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# Domestication of smartphones and mobile applications: A quantitative mixed-method study

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## Abstract:

Smartphones are finding their way into our daily lives. This paper investigates domestication of smartphones by examining how using mobile applications affects daily life routines. Data is collected through an innovative quantitative mixed-method approach, combining log data collected via smartphones and survey (perception) data. We find that dimensions of domestication explain how smartphone usage affects daily life routines. Contributions are stronger for downloaded applications than native applications. Especially those applications requiring interaction with others, such as social media and instant messaging, have the greatest effect on daily life routines. So appropriation is core in incorporating smartphones in daily life routines. However, frequency of use and the total number of minutes spent on a type of application per day affect daily life routines differently. The paper is the first quantitative domestication study that focuses on smartphones rather than feature phones. The theoretical contribution and practical implications are outlined.

## Keywords

Mobile media, domestication theory, smartphone, mobile communication, mobile applications

## 1. Introduction

Mobile technologies have a tremendous impact on the lives of people across the globe (Katz, 2008). Mobile technologies can offer increased productivity, independence, ability to contact others, flexible coordination, connectedness, interpersonal relationships and new ways to express emotions and feelings (Jarvenpaa et al., 2003). Ultimately, mobile technologies even change how people perceive time, space and social context (Arnold, 2003). Mobile technologies can also negatively affect users, for instance leading to social inclusion (Geser, 2006), addiction (Walsh et al., 2008), enslavement and dependence (Järvenpää and Lang, 2005), or cyberbullying. Forming productive habits regarding mobile technologies takes time and requires longer periods of use (Srivastava, 2005).

How information and communication technologies contribute to the formation of daily life routines is the core concern of domestication theory (Tojib et al., 2015; Silverstone and Haddon, 1996; Silverstone et al., 1992). Domestication literature studies how people utilize, give meaning to and are affected by technologies. Domestication of mobile technologies has been subject of previous studies (Glottz et al., 2005; Green and Haddon, 2009; Haddon, 2003; Ishii, 2006; Katz, 2008; Ling, 2004). However, these studies focus on traditional mobile devices rather than smartphones. Besides basic communication functions that are similar to traditional mobile phones, smartphones can be used to access a range of information, entertainment, social media, and financial services. Domestication of smartphones will likely differ from traditional phones since consumers can actively adapt the functionality of their smartphone to their daily life routines by installing a wide variety of applications.

This paper aims to *investigate based on domestication theory how smartphone applications usage contributes to the formation of daily life routines of consumers making use of a quantitative mixed method approach*. We focus on understanding “social dynamics surrounding the adoption and use of

1 ICTs as people try to find a place for new technologies in everyday live” (Loos et al, 2008,  
2 p.1).Therefore we analyse how different dimensions of domestication can be related to the use of  
3 different types of smartphone applications. In terms of domestication literature, we focus on  
4 practical operationalization of core concepts rather than symbolic meanings, on individuals rather  
5 than households, and on embedding in daily life routines (Keen& Mackintosh, 2001), rather than on  
6 societal implications (Ling, 2004, 2008; Oksman and Turtiainen, 2004).

7  
8 We adopt an innovative quantitative mixed-method approach. To measure the use of mobile  
9 applications, we collect log data directly from the smartphone of 233 Dutch consumers. Log data is  
10 to be preferred over self-reports of mobile application usage, which tends to be biased due to  
11 unsystematic misestimation (Boase and Ling, 2013; De Reuver and Bouwman, 2014; Kobayashi and  
12 Boase, 2012). By installing a background application on the users’ smartphone, a direct measurement  
13 on how users deal with devices and mobile applications can be performed (Verkasalo, 2008;  
14 Verkasalo, 2007). The background application enables one to unobtrusively log and record users’  
15 activities and gain insights into user-device relationship. The unobtrusive nature of the background  
16 application is related to the fact that the user is conscious, but not aware of the data being collected.  
17 The log data contains detailed information regarding time, duration and type of mobile applications,  
18 as well as whether the application was preinstalled in the smartphone or downloaded by the user. To  
19 assess the embedding of smartphones in daily life routines, we conduct a survey making use of the  
20 same sample. Combining survey and log data eliminates the risk of common method bias (MacKenzie  
21 and Podaskoff, 2012), question order, recall bias, and under- or overreporting (Schwartz, 2000), and  
22 internal validity (Verkasalo, 2007), which are prominent concerns for many user studies on mobile  
23 applications.

24  
25 Section 2 develops the theoretical framework building on domestication theory. Section 3 details the  
26 method, followed by results in Section 4. Section 5 discusses results, and Section 6 presents the  
27 discussion and Section 7 concludes the paper with limitations and future research directions.

## 29 **2. Background: Domestication and related research on mobile technology**

### 30 *2.1 Domestication theory*

31  
32 Domestication theory concerns the commodification, appropriation and conversion of technology in  
33 everyday life as well as the societal consequences of the domestication of technology (Silverstone et  
34 al., 1992). While technology adoption or acceptance theories consider adoption as a discrete event,  
35 domestication theory considers adoption as a process. Domestication theory does not only include  
36 use but also the way people experience technologies, what technologies mean to them and how  
37 technologies play a role in daily lives (Haddon, 2003). During the process of domestication,  
38 dimensions like appropriation (i.e., purchasing the technology), objectification (i.e., using the  
39 technology and exploring basic functionalities), incorporation (i.e., giving the technology a place in  
40 daily routines and making it functional) and conversion (i.e., displaying the technology to the outside  
41 world) are core (Silverstone et al., 1992).

