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Mobile handset study 2012: evaluation of mobile measurement software to monitor the use of smartphones and tablets in the Netherlands

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The views expressed in this paper are those of the authors and do not necessarily reflect the policies of Statistics Netherlands.

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Preface

In 2011 and 2012 two similar pilots with a smartphone measurement application ("app") were carried out by a consortium of Delft University of Technology (TU Delft), the research firm MarketResponse Nederland BV and the software company Arbitron Espoo Finland. These pilots were commissioned by Statistics Netherlands and co-financed by the Ministry of Economic Affairs. This report concerns the study of 2012.

Mobile devices, such as smartphones and tablet computers, are playing an ever larger and rapidly growing role in the daily lives of people. It is expected that in the near future smartphones and tablets will become the primary personal device, for leisure as well as for work. That means that it has become relevant for Statistics Netherlands to produce statistics on the developments of the use of these mobile devices and the mobile services being used. The relevance is also re-inforced by the fact that the industry for the development of mobile services, such as applications ("apps"), has become a serious economic industry. The study is also of importance for the telecommunications industry (e.g. data and networks used by mobile devices and network neutrality) and the possibility to use smartphones for mobility and location related as well as time spend studies.

Until now data on the use of mobile devices, mobile services etc. were collected with surveys. Surveys depend on self-reporting, that is what the respondent thinks what he/she has done. However, smartphones and tablets present the possibility to measure the use directly by installing an app, which measures the use in the background of these devices.

The objective of the study was to explore if it is possible to use by means of software downloaded on smartphones and tablet computers to gain insight in the use of mobile services, networks and other functionalities as offered by these handhelds.

The data collected in this study concerns, among opthers, calling and SMS behaviour, use of downloaded and pre-installed applications and functionalities, internet behaviour and data and network use. Of all the events also the location and the duration is recorded. This means that it is also possible to make mobility heat maps (see the results from 2011). In addition, the study experimented with the possibility to use graph theory for the mapping of surfing behaviour. Finally, also the differences between actual and reported behaviour were analysed.

These kinds of studies also have relevance for the scientific research community. Current research does not go beyond the production of statistics on the availability of mobile devices and services. Direct mobile measurement, as an innovative way of data collection, takes research a step further towards being able to understand the use (e.g. frequency and duration) and the impact of these devices on people's lives and the economy (e.g. transactions) better. The possible use of the collected data in this study is also further enhanced by the use of two flanking surveys, which collected more subjective data, which cannot be collected by the use of direct measurement. Multi-method research, finally, also increases the reliability and validity of the end results.

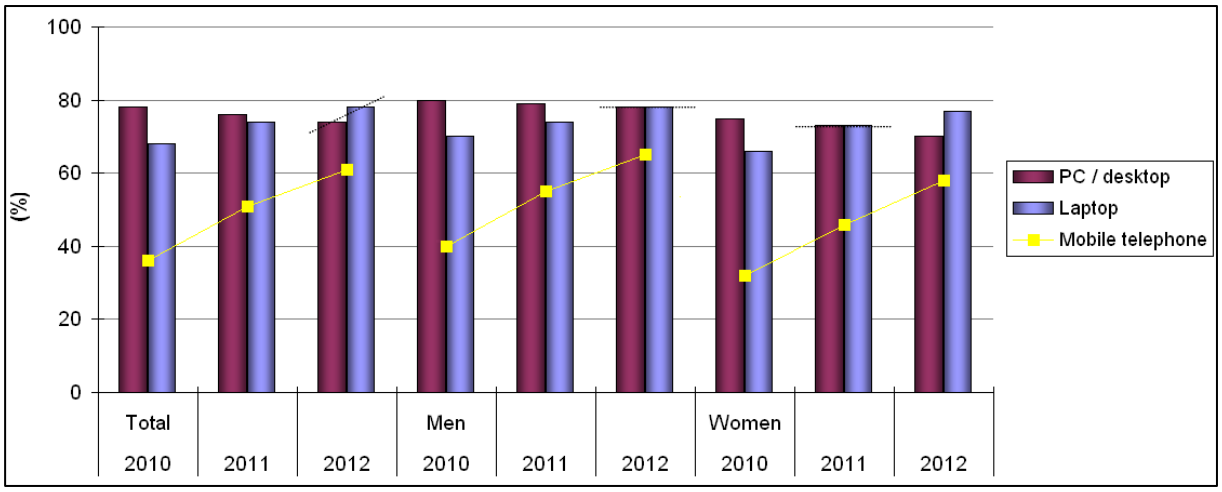
The past two years have demonstrated the potential of direct measurement studies by using smartphones and tablet computers to get more insight in the "digital" behaviour of people. It also has been found that in the outside world there is a strong and growing demand for data about the increasing relevance of mobile devices for, for example, the access to internet, voice telephone, gaming, data traffic, mobility, social media and all kind of economic activities.

A point of concern remains the willingness of people to participate in mobile measurement studies. It affects their private situation directly. Therefore, extra attention has been paid to the security of the data, data handling and privacy issues.

CONTENT:

1. Introduction and background

The last two decades there has been a significant increase in the ownership and use of mobile phones and especially smartphones. One can speak about a “portable revolution”. Smartphones are becoming the main access point to the Internet. It is estimated that over 50% of the Dutch population has a smartphone[1] and that this number will keep growing rapidly in the coming years. See figure 1.1.



Source: Statistic on the use of ICT by persons and households, Statistics Netherlands, 2012

Figure 1.1 Percentage of the development in the ownership of desktops, laptops and mobile phones in the Netherlands, 2010 - 2012.

This growth also means that the impact of smartphones, smartphone applications (“apps”) and mobile access to Internet on people's behaviour and on the economy is rapidly growing. Smartphones have become a part of our daily lives. Besides calling, with smartphones it has become easier to browse the Internet, email, play games and use multimedia applications where and when it is convenient. It is expected that with new developments in hardware, software, services, web interfaces, and networks in the future smartphones, or more general mobile devices, will become the primary personal devices, for leisure as well as for work. One can think of cloud based computing, smarter applications, HTML 5, gesture and retina tracking, navigation and localisation, mobile sensors, second screen applications for entertainment, and NFC-smartphones as a replacement for credit cards and digital identification. These innovative developments will help to enhance that more and more economic and social activities will be conducted through mobile devices. This also implies that the development of apps for mobile devices, as well as HTML5 based web browsers, have become a serious industry with a rapidly growing economic importance. Furthermore, it will affect the telecommunications industry in its core (e.g. data and networks used by mobile devices). Net neutrality, at the one hand, helps to create new Over the Top (OTT)-providers. At the other hand, it hampers current Telecom Operators business and revenue models.

Seen the growing importance of these developments, it becomes relevant for Statistics Netherlands (Centraal Bureau voor de Statistiek) to gain insight in these new developments and produce statistics on a regular basis, for example, for policy makers, industry and regulators.

As yet these statistics on mobile devices and mobile services are produced by surveys. These surveys refer to self-reported behaviour. However, self-reported behaviour is not always reliable. Besides,

[1] A recent study mentions that Smartphone in the Netherlands is being used by 54% of the Dutch population http://communities-dominate.blogs.com/brands/2013/04/rare-national-smartphone-market-data-via-mary-meeker-analyzed-further-and-reported-also-per-capita-b.html

there are other restrictions with surveys, such as a single-point measurement, limitation in the type and number of questions, survey burden and variables such as duration and frequency of use or type of network, which cannot be properly measured. In this context mobile devices, such as smartphones and tablet computers, themself provide the solution. There are apps available that allow the use of mobile devices to be recorded real-time. These apps can easily be downloaded and installed. The main advantage of this innovative way of data collection is that it is directly recorded what a person is doing, rather than asking him after the fact what he thinks he has done. As the app is running in the background of the mobile device, it does not bother the user. Hence, by installing an app on mobile devices it possible to collect data on the actual use of mobile services and all kind of other functionalities. An important added-value of this way of measuring behaviour is that location (GPS and assisted GPS) and time (duration) can also be recorded. There are also areas of attention, such as privacy issues, the phone's battery drainage, data traffic and maintenance of the application software due to the many fast changing platforms on which these apps run on and the rapid developments in this field.

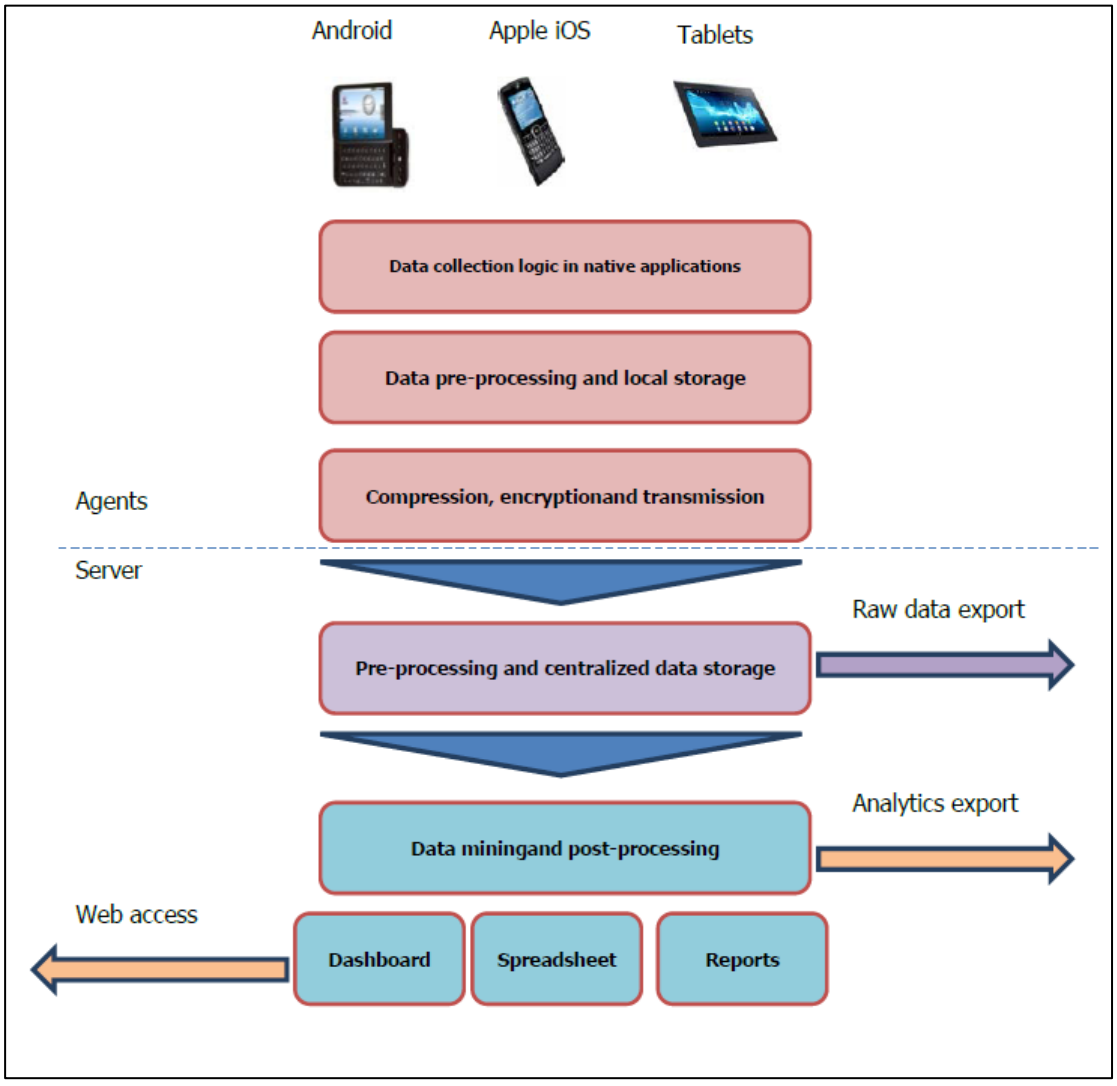


Figure 1.2 The infrastructure of the direct mobile measurement research, which was carried out in 2012 (and 2011).

In 2011 a first pilot was conducted with this new method of direct mobile measurements (Bouwman. et al, 2012). This pilot was executed by a consortium of Delft University of Technology (TU Delft), the research firm MarketResponse Nederland BV and the software company Arbitron Espoo Finland, as commissioned by Statistics Netherlands. The study was successfully completed, resulting in a rich

data set, as, in addition to the direct recording, two flanking surveys were conducted. In those flanking surveys perception and attitude related questions were asked which could not be obtained by direct recording. A main point of attention was the rather small size of the panel, which participated in the research.

In 2012, the research is repeated in the same setting and with the same partners. In this research not only smartphone users were recruited, but also a small number of tablet computer users, or users who made use of both devices were added. The objective of the research is similar to the research in 2011, that is to explore if it is possible to use by means of software downloaded on smartphones and tablets to gain insight in the use of mobile applications, networks and other functionalities as offered via handsets. Functionalities differ for end user device, platform used, and varies from simple telephony via visits to mobile Internet to the use of specific highly innovative applications, such as augmented reality. The software as installed on the smartphones and tablets offers information on location, time of the day, duration, which type of apps and websites being consulted, and so on. Next to the data acquired via the measurement software (see figure 1.2.), also two flanking questionnaires were used during the research project (see annex 1 and 2).

Besides this smartphone and tablet measurement study, Statistic Netherlands also gained experience with other smartphone studies in 2012. A pilot was set up to investigate if it was possible to use smartphones for the data collection for mobility statistics. In this research, the location and time of the beginning and the end of trips, which were made by the respondent, were recorded through an installed smartphone mobility-tracking app. In addition, also the mode of transportation was derived with intelligent software. In another pilot mobile position data were used to investigate if statistics could be made on, for example, mobility, tourism and daytime population.

In the two pilots with the TU Delft it has become already clear that the use of smartphones and tablets as an innovative way of collecting data has potential and relevance.

Contents of the report

Because it is an important condition for this kind of research the report continues in chapter 2 with the describtion in which way privacy and security of the data was handled. Chapter 3 discusses the research design, response and the representativeness. The main results are presented in chapters 4 to 6. Chapter 4 describes the results from the two flanking surveys, the selection survey and the evaluation survey. Chapters 4 and 5 describe the results from respectively the smartphone and the tablet computer measurements. In chapter 7 the differences between reported (surveys) and actual use (measurements) are analysed. Chapter 8 describes the experiences of the participants with the study. And, finally, the report is concluded in chapter 9 with conclusions and recommendations. Besides the two questionnaires, that were used, the annexes include a proposed method to weight the results, detailed reponse to the selection survey and additional crosstabs.

2. Privacy issues

In this type of research, it is of great importance to ensure that the security of the data is handled properly and the privacy of the participants is guaranteed.

With regard to privacy issues in this study, there are several principles that were applied. Firstly, apart from the fact that there is, of course, a voluntary participation (informed consent), a privacy policy was set up, ensuring that participants could opt-out any time during the survey. For various reasons some respondents have actually used this option during the study. Secondly, the transmission and the storage of the data took place in a secure manner. Thirdly, only specifically designated researches are able to use the data. The data are stored and only accessible by using a password-protected login. Results are only reported on an aggregated level. And, finally, the data were carefully anonymised by the fact that the data were collected and analysed by separate entities. The sample was drawn and the recruitment was done by MarketResponse. They made use of their own panel and have (Internet) access to respondents. Only anonymised identification keys and email addresses of the participants were supplied to Arbitron, the organisation responsible for the data collection. Arbitron then send the participants a link to download and install the measurement app on their smartphone or tablet computer on a voluntary basis. After the end of the research Arbitron transferred the data to the TU Delft researchers only with the identification keys and then deleted all the data. The TU Delft researchers also received the data from the two flanking surveys from Market-Response only with the designated identification keys. So, this means that the researchers of TU Delft only have anonymised data, with no names, addresses, email or phone numbers of the participants. The researchers cannot link the unique identifiers back to personal information. Arbitron has no data at all anymore. Although MarketResponse has the names and addresses of the participants, they do not have the measurement data. The results of the flanking questionnaires are not available to third parties.

To ensure openness to the outside world also a mandatory notification of the research was sent to the Data Security Officer of Statistics Netherlands. This notification is published on the website of Statistics Netherlands. In addition, a privacy impact assessment was carried out before the start of the research.

Furthermore, all-participating organisations endorse the industry-related and statistical codes of conduct and regulations on privacy.

3. Research design, sampling and representativeness

In this chapter we will explain the research design and the main methodological issues like response and representativity.

3.1 Research design

The research design has three major steps:

1) First, a selection survey was used to recruit the respondents for the measurement study. The starting point was a sample from the panel of MarketResponse (so-called Onderzoeksgroep panel). In the questionnaire of the selection survey the objective of the research was explained and the respondents were asked if they were willing to participate. To participate in the study respondents must also meet criteria such as the use of a smartphone and/or a tablet computer and the capabilities of these devices for downloading and installing the measurement software. This part of the research was executed by MarketResponse. The average time necessary to fill out the questionnaire was 10 minutes. The questionnaire was administered by making use of Computer Assisted Self-completion Interviewing (CASI) between October 12 and November 1. See annex 1.
2) Next, log data was collected on the use of the smartphone and/or tablet computer of the respondents by automatic recording of relevant data after participants installed the measurement app. Data was collected in the period October - November 2012. This part of the research was executed by Arbitron. Data was collected starting from Mid-October, and continued until the respondents removed the app. In principal four weeks of data were collected.
3) Finally, an evaluation questionnaire was administered. In this questionnaire data was collected with regard to perceptions, as well as complementary questions related to patterns of use. In addition, evaluation questions assessing the experience of respondents were presented to the participants. This part of the research was again executed by MarketResponse. The average time for completing the questionnaire was 12 minutes. Again, MarketResponse made use of CASI in the period December 3 to 11. At the end of the questionnaire, it was made clear that the respondents could remove the app. See annex 2.

3.2 Response

3.2.1 Response selection survey (MarketResponse)

The population and target group of this research are the Dutch smartphone and tablet users of 16 years and above. The sample framework consists of what MarketResponse labels as De Onderzoeksgroep. De Onderzoeksgroep is the research panel of MarketResponse and it is assumed that this panel is representative for the Dutch population. From the panel a random sample was drawn. Next, a selection questionnaire was sent to the persons in the sample inviting them to participate in the research.

As the first round of recruiting did not lead to sufficient response, the procedure was repeated (so-called Boost sample). In this second round of recruitment, specific additional information of availability and use of smartphones by respondents was used by MarketResponse. Finally, in a third procedure, panellists who participated in the 2011 pilot were also approached to participate. The last group was approached on request of the researchers of the TU Delft in order to see if a start could be made with collecting panel data. See for the details of the response of the three rounds of recruitment annex 4.

After data cleaning for partial non-response, the three rounds of recruitment resulted in data from 1653 persons that filled in the selection questionnaire, and 519 persons that said that they were willing to participate in the research. See table 3.1.

The respondents that did not want to participate in the research gave a large number of different, and sometime a set of multiple, reasons. Therefore, people could mention that both low usage levels as well as no experience with downloading apps were a reason not to participate. All the reasons mentioned were coded.

	N	%
Total number of respondents selection questionnaire	1653	100
Missing data (no telephone or smartphone)	204	12.5
	1449	
Doesn't want to participate	930	64
Said that they were willing to participate, of which:	519	36
Participate with smartphone	373	26
Participate with tablet	79	5.5
Participate with smartphone and tablet	67	4.5

Source: TU Delft

Table 3.1 Response concerning the willingness to participate in the measurement study.

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 "normal" non-response, such as holidays, sickness and travelling abroad. Technical reasons were mentioned by 2% of the respondents, while, the fact that respondents are not expected to download apps on company telephones was mentioned by 3% of the respondents. Of the respondents 1% indicated earlier experience in the 2011 pilot and having met problems like battery drainage. Examples of other reasons provided are: usage is minimal, no experience with downloading apps, self-efficacy and lack of capabilities in managing their telephone.

3.2.2 Response smartphone and tablet measurement (data Arbitron)

Although 519 respondents initially indicated that they were willing to participate in the study, only a part of them downloaded and installed the app (369).

After checking the results of the measurements only a select number of respondents (232) participated for a long enough period of time in the actual recording of their smartphone use so that their data was worthwhile to be used for the analysis. For tablet computers this was 47 participants. The reasons mentioned to drop out at the last moment were especially technical problems, like battery drainage and the impression that the app slowed down the telephone or they upgraded to a new OS-version (see also chapter 8).

These numbers of participants are consistent with the experience of last year. Of the persons who are initially recruited only 5 – 10% are willing to participate in this kind of research. Three groups of reasons play a role, that is: "normal" non-response, privacy, but also all kinds of technical issues (last minute dropouts).

As smartphones become an increasingly important part of the daily lives of people, it should also be said that logging almost all the userdata for four weeks in a row can have an impact, which is maybe too big for people. For studies on mobility or time spent, this probably plays a lesser role, because the logging of data is limited and the period of logging is much smaller. This suggests that a smaller period of logging of the data could improve the willingness to participate. In addition, the drop out at the last minute due to all kinds of technical problems could be minimised more.

3.2.3 Response of the evaluation questionnaire (data Market Response)

The evaluation questionnaire was send to 369 persons who said to MarketResponse that they downloaded and installed the measurement app. Of these 369 persons 324 persons filled in the evaluation questionnaire. See for more detail table 3.2.

Gross Sample	369	100
- contacts	329	89
- Internet link not used	42	11
No of contacts	329	100
- Internet stopped	2	1
- Internet refusal	3	1
Net response	324	98

Source: Market Response

Table 3.2 Response on the evaluation questionnaire send out to respondents that said they downloaded and installed the measurement app.

Figure 3.1 gives an overview of the response in the different stages of the reseach. There is only a marginal overlap between the smartphones users and the tablet users, who eventually took part in the measurement study.

