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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 (Glotz 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

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

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

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

2. Background: Domestication and related research on mobile technology

2.1 Domestication theory

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

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

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

2.2 Related work on mobile technology relevant from a domestication perspective

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

2.3 Applying domestication theory to smartphones

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

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

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

2.4. Hypotheses development

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

H1: *Demographics affect appropriation of smartphones*
H1a: *Younger people are more likely to appropriate smartphones*
H1b: *Males are more likely to appropriate smartphones than females*
H1c: *People with higher income are more likely to appropriate smartphones*
H1d: *People with higher education levels are more likely to appropriate smartphones*

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

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

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

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

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

H3a: Use of downloaded mobile information applications contributes positively to daily life routines

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

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

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

4. Method

4.1 Sample

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

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

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

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

Table 1

Demographics of final sample (N=233).

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

4.2 Log data metrics

Usage of mobile application categories was measured by collecting log data directly on the participant smartphone. Our approach is similar to the few previous studies that utilize smartphones to automatically log user activities (Eagle and Pentland, 2006; Falaki et al., 2010; Raento et al., 2009; Verkasalo and Hämmäinen, 2007, for an overview see Karikoski, 2012).

To carry out smartphone measurement, a number of software tools are available, for example LiveLab used by Shepard et al. (2011) and Device Analyser (deviceanalyzer.cl.cam.ac.uk). The present study utilizes the commercially available smartphone measurement application from Arbitron Mobile. The measurement application runs on the background of the mobile phone, and transmits log files to the server on a daily basis. The application can be downloaded from the regular app-stores. Participants were already fully aware of the types of activities and events being logged unobtrusively, as became apparent from an evaluative questionnaire after the study period.

Table 2

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

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

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

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

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

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

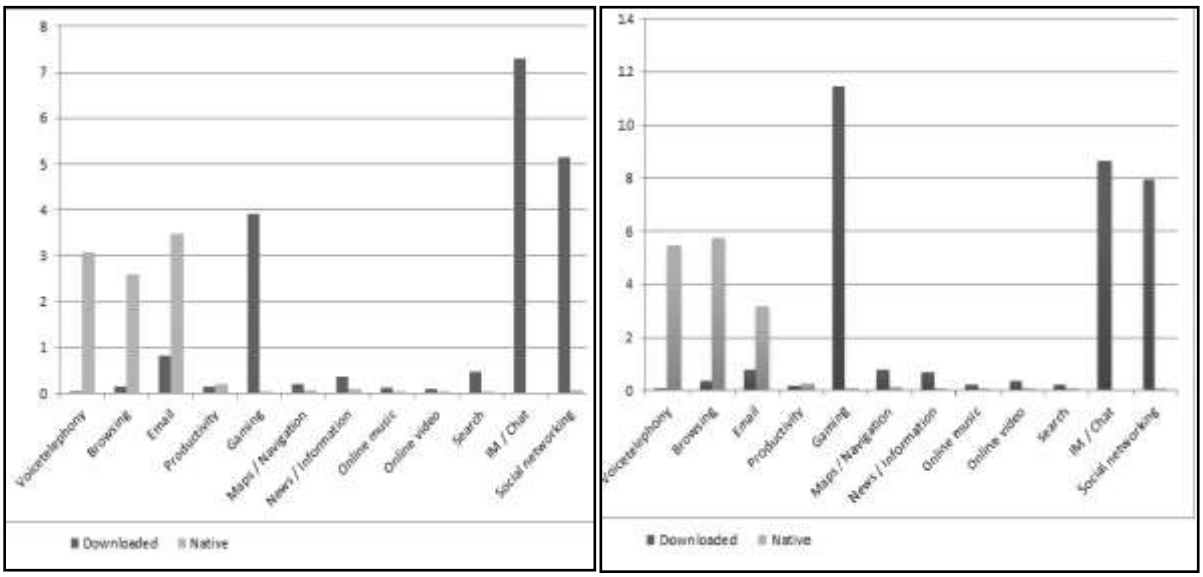

Figure 1
Frequency and intensity of use of native and downloaded mobile applications

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

4.3 Survey measures

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

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

Table 3
Confirmatory factor analysis.

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

5. Results

Hypothesis H1 states that demographics affect adoption rates of smartphones. Based on the questionnaire used to select the participants in the study we could compare smartphone users (43.5%) versus non smartphone (56.5%) users (N=1070). For hypothesis H1, we thus use a different sample than for the other hypotheses as referred to in Table 1. For instance, this sample includes respondents that later refused to participate in the log data study or that possessed operating systems that were not supported by our software.
Smartphone users are significantly younger than non-smartphone users ($t(1141) = -12.42$, $p<.01$).

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

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

H1b: Males are more likely to appropriate smartphones than females – *NOT SUPPORTED*
Smartphone owners have higher incomes ($\chi^2(4) = 56.93$, $p<.001$).