42  
43 Early work on domestication considers the household as unit of analysis (Silverstone et al., 1992).  
44 However, later domestication studies take the individual consumer as unit analysis, who may or may  
45 not be within the boundaries of the home (Haddon, 2003, 2007). For example, Lee (2013) argues that  
46 smartphones enable individual to stay connected and ubiquitously communicate with peers and  
47 friends across a personal networks and reinforce the individualization of personal relationships.  
48 Through social media applications, for example, individuals can expose their thoughts and feelings,  
49 share and seek information which in turn in the context of domestication theory, these actions  
50 resemble the conversion phase of the domestication process. Moreover, using smartphones as an  
51 instrument to seek for information irrespective of the time and place has become an integrated part  
52 of individual’s life, especially among younger generations (Bertel, 2013). This is agreed upon by

1 Damásio et al. (2013) that by using smartphones individuals gain values not because of having access  
2 to technology, rather through its use and accessing the specific network of users with whom they  
3 share specific activities. Domestication theory is applied in various contexts, such as domestication of  
4 media and technology (Berker et al., 2005), technology transmission within families (Correa, 2014)  
5 and the domestication of digital games in the lives of older adults (De Schutter et al., 2014).  
6

## 7 2.2 Related work on mobile technology relevant from a domestication perspective

8 One of the first studies on telephony was done by Pool (1977, 1983) who forecasted the effect of  
9 telephony on everyday life and social interactions. The first to study telephony with an explicit  
10 domestication perspective was by Bergman (1994) who focused on gender identities and  
11 connotations. Domestication research on mobile telephony started with Haddon (2003).  
12 Subsequently, researchers focused on self-expression and entertainment value of mobile  
13 technologies (Fortunati and Contrarellos, 2002; Ling, 2003; Oksman and Turtianinen, 2004). Others  
14 have studied how mobile phones interact with work-related activities of daily life (Palen et al., 2001).  
15 Besides functional implications, also the implications of mobile phones as a fashion statement have  
16 been studied (Fortunati and Contrarellos, 2002; Katz and Sugiyama, 2006; Ling, 2003). A recent study  
17 making use of domestication theory focuses on cultural differences and market conditions (Bolin,  
18 2010). Ling and Donner (2010) discuss mobile technologies in relation to micro-coordination, the  
19 display of the self, and dynamics of family integration. On a macro-level, the social implications of  
20 mobile communications on national, cultural and comparative bases have been studied (Katz and  
21 Aakhus, 2002). One of the first quantitative studies on domestication of mobile phones was  
22 conducted by Cohen and Lemish (2003) who use a combination of pop-up surveys and experience  
23 sampling.  
24

## 25 2.3 Applying domestication theory to smartphones

26  
27 Although domestication of mobile telephony has thus been amply studied, domestication of  
28 smartphones has not been studied. Smartphones differ from traditional mobile telephones as they  
29 allow using applications and downloading new applications to adapt the functionality of the phone.  
30 Moreover, social media applications provide a means to display the technology to the outside world  
31 in ways that were not possible with traditional phones.  
32

33 Applying domestication theory to smartphones requires three specifications on Silverstone et al.'s  
34 (1992) original work. First, smartphones are typically used by individuals rather than households,  
35 thus changing the unit of analysis. Second, usage of smartphones is not limited to the physical  
36 boundaries of a household, but specifically break with time and space limitations. Third, the four  
37 dimensions of the domestication process from Silverstone et al. (1992) have to be adapted to the  
38 specific characteristics of smartphones. The appropriation dimension implies that a person acquires a  
39 smartphone. The objectification dimension, defined as *taking technologies home or in the private*  
40 *cultural spaces and making or not making, them acceptable and familiar* (Silverstone and  
41 Heddon, 1996, p. 64), is related to how the person uses the technology and finds out basic native  
42 functionalities. Regarding smartphones, we argue that individuals try out, adjust settings and use  
43 mobile applications that are preinstalled on the smartphone, so-called 'native' applications. The  
44 incorporation dimension, is described as *removing functions from those intended by designers, i.e.*  
45 *functions that may change or disappear* (Silverstone and Heddon, 1996, p. 45) and to *release time for*  
46 *other activities, like mobile phone enable coordination activities* (Bergman, 1994; Silverstone and  
47 Heddon, 1996, p. 64). So individual gives the technology a place in daily routines and makes it  
48 functional. In the case of smartphones, we argue that individuals do so by downloading additional  
49 applications to meet personal needs. Although Silverstone and Heddon (1996) discuss the social  
50 dynamics and politics of households in this context, we advocate, like Ling (2004, 2008), that mobile  
51 phones are largely individual; hence peers, rather than family, might impose rules and policies. The  
52 conversion dimension relates, to how people display the technology to the outside world. Conversion

1 *signals the importance of the need to legitimate one's participation in consumer culture in the display*  
2 *of competence and ownership* (Silverstone and Heddon, 1996, p. 64). For smartphones, we argue this  
3 is done through applications that facilitate digital self-expression and social interaction, being most  
4 manifest via social media and instant messaging applications. These dimensions have a certain  
5 implicit time order. Users reshape the smartphone from an object into a meaningful device for social  
6 interaction, beyond mere person-to-person communication. Thus using domestication theory  
7 provides insights into how smartphone applications usage contributes to the embedding of the  
8 smartphone in daily life routines of consumers (Keen & Mackintosh, 2001). For instance, Jung et al.  
9 (2014) argue that once individual established their habits towards acquisition of mobile application,  
10 the level of concentration of mobile application usage will be higher

#### 11 12 *2.4. Hypotheses development*

13  
14 In the remainder of this section, we develop hypotheses on the dimensions of domestication. It starts  
15 with the initial decision to acquire the smartphone. Most domestication studies on traditional mobile  
16 phones suggest demographics are an important predictor of the decision to acquire a mobile phone  
17 (Pedersen and Ling, 2003). Leung and Wei (1999) found that young males with high incomes and  
18 higher education are most likely to adopt mobile technology first. Rice and Katz (2003) found similar  
19 results with income, work status (working part-time) and marital status being the core predictors.  
20 Wareham et al. (2004) reported similar findings. We propose the following hypotheses.

21  
22 **H1:** *Demographics affect appropriation of smartphones*

23 **H1a:** *Younger people are more likely to appropriate smartphones*

24 **H1b:** *Males are more likely to appropriate smartphones than females*

25 **H1c:** *People with higher income are more likely to appropriate smartphones*

26 **H1d:** *People with higher education levels are more likely to appropriate smartphones*

27  
28 The second dimension of domestication process that follows temporary on the appropriation of the  
29 device, is the objectification dimension. This dimension relates to how individuals start to explore  
30 basic functionalities that are preinstalled on smartphones and adjust setting. Such native applications  
31 include telephony, messaging, cameras and alarm clocks. Typically, navigation, browsing, email and  
32 calendar applications are also preinstalled in smartphones. Individuals learn how to deal with these  
33 applications specifically the built-in features and functionalities. We assume that using these native  
34 applications helps individuals to fit the smartphone into their daily life routines. We use the concept  
35 of daily life routines as proposed by Keen & Mackintosh (2001). Based on the French historian  
36 Braudel they argue that *technologies have value when it changes the limits of the possible in the*  
37 *structures of everyday life*. The assumption is that only when an innovative technology, like  
38 smartphones, has become part of everyday life it has value for the user or in the words of Silverstone  
39 and Haddon " *are brought (or not) under control by and on behalf of domestic users*" (1996,  
40 p.60). Therefore, we hypothesize that