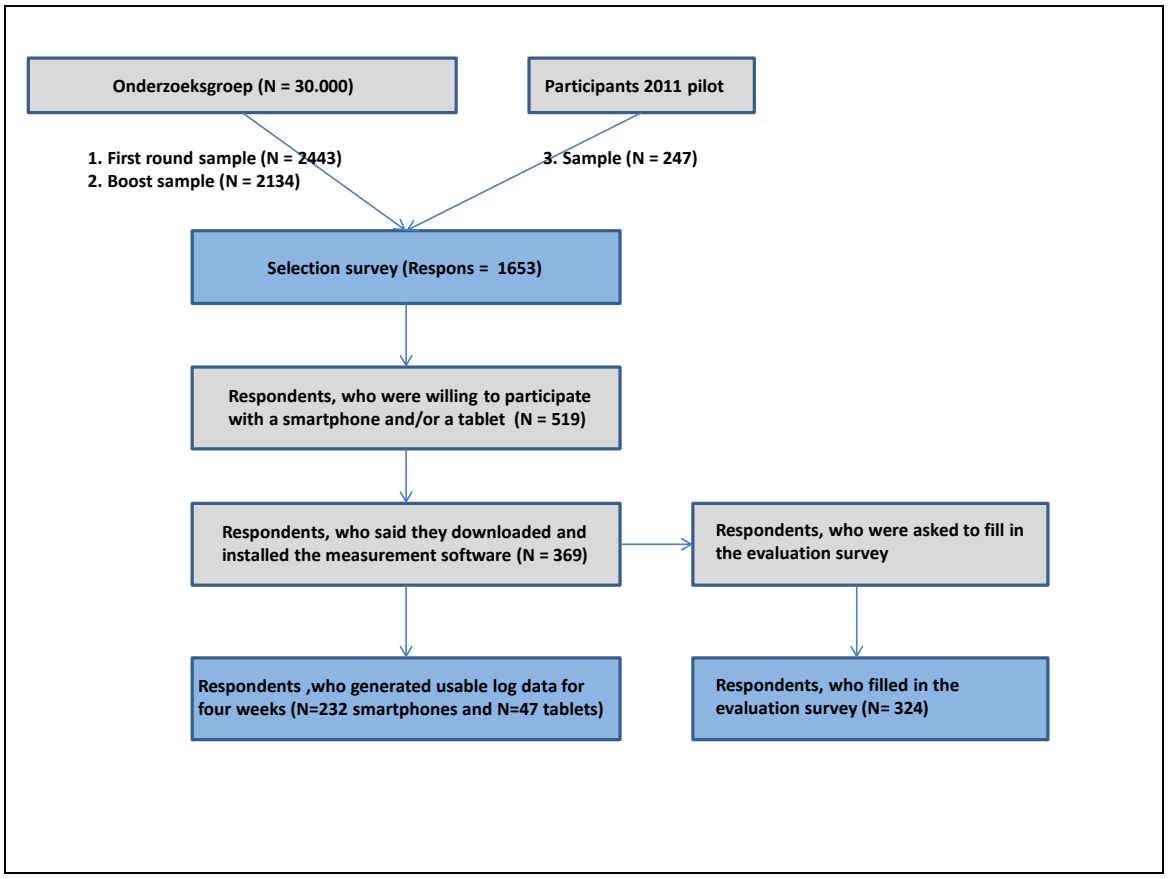


Figure 3.1 Response stages of the study.

3.3 Representativeness

The results in this report are presented without weighting. This is due to the fact that there is no reliable weighting model for the target population, that is people with their background characteristics in the Netherlands from 16 years and older that use a smartphone and/or a tablet. Statistics Netherlands can only present some background data for people in the Netherlands of 16 to 75 years that own a mobile phone, not necessarily being a smartphone, let alone a tablet. See table 3.3. In the sections below, for comparison reasons only, data (N=422) are used that are supplied by MarketResponse and that are believed to be representative of the Dutch smartphone users. However, there is no statistical guarantee that these are representative figures.

In annex 3 a method is described to weight the results of these kinds of studies in the future. This is not carried out in this particular study because a representative weighting model for all the Dutch smartphone and/or tablet users was lacking. In addition, pure practical reasons played a role. It is, however, advisable to pay more attention to the issue of representativeness in a next study, realising that this is a complex issue due to the many selection and drop out stages in the research and the multi-method approach with the two flanking questionnaires.

3.3.1 Selection questionnaire (data MarketResponse)

Table 3.3 and especially table 3.4 provide some insight in the representativeness of the response to the selection survey. In table 3.4 the response of the selection survey is plotted against data from MarketResponse which they say is representative for all the Dutch smartphone users (N=422).

	Phone usage Netherlands %
Gender	
Male	55%
Female	45%
Education	
High	34%
Middle	37%
Low	29%

Source: Statistic on the ICT use of persons and households, 2012, Statistics Netherlands

Table 3.3 Distribution of the characteristics of mobile phones users of 16 – 75 years in the Netherlands, including smartphones, 2012.

		Representative sample Dutch smartphone population according to MarketResponse (N = 422)	**Sample selection survey (total) (N = 1653)**
Gender	Male	55%	51%
	Female	45%	49%
Age	Average		49 years
Position in household	Primary wage earner	32%	30%
	Caretaker	25%	29%
	Both	22%	32%
	Child	16%	7%
	Other	5%	3%

		Representative sample Dutch smartphone population according to MarketResponse (N = 422)	Sample selection survey (total) (N = 1653)
Education	HW	16%	15%
	HB	41%	41%
	HA	11%	9%
	MB	25%	23%
	MA	4%	7%
	LB	3%	4%
	LA	0%	0%
Activity	Work:	76%	71%
	Retired:	4%	10%
	Caretaker:	2%	4%
	Student:	13%	7%
	Unemployed:	2%	2%
	Incapable to work:	2%	4%
	Social Benefit:	0%	0%
	Other:	1%	1%
Family size	1	13%	20%
	2	29%	40%
	3	23%	15%
	4	25%	18%
	>4	9%	7%
Income	Bellow Modus	13%	12%
	Modus	22%	22%
	Above Modus	58%	62%
	DNK, no answer	7%	4%
Nielsen Regions	Amsterdam, Rotterdam, The Hague	13%	12%
	Rand-gemeenten	4%	5%
	West (ex 3 majors cities)	32%	33%
	North	10%	9%
	East	18%	19%
	South	23%	22%

Source MarketResponse / TU Delft

Table 3.4 Distribution of the characteristics of the response of the selection survey (N=1653) in relation to the characteristics of a group of repondents which MarketResponse considers representative of all the Dutch smartphone users (N=422), 2012.

So, the main characteristics of this sample (N=1653) of the selection survey, based on the data as transferred from MarketResponse to TU Delft, are as follows:

- Males 51% and females 49% (CBS: 55%; respectively 45%)
- Average age of respondents is 49 years old: range from 18 till 91

- 30% is main wage earner
- 56% had higher academic or vocational training
- 71% is fulltime occupied
- average family size is 2.54 persons
- 62% have an income above the model Dutch income
- 45% of the sample lives in the western parts of the Netherlands (including the three major cities). Only 9% live in the Northern part of the Netherlands

3.3.2 Respondents, who participated in the recording of their smartphone use

In table 3.5 the background characteristics of the respondents (N=232), who participated in the measurement of their smartphone use, are presented in relation to the characteristics of the group, which is presented as representative for all the Dutch smartphone and tablet users (N=422).

		Sample with enough usable data point (N=232)	**Representative sample Dutch smart phone population according to MarketResponse (N=422)**
Gender	Male	52%	55%
	Female	48%	45%
Age	Average	46 years	
Position in household	Primary wage earner	28%	32%
	Caretaker	27%	25%
	Both	32%	22%
	Child	12%	16%
	Other	1%	5%
Education	HW	12%	16%
	HB	40%	41%
	HA	9%	11%
	MB	28%	25%
	MA	6%	4%
	LB	4%	3%
	LA	0%	0%
Activity	Work:	73%	76%
	Retired:	8%	4%
	Caretaker:	1%	2%
	Student:	10%	13%
	Unemployed:	3%	2%
	Incapable to work:	3%	2%
	Social Benefit:	0%	0%
	Other:	1%	1%
Family size	1	20%	13%
	2	28%	29%
	3	17%	23%

		Sample with enough usable data point (N=232)	Representative sample Dutch smart phone population according to MarketResponse (N=422)
	4	28%	25%
	>4	8%	9%
Income	Bellow Modus	13%	13%
	Modus	25%	22%
	Above Modus	59%	58%
	DNK, no answer	3%	7%
Nielsen Regions	Amsterdam, Rotterdam, The Hague	8%	13%
	Rand-gemeenten	5%	4%
	West (ex 3 majors cities)	34%	32%
	North	7%	10%
	East	23%	18%
	South	23%	23%

Source: MarketResponse / TU Delft

Table 3.5 Comparison of marginal distributions for a core set of variables of participants (N=232) who did use the measurement app and the group which are supposed to be representative for all the Dutch smartphone users (N=422).

If we look at the data from the respondents (N=232) that have used the measurement app for an acceptable period of time and compare their marginal distribution of core characteristics with the sample that is used as a representative group for the Dutch smartphone users (N=422) than we see smaller and bigger deviations. Respondents, who participated in the measurement, have a combined position as a wage earner as well as care tacker (32% for the final sample and 22% as suggested by MarketResponse). One-person households are slightly overrepresented. The western part of the Netherlands is well represented, the northern part is a bit under and the eastern part slightly overrepresented.

3.3.3 Evaluation survey

The evaluation questionnaire was sent to 369 persons and eventually filled in by 323 respondents. Table 3.6 gives an overview of the distribution over their characteristics in comparison with the distribution of characteristics of the representative sample (N=422) and the respondents of the selection survey.

		Sample with enough usable data point (N=323)	Representative sample Dutch smart phone population according to MarketResponse (N=422)	Sample Total (N=1653)
Gender	Male	52%	55%	51%
	Female	48%	45%	49%
Age	Average	47 years		49 years
Position in	Primary wage	29%	32%	30%

		Sample with enough usable data point (N=323)	Representative sample Dutch smart phone population according to MarketResponse (N=422)	Sample Total (N=1653)
household	owner			
	Caretaker	27%	25%	29%
	Both	30%	22%	32%
	Child	11%	16%	7%
	Other	2%	5%	3%
Education	HW	15%	16%	15%
	HB	38%	41%	41%
	HA	10%	11%	9%
	MB	26%	25%	23%
	MA	6%	4%	7%
	LB	4%	3%	4%
	LA	0%	0%	0%
Activity	Work:	72%	76%	71%
	Retired:	9%	4%	10%
	Caretaker:	2%	2%	4%
	Student:	8%	13%	7%
	Unemployed:	1%	2%	2%
	Incapable to work:	5%	2%	4%
	Social Benefit:	1%	0%	0%
	Other:	1%	1%	1%
Family size	1	19%	13%	20%
	2	32%	29%	40%
	3	15%	23%	15%
	4	25%	25%	18%
	>4	8%	9%	7%
Income	Bellow Modus	13%	13%	12%
	Modus	24%	22%	22%
	Above Modus	60%	58%	62%
	DNK, no answer	3%	7%	4%
Nielsen Regions	Amsterdam, Rotterdam, The Hague	9%	13%	12%
	Randgemeenten	5%	4%	5%
	West (ex 3 majors cities)	33%	32%	33%
	North	11%	10%	9%

		Sample with enough usable data point (N=323)	Representative sample Dutch smart phone population according to MarketResponse (N=422)	Sample Total (N=1653)
	East	21%	18%	19%
	South	21%	23%	22%

Source MarketResponse / TU Delft

Table 3.6 Comparison of marginal distributions for a set of core variables of participants who used the measurement app, the respondents of the selection survey and the group which is supposed to be representative for the Dutch smartphone users.

3.4 Conclusions

In the section above some idea is given of the "representativeness" of the data from the selection survey, the evaluation survey and the log data from the smartphone measurement. The main problem, however, is that there is no clear representative weighting model with a set of background characteristics of all the Dutch smartphone (and tablet) users. In the overview above distributions of background characteristics were used from MarketResponse (N=422). However, it is not guaranteed that these are representative data for the smartphone users in the Netherlands. In general the impression is that the persons who participated in the research are the more heavy users of smartphones. Concerning the users of tablet computers more general background data is lacking at all. So no comparisons for representativeness were made.

So, it stays an open question if the three samples of the selection survey, the log data of the measurement app and the evaluation survey are representative or, if not, which weights should be used to correct the possible bias.

So, due to lack of better options, the decision was taken to present the data of this study unweighted. Annex 3 presents a possible weighting model.

4. Main results of selection and evaluation surveys

In this chapter the main results of the selection and evaluation surveys are presented. The results of the log data of the smartphones and tablets measurements are discussed in detail in respectively chapters 5 and 6.

As mentioned before, in this chapter it concerns self-reported behaviour through a survey, in contrast to the results in chapters 5 and 6, which are based on log data of smartphone and tablet measurements. A comparison between reported and measured behaviour is made in chapter 7.

4.1 Main results of the selection survey

All respondents that filled in the selection questionnaire (N=1653) own a smartphone and/or a tablet with only eight exceptions. Of the 1645 respondents 88% own a smartphone and 56% a tablet computer. Both devices are used for access to mobile Internet: 56% only use their mobile phone, 15% only a tablet, and 29% make use of both.

Telephony (N=1409)
Due to the fact that phone calls are not made via tablets, the number of respondents is 1409. On average people report to make phone calls for about 16 minutes a day on an ordinary day in the week, and about 9 minutes in the weekend. Of the respondents 6% don't make calls at all on an average day in the week and 9% during the weekend. Most people (modus) phone for 5 minutes on an ordinary day (22%), and 28% during the weekend. The range for weekdays is from no phone calls (5.6%) to 420 minutes per day (1 person), and again from no phone calls (9.5%) in the weekend to 180 minutes (again one person).

SMS (N=1409)
Due to the fact that there are no text-messages (SMS) sent via tablets, the number of respondents is 1409. On average 3.25 text-messages are sent and 3.39 received on an ordinary weekday. In the weekend this is slightly less, respectively 2.68 and 2.74. Of the respondents 20.9% don't send text-messages, and 16.7% don't receive text-messages on an ordinary week day. During the weekend this is 25.8% and 23.6%. Most people only send (modus is 29.7 %) or receive (modus is 29.6%) one text-message per day. The range is between 0 and 100 text-messages send and 0 and 75 received per ordinary day. In the weekend the pattern is the same, although the modus for sending and receiving one text-message (27.4% and 27.5%) is a bit lower.

Email (N=1653)
The sending of email on an ordinary day in the week is 3.48. The number of emails received is significantly higher. On average one receives 12.4 emails on ordinary day during the week. In the weekend this is 2.33 (send) and 8.05 (receive). This is also reflected by the modus: one email send (18%), and 10 received (12.6%). These scores are almost the same for weekdays and weekends. Again 33% of the respondents don't send emails at all, and 19.6% don't receive emails via their smart phones. In the weekend this is 40% and 25%.

Social media (N=1653)
Mobile messaging and chat (What's App, IM messenger, Skype chat function) are daily used by 47% of the respondents. Social networks, like Facebook and LinkedIn, are being used on a daily basis by 39%. 31% never has used social media via their smartphone or tablet. Twitter is used by 21% of the respondents. Average time spend on Twitter is about 4 minutes. There is only a slight difference between weekdays and weekends (4.45 versus 4.39 minutes).

Other results (N=1653), based on personal perceptions, are:
Information use related:

- Of the respondents 53% consult news and weather information on a daily basis;

- About 45% of the respondents surf the Internet daily via smartphone or tablet;

Game, entertainment related:

- One third of the respondents plays games on a daily basis via their smartphone or tablet;
- Of the respondents 23% watch television via a tablet a couple of times during a month. Daily use is only 3%. For smartphones this is a bit lower: 16% watch television via their smartphone a couple of times during a month. Daily use is 1%;

Communication:

- Of the respondents 18% use mobile video-telephony (Skype) via their smartphone or tablet a couple of times during a month. Daily use is only 2%;

Transaction related:

- Mobile-payments are still very under used. Only 1% makes use of mobile payment possibilities on a daily basis. Of the respondents 83% never used mobile payment options at all;

Location and navigation related:

- Localization and navigation services are used on a weekly or monthly basis. Localization services are weekly used by 15%, and monthly by 29% of the respondents. For navigation services this is 22% (weekly usage) and 33% (monthly). It is clear that this type of use is less frequent;

Business applications:

- Of the respondents 50% use business applications, such as calendar scheduling activities, or business email, at least on a weekly basis. On a daily basis this is 37%.

4.2 Main results of the evaluation survey

The evaluation survey was presented to 369 respondents, who said they downloaded the measurement app. Of these, 323 persons completed the survey.

Costs of mobile telephony subscription (N=323)

Respondents spend 33 Euro on average on their subscription or prepaid cards per month (outliers both in a negative and a positive sense were removed).

Apps (N=323)

About 80% of the respondents downloaded ten or less apps per month on average in the last half year. Paid for apps are hardly downloaded. Of the respondents 66% never downloaded a paid app. Only 3% downloaded 10 to 20 paid for apps, the last half year, on average per month. Comparable figures are found for apps for tablets. Here we see that 84% of the respondents downloaded ten or less apps per month on average in the last half year. Only 3% downloaded 10 to 25 paid for apps the last half year, on average per month for their tablet.

Transactions (N=323)

Money transactions via smartphones and tablets are still limited. Only 30% of the respondents stated that they did buy something via their smartphone or tablet. Of those who did buy apps and software are mentioned the most (19%), as are (electronic 16%; hard copy 14%) books, magazines and newspapers. Travel is mentioned next (12%).

Of the people who did buy via their smartphone or tablet, 25% spend less than 50 Euros, 23% between 50 and 100 Euros, 39% between 100 to 500 and 13% more than 500 Euro. Money was most spend in the Netherlands: 88% of the respondents did their purchase in the Netherlands.

Other (N=323)

In the evaluation questionnaire psychometric scales were used with regard to loyalty towards the telecom provider, substitution between pc, en mobile telephone, but also with regard to addiction to smartphones and, or tablets, and perceived stress. A specific set of psychometrics was used for ana-

lysing acceptance patterns of second screen applications. On the more psychometric analyses we will publish separately in academic papers.

One of the sets of questions, that was asked, concerns the impact of the use of smartphones on people's lives. According to the respondents (see figure 4.1; N=302 smartphone users):

- 70% of the respondents (strongly) agrees that smartphones enables him/her to be more quickly informed about the news;
- the use of smartphones looks to have for more than 40% of the respondents a negative effect on their use of the pc and laptop, but not on their use of the TV;
- the use of smartphone does not lead to stress, but it can be addictive (more than 50% strongly agrees or agrees). Of the respondents 40% cannot live without a smartphone anymore;
- 40% says that due to the smartphone they have more contact with friends and acquaintances, while about 15% says the number of contacts is decreasing.
- about 45% of the respondents (strongly) agree that the use of smartphones changed their life. And 70% (strongly) agrees that smartphones fits their daily routine.

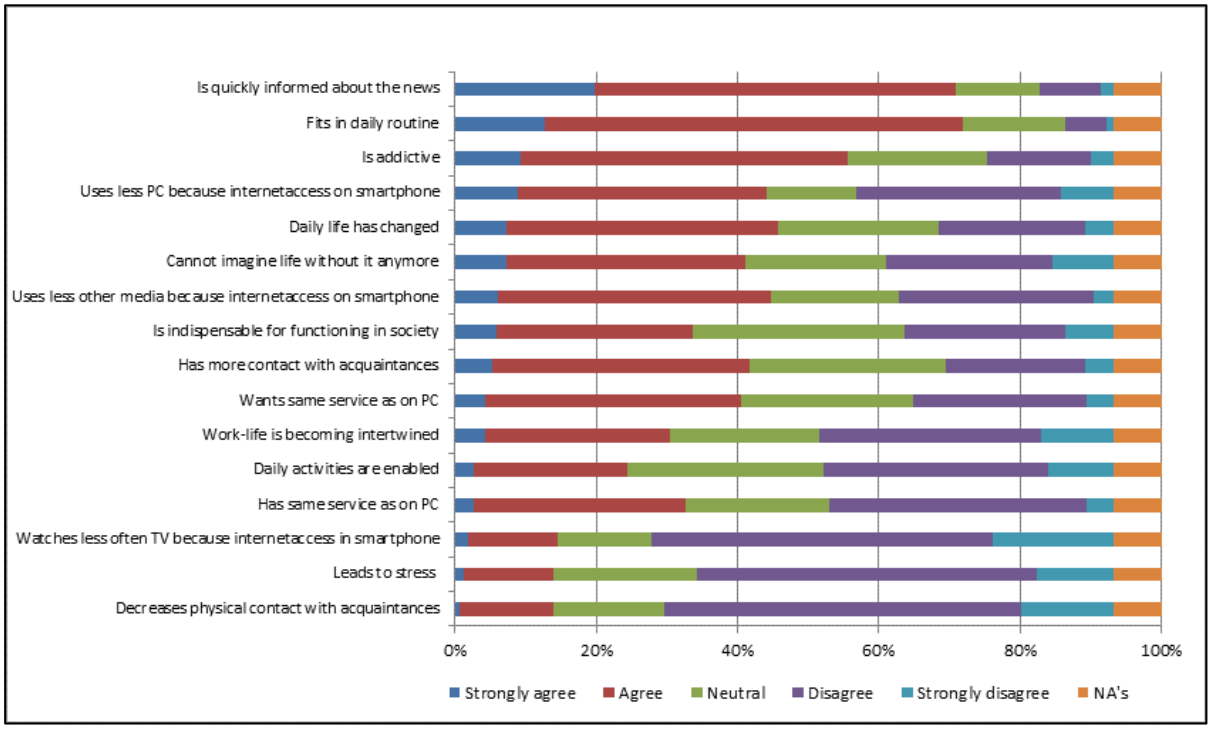


Table 4.1 Pros and cons on the use of the smartphone (N=302 smartphone users), 2012.

The results of the questions in the evaluation survey about the experiences of the respondents with the smartphone and tablet measurements are discussed in chapter 8.

5. Main results based on smartphone measurements

In this chapter, we present the results of the analysis of the log data from the smartphone measurements. The results of the tablet measurements are presented in chapter 6.

In 2012, 232 panellists participated in the study through their smartphone. Details on the sample are given in chapter 4. Here, we analyse:

- Applications (5.1)
- Telephone (phone calls) (5.2)
- SMS-messaging (5.3)
- Data traffic (5.4)
- Internet browsing behaviour: network analysis (5.5)

In addition, we analyse:

- A time series of the smartphone participants (N=36) of the 2011 and 2012 pilots (5.6).