H1c: People with higher income (above modus) are more likely to appropriate smartphones – *SUPPORTED*
Higher educated respondents (college and university levels) are more likely to own a smartphone ($\chi^2(7) = 79.30$, $p<.001$).

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

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

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

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

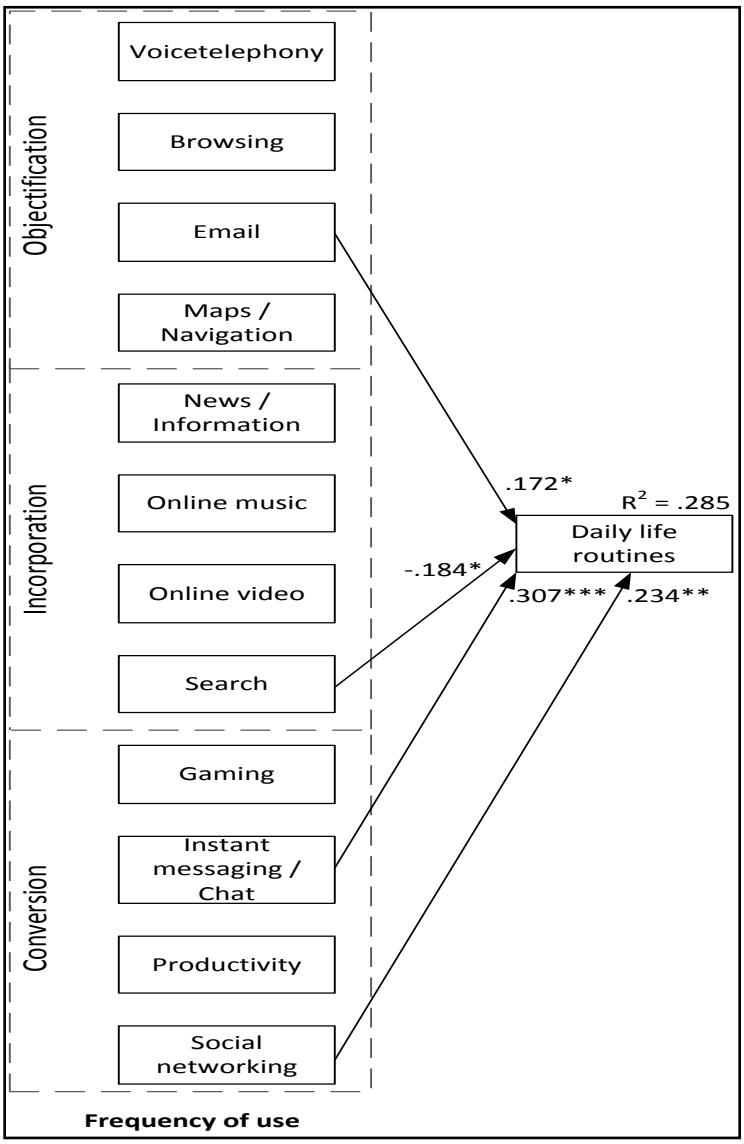

Figure 2

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

The model that explains daily life routines through intensity of use metrics shows acceptable overall fit: χ^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.

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.