41  
42 **H2:** *Objectification of smartphones (i.e., use of native applications) contributes positively to daily*  
43 *life routines*

44  
45 In the third phase of domestication process, i.e., incorporation, individuals start to download, install  
46 and use new applications based on their needs and preferences. In this way, the functionality of the  
47 smartphone is being incorporated to the specific needs and daily life activities of the user. Therefore,  
48 we hypothesize that:

49  
50 **H3:** *Incorporation of smartphones (i.e., use of downloaded applications) contributes positively to*  
51 *daily life routines*

52

1 A wide range of applications is available in app-stores that can be downloaded and installed to a  
2 smartphone. Revels et al. (2010) argue that domestication researchers should focus on specific  
3 applications rather than the telephone as a whole, since primary functions, like telephony, are  
4 blurred with entertainment features. Bouwman et al. (2012) study how innovativeness, effort,  
5 usefulness, context dependency and use intention differs across 48 specific mobile applications.  
6 Across different dimensions, their study shows major differences between application categories of  
7 communication (i.e., instant messaging, voice-telephony, and email), information (i.e., search, news,  
8 weather and browsing applications), entertainment (i.e., music, video, and gaming), and transactions  
9 (i.e., payment, ticketing, and banking). In this paper, we omit transaction services since current  
10 adoption levels are still low. However, we do specify the generic hypothesis H3 to reflect the  
11 differences between mobile service categories.

12  
13 **H3a:** Use of downloaded mobile information applications contributes positively to daily life  
14 routines

15 **H3b:** Use of downloaded mobile entertainment applications contributes positively to daily life  
16 routines

17  
18 The last dimension of domestication, i.e., conversion, discuss how individuals use their smartphone  
19 to present it to others and to display their ownership and competence to others in a digital way. We  
20 argue that applications that require interaction with others can serve this purpose. Such services  
21 include instant messaging (e.g., WhatsApp), social media for sharing information (e.g., Facebook,  
22 LinkedIn, Instagram and Twitter) and productivity tools like sharing contacts, calendar and agenda  
23 functions. These applications combine two or more communication, information and entertainment  
24 features (Bouwman et al., 2012; Kuo and Chen, 2006). We hypothesize that:

25  
26 **H4:** *Conversion of smartphones (i.e., use of applications that require involvement of others)*  
27 *contributes positively to daily life routines*

## 28 29 **4. Method**

### 30 **4.1 Sample**

31  
32 A commercialuser panel comprising 20.000 households, as provided by Marketresponse, was used  
33 to sample respondents. The user panel is representative for the Dutch population in terms of  
34 demographics. The panel is regularly renewed through active recruitment (i.e., thus no self-selection  
35 bias is involved) and panellists are typically not compensated for taking part in surveys. As the  
36 measurement software utilized in this research only works with iPhone and Android smartphones  
37 (the most popular platforms), Symbian, Blackberry and Windows phone users are excluded from the  
38 study. From the panel, a random sample was drawn at the end of 2012. Next, an initial questionnaire  
39 was sent to the persons in the sample inviting them to participate in the study. The initial  
40 questionnaire extensively explained how log data on smartphones would be collected, stored and  
41 analysed in the study, as well as how privacy would be guaranteed (Bouwman et al., 2013). As the  
42 first round of recruiting did not lead to sufficient response of smartphone users, the procedure was  
43 repeated but only including the subset of respondents that were known to possess a smartphone.  
44 Finally, in order to increase the number of participants in the research, in a third recruiting round,  
45 panellists who participated in an earlier pre-test based study were also approached to participate. A  
46 multi-group analysis on the final model in Figure 5, shows no significant differences across the three  
47 recruitment groups with regard to measurement weights ( $\chi^2 D (2) = .082, p = .960$ ), measurement  
48 intercepts ( $\chi^2 D (3) = .1.575, p = .665$ ) and structural weights ( $\chi^2 D (14) = 18, p = .189$ ).

49  
50 After data cleaning for partial non-response, the three rounds of recruitment resulted in data from  
51 1653 persons that filled in the initial questionnaire, out of which 519 (31%) were willing to  
52 participate in the study. A large part of the smartphone users refused to participate (59%). Of the

1 reasons for non-participation provided, the core reason was privacy (by 16% of the respondents). For  
 2 15% of the respondents the reasons were related to typical non-response reasons, such as holidays,  
 3 sickness and travelling abroad. Technical reasons were mentioned by 2% of the respondents, and 3%  
 4 indicated their employer would not allow them to download apps on their phones. Other reasons  
 5 (23%) provided included low usage of the smartphone and no experience or cognitive capabilities to  
 6 install applications on their smartphone.

7  
 8 Although, 519 respondents initially indicated that they were willing to participate in the study, only a  
 9 part of them downloaded and installed the application (369). Of those, 233 respondents participated  
 10 for the full four weeks of the study. Reasons to drop out during the study were related to technical  
 11 problems, like battery drainage and reduced performance of the phone. Some respondents dropped  
 12 out because they upgraded to a new version of their operating system or due to travelling abroad,  
 13 and so on. Sample characteristics are given in Table 1. On average, participants were 46 years old,  
 14 while the average age for the whole Dutch population is 47 years old (excluding all the under 16  
 15 years). Gender, position in household, and income are representative. However the final sample is  
 16 biased to bigger households, and the higher educated. Also retired persons are overrepresented,  
 17 while working persons are underrepresented.

18  
 19  
 20  
 21  
 22  
 23 **Table 1**  
 24 Demographics of final sample (N=233).  
 25

Data on sample and population 16 years and older		Sample	Dutch population (based on multiple sources provided by statline.nl; data of Dutch Statistical Office 2012)
Gender	Male	52%	53%
	Female	48%	47%
Position in household	Primary wage earner	28%	26%
	Caretaker	27%	24%
	Both	32%	34%
	Child	12%	16%
	Other	1%	-
Education	Higher education	61%	28%
	Middle education	34%	40%
	Lower education	4%	30%
Activity	Working	73%	61%
	Retired	8%	19%
	Caretaker	1%	-
	Student	10%	11%
	Unemployed	3%	3%
	Incapable to work	3%	3%
	Social Benefit	0%	3%
	Other	1%	-
Family size	1	20%	36%
	2	28%	33%
	3	17%	12%
	4	28%	19%
	>4	8%	-
Income	Below Modus	13%	17%
	Modus	25%	23%
	Above Modus	59%	59%
	DNK, no answer	3%	-
Operating system	iOS (Apple)	26%	Not Available
	Android	74%	Not Available