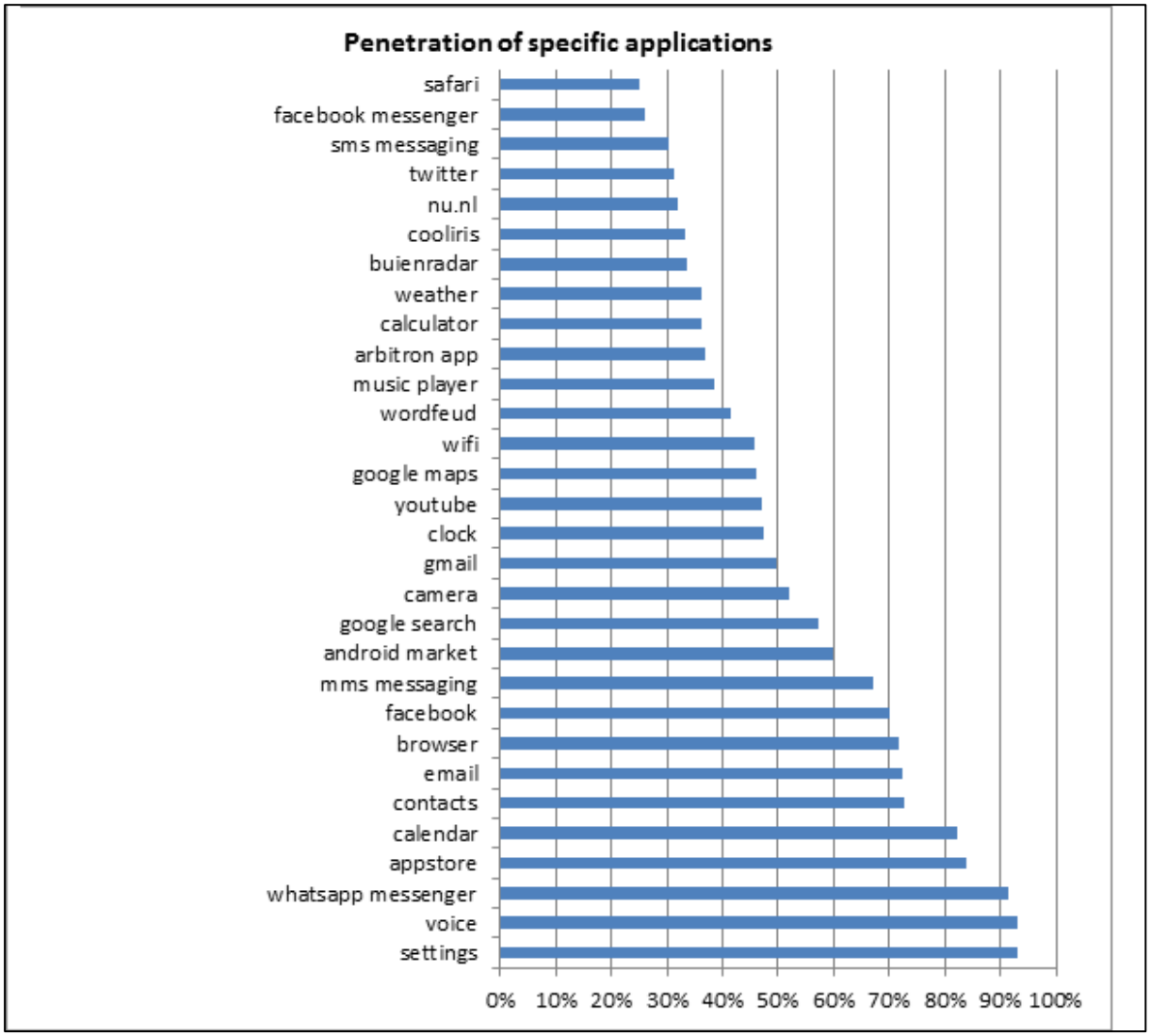


Figure 5.1 Most popular applications: percentage of smartphone panellists that launched a specific application at least once (N=232).

5.1 Applications

Besides storing the name of the application that is used by a panellist, the measurement app also codes the application in specific categories. In this section, we analyse the specific applications first, followed by the categories of applications. As panellists can also use their browser to access services, we, finally, combine data gathered on application use with data on websites to which users have browsed.

Most popular applications

Figure 5.1 shows the most popular applications, based on the number of panellists that launched the application at least once in the period of the study. Almost all panellists use voice, Whatsapp, appstore and Calendar. Also often used are contacts, email, browser, Facebook and MMS. It should be noted that some applications are only available for a specific operating system, such as android market or appstore.

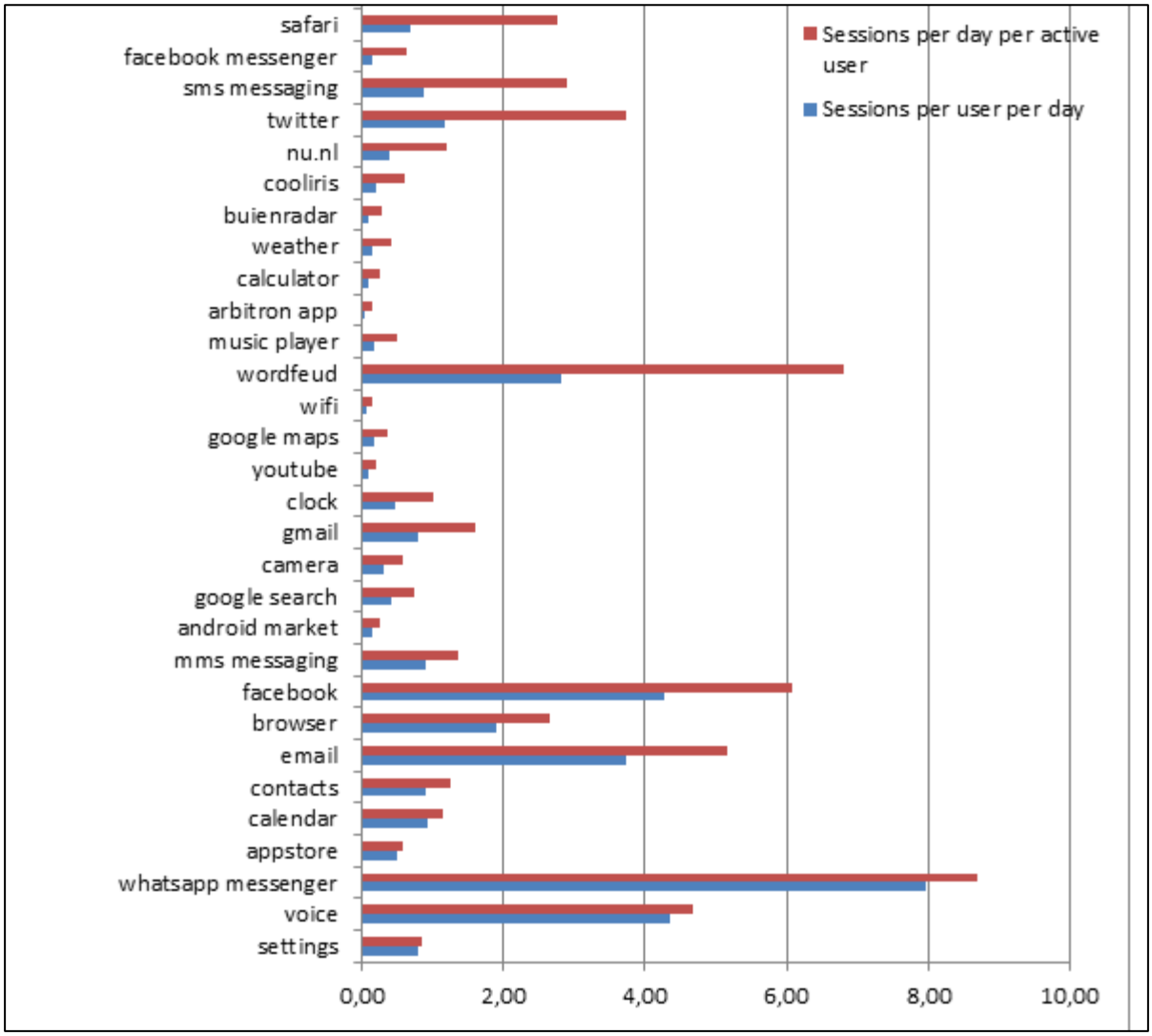


Figure 5.2 Average number of sessions per day per user for specific applications (N=232). Sessions per day per active user are the group of panellists who launched the application at least once during the study. Sessions per user per day concerns all panellists.

Frequency of use

The frequency of use for an application is defined as the number of times an application is being launched by the user per day. A distinction is made between all users (sessions per user per day) and the users who used the application at least once in the period of the study (sessions per day per *active* user)

The frequency of use for these 30 most popular applications (see figure 5.1) differs strongly, see Figure 5.2. Especially applications like Telephony, Whatsapp, Facebook, Wordfeud and email are used often. Applications like (Safari) browser, Twitter and SMS are used more moderately over the day. Applications like settings, appstore, calendar, contacts and android market have high penetration, but are not used very frequently. On the other hand, applications like Safari, SMS and Twitter have a lower penetration but are more frequently used.

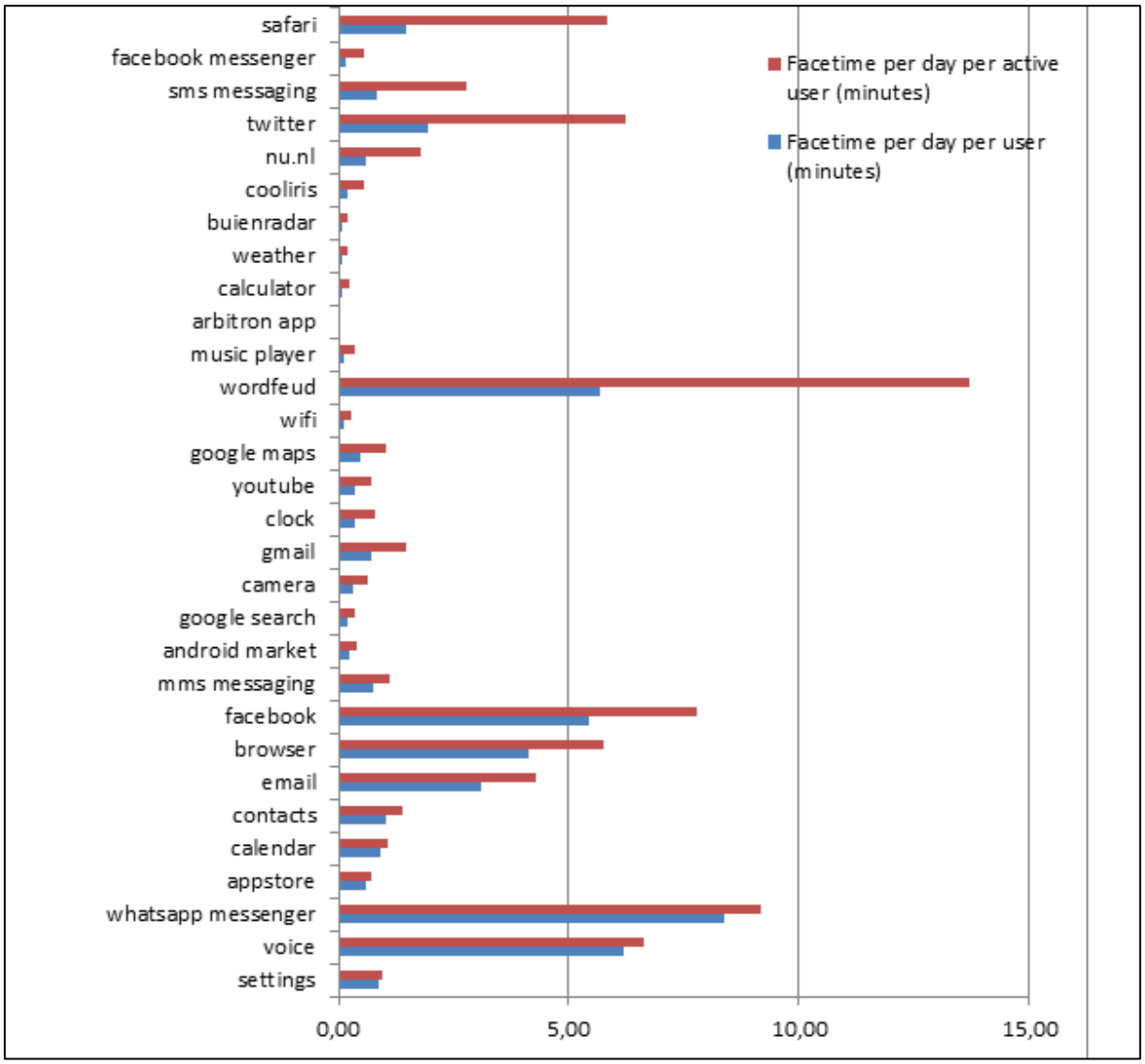


Figure 5.3 Average number of minutes per day spent per user on specific applications (N=232). Face time per day (time spent) per active user are the group of panellists who launched the application at least once during the study. Face time per day (time spent) per user concerns all panellists.

Duration of use

The measurement software also logs the seconds spent while using an application. As shown in Figure 5.3, *active* users spend a lot of time on games, like Wordfeud, but also on social apps like Facebook, Whatsapp, voice, email and Twitter. Browsers are also used for a moderate amount of minutes per day. Again, various applications have high penetration levels but are not used a lot of minutes per day: settings, appstore, calendar, contacts, Google search and the camera.

Specific applications

Commerce

The use of commerce apps is still very low. When looking into specific applications, commerce apps being used are:

- voucher/coupon services, like: Passbook (11 users), Groupon (5 users) and Vouchercloud (2 users)
- auctioning services, like Marktplaats (9 users) and eBay (3 users)
- online purchasing services, like booking.com (2 users) and Amazon (1 user).

Gaming

When zooming in on games (see Table 5.1), there are as much as 127 different game apps being used. 110 of them are used by less than 5 users, 71 even by only 1 person. The most popular game at the moment, Wordfeud, has 41% of the panellists using it for on average 6.8 times a day and 13.7 minutes.

There is strong variance in the time spent per day per user. Applications like Wordfeud, Words rumble and Word search are used over 10 minutes per day, while other popular games are not used for more than 2 minutes per day. Angrybirds, which was highly popular in 2011, is now only used by 2% of the panellists.

Some games have only one or two users in the panel, but these users are very frequent users. For instance, Free solitaire is used by just one user, but on average 34.45 minutes per day. Solitaire city even on average for almost 75 minutes per day.

Game name	Percentage of users with at least one session	Sessions per user per day	Time spent per day per user (minutes)	Sessions per day per active user	Time spent per day per active user (minutes)
wordfeud	41%	2.82	5.67	6.80	13.69
drawsomething	12%	0.12	0.48	1.00	4.02
Songpop	11%	0.18	0.47	1.65	4.19
words rumble	7%	0.25	0.83	3.39	11.40
bubbleblast	4%	0.02	0.08	0.46	1.94
Solitaire	4%	0.02	0.18	0.39	4.12
sudoku free	4%	0.05	0.16	1.20	3.73
jewels star	4%	0.03	0.24	0.68	6.30
Mah-jong	4%	0.02	0.08	0.43	2.02
fruit ninja	3%	0.01	0.04	0.25	1.23
word search	3%	0.02	0.28	0.70	9.50
coin dozer	3%	0.01	0.04	0.51	1.67
angrybirds	2%	0.01	0.05	0.26	2.17

Table 5.1 Games applications with at least 5 users (N=232).

Categories of applications

Most poplar categories

The measurement software automatically classifies applications in specific categories. It should be noted that 14.6% of the application sessions could not be automatically coded by the software; these sessions are omitted from further analysis in this section. The quality of the coding itself was checked to a limited extent.

Figure 5.4 shows the total number of sessions per application category as a percentage of all application sessions. These percentages are thus aggregated over all panellists. It can be observed that most sessions are instant messaging, followed by social networking, email, voice and gaming.

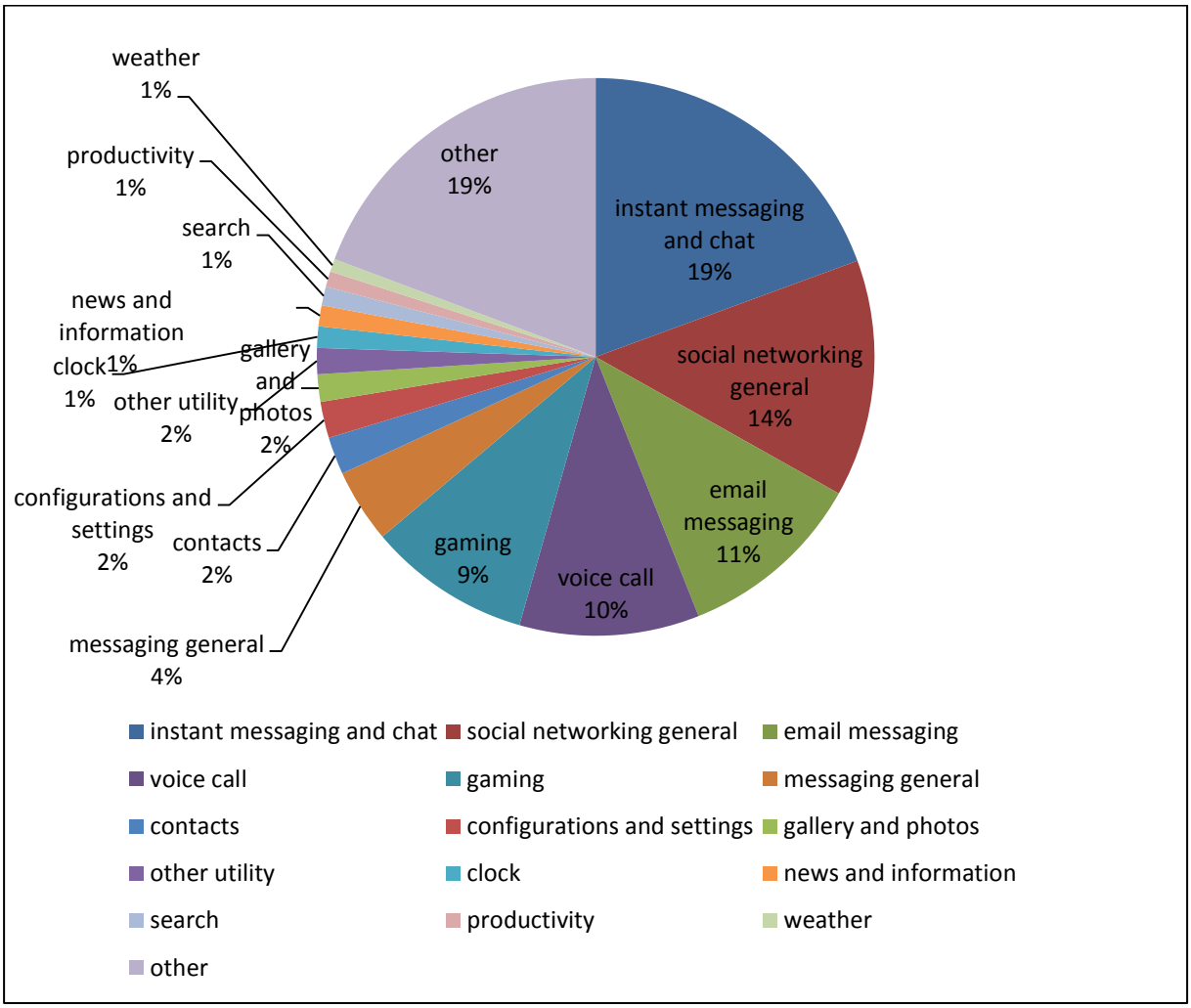


Figure 5.4 Application categories: percentages of categories of applications used related to the total number of sessions (N=232).

Figure 5.5 shows the penetration of the application categories, i.e. the percentage of panellists that used an application in that category at least once. Several types of applications are adopted by almost all panellists: messaging, configurations, instant messaging, voice calling, email, social networking and photos.

We omit application categories with less than 10% penetration from further analysis in this section.

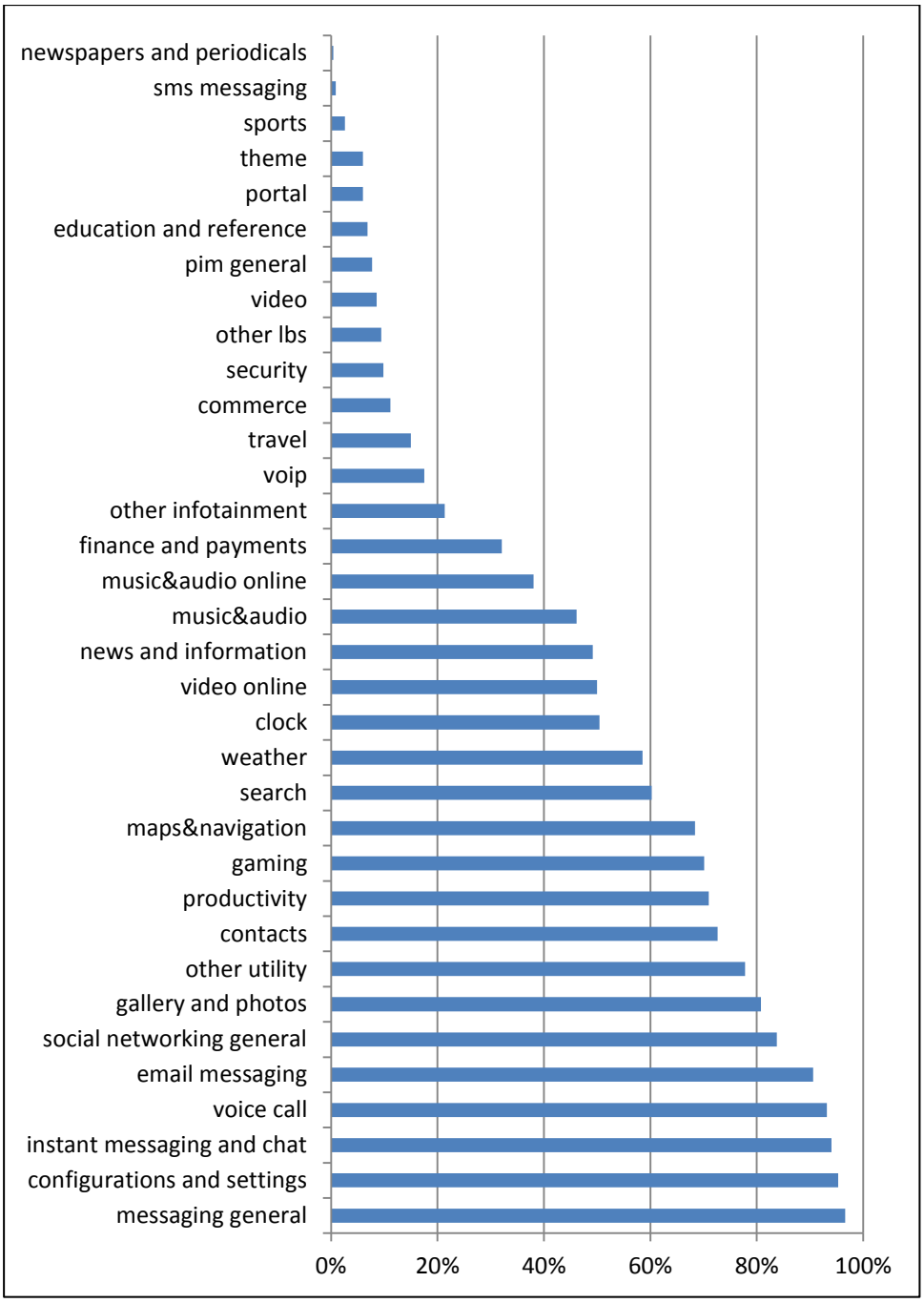


Figure 5.5 Percentage of panellists that launched an application out of that category at least once (N=232).