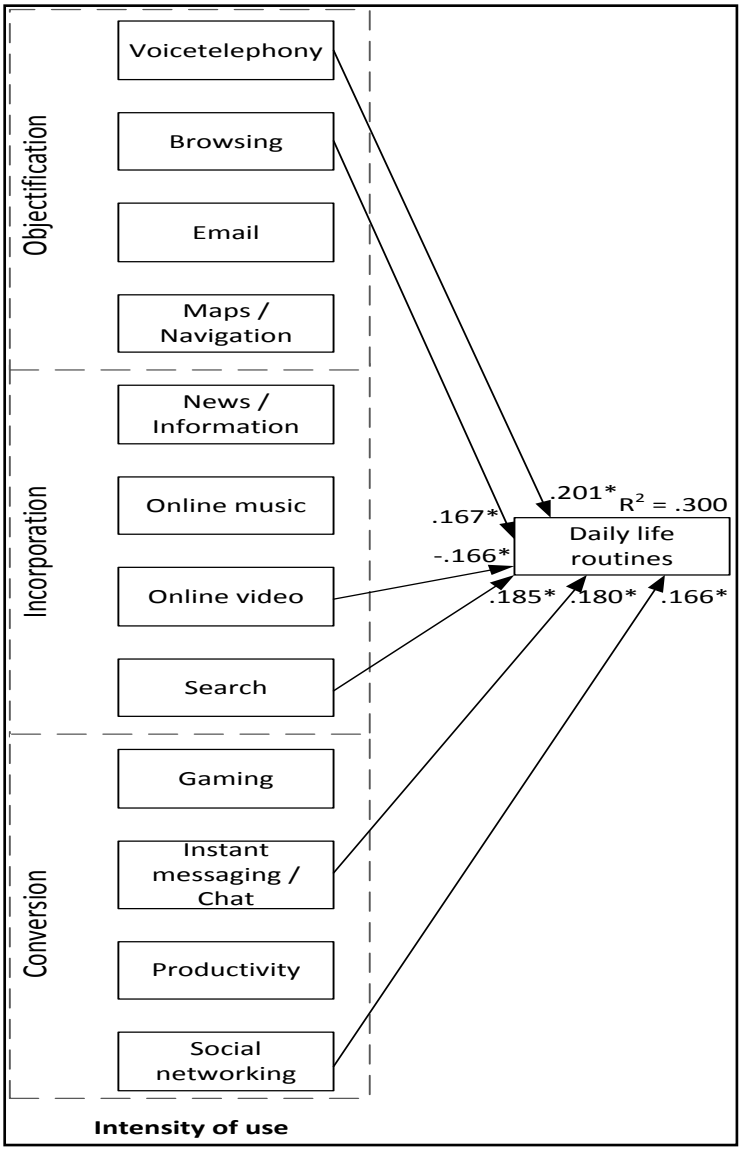

Figure 3

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

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

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

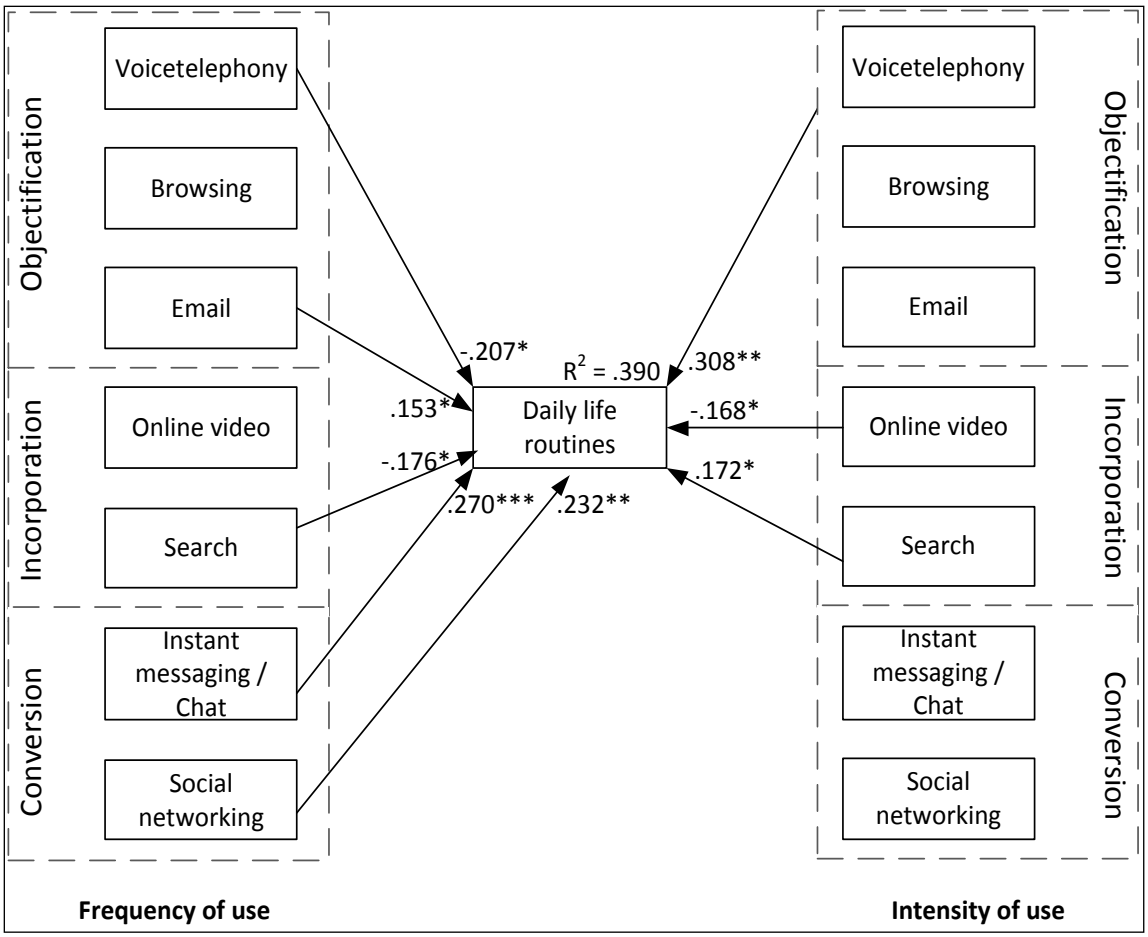

Figure 4
Structural regression model on intensity and frequency of use (*** p<.001; ** p<.01; * p<.05).

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

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

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

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

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

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

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

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

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

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

6. Discussion

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

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

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

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

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

7. Conclusions

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

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

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

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

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

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

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

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