charge directly. Such reference relationship like scale-free network is considered to exist.

On the other hand, 17 other municipalities in Fukui Prefecture has conducted Open Data at the time of this survey. Municipalities which has already implemented Open Data are at most 182, of the nationwide 1963 local governments as seen in Table 2. Municipalities with Open Data in Fukui Prefecture are 18. This number is the first in Japan except the administrative district of Osaka City. On the flip side, it does not mean that the impact of Sabae city uniformly delivered across the country. It can be said the regional influence has appeared heavily.

Conclusion

Analysis of the details of the regional bond yield to another draft, but in this study, compared the information network of WEB site with the low cost of reference, that of the persons in charge of public information had a less tendency of over-concentration.

This study only showed the difference of distributions in information networks between online and offline, and pointed out the possibility

that regional bonds work well. But aiming to further promotion of Open Data, we should also remember that the regional peer pressure plays one of the important roles, and not limit ourselves by following the success stories of some pioneering local governments.

In the formation of the social network, considering human constraints of time and money, it is also necessary to focus on familiar and homogeneous relationship. Findings of this study may not stay only in the range of Open Data promotion. Future task is to generate them considering peculiarity of Open Data.

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