Frequency of use

The figure 5.6 shows the average number of sessions of catergories of applications per day per user. Especially applications in the categories instant messaging, social networking, email, voice and gaming are used frequently.

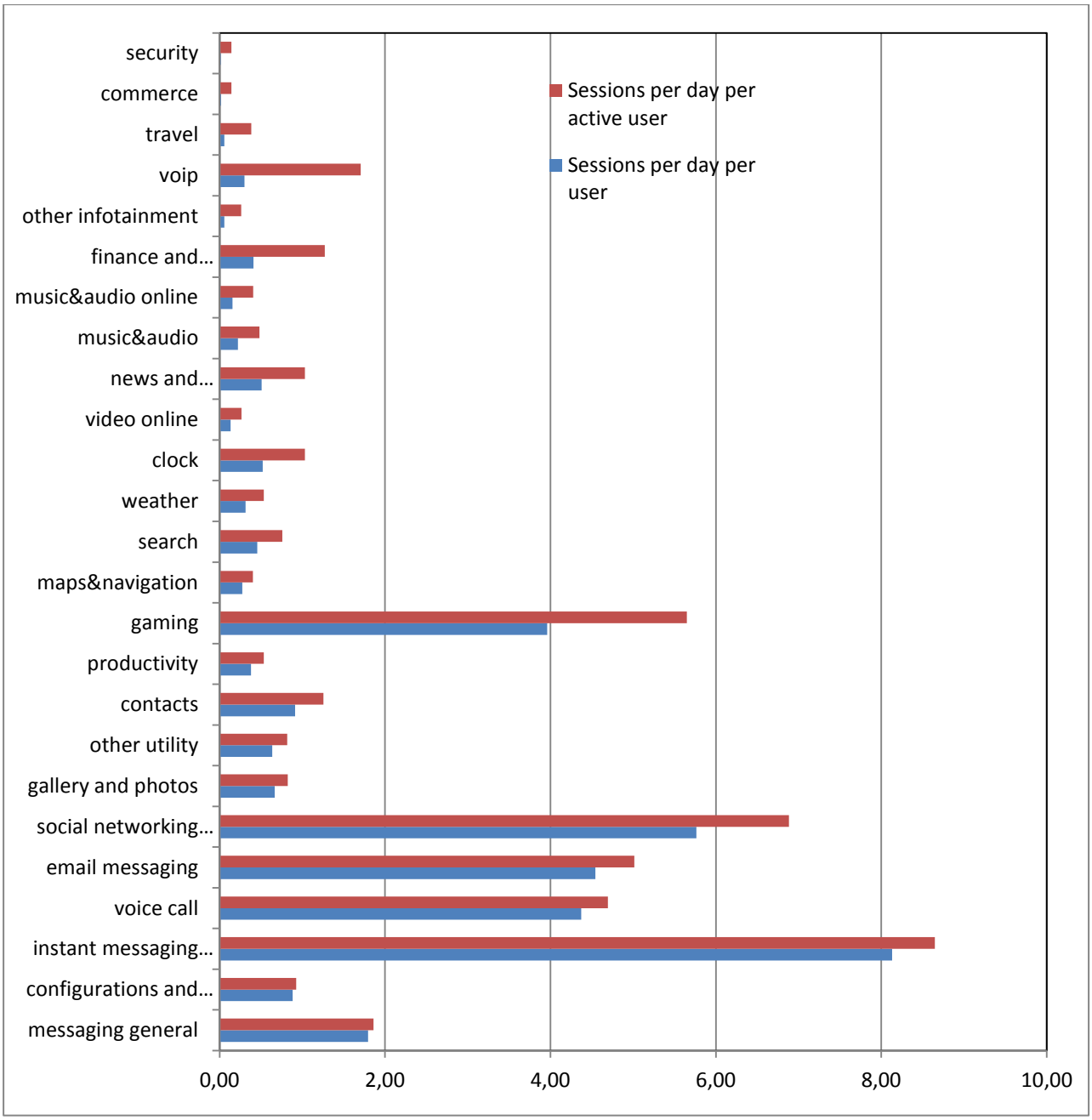


Figure 5.6 Average number of sessions per user for different application categories per day (N=232). Sessions per day per active user are the group of panellists who launched the application at least once during the study. Sessions per user per day concerns all panellists.

Duration of use

For the number of minutes spent (face time) on applications categories per day per user, gaming apps consume the most time over all panellists: on average 16 minutes per day for the *active* gamers. Social networking, instant messaging, voice and email are also used for more than five minutes per day.

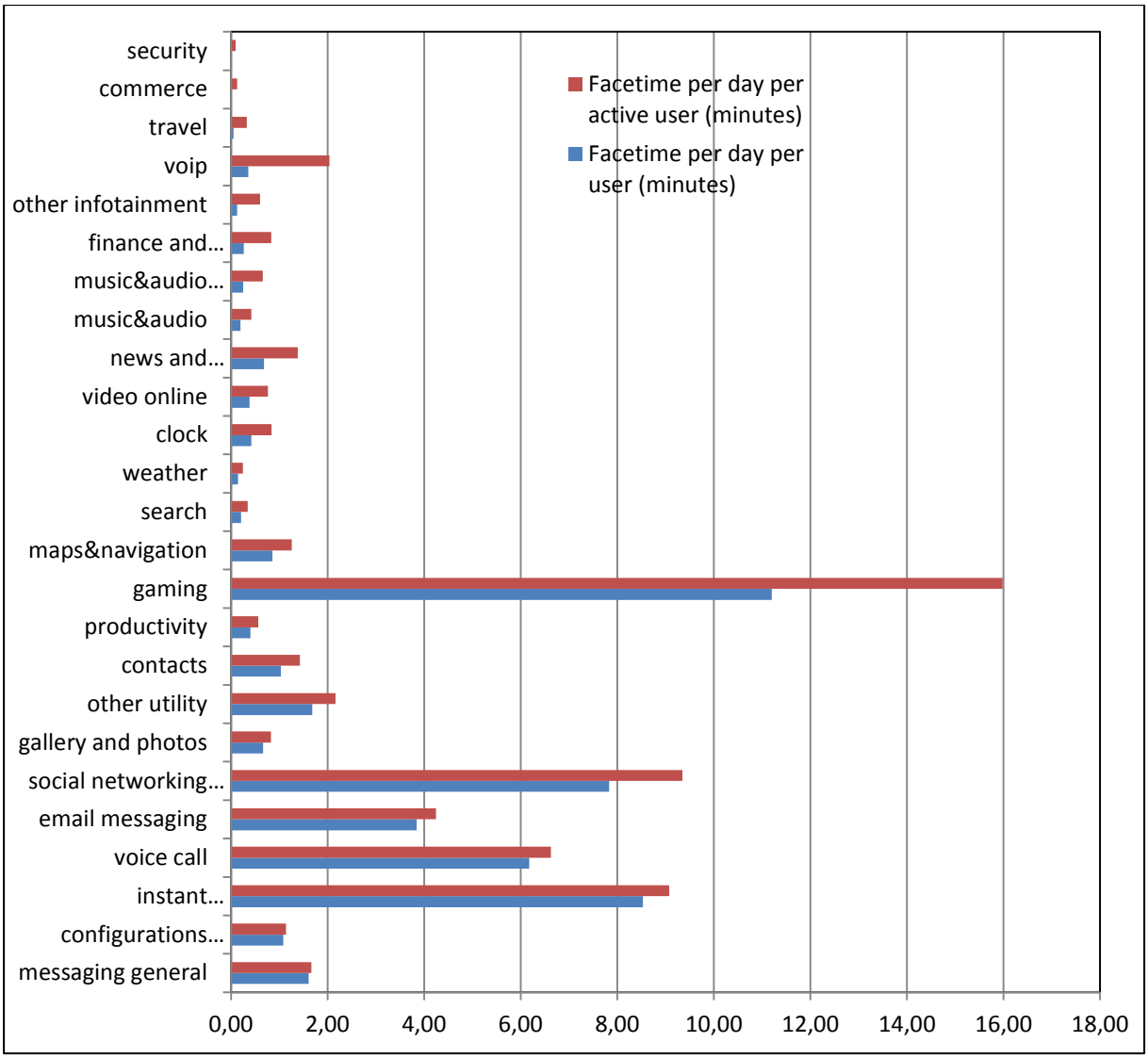


Figure 5.7 Average number of minutes per day spent on application categories per user (N=232). Face time per day (time spent) per active user are the group of panellists who launched the application at least once during the study. Face time per day (time spent) per user concerns all panellists.

Combining applications and browser sessions

Some services, like social networking, can be used through the browser as well as through an application. The measurement software captures these sessions in separate datasets. For Figure 5.8, we combined these two datasets. We only analysed the Android users (N=172) as the software cannot capture the web address in a browser of iPhones.

To get insight in the use, we computed the total number of days that users had at least one session, and the total number of weeks in the 4-week period that users had at least one session. Based on these numbers, we derived for the application and URL class combined:

- daily use, as the application/URL was used at least once in 75% of all days, i.e. at least 21 days;
- weekly use, as the application was used at least once in 75% of all weeks, i.e. at least 3 weeks;
- monthly use, as the application was used less than 75% of all days and weeks;
- or never, if there were no sessions recorded.

The percentages in Figure 5.8 indicate the proportion of panellists who used the type of application or website on a daily, weekly or monthly basis. It can be seen that especially instant messaging and chat services were part of daily routines: more than 60% of the panellists used these services on a daily basis. Social networking was used by almost half the panellists on a daily basis. Browsing was also used by a lot of users: almost 90% used browsers on at least a weekly basis.

Again gaming showed big differences between users. More than 30% of panellists used games on a daily basis, but almost a similar amount of users never used games at all (almost 30%).

Several services have not yet reached daily life of any of the panellists: navigation, VOIP and online music have almost no daily users. Online music and VOIP are not being used at all by the vast majority of the panellists.

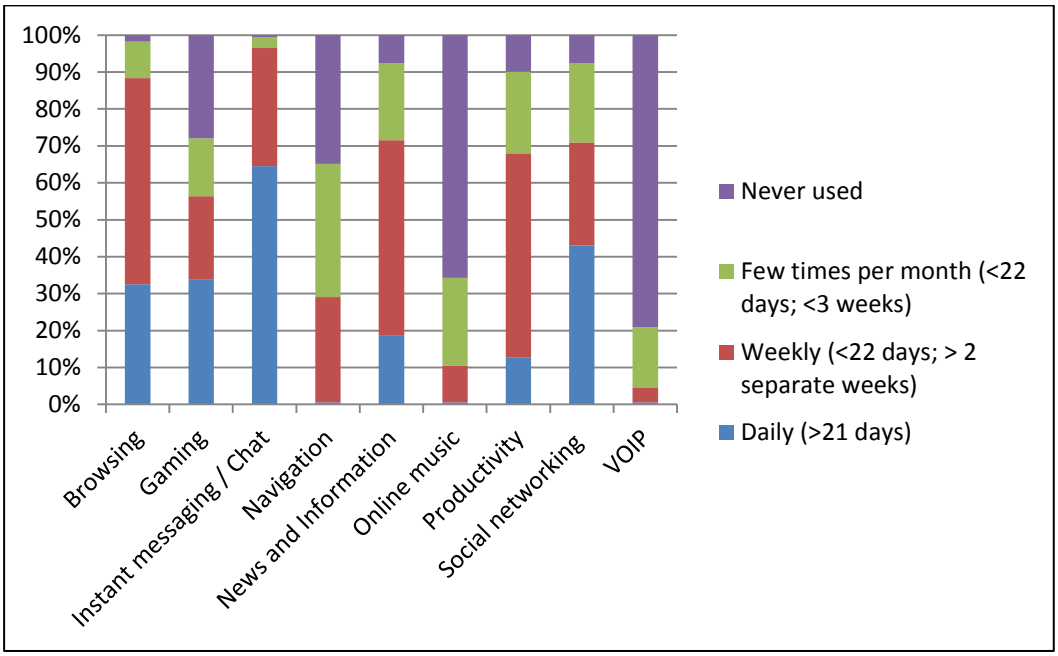


Figure 5.8 The use of applications and URL classes combined (N=172, Android users only).

5.2 Telephony (phone calls)

As the log software could not register phone calls on Samsung Galaxy S2 handsets, this section only analyses 218 panellists.

	Minimum	Maximum	Average	Standard deviation
Incoming calls	0.04	7.07	0.95	1.09
Outgoing calls	0.04	10.04	1.28	1.45

Table 5.2 Average number of phone calls per day per user (N=218, Samsung Galaxy S2 users excluded)

	Minimum	Maximum	Average	Standard deviation
Incoming calls	2.95	22.50	4.01	0.80
Outgoing calls	2.99	27.74	4.44	0.99

Table 5.3 Average number of minutes spent per day per user on phone calls (N=218, Samsung Galaxy S2 users excluded)

The average number of phone calls per day per panellist is around 1, although there are some heavy users that make more than 17 calls per day on average. See Table 5.2. Table 5.3 shows that panellists

spend around 4 minutes per day on phone calls.The two figures below (see 5.9) show that the number of minutes spent on phone calls differs strongly between the panellists. A substantial number of panellists hardly made any phone calls on a regular day.

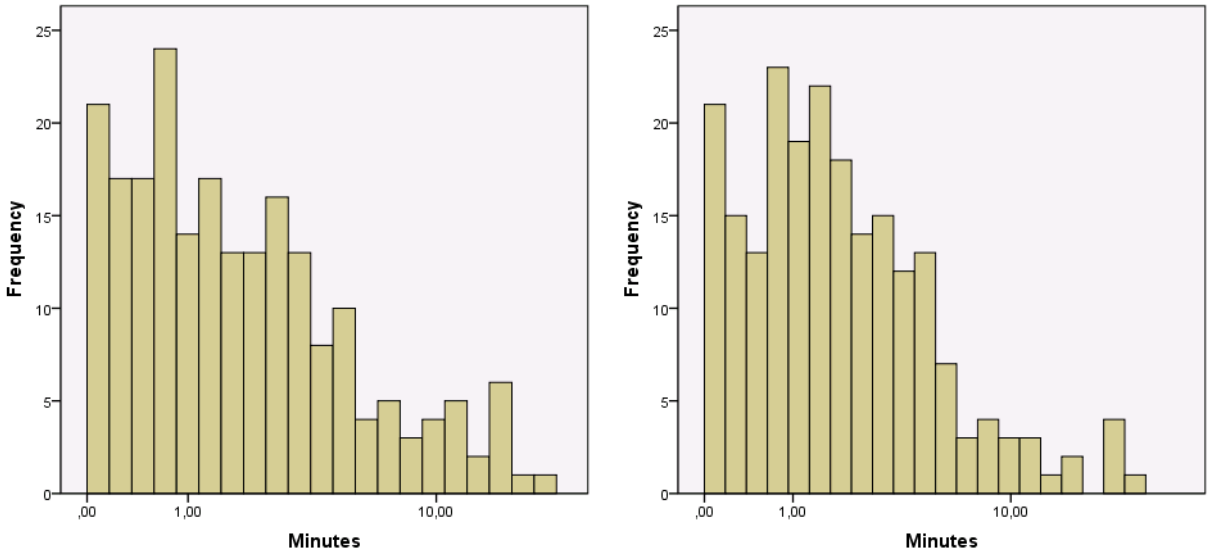


Figure 5.9 Frequency of average number of minutes spent per day per user on incoming (left) and outgoing (right) calls (logarithmic scale)(N=218).

We find similar differences between the panellists when comparing the average number of phone calls per day per user, see Figure 5.10.

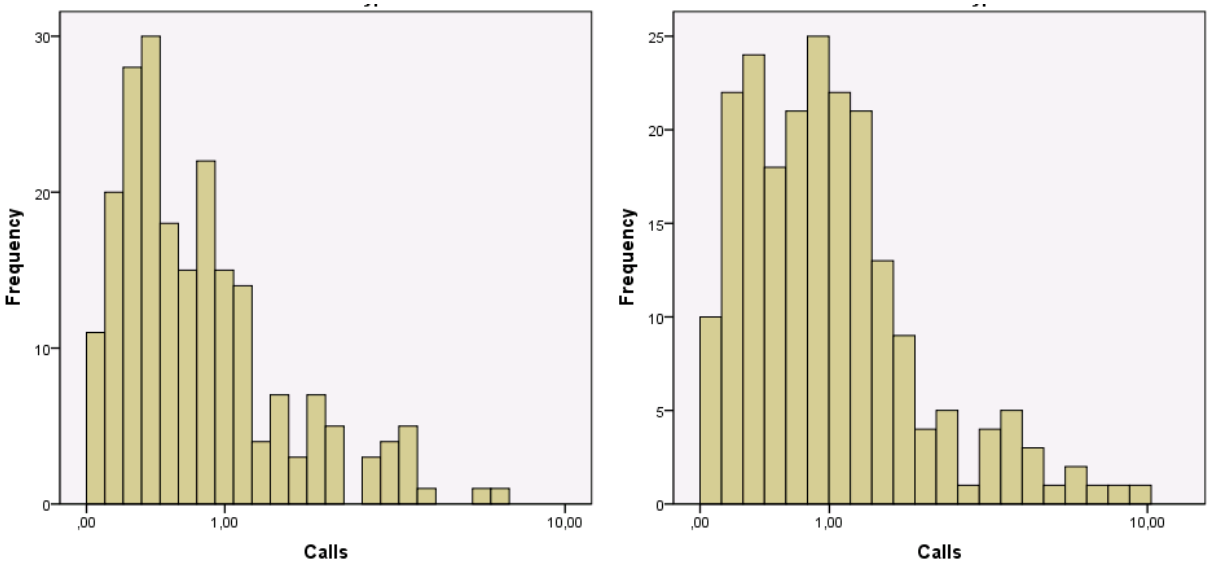


Figure 5.10 Frequency of average number of phone calls per day per user: incoming (left) and outgoing (right) (logarithmic scale)(N=218).

	Minimum	Maximum	Average	Standard deviation
Weekend	0	24.14	2.86	4.22
Weekday	0	59.59	6.96	9.85

Table 5.4 Average number of minutes spent on phone calls per user per day: weekend days versus weekdays (N=218, Samsung Galaxy S2 users excluded).

As table 5.4. shows, patterns of phone calls differ between weekend and weekdays.

5.3 SMS messaging

The measurement app could only measure text-messaging (SMS) on Android handsets. On average, users exchanged around 2 text-messages a day, see Table 5.5. On weekdays, the use of text-messages was a bit higher than on weekend days. See table 5.6.

	Minimum	Maximum	Average	Standard deviation
Incoming	1	12.29	1.16	1.39
Outgoing	1	9.29	0.77	1.10

Table 5.5 Average number of text-SMS messages per user per day (N=172, Android only).

		Minimum	Maximum	Average	Standard deviation
Weekday	Incoming	0	12.50	1.21	1.45
	Outgoing	0	9.30	0.78	1.08
Weekend	Incoming	0	11.75	1.02	1.57
	Outgoing	0	9.25	0.74	1.28

Table 5.6 Average number of text-messages per user per day: weekend days versus weekdays (N=172, Android only).

5.4 Data traffic

Data traffic can take place via an operator network (i.e. cellular network, which can be 2G or 3G) or a WiFi network. Overall, consistent with the data from 2011, more megabytes are transmitted through WiFi networks than through cellular networks. In addition, more data is received than transmitted via a smartphone.

The descriptive statistics for the different types of networks are shown in Table 5.7.

			Minimum	Maximum	Mean	Standard deviation
Weekdays	Cellular	Sent	0	8.08	0.53	0.96
		Received	0	23.46	3.30	4.57
	WiFi	Sent	0	32.09	1.97	3.39
		Received	0	321.83	17.51	34.84
Weekend days	Cellular	Sent	0	10.13	0.50	1.05
		Received	0	34.79	2.75	4.95
	WiFi	Sent	0	54.51	2.23	4.69
		Received	0	441.93	19.48	47.41

Table 5.7 Average data traffic (MB) per user per day (N=232).

The boxplots in Figure 5.11 indicate the spread of data traffic across the sample, like minimum, maximum and median. When the scale is transformed logarithmically, only few outliers remain. There are more outliers for cellular networks than for WiFi networks, which indicate that the spread here is larger. The data shows that there is a considerable amount of individuals that hardly use cellular networks, or even not at all and only apply WiFi.