26  
 27  
 28 **4.2 Log data metrics**  
 29

1 Usage of mobile application categories was measured by collecting log data directly on the  
 2 participant smartphone. Our approach is similar to the few previous studies that utilize smartphones  
 3 to automatically log user activities (Eagle and Pentland, 2006; Falaki et al., 2010; Raento et al., 2009;  
 4 Verkasalo and Hämmäinen, 2007, for an overview see Karikoski, 2012).  
 5 To carry out smartphone measurement, a number of software tools are available, for example  
 6 LiveLab used by Shepard et al. (2011) and Device Analyser (deviceanalyzer.cl.cam.ac.uk). The present  
 7 study utilizes the commercially available smartphone measurement application from Arbitron  
 8 Mobile. The measurement application runs on the background of the mobile phone, and transmits  
 9 log files to the server on a daily basis. The application can be downloaded from the regular app-  
 10 stores. Participants were already fully aware of the types of activities and events being logged  
 11 unobtrusively, as became apparent from an evaluative questionnaire after the study period.  
 12  
 13  
 14  
 15  
 16  
 17  
 18

19 **Table 2**

20 Application types with at least ten per cent penetration among participants.

Application type	Most frequently used applications
Voice telephony	Native voice-telephony app
Browsing	Native* browser, Safari, Chrome, Dolphin, Opera, Firefox
Email	Native email client, Gmail, Yahoo mail
Maps / Navigation	Google maps, native maps app, Navigon, Locus, Navfree
News / Information	Nu.nl, Genie widget, BBC news, Google reader, TV guide
Online music	Spotify, Shazam, iTunes, Sound hound, Tunein radio
Online video	YouTube, HTC stream player, Podcasting
Search	Google search, Android voice-search
Gaming	Wordfeud, Words Rumble, Song pop, Draw Something, Mindfeud, Solitaire, Sudoku
Instant messaging / Chat	Whatsapp, Facebook messenger, Google Talk
Productivity	Notes, Calculator, Dropbox, Adobe reader, Evernote
Social networking	Facebook, Twitter, LinkedIn, Pinterest

21 \* Native = embedded in the operating system of the mobile phone (i.e., not manually downloaded by the user)  
 22

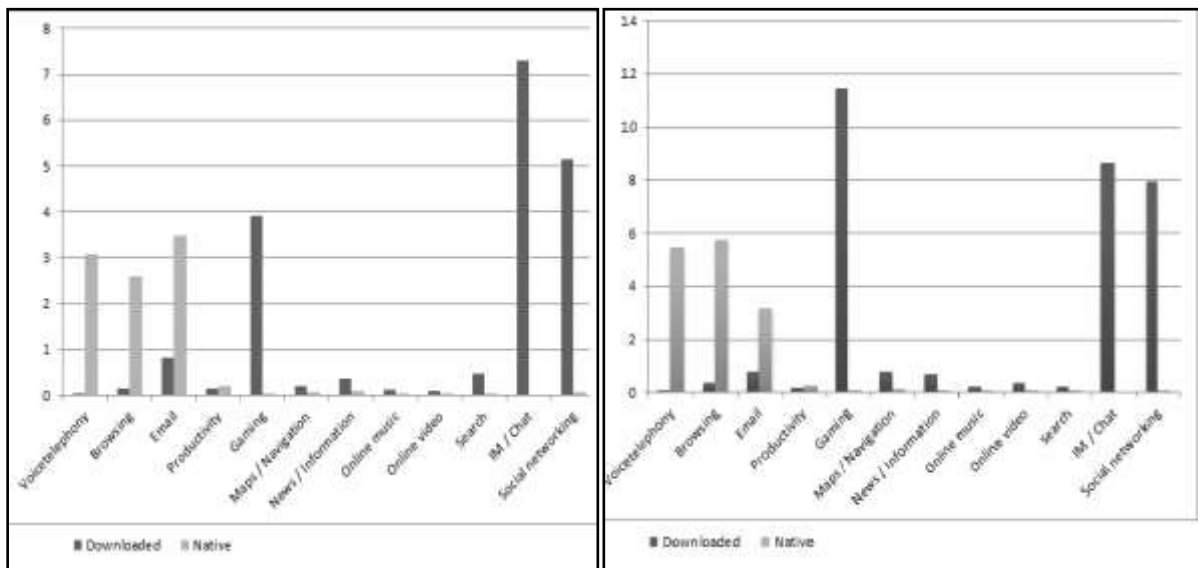
23 The software logged each action of the participants over a period of 28 days (30 October–27  
 24 November 2012). Each time an application is launched, the software logs the application name, date  
 25 and time, and duration in which it is displayed on the foreground of the device. The software  
 26 classifies applications into specific types using automated content analysis. The researchers manually  
 27 checked and verified the most frequently used applications and found no errors. Of the application  
 28 sessions, the software could not log 15% code automatically. These sessions are omitted from further  
 29 analysis. Elimination of those sessions from the analyses did not influence the research results, as  
 30 they were dispersed across a highly diverse set of applications. In the paper, we include the  
 31 application types that were used at least once by at least 10% of the participants, for instance VOIP  
 32 did not reach this cut-off point. SMS was not included in the analyses due to two reasons: (i) the high  
 33 usage of SMS in various contexts is already a well-known fact (Naughton, 2014; Gerpott and Thomas,  
 34 2014; Ho, 2012) and (ii) technical issues e.g., the measurement of SMS is not possible for iPhones.  
 35 The twelve application types included in the study are provided in Table 2.  
 36

37 Use of mobile application types is operationalized into two distinct metrics. First, we consider the  
 38 intensity of use, defined as the average number of minutes spent on that type of application per day.



1 We measure intensity of use by calculating the average number of minutes an application type is  
 2 shown on the foreground of the mobile device. Second, we consider the frequency of use, defined as  
 3 the average number of usage sessions for that type of application per day. A usage session is defined  
 4 here as the event of launching an application, either after having been idle for at least ten seconds or  
 5 after having used an application of a different type.

6  
 7 Descriptive statistics for both metrics per application type are given in Figure 1. Instant messaging,  
 8 social networking, gaming and email applications are most frequently (i.e., number of sessions) used.  
 9 Most intensively used are gaming, instant messaging, social networking, browsing applications and  
 10 voice telephony. There is wide variation in how often applications are being used. Especially gaming,  
 11 instant messaging and browsing have high standard deviations compared to the means. One  
 12 participant launches instant messaging applications as much as 95 times a day on average and  
 13 another participant uses gaming applications for over two hours on an average day. To deal with  
 14 such severe non-normality and reduce the impact of outliers, we transform all metrics using a  
 15 logarithmic transformation. After the transformation, all variables have a close to normally  
 16 distributed shape, and have acceptable Kurtosis and Skewness. The frequency distributions of the  
 17 transformed variables do not exhibit extreme outliers.



19 **Figure 1**  
 20 Frequency and intensity of use of native and downloaded mobile applications

21  
 22 Figure 1 also shows whether application types are typically used through downloaded or native apps.  
 23 As shown in Figure 1 Voice-telephony and browsing are predominantly used through native  
 24 applications and easy to accept and to familiarize with, thus representing the objectification  
 25 dimension. Maps/navigation and email are used both through native and downloaded applications,  
 26 and are thus on the edge between the objectification and incorporation.. News/information, search,  
 27 online music, gaming and online video are all used through downloaded applications. So the  
 28 necessary changing of functionalities is typical for the incorporation dimension. The remaining  
 29 application types that require interaction with others are all downloaded as well, i.e., instant  
 30 messaging and social networking offering the possibility for users to show their ownership and  
 31 competences digitally to others.

32  
 33  
 34 **4.3 Survey measures**

35  
 36 Effect of smartphones on daily life routines as proposed by Keen & Mackintosh (2001) is measured  
 37 using a self-developed three-item survey scale. The scale measures whether respondents experience

1 their daily life, routines and activities to be adjusted to usage of smartphones. This notion comes  
 2 close what Silverstone and Haddon (1996) describe as technologies “brought (or not) under control  
 3 by and on behalf of domestic users” (p. 60). All items were measured using 7-point Likert scale from  
 4 “Strongly disagree” to “Strongly agree”. Respondents answered the scales before installing the  
 5 logging application. Table 3 shows the results of confirmatory factor analysis, which exhibits  
 6 acceptable convergent validity and composite reliability.

7  
 8 **Table 3**  
 9 Confirmatory factor analysis.

Construct	Item	Factor Loading	AVE (Average Variance Extracted)	Composite Reliability
	My daily life has changed due to use of smartphones	.70		
Daily life routines	My daily activities are enabled through smartphones	.64	.45	.74
	Using smartphones fits my daily routines	.66		

10  
 11 **5. Results**

12 Hypothesis H1 states that demographics affect adoption rates of smartphones. Based on the  
 13 questionnaire used to select the participants in the study we could compare smartphone users  
 14 (43.5%) versus non smartphone (56.5%) users (N=1070). For hypothesis H1, we thus use a different  
 15 sample than for the other hypotheses as referred to in Table 1. For instance, this sample includes  
 16 respondents that later refused to participate in the log data study or that possessed operating  
 17 systems that were not supported by our software.

18 Smartphone users are significantly younger than non-smartphone users ( $t(1141) = -12.42, p < .01$ ).

19  
 20 **H1a:** Younger people are more likely to appropriate smartphones – *SUPPORTED*

21  
 22 We find that males are slight more likely to own a smartphone (54%) then females (46%), although  
 23 the difference is not significant ( $\chi^2(1) = 1.49$ , not significant).

24  
 25 **H1b:** Males are more likely to appropriate smartphones than females – *NOT SUPPORTED*

26 Smartphone owners have higher incomes ( $\chi^2(4) = 56.93, p < .001$ ).

27  
 28 **H1c:** People with higher income (above modus) are more likely to appropriate smartphones –  
 29 *SUPPORTED*

30 Higher educated respondents (college and university levels) are more likely to own a smartphone ( $\chi^2$   
 31 (7) = 79.30,  $p < .001$ ).

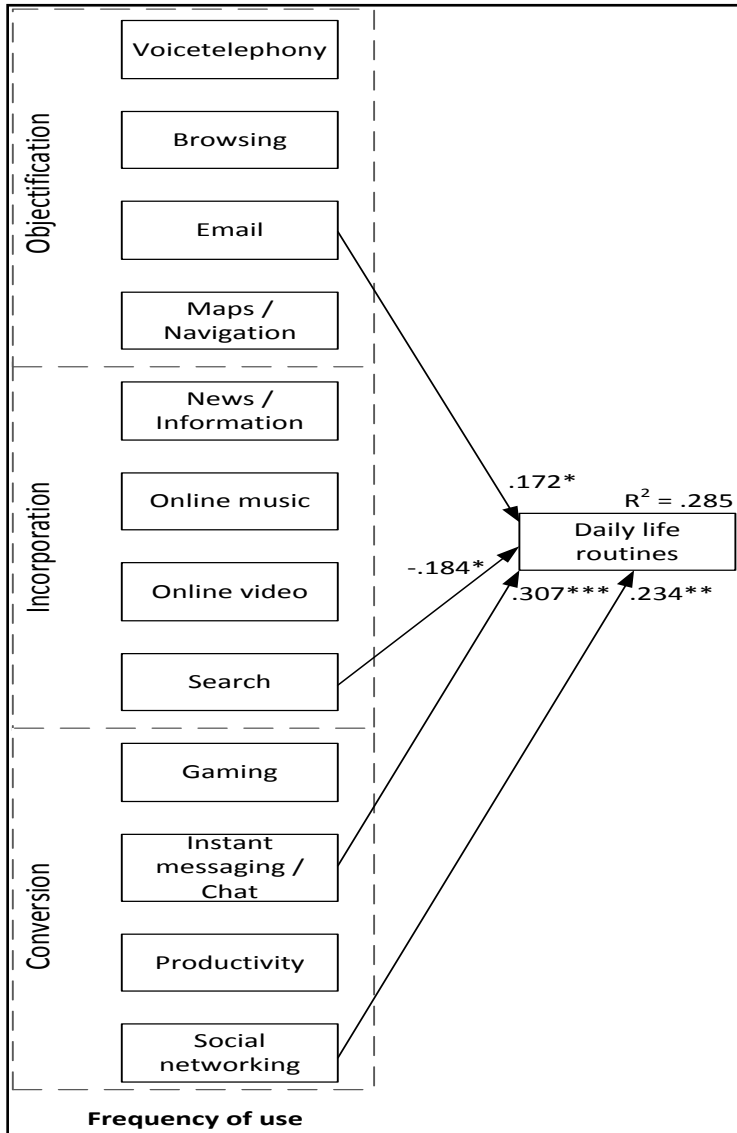
32  
 33 **H1d:** People with higher education levels are more likely to appropriate smartphones – *SUPPORTED*

34  
 35 Hypothesis H1 is therefore supported, except for the effect of gender, which was not significant.  
 36 Appropriation of smartphones thus starts with the young, more affluent and higher educated.

37  
 38 Next, we test hypotheses H2, H3 and H4 through structural equation modelling using SPSS AMOS as  
 39 an analysing tool. Figure 2 shows a structural model, which explains fit of smartphones into daily life  
 40 routines through frequency, i.e., number of sessions, of use metrics. Non-significant paths and the  
 41 measurement model are omitted from the figure for readability.

42  
 43 This model has a high fit:  $\chi^2(32) = 27.171, p = .710, NFI = .961, TLI = 1.03, CFI = 1.000, RMSEA = .000$ .  
 44 It is striking that instant messaging / chat has the biggest effect on daily life routines, followed by  
 45 social network and gaming. Frequency of use of search applications has a negative effect: apparently,  
 46 using search applications more frequently makes it difficult to fit smartphones to daily life routines.  
 47 Possible explanation might be that search via smartphone is cumbersome.

1



2

3

**Figure 2**

4

Effect of frequency of use on daily life routines –structural regression model (\*\*\*)  $p < .01$ ; \*  $p < .05$ ).

5

6

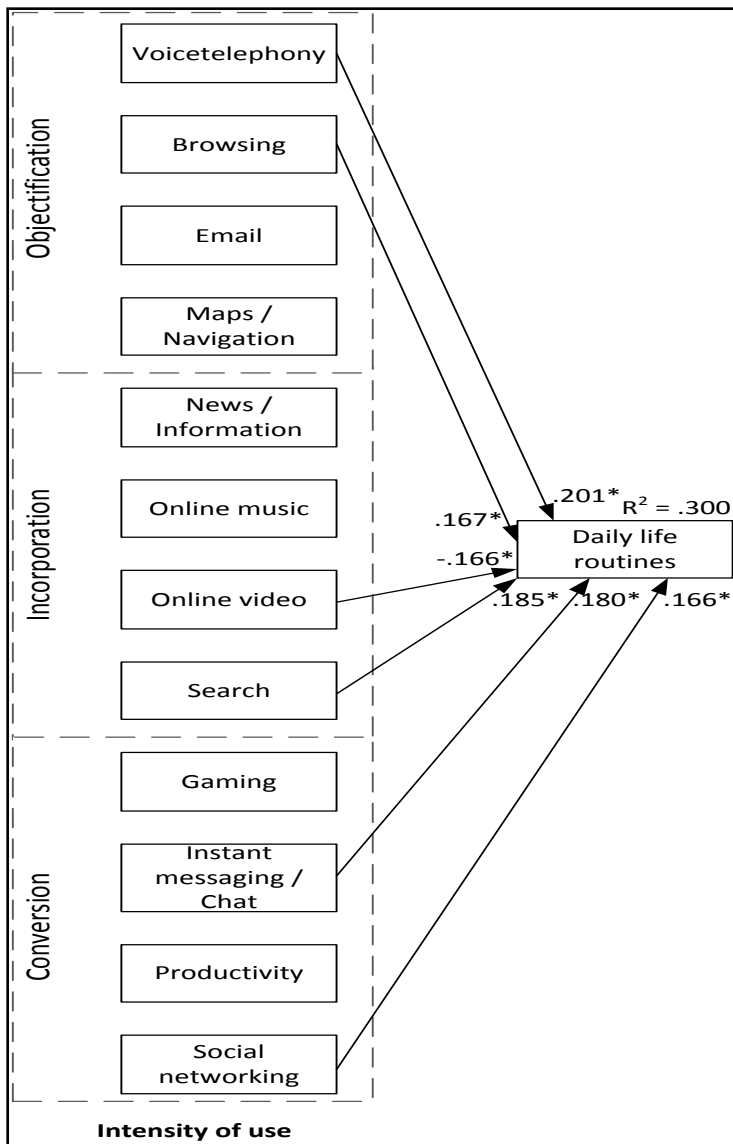
The model that explains daily life routines through intensity of use metrics shows acceptable overall fit:  $\chi^2(30) = 19.352$ ,  $p = .932$ ,  $NFI = .949$ ,  $TLI = 1.17$ ,  $CFI = 1.000$ ,  $RMSEA = .000$ , see Figure 3. Explained variance is moderate (30%). All path weights are relatively small. Especially the duration of communication services has a significant effect on daily life routines.

10

11

The more time spent on voice- telephony, instant messaging and social networking, the more smartphone usage has an impact on daily life routines. Also time spent on information services like browsing and search have a significant effect, although news, maps and productivity tools do not. Entertainment services are not significant, except for online video, which, strikingly, has a negative effect on daily life routines.

15

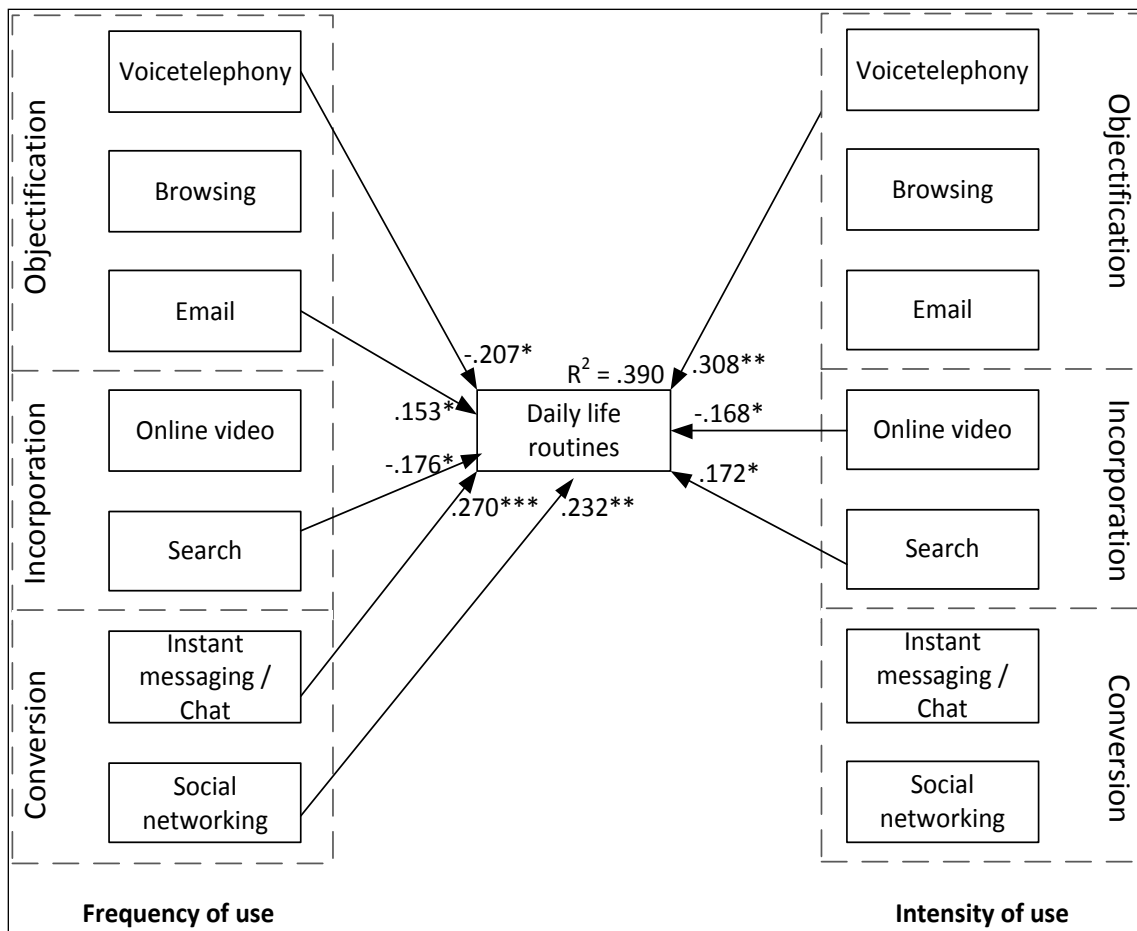


1  
2 **Figure 3**

3  
4 Effect of intensity of use on daily life routines – results of structural regression model (\* p<.05).

5  
6 Next, we examine the relative importance of intensity and frequency of use metrics by constructing a  
7 combined model. In order to obtain a parsimonious model that suits the moderately sized sample,  
8 we only include those application types that had a significant effect in Figure 2 or 3.

9  
10 The combined model is provided in Figure 4, and shows high fit:  $\chi^2 (34) = 27.873$ ,  $p = .761$ ,  $NFI = .985$ ,  
11  $TLI = 1.017$ ,  $CFI = 1.000$ ,  $RMSEA = .000$ . Explained variance is substantially higher than in the  
12 individual models: 39%.



1  
2 **Figure 4**

3 Structural regression model on intensity and frequency of use (\*\* $p < .001$ ; \* $p < .01$ ; \* $p < .05$ ).

4  
5 Regarding frequency of use, all significant paths from the model in Figure 2 are replicated, with  
6 similar effect sizes. However, one path has been added to the model: voice-telephony has a negative  
7 effect on daily life routines. Several effects regarding intensity of use drop out of the combined  
8 model. Intensity of use of browsing, instant messaging and social networking applications are no  
9 longer significant. The effect size of online video and search is similar to the model in Figure 3. The  
10 effect size of voice telephony has increased with about 50% to .308.

11  
12 Overall, frequency of use metrics has a higher total effect size than intensity of use metrics. Counting  
13 the number of times an application is launched thus has a higher predictive power than counting the  
14 number of minutes spent on the application. However, explained variance of the combined model is  
15 higher than that of the model that solely includes frequency of use metrics. Moreover, intensity of  
16 use metrics related to online video, search and voice-telephony are still significant in the combined  
17 model. As such, measuring both the intensity and frequency of use has the highest explanatory  
18 power for the effect of smartphones on daily life routines.

19  
20 The hypothesis with regard to objectification of basic functionalities as provided by native  
21 applications is conformed, but limited to the frequency and use of voice-telephony, and frequency of  
22 emailing.

23  
24 **H2:** Objectification of smartphones (i.e., use of native applications) contributes positively to daily life  
25 routines – *SUPPORTED*

26

1 The hypothesis on incorporation is also confirmed but mainly for frequency and intensity of search  
2 functionality. Only some information applications affect daily life routines positively (i.e., search), but  
3 others do not have an effect (i.e., News, Maps and navigation, productivity).  
4

5 **H3a:** Use of downloaded mobile information applications contributes positively to daily life routines  
6 – *SUPPORTED*  
7

8 Entertainment applications have no effect on daily life routines (i.e., gaming, music). Online video  
9 plays a rather unclear role here. We will come back to this in the discussion.  
10

11 **H3b:** Use of downloaded mobile entertainment applications contributes positively to daily life  
12 routines – *NOT SUPPORTED*  
13

14 Finally the hypothesis on conversion is supported but only for the frequency of usage of social media  
15 and instant messaging.  
16

17 **H4:** Conversion of smartphones (i.e., use of applications that show ownership and competence to  
18 others) contributes positively to daily life routines – *SUPPORTED*  
19

## 20 **6. Discussion**

21

22 Our study shows that the impact of mobile applications on daily life routines differs strongly for  
23 different types of services. Researchers should therefore distinguish specific mobile applications in  
24 detail and not treat mobile application as a black box, as is common in domestication as well as in  
25 acceptance studies (e.g., Skog, 2002; Pedersen and Ling, 2003; Haddon, 2003; Nikou, 2012, Oksman  
26 and Turtiainen, 2004; Ling, 2012).  
27

28 With regard to objectification, use of native applications for communication purposes contributes to  
29 daily life routines, specifically voice-telephony and email. This finding confirms earlier studies on how  
30 mobile voice-telephony and SMS affect the social aspects of people's lives (Ling, 2008; Srivastava,  
31 2005). We found that voice-telephony has a paradoxical effect: frequency of use negatively  
32 contributes to daily life routines, while intensity of use provides a positive contribution. Apparently,  
33 making longer phone calls contributes to daily life routines, while making more frequent and shorter  
34 phone calls has a negative effect. Short and frequent calls might disturb daily life activities, while on  
35 the other hand one may argue that short phone calls should be suited to arrange practicalities of  
36 daily life, e.g. coordination activities, better than long calls. A future research direction would be to  
37 explore if size of the household moderates the effect of voice-telephony frequency on daily life  
38 routines.  
39

40 With regard to incorporation, downloaded applications contribute to daily life routines. However,  
41 findings suggest a sharp contrast between information and entertainment application categories.  
42 Information services as well as browsing and search only mildly affect the daily routines of people.  
43 Apparently, even heavy users of information types of applications do not feel that the smartphone  
44 has greatly influenced their daily routines. Possibly, distinguishing between different topics and  
45 issues that people browse and search for could result in more sophisticated understanding of how  
46 information services fit with daily life routines. Search services have a paradoxical effect: frequency is  
47 negatively related, while duration is positively related to daily life routines. Apparently, quickly and  
48 frequently looking up something does not fit in daily routines, and again can be considered to be  
49 distracting. Sparse and more intensive use does help to solve problems. One alternative explanation  
50 is that frequent and quick searches do not provide the answers people are looking for in their daily  
51 activities. Taking into account whether people are able to find what they are looking for would be  
52 relevant.

1  
2 Downloaded entertainment applications, like gaming, online music and video do not contribute to  
3 daily life routines at all. Assuming that entertainment services are predominantly used when bored  
4 or to kill time, such casual use of applications may explain why they do not support routines and  
5 processes. An alternative explanation is that especially online music is used on the background of  
6 people's activities, and thus do not require the user's full attention. Online video even has a negative  
7 effect on daily life routines. While this finding may explain the lack of the success in mobile television  
8 experiments, it might also be that individuals frame their smartphone as a communication device  
9 rather than a tool to view videos. Alternatively, spending time on online video might disrupt or  
10 disturb daily routines in a negative way, for instance watching videos while one is supposed to  
11 executive other tasks.

12  
13 With regard to conversion, application categories offer users their ownership and capabilities in using  
14 the device require others to be involved. Instant messaging and social networking have a great effect  
15 on daily life routines. Possibly, these advanced communication services make social interactions  
16 more visible and flexible, thus adding freedom to how people organize and control their (social)  
17 activities (Frissen, 2000; Keen and Mackintosh, 2001; Ling and Yttri, 2002). In addition, advanced  
18 communication services enable individuals to develop intimate relationships and to remain abreast  
19 of social life (Ling and Yttri, 2002). Moreover, sophisticated communication services like social  
20 networking allow users to generate their own content, which may contribute to the sense of self of a  
21 person (Srivastava, 2005) confirming insights based on domestication theory.

## 22 23 **7. Conclusions**

24  
25 Usage of smartphones affects daily life routines. Trying out basic functionalities, preinstalled  
26 applications like email and voice-telephony affect daily life routines. Next, when individuals start to  
27 adapt the smartphone functionality by downloading applications, information types of applications  
28 contribute to daily life routines. However, downloaded entertainment applications like gaming, video  
29 and music do not affect daily life routines. In the final phase of conversion, when technologies are  
30 shown to other people, interactive applications like social media and instant messaging have a great  
31 effect on daily life routines. Overall, when individuals advance through familiarizing themselves and  
32 their environment with their usage of a smartphone, the effects on daily life routines increase  
33 gradually, confirming basic assumptions of domestication

34  
35 The mixed method approach adopted in this paper is a unique and alternative contribution to the  
36 typical qualitative approach of domestication theory. We combine log data on actual usage levels  
37 which omits the typical measurement error in self-reports due to recall accuracy and social  
38 desirability. Moreover, we avoid the risk of common method bias that is common in typical survey  
39 studies. At the same time, big data or predictive analytics studies that solely rely on log data on usage  
40 levels typically miss the subtle effects that usage may have on people. This study shows that the  
41 observed usage levels do not correlate one-on-one with the effect on daily routines of people.  
42 Combining survey and log data will provide major opportunities for future research on  
43 domestication, in classes of applications as well as in individual usage.

44  
45 At more methodological level, we contribute to domestication literature on mobile technologies  
46 (Haddon, 2007) by adopting a quantitative approach. The merits of quantitative approaches to  
47 domestication have been discussed previously (Haddon, 2007), but the few quantitative studies that  
48 exist are typically descriptive in nature (Pedersen and Ling, 2003). We show how a quantitative  
49 approach that combines multiple sources of data can be used in an explanatory fashion. Overall, the  
50 methodology employed in this study has the potential to counter typical critique on domestication  
51 literature for being descriptive and non-replicable in nature.

1 Future studies on domestication of smartphones should distinguish the different classes of mobile  
2 applications, as this study shows that they affect daily life routines differently. Moreover, we argue  
3 that future studies should consider not only the time spent on mobile applications (i.e., intensity of  
4 use) but also the number of times a user launches applications (i.e., frequency of use), as both affect  
5 daily life routines differently.

6  
7 While the sample in this study is representative of the Dutch population for most of the core  
8 demographic variables, it is not representative on some other variables or on combinations of  
9 characteristics. The sample used cannot be used to make detailed analyses for specific sub samples.  
10 Another limitation is that SMS could not be included in the analysis as it cannot be measured on  
11 iPhones. We want to point out that such technical issues are hard to avoid in a log data study.  
12 Arguably texting is one of the most central function of mobile phones (Lenhart, 2012), and has  
13 sustained to be an important form of mediation. Since SMS can substitute short calls, it may play into  
14 an eventual explanation of the role of short calls for people who have a lot of coordination tasks.  
15 New over-the-top services offer similar functionality and are moving into this space, as the success of  
16 WhatsApp, SnapChat and Instagram (Dugan, 2013) illustrates and is confirmed if we look to the role  
17 of instant messaging in this paper.

18  
19 We are aware that a four week study is a short time to understand processes that are longitudinal in  
20 nature. However we see this study as a first that can be repeated with a panel design. We are aware  
21 that in order to truly investigate how applications 'affect' our daily life, 'how consumers fit their  
22 smartphones to their routines' or to 'systematically compare different application types' a more  
23 longitudinal study would give deeper insights. We see our quantitative study as complementary to  
24 more in-depth qualitative studies on domestication.

25  
26 Future research could take a more fine-grained understanding of domestication. Both quantitative  
27 and qualitative methods could be applied. Various mediating constructs could be included in future  
28 studies. Enjoyment, perceived value and technological affordance may be added to our model to add  
29 understanding why the use of applications contributes to daily life routines. More explicit attention  
30 for use context in a broader sense is also relevant to explain the impact of mobile applications on  
31 activities and performance (Gebauer et al., 2004). Specifically for communication services, maturity  
32 of the relation with significant others as well as the impact on group processes could be taken into  
33 account (Zigurs and Buckland, 1998). Similarly, the interaction of mobile applications usage in  
34 organizational life as well as the interaction between private and organizational life, could be  
35 researched in more detail (Schlosser, 2002; Sheng et al., 2005).

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