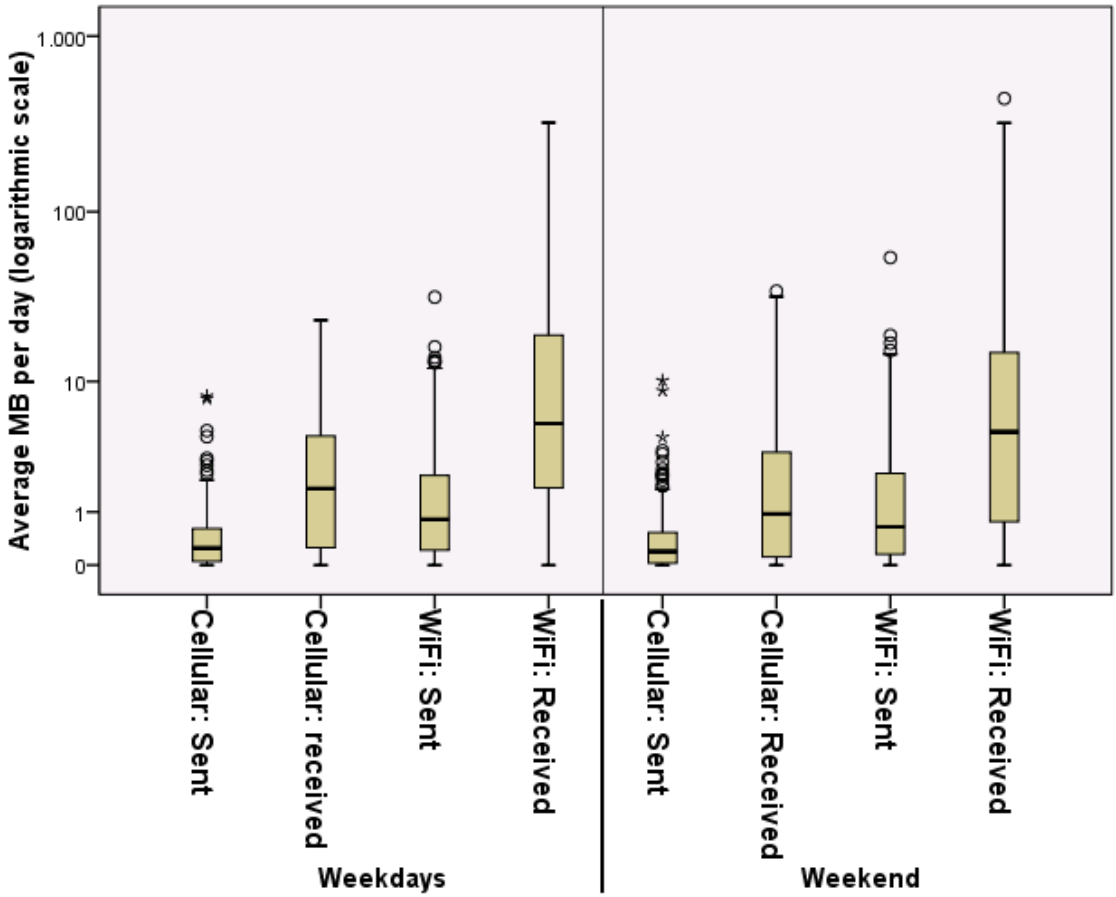


Figure 5.11 Boxplots: average data traffic (MB) per day[2] (logarithmic scale)(N=232).

On average, about 30% of outgoing bytes and 27% of incoming bytes are transmitted via cellular networks. The boxplots in Figure 5.12 show again the large variation across the sample, with the range between 0% and 100%.

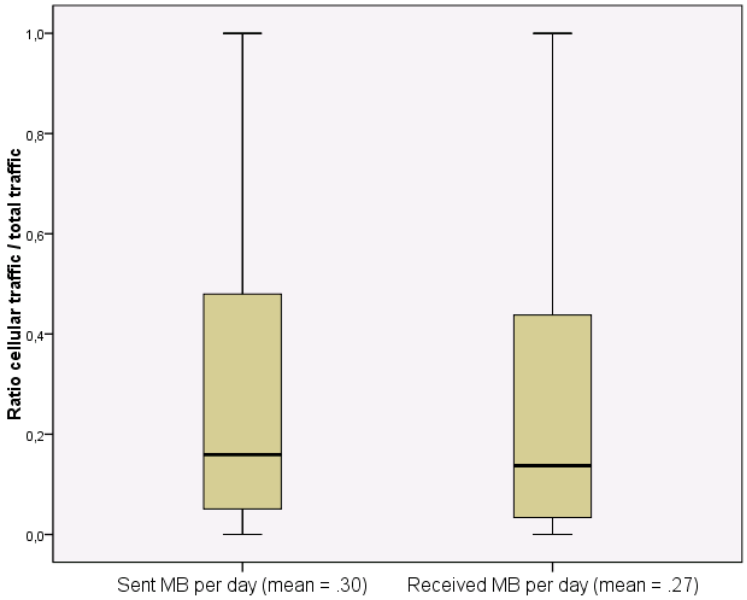


Figure 5.12 Boxplots: proportion of data traffic (MB) via cellular networks (N=232).

[2] MB = 1048576 bytes

There is strong correlation between the amount of MB's sent and received over cellular networks and over WiFi networks. In other words, heavy users of WiFi are also heavy users of cellular networks. See table 5.8.

	Cellular: sent	Cellular: received	WiFi: sent	WiFi: received
Cellular: sent	1			
Cellular: received	.63**	1		
WiFi: sent	.40**	.20**	1	
WiFi: received	.14*	.17**	.50**	1

** p < .01

Table 5.8 Correlation between amount of data traffic (MB) through Wifi and cellular networks (N=232).

The use of cellular networks on Android versus Apple is not significantly different. However, the use of WiFi is significantly different for both MB sent (t(231=2.31, p = .022) and received (t(63)=4.05, p = .000). See Figure 5.13.

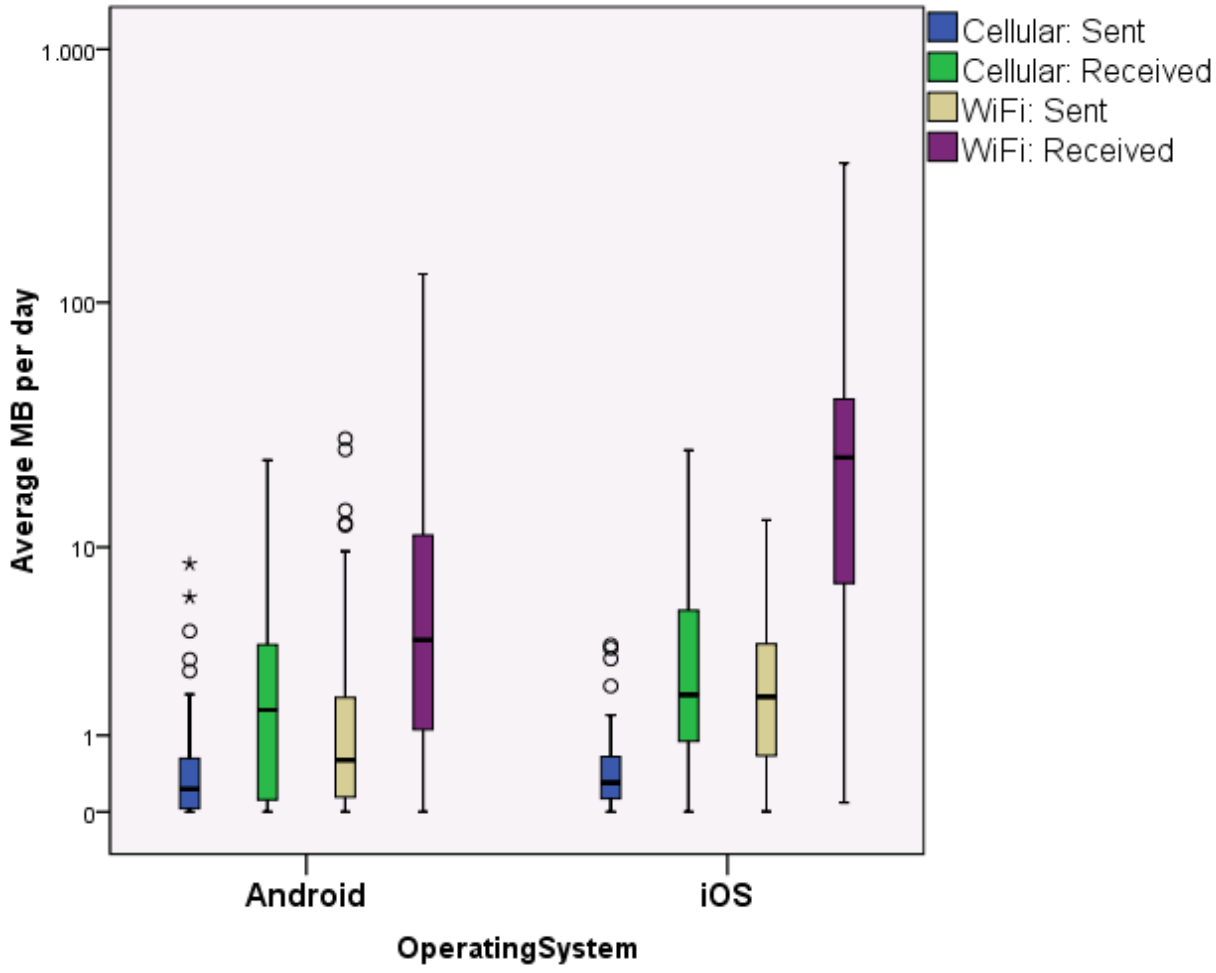


Figure 5.13 Boxplots: data traffic (MB) per day, compared between operating systems (logarithmic scale)(N=232).

Correlation between use of applications and data traffic

It can be expected that data traffic and the use of applications are interrelated. The graph in Figure 5.14 shows the number of minutes spent on the four major types of applications per day, and the total amount of MB sent and received on both cellular and WiFi networks per day. It is striking that the trend line for browsing, social networking and chat applications are more of less similar. For gaming the trend line is not very strong, likely because games are often used offline without heavy data traffic. Overall, explained variance is low.

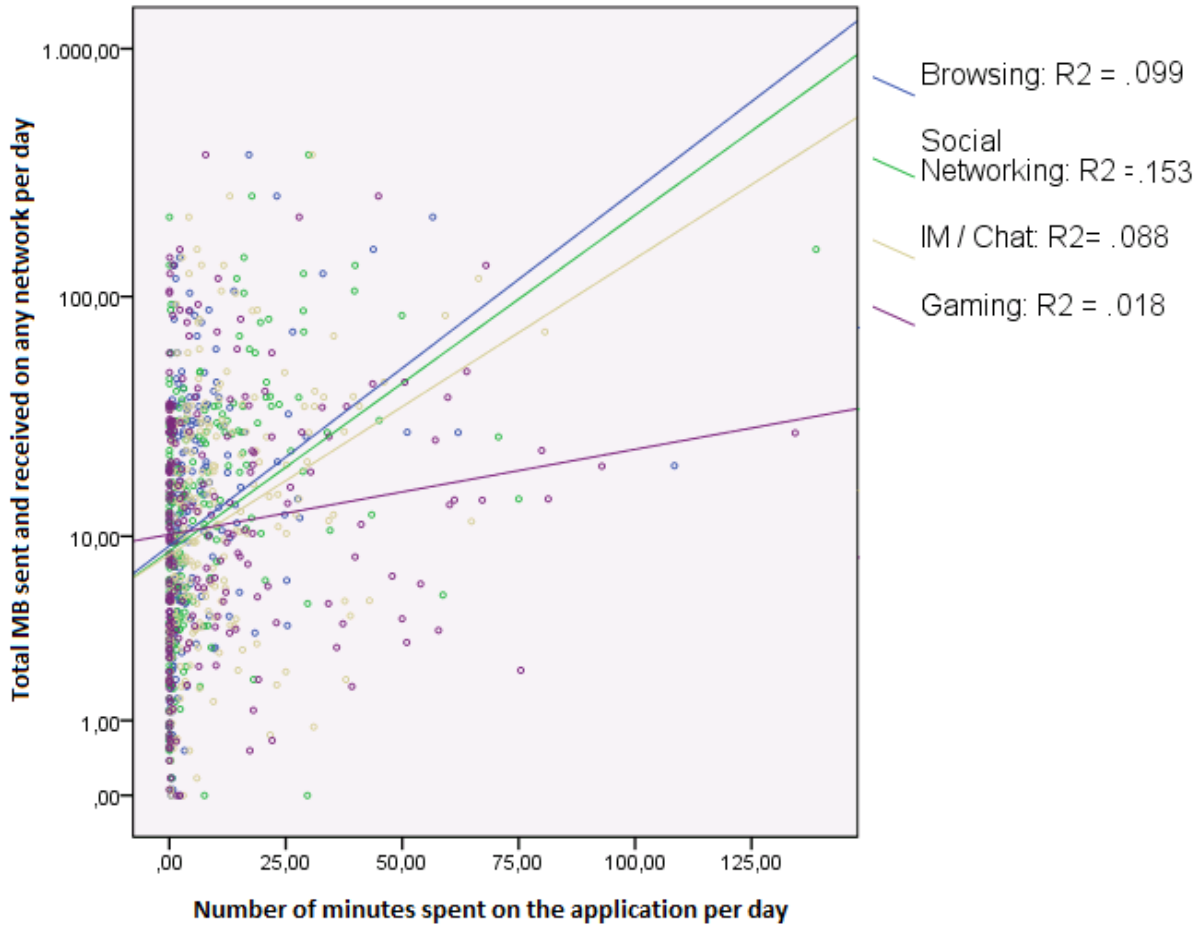


Figure 5.14 Relation between application usage and data traffic (N=232)

Table 5.9 shows a regression model that explains that the number of MB's by all four application types is significant (F(4)=16.477, p =.000; R^2 = .227). The effect size of social networking apps is the largest, followed by IM / Chat and browsing.

	Beta	t	P	VIF
(Constant)		14.467	.000	
Social Networking Apps (avg minutes / day)	.270	4.134	.000	1.237
Browsing Apps (avg minutes / day)	.178	2.818	.005	1.160
Gaming Apps (avg minutes / day)	.105	1.778	.077	1.010
IM / Chat Apps (avg minutes / day)	.185	3.033	.003	1.080

Table 5.9 Regression model explaining data traffic through application usage (N=232).

5.5 Browsing behaviour: network analysis

In this section, we analyse, by using graphs, how panellists browse through different websites. As the log data provides all the browsing sessions, including the end and start time, we can assess how panellists browse from one website to another. This concerns only the Andriod users (N=172).

Browsing behaviour: aggregated among all users

When a user visits a web domain within 30 seconds after closing a previous web domain, we assume that the user moves from one website to another within the same browsing session.

An edge list is computed as follows:

- M_k: Previous website in same browsing session (category)
- N_i: Current website (category)
- X = Total number of pairs for user *n* from M_k to N_i
- Y = Total number of pairs for user *n* for all M to all N

Next, the weight in the edge list for M_k, N_i equals:

$$\text{Weight}_{M,N} = \frac{1}{163} * \sum_{n=1}^{n=163} \text{X\_n/Y\_n}$$

Figure 5.15 shows the directed graph for the most popular URLs that were visited. The size of the node indicates between-ness, i.e. the centrality of the node. The thickness of a line indicates the strength of the tie, i.e. the weighted percentage of browsing sessions in which a user goes from the one node to the other. The factor 1/163 represents the number of panellist with a browsing session. The resulting graph is displayed in Figure 5.15.

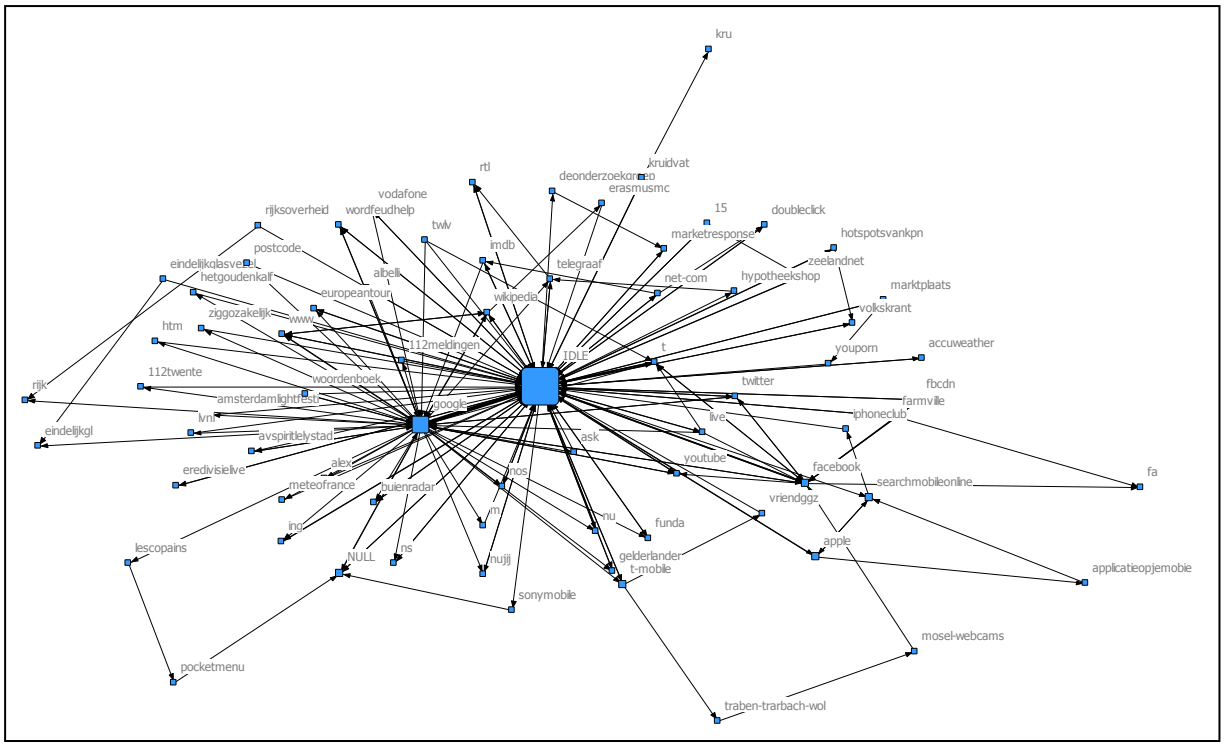


Figure 5.15 Browsing behaviour of panellists across website domains (N=163; most popular websites only).

As can be seen in Figure 5.15, the node called `IDLE' is most central, which indicates the beginning or end of a session. Google is also relatively central, as are several news websites such as NOS, nujij, De Telegraaf, Live, Buienradar and t (related to Twitter). Overall, this is a very scattered picture.

A similar figure is constructed in Figure 5.16, but now for website categories (URL classes) rather than individual website names. This shows a more coherent picture. For readability, links with low weights are filtered from the diagram. Again, the idle state is most central, but users are just as likely to move from a news and information or search website. Social networking, process and commerce websites are also relatively central. The website categories at the periphery should be understood as websites that panellists do browse to but then not move to another class or website.

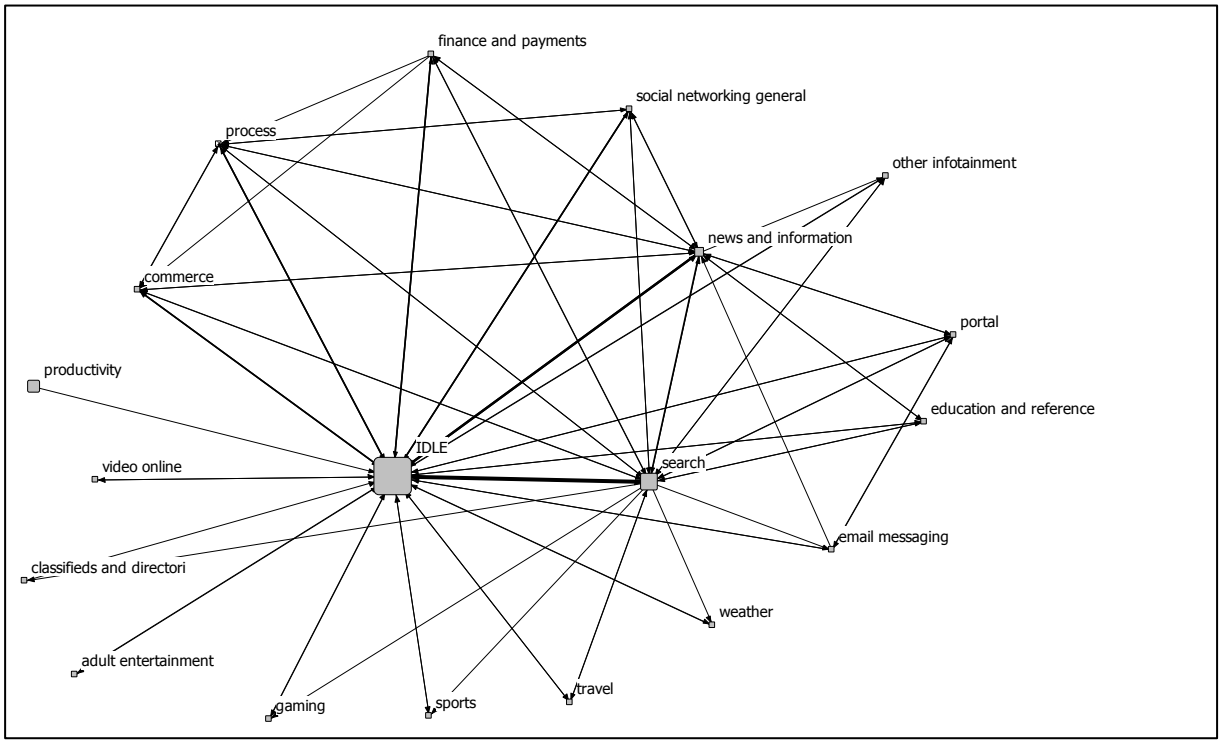


Figure 5.16 Browsing behaviour across different categories of websites (N=163; most popular websites only).

These types of graphs can also be compiled for different subsets of users. For instance, the Figures 5.17a and b contain a similar graph as Figure 5.16, but separates between male and female users. As it can be seen, the behaviour is quite different. Social networking is much more important as an intermediate step in the browsing process for females than for males, while the opposite holds for news and information.

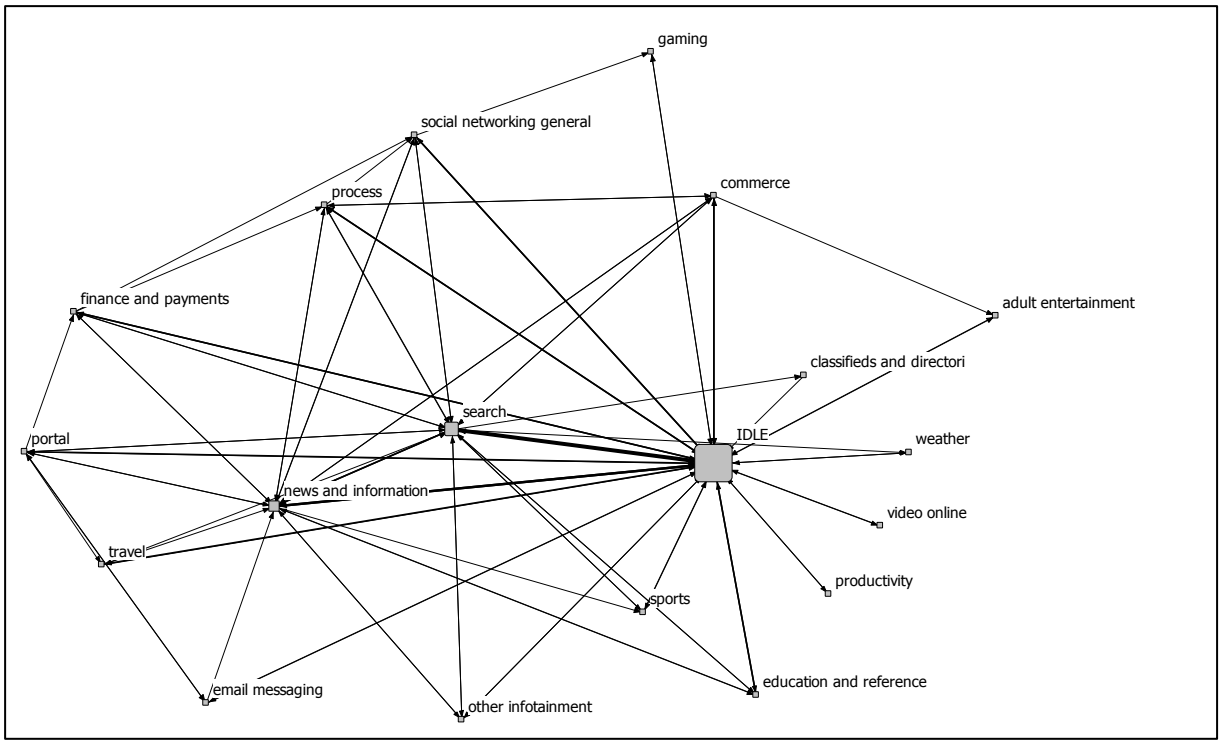


Figure 5.17a Browsing behaviour across different categories of websites: males.

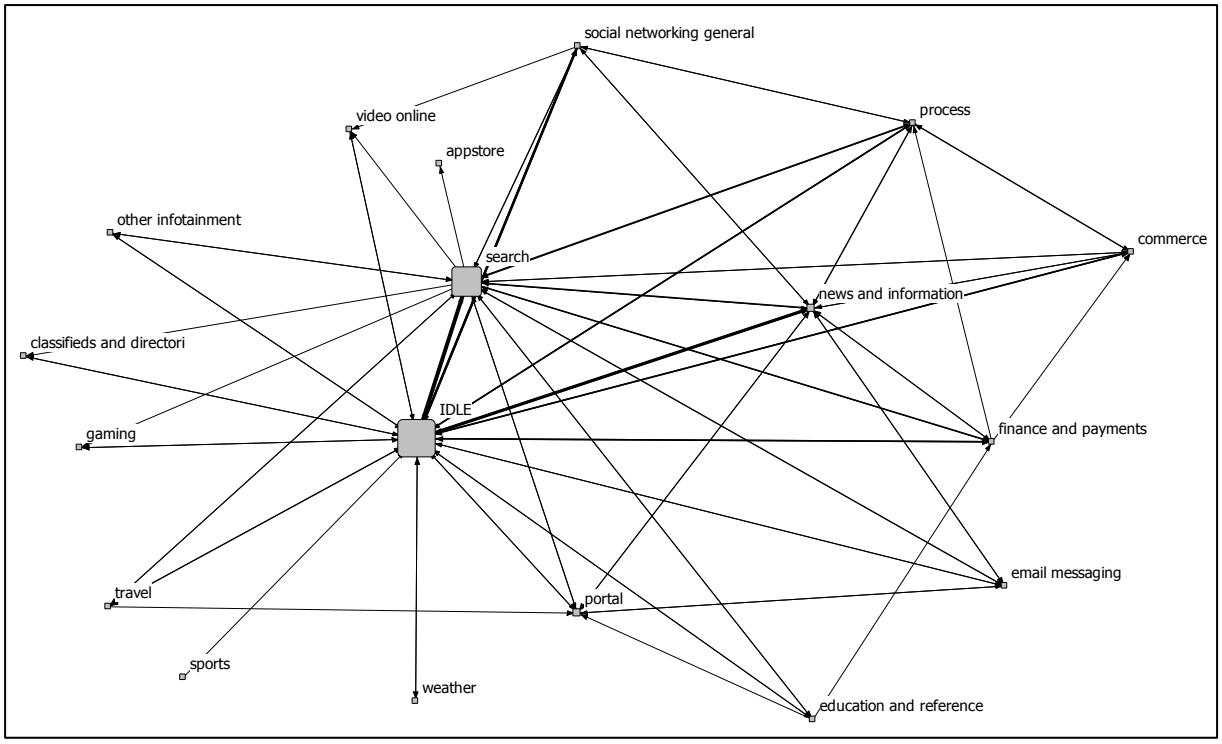


Figure 5.17b Browsing behaviour across different categories of websites: females

B**rowsing behaviour across websites: reducing idiosyncrasy**

The graphs constructed so far may be sensitive to individual idiosyncrasies: individuals that browse often between two types of websites may have a strong effect on the resulting pictures. Therefore, we repeat the analysis, while including only those patterns that exist for at least two panellists in the sample.

If a person navigates within 10 seconds after a session ends to another website, we assume this is done by clicking a link rather than typing in a new address. We then get a list of domains from and to which a person browses. Next, we take only those pairs that exist for at least two users. This produces a graph of 144 x 144 nodes, see Figure 5.18. In this graph, size of the node indicates between-ness, and the tie strength indicates the weight. Colours are used to indicate the different cores of the network: it can be seen that central nodes as Google, Facebook, Twitter, Live and t are grouped in the same category, while news and information types of websites are grouped in another category.

From Figure 5.18, it becomes clear that Google is the most central node in this network. But also Facebook and YouTube are hubs that lead to other sites. Most websites are on the periphery of this network.

Figure 5.18 is a rather scattered picture, in which a lot of website domains appear at the periphery. When taking out nodes from the graph that only have one tie, we produce Figure 5.19. Again, this picture shows that certain cores can be identified. The same 5 website domains are central as in Figure 5.18 and the second group comprises news and video websites. The blue nodes are peripheral but have both incoming and outgoing ties, while the grey nodes only have incoming ties, and are thus the end point of a browsing session.

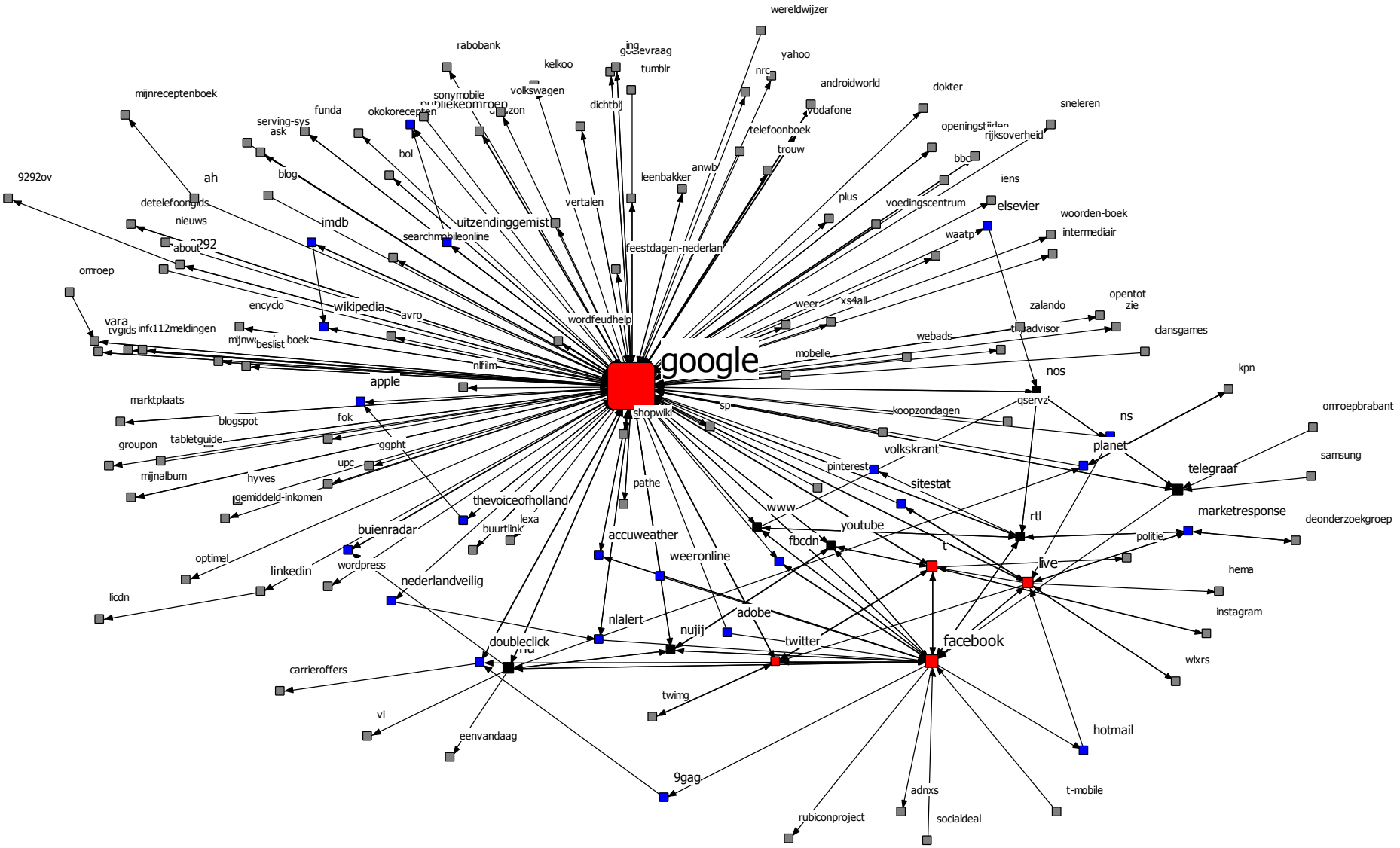


Figure 5.18 Browsing behaviour across websites: patterns shared by at least two panellists

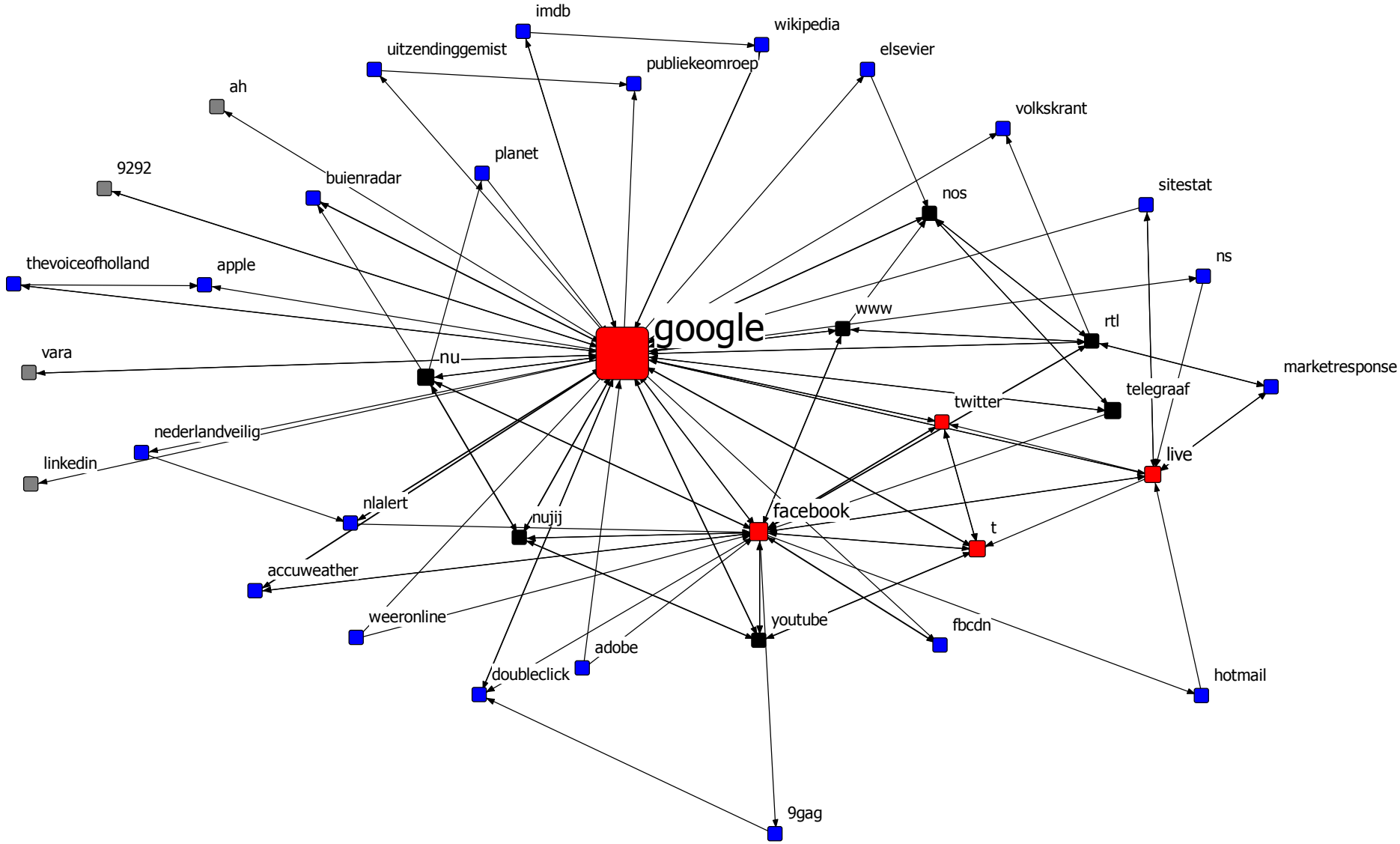


Figure 5.19 Browsing behaviour across websites: patterns shared by at least two panellists, nodes with only one tie omitted

5.6 Time series analysis of 2011 and 2012 smartphone users

Thirty six panellists participated both in 2011 (at least for 14 days) and in 2012 (the full 28 days). In this chapter, we zoom in on those 36 panellists to explore trends in their usage behaviour. The statistics provided are meant for exploratory purposes solely and are not intended to be generalizable to any population.

5.6.1 Sample

In 2011, 128 panellists participated in total, out of which 36 participated again in 2012. As shown in the table below, there are some demographic differences between those that participate again and those that do not.

		Participated in 2011 and 2012 (N=36)	Only participated in 2011 (N=92)
Gender	Male	56%	54%
	Female	44%	46%
Position in household	Primary wage earner	28%	24%
	Caretaker	33%	25%
	Both	22%	39%
	Child	14%	9%
	Other family member	3%	2%
	Other person	0%	1%
Education level	HW	14%	18%
	HB	39%	35%
	HA	3%	10%
	MB	31%	23%
	MA	8%	10%
	LB	6%	3%
	DNK, no answere	0%	1%
Income	Below modus	19%	17%
	Modus	14%	21%
	Above modus	67%	57%
	DNK	0%	3%
	No answere	0%	2%
Average age		42.7	46.1

Table 5.10 Comparing distributions of demographics for repeating and non-repeating panellists.

Panellists that participate in both years do appear to be more heavy users of specific types of applications, specifically email, instant messaging / chat, and gaming (not shown in tables here). However, there are no significant differences for any of the other types of apps, voice calls, messaging and URLs visited.

		Participated in 2011 and 2012 (N=36)	Only participated in 2011 (N=92)
Handset brand	Apple	8%	21%
	Blackberry	0%	11%
	HTC	36%	32%
	LG	3%	0%
	Samsung	42%	29%
	Sony Ericsson	8%	4%
	Other	3%	3%

Table 5.11 Comparing handset brands for repeating and non-repeating panellists.

We do see that users that had a Blackberry in 2011 do not participate again in the study (as the software no longer supported this brand), and that Apple users are less likely to repeatedly participate probably due to the fact that iPhone panellists experienced technical problems with the measurement app in 2011 (e.g. battery drainage). See Table 5.11.

Most of the panellists that take part in the study in both years still have the same brand of smartphone, see the table 5.12.

		2011						Total
		HTC	iPhone	LG	Samsung	Sony Erics-son	Other	
2012	HTC	10	0	0	1	0	0	11
	iPhone	1	3	0	1	0	1	6
	LG	0	0	1	0	0	0	1
	Samsung	2	0	0	13	1	0	16
	Sony Ericsson	0	0	0	0	2	0	2
Total		13	3	1	15	3	1	36

Table 5.12 Handset brands owned by panellists that participate in 2011 and 2012 (N=36).

5.6.2 Results

Phone calls and text-messaging (SMS)

The use of phone calls and SMS messages does not significantly change between 2011 and 2012, according to paired sample t-tests. Average number of phone calls per user per day is still around 1, see Figure 5.20. The number of text-messages seems to have reduced slightly. Please note that the use of text-messages is based only on the Android users.

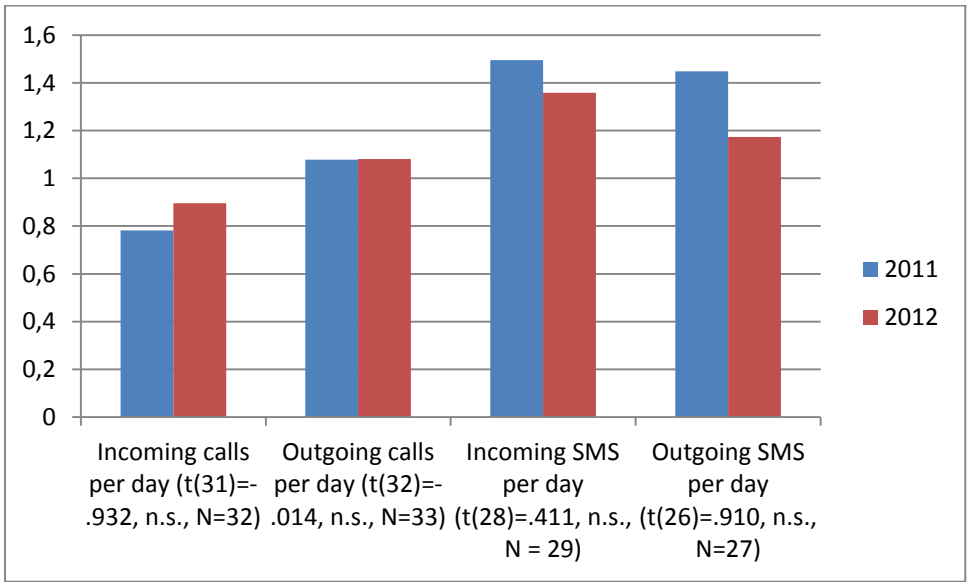


Figure 5.20 Phone calls and SMS traffic in 2011 and 2012.

	N	Minimum	Maximum	Mean	Standard deviation
Incoming SMS per day	29	-5.54	6.54	-.14	1.79
Outgoing SMS per day	27	-6.29	4.00	-.28	1.57
Incoming calls per day	32	-1.57	2.39	.12	.70
Outgoing calls per day	33	-2.47	2.11	.00	.89

Table 5.13 Differences phone calls and SMS traffic 2011 – 2012.

Table 5.13 shows how many more text-messages and phone calls were recorded in 2012 compared to 2011. The differences for phone calls between the two years are small for most panellists. Howev-

er, differences for text-messages have large standard deviations, showing that some users increased and others decreased their usage.

The average duration of a phone call seems to have increased a bit, although this is not significant according to paired sample t-tests.

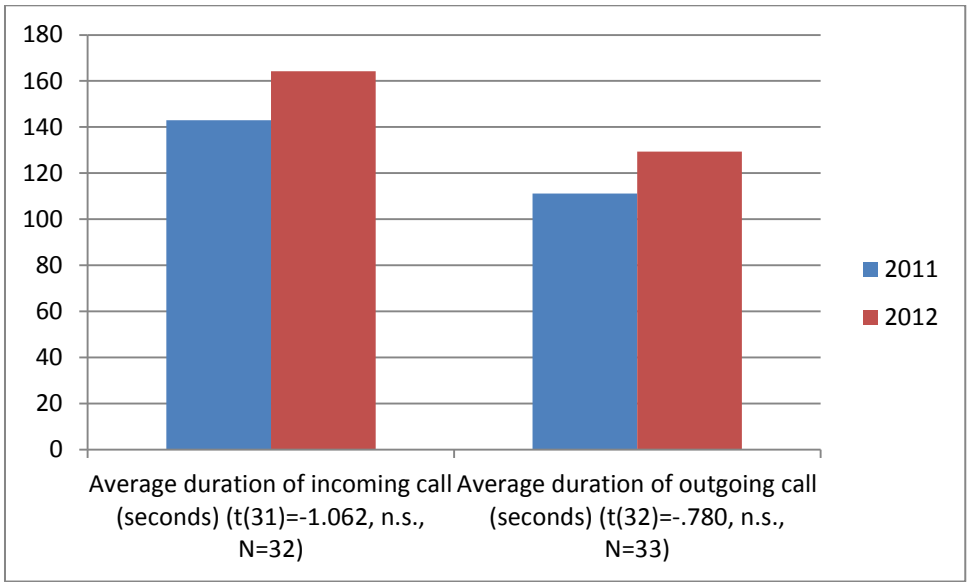


Figure 5.21 Average duration of phone calls per user 2011 and 2012.

Application categories

Number of sessions

Figure 5.22 shows the average number of sessions per day per user for the different types of application categories. Significant differences between the two observed years are indicated with a reported Wilcoxon Z-score. The number of times email is used is more or less similar in both years. Significant growth can be observed in the use of instant messaging / chat (e.g. Whatsapp), social networking (e.g. Facebook), browsing and news and information apps.

Duration of use

Figure 5.23 shows the average number of minutes that applications are being used on a day. The minutes spent on using email and gaming has been reduced. People spend more time, overall, on instant messaging / chat, social networking and browsing.

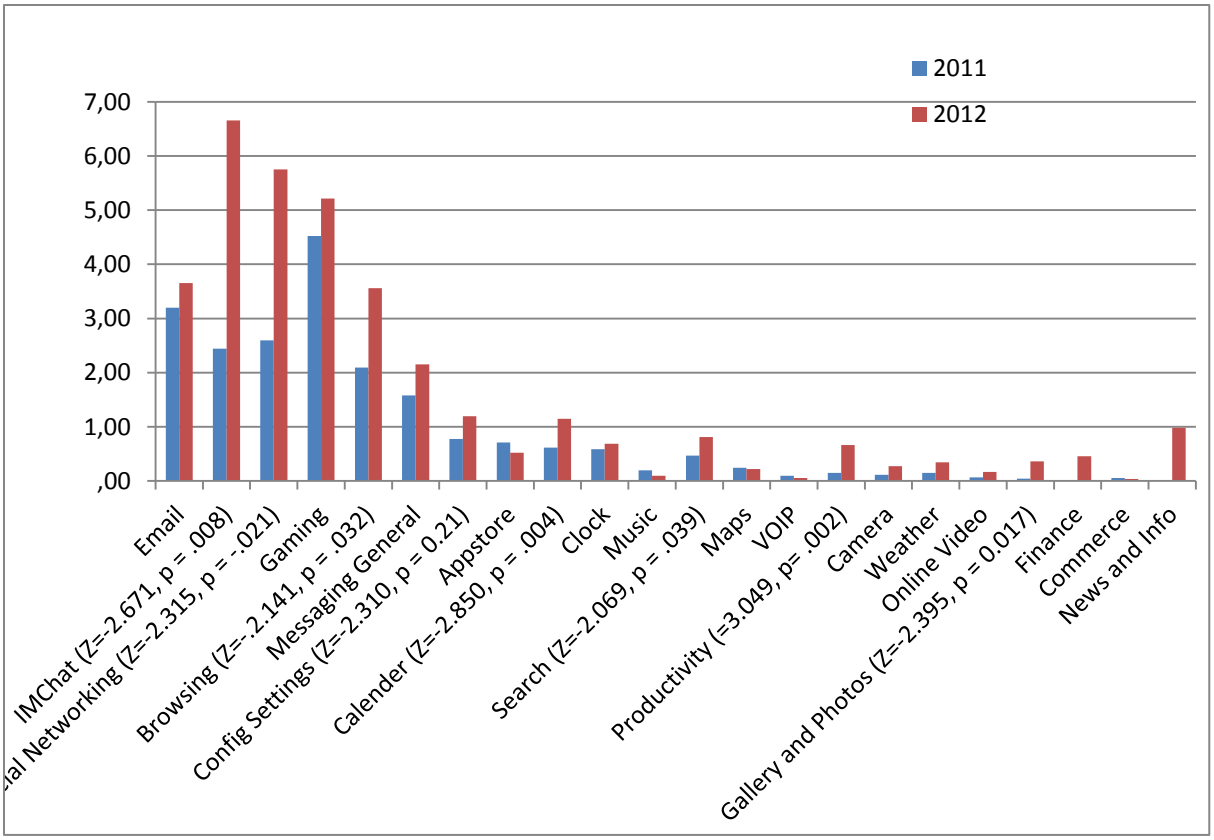


Figure 5.22 Average number of sessions per user per day for different categories of applications (N=36).

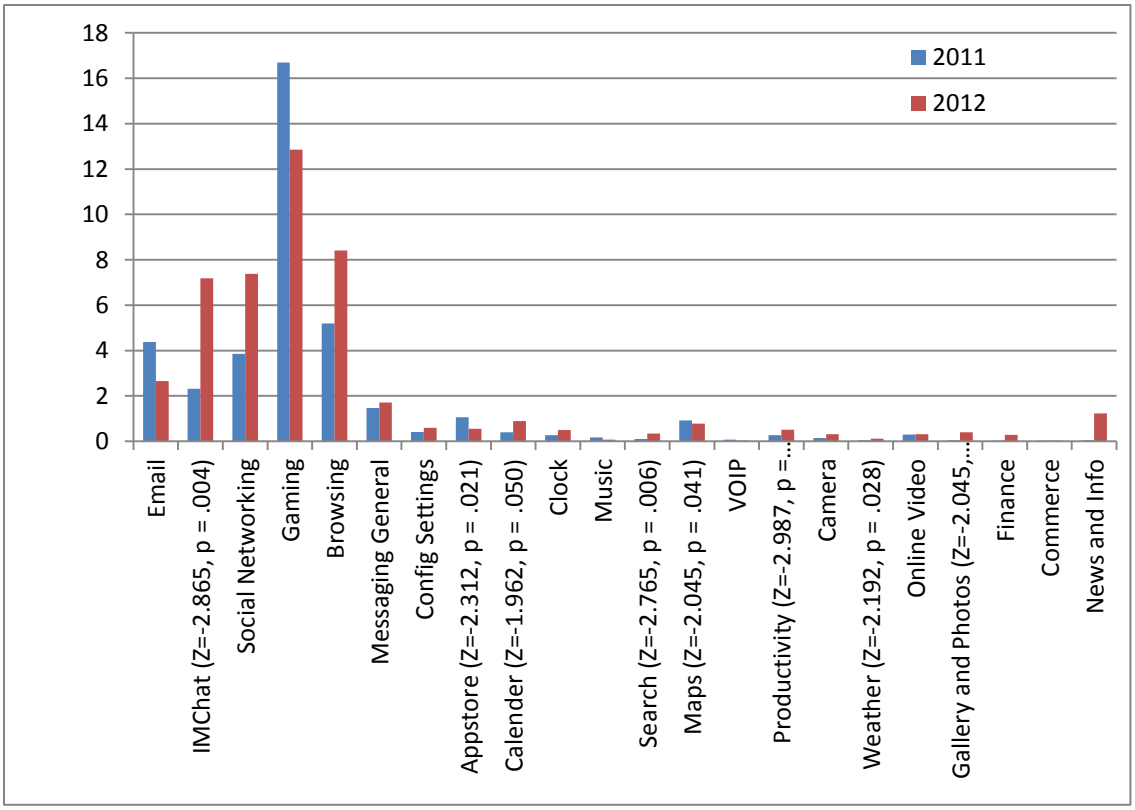


Figure 5.23 Average number of minutes per day per user for different categories of applications (N=36).

Most popular application categories

Next, we zoom in on the penetration of the different application categories. The figure 5.24 shows the percentage of panellists who used the application type at least once over the observed period. Several services are used by a larger percentage of the panellists: gallery and photos (39%), news (36%), finance (33%), weather (31%), social networking (25% increase) and search (17%).

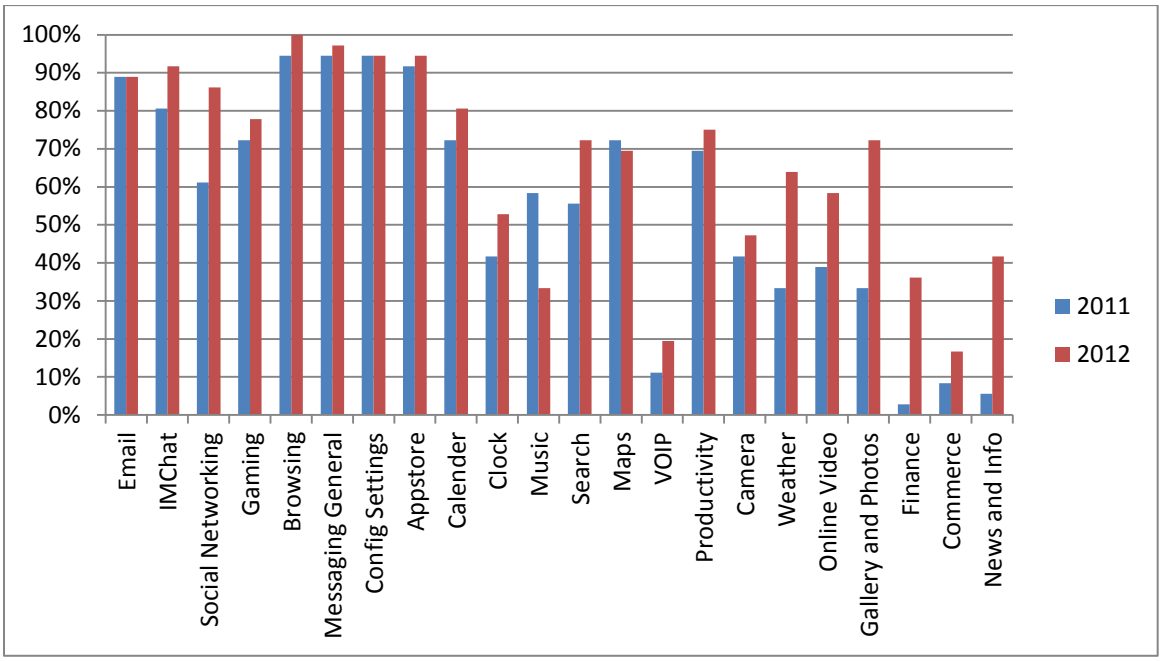


Figure 5.24 Percentage of panellists that used the application category at least once in observed period (N=36).

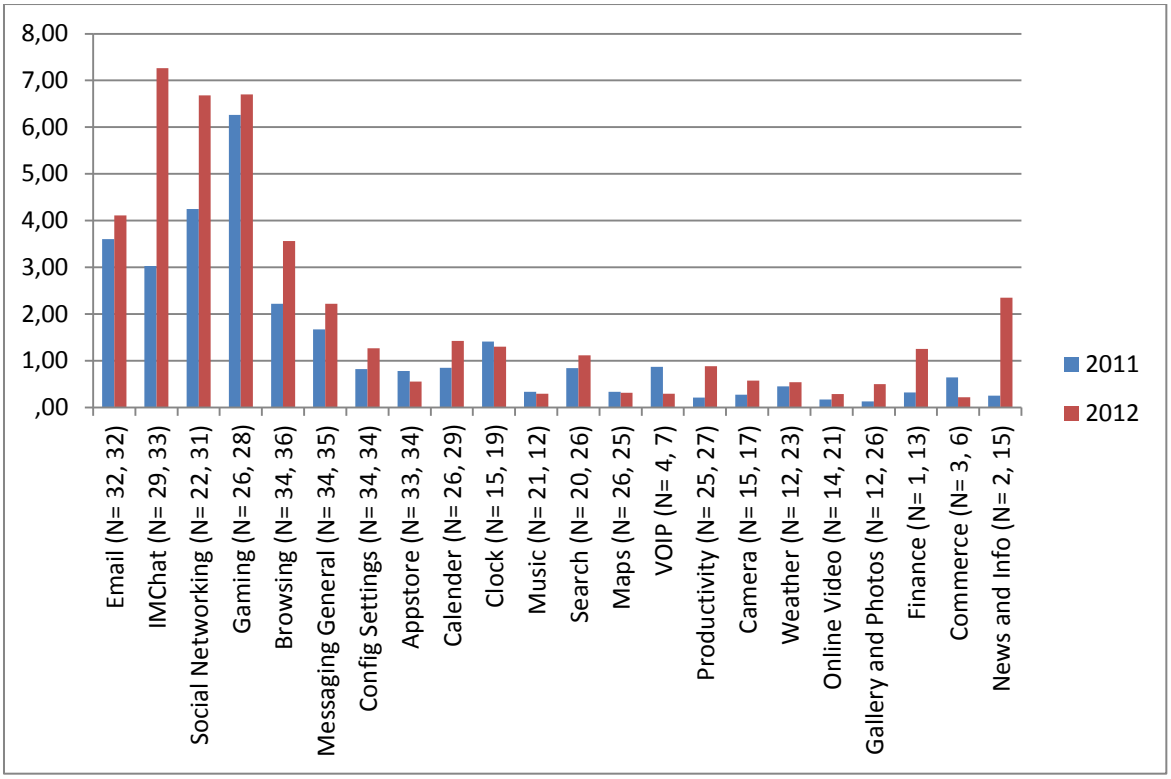


Figure 5.25 Average number of sessions per day per *active* user for different categories of applications.

Active users

If we analyse the average number of sessions per day again, but this time only for *active* users, i.e. users that use the application category at least once. Figure 5.25 shows similar patterns: IM/Chat, social networking, browsing are all used more times per day by the active panellists.

Also in terms of number of minutes per day, we see similar patterns for active users between the years. Email and gaming are becoming less intensively used; IM/Chat, social networking and browsing are more intensively used. Overall, the differences between the years are small.

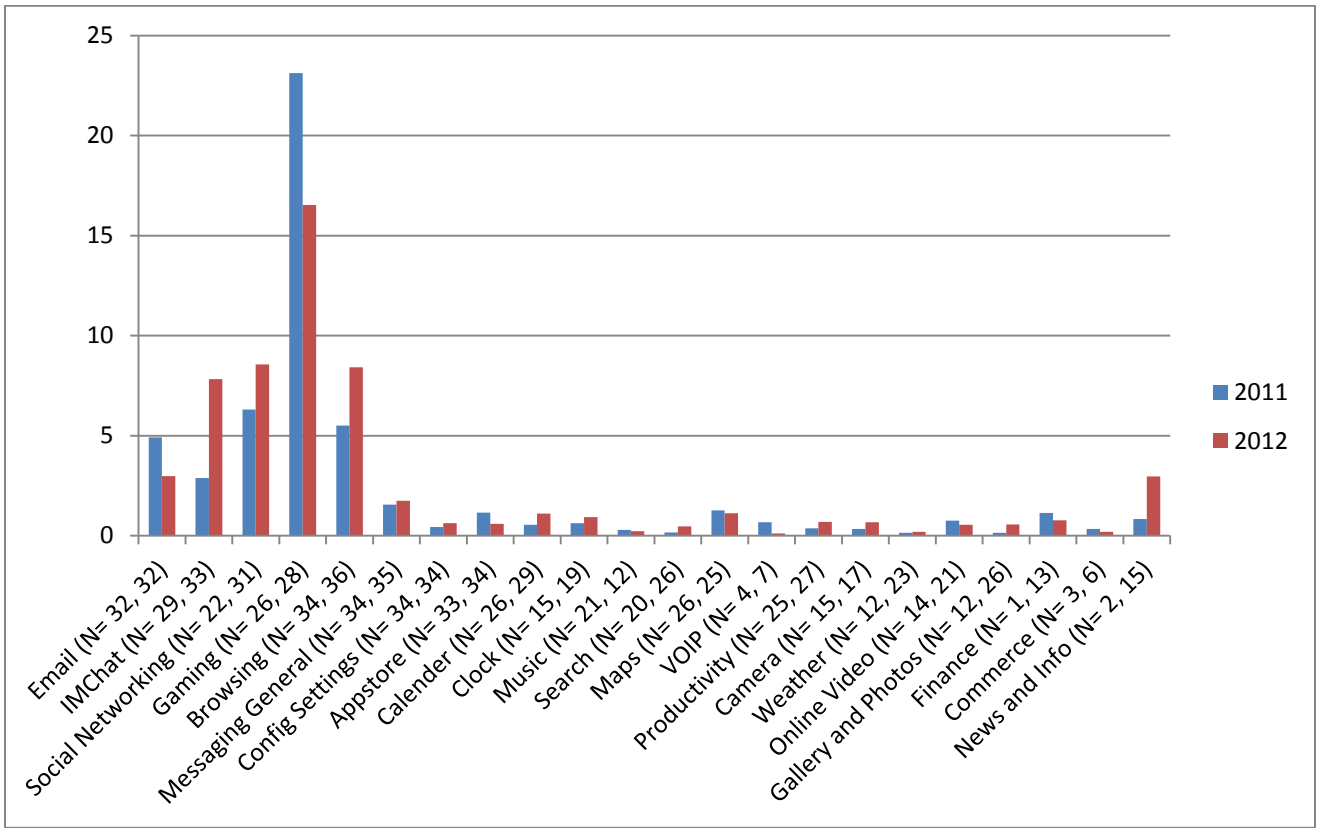


Figure 5.26 Average number of minutes per day per *active* user for different categories of applications.

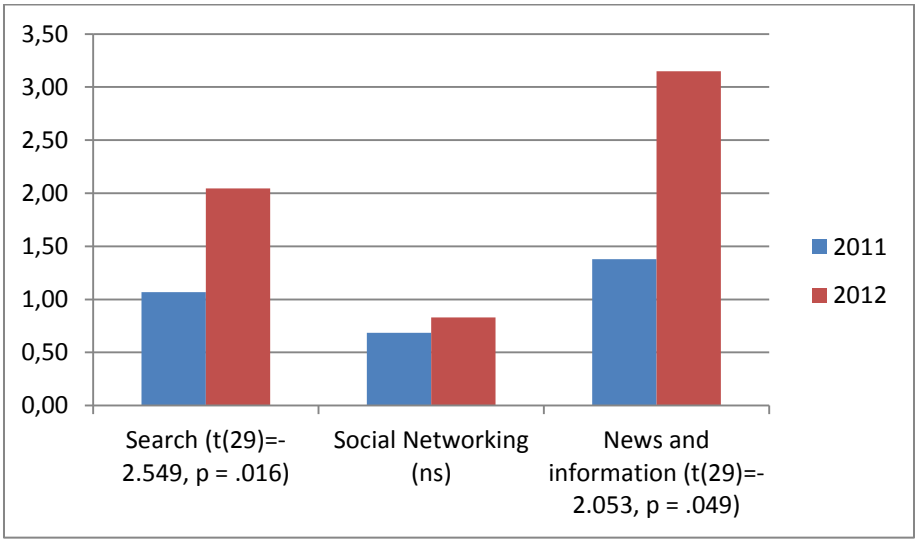


Figure 5.27 Average number of visits to URL types per day (non-I-phone users only, N=30).

URLs visited (N=30, only Android users)

When considering the three most prominent types of websites visited (i.e., search, social networking and news/information), we find that use dramatically increases in 2012. Especially search and news and information websites are browsed significantly more often. See Figure 5.27.

The number of minutes spent on these classes of URL pages shows a similar pattern: usage increases dramatically between the two years.

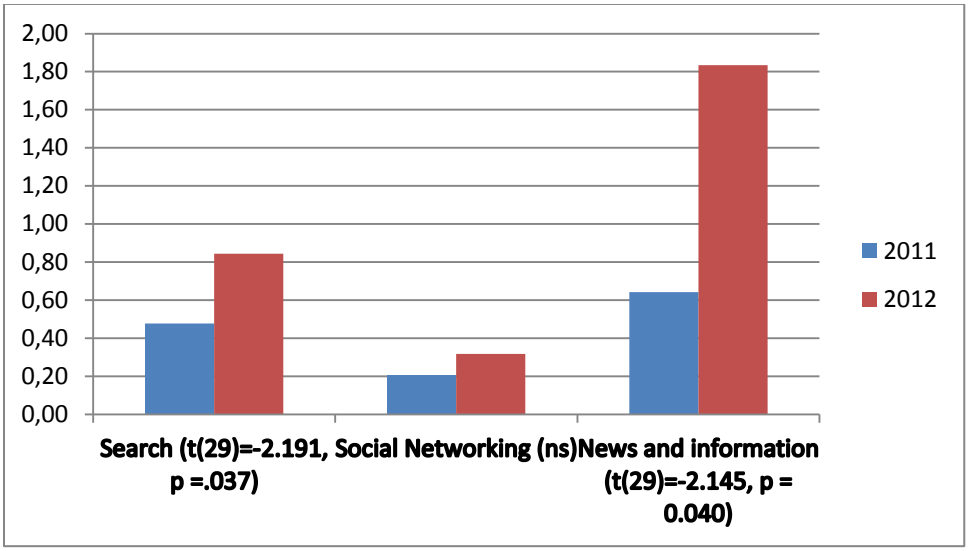


Figure 5.28 Average number of minutes spent at URL types per day per user (non-I-phone users only, N=30).

5.6.3 Conclusions

Only 36 panellists from 2011 participated again, and we do not claim the sample is representative. Still, patterns can be observed.

The use of the browser to visit popular types of web pages such as search, social networking and news and information has increased dramatically between the two years.

For several applications, we can also observe that the intensity of use has increased significantly for most users.

The use of voice and SMS messaging is more or less similar between 2011 and 2012.

5.7 Conclusions

In this chapter, the main results of the smartphone measurements are presented, based on the log data collected. In fact, this only is a small part of the analyses, which can be carried out. These analyses relate to the 2011 pilot and concern:

- Applications and categories of applications used. Most sessions (frequency and duration) are related to categories, such as instant messaging, social networking, email, voice and gaming. The use of commerce apps is still limited.
- Telephony. The number of minutes spent on phone calls differs strongly between panellists. There are also differences for incoming calls (on average 1 per day with a duration of 4 minutes), outgoing calls (on average 1.3 per day with a duration of 4.4 minutes), weekdays (on average 7 minutes) and weekends (on average 2.9 minutes).
- SMS messaging. On average people receive 1.2 text-message per day and send 0.8 text-message per day.

- Data traffic. Consistent with the 2011 pilot, people transmit more data through WiFi networks than cellular networks.

Furthermore, the browsing behaviour of the panellists is analysed. In detail, this provides a rather scattered picture, in which many websites appear. When the nodes, which are less important, are removed, especially, Google, search, news and information, Twitter and Facebook are central. There are also differences between the browsing behaviour of men and women.

Finally, also a comparison was made between the smartphone users, who participated in the 2011 and 2012 pilot. This only concerns 36 panellists, so one should be cautious in drawing conclusions.

6. Main results based on tablet computer measurements

Only 47 panellists participated with their tablet for the full 4-week period. See table 6.1.

iOS	iPad 1	7
	iPad 2	15
	iPad 3	8
	Total	30
Android	Samsung	8
	Asus	3
	Android	2
	Other	4
	Total	17

Table 6.1 Types of tablet computer included in the study.

Applications

Figure 6.1 figure below displays the penetration of application types. Browsing is used at least once in the observed period by almost all panellists. Gaming, email, configurations and settings and appstore applications are used by at least four out of five panellists. Social networking, gallery and photos, maps, productivity tools and calendar applications are used by just over half the panellists. Other applications have low levels of uptake among the panellists.

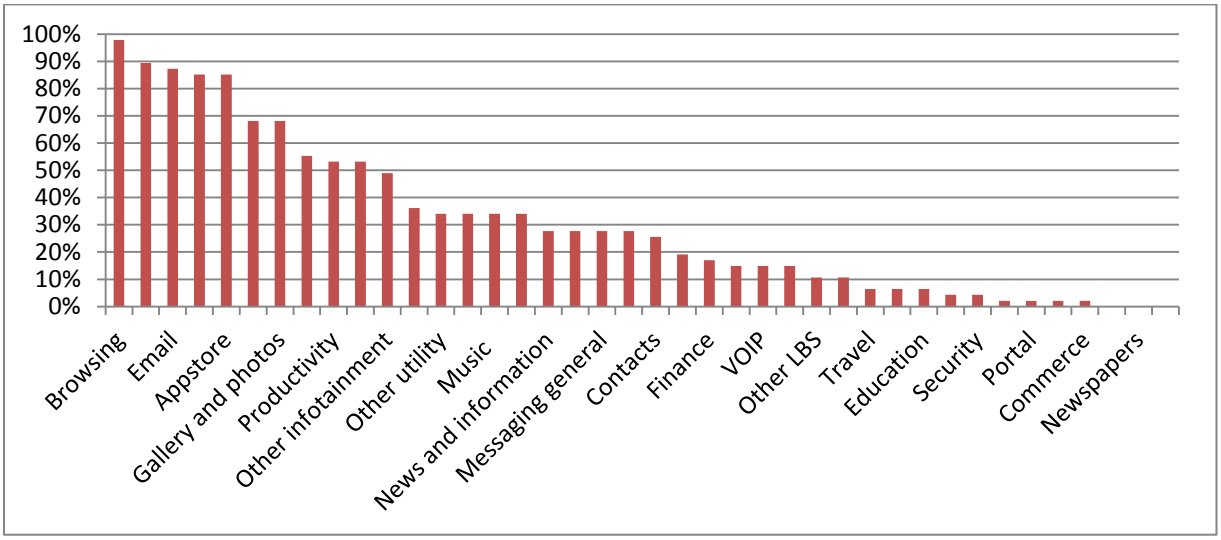


Figure 6.1 Percentage of panellists that used an application type at least once on a tablet computer (N=47).

In total, panellists spend 104.74 minutes on average on applications per day. Half of this time is spent on browsing and gaming. Six minutes on average are spent on email and almost 5 minutes on social networking. Other applications are used on average for one or less than one minute per day. 32 minutes per day are spent on applications that the measurement software cannot automatically classify. See figure 6.3.

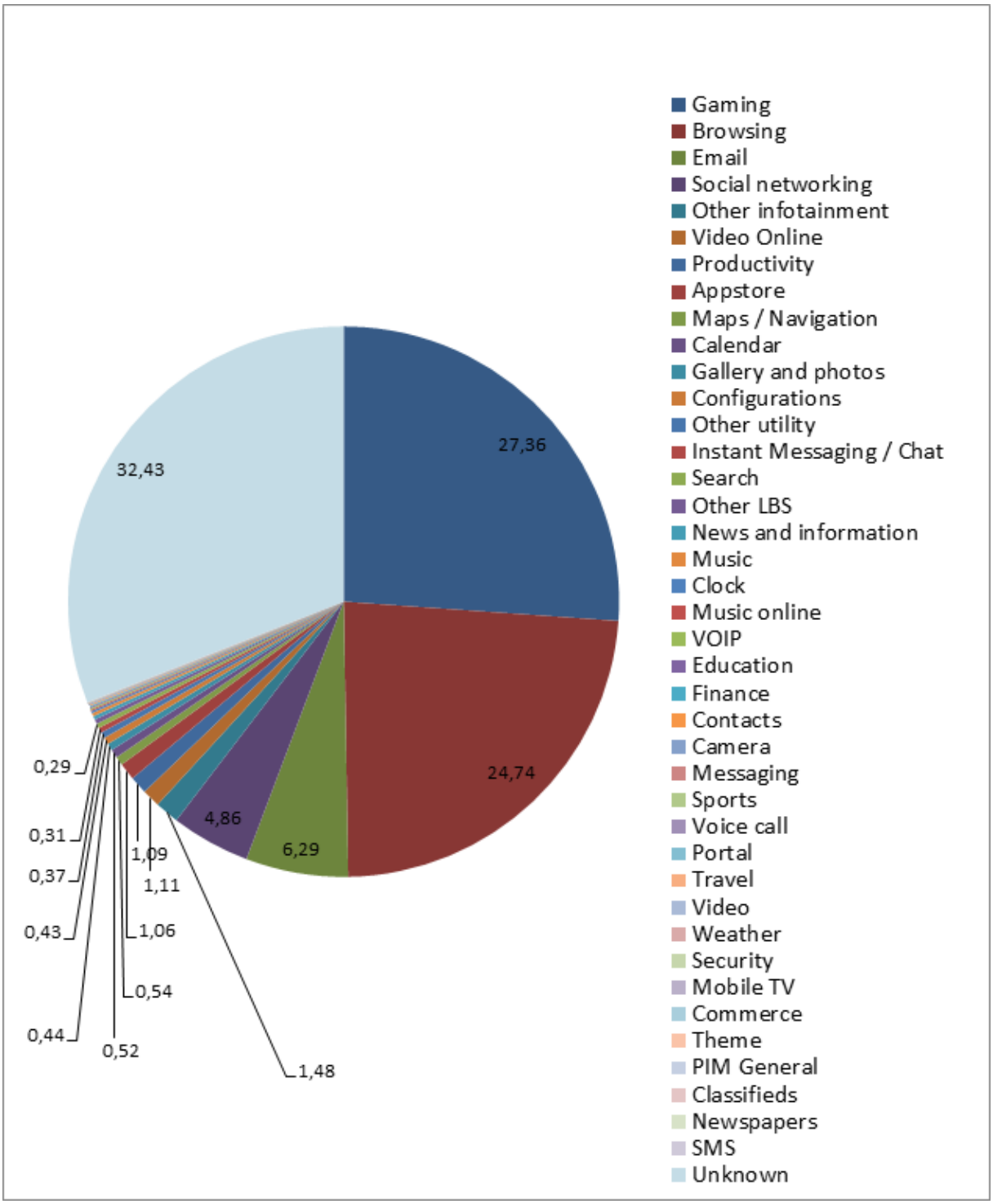


Figure 6.3 Average number of minutes spent per day per user on application types on a tablet computer (N=47).

The boxplots (Figure 6.4) below shows the average number of minutes per day for the specific applications. When displayed on a logarithmic scale there are no outliers, except for instant messaging and chat applications. It is clear that the spread is quite large for the most popular application types.

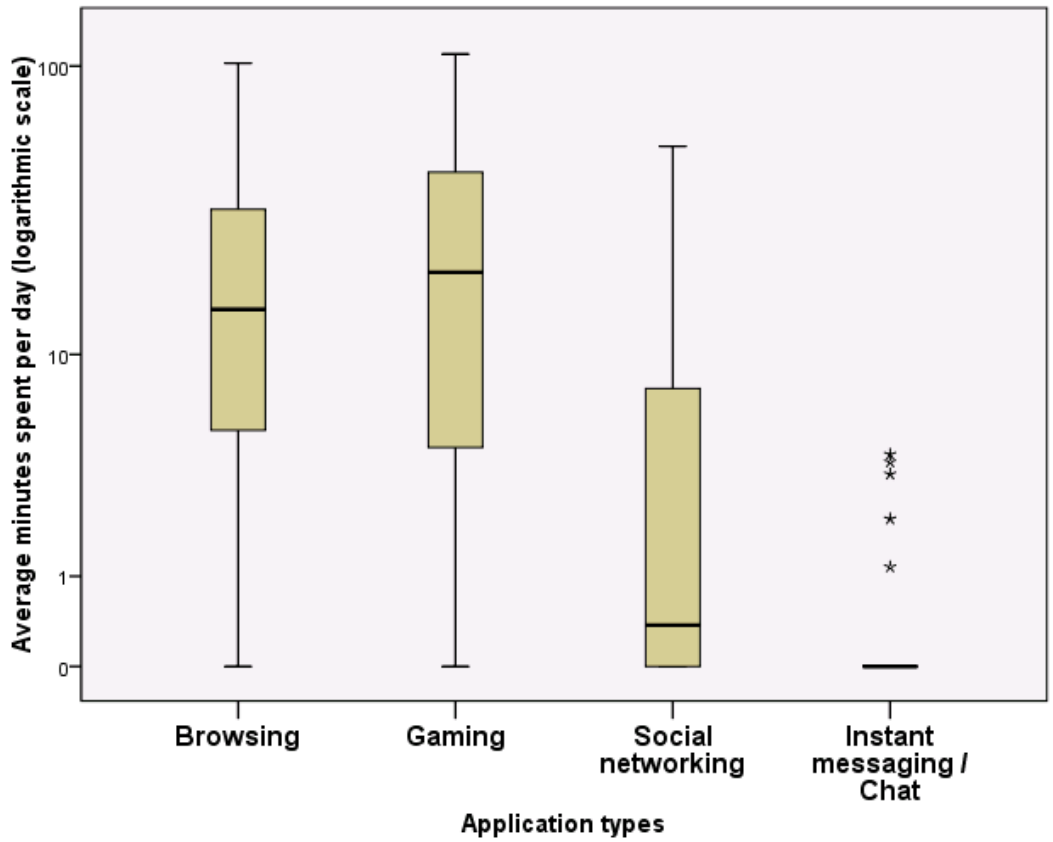


Figure 6.4 Boxplots showing the spread of the average number of minutes time spent on browsing, gaming, social networking and IM / chat applications via tablet computer (N=47).

Data traffic

Table 6.2 gives an overview of the data traffic per day per user. Only iPads can use cellular networks for data traffic.

		Mean	Std deviation	Minimum	Maximum
Cellular: Sent	iOS	0.04	0.10	0.00	0.43
	Android	0.00	0.00	0.00	0.00
Cellular: Received	iOS	0.50	1.46	0.00	6.62
	Android	0.00	0.00	0.00	0.00
WiFi: Sent	iOS	1.82	3.24	0.00	12.62
	Android	3.65	3.86	0.22	10.89
WiFi: Received	iOS	38.28	70.08	0.00	286.31
	Android	46.40	59.53	1.10	225.31

Table 6.2 Average MB sent and received per day per user via tablet computers.

7. Reported versus actual use (smartphones)

Response bias in self-reports on behaviour has long been a well-known issue (Bernard et al 1984). Social desirability may be a source of bias (Fisher & Katz 1999), but especially recall inaccuracies pose a major threat to the validity of reported behaviour. More probing questions or log data may be requested from respondents to improve the quality of data, but this often leads to an increased non-response bias (Warriner 1991).

Research on mobile communication services has largely been based on survey methods to collect insights on actual or intended behaviour. New methods based on running software on smartphones (and tablets) allow for more unobtrusive collection of data (Boase 2013; Bouwman et al 2013). By installing an application on the smartphone that logs all user activity, the researcher can directly observe user behaviour (Verkasalo & Hämmäinen 2007). A few studies have so far attempted to compare log data with self-reported survey data on the use of mobile communication services such as mobile voice and SMS. Overall, earlier studies have shown that self-reported mobile phone use may not fully represent patterns of actual use (Parslow et al 2003). Response bias in self-reports is difficult to model, as it appears largely unrelated to demographic factors (Boase & Ling 2011; Kobayashi & Boase 2012). Previous studies do suggest an effect of the intensity of use as heavier users would be more likely to overestimate their use of mobile voice services (Vrijheid et al. 2006).

In this chapter, we compare reported versus actual use of voice and text-messaging (SMS) services. We only analyse the 157 smartphone panellists that use Android, excluding Samsung Galaxy S2, to ensure that both services are captured for them.

Descriptive statistics

Phone calls (voice services)
To measure the self-reported use of mobile voice services, respondents were asked to indicate how many minutes they use voice services per day. As this number may differ between weekend and week days, two survey items were compiled. The observed use of mobile voice services was compiled by aggregating the log data over the 28-day period. Average number of minutes per week and weekend day were computed.

		Minimum	Maximum	Mean	Standard deviation
Weekday	Self-report (survey)	0.00	120	11.76	16.09
	Observed (log data)	0.02	55.53	5.69	7.69
Weekend day	Self-report (survey)	0.00	120	9.13	13.02
	Observed (log data)	0.00	18.51	2.00	2.91

Table 7.1 Self-reported versus observed phone call minutes (N=157 smartphones).

Table 7.1 already indicates that respondents typically overestimate the use of voice services. On weekdays, they overestimate their use levels with a factor two, and on weekend days even a factor 4.5. Standard deviations in self-reports are also considerably higher than in the observed log data, indicating that self-reports are more likely to lead to reliability issues than log data.

Text-messages (SMS)
We distinguish sending and receiving SMS messages, also because sending messages is within the control of user while receiving is not. Again, we distinguish week days and weekend days. In the survey, respondents were asked to indicate the average number of SMS messages sent and received on weekdays and weekend days. The observed metrics are again based on aggregating the log data over the full 28-day period. Table 7.2 presents descriptive statistics.

			Minimum	Maximum	Mean	Standard deviation
Weekday	Incoming	Self-report (survey)	0	50.0	2.62	4.80
		Observed (log data)	0	12.5	1.27	1.49
	Outgoing	Self-report (survey)	0	30.0	2.43	4.04
		Observed (log data)	0	9.3	0.83	1.12
Weekend day	Incoming	Self-report (survey)	0	25.0	2.31	3.12
		Observed (log data)	0	11.8	1.09	1.62
	Outgoing	Self-report (survey)	0	30.0	2.24	3.33
		Observed (log data)	0	9.3	0.80	1.33

Table 7.2 Self-reported versus observed number of text-messages, weekdays and weekends (N=157)

On average there is thus a great overestimation. Respondents overestimate their number of SMS messages sent and received with a factor of between two and three.

Next, we compute overestimation metrics that subtract the number of observed voice minutes and SMS-messages from the self-reported ones respectively. Table 7.3 shows the correlation between the overestimation metrics.

	Voice: Weekday	Voice: Weekend	SMS: Weekday In	SMS: Weekday Out	SMS: Weekend In	SMS: Weekend Out
Voice: Weekday	1					
Voice: Weekend	.700***	1				
SMS: Weekday In	ns	ns	1			
SMS: Weekday Out	ns	ns	.863***	1		
SMS: Weekend In	ns	ns	.721***	.669***	1	
SMS: Weekend Out	ns	ns	.766***	.714***	.927***	1

Table 7.3 Correlation between overestimation of voice minutes and text-messages.

Table 7.3 shows that errors of estimation for voice minutes are strongly correlated between week days and weekend days. The same holds for text-messages. Strikingly, there is no significant correlation between estimation error of voice and SMS.

Analysis: predicting overestimation and underestimation

	N	R^2	Use intensity	Gender	Age	Education level	Income high	Income medium
Voice: Weekdays	107	.134	-.316***					
Voice: Weekend days	125	.340	-.557***					
SMS: Weekdays Out	97	.235	-.440***					
SMS: Weekdays In	95	.240	-.456***					
SMS: Weekend days Out	77	.115	-.281*					
SMS: Weekend days In	82	.181	-.373***					

Table 7.4 Regression analysis to predict overestimation of voice and text-messages.

We compute the ratio between the overestimated number of voice minutes or text-messages and the actually observed voice minutes and text-messages. In the subsequent analysis, we separately analyse the overestimation and underestimation of the use of the services. Those users that were

not observed to be using a certain type of voice or text-message at all, were excluded from the analysis.

Table 7.4 presents the regression analysis for overestimation of voice and text-messages. The predictors include both intensity of use (defined as the number of voice minutes or text-messages observed in the log data) as well as demographics of gender, age, education level and income level. To reduce the potential effect of outliers, the intensity of use variables were transformed logarithmically. Only significant effects are displayed in the table.

Table 7.4 shows that the overestimation of voice and text-messages is only explained by the use intensity, and that the used demographic variables are not significant. Explained variance is moderate, between 12% and 34%. Use intensity is mostly negatively related to the overestimation levels, i.e. more intense users are more likely to estimate their use level correctly.

Table 7.5 shows a similar regression analysis result for underestimation. It should be noted that the number of observations that have underestimation is substantially lower than those with overestimation, and should be interpreted with care.

	N	R^2	Use intensity	Gender	Age	Education level	Income high	Income medium
Voice: Weekdays	49	.415	-.436**					
Voice: Weekend days	22	.498	-.627*					
SMS: Weekdays Out	44	.485	-.718***					
SMS: Weekdays In	59	.465	-.625***					
SMS: Weekend days Out	38	.688	-.776***				-.227*	
SMS: Weekend days In	50	.411	-.645***					

Table 7.5 Regression analysis to predict underestimation of voice and text-messages.

Table 7.5 shows that the underestimation can be better explained than the overestimation in Table 7.4. The explained variance is between 41% and 69%. Still, the intensity of use is typically the only significant predictor.

Discussion and conclusions

Wrong estimations in self-reports are prominent when compared with log data. Demographic variables play no role.

The only significant predictor is intensity of use. This suggests that future studies should be especially reluctant to use self-reports for rare behaviour.

The error in wrongly estimating the use of voice and text-messages does not differ strongly between week and weekend days or between incoming and outgoing messages. However, there are strong differences between voice and text-messaging: those misestimating voice are not significantly likely to make a similar misestimating for text-messaging.

8. Evaluation of the research by the respondents

In the evaluation survey also questions with regard to the research process were formulated in order to get insight how the research process was experienced. The evaluation was send to 369 persons, who reported to Arbitron / MarketResponse that they downloaded and installed the measurement app. Eventually. 324 persons returned the questionnaire.

Of these 324 respondents, 302 (93%) persons said in the questionnaire that they downloaded the measurement app after receiving an SMS.

Some people decide not to participate at the latest moment. Two respondents were not able to install the application. Of the people who installed the measurement app 13% stopped using the app and de-installed the app during the month in which data was collected. The main reason mentioned, was excessive battery drainage, as well as problems with telephones, like phone calls that were attributed to the app. Other reasons to stop were upgrading of the telephone, impression that the telephone became slower, or users upgraded OS-version or changed to new devices.

On a more subjective level people were willing to participate in the research. Just like last year most people are quite willing to participate and are not directly concerned about their privacy. See Figure 8.1.

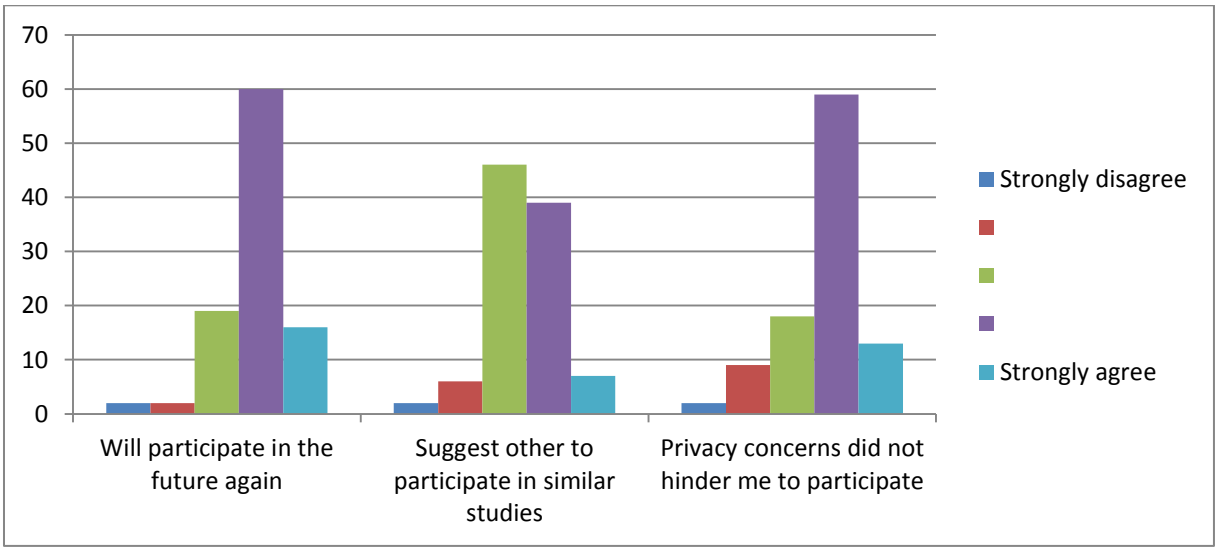


Figure 8.1 Subjective evaluation of experience with regard to privacy (N=324)

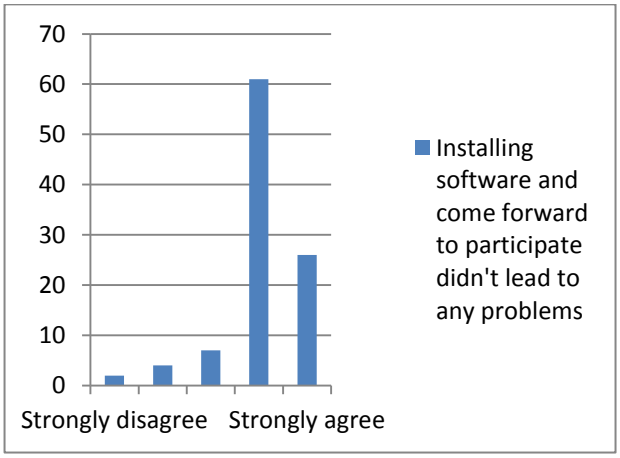


Figure 8.2 Subjective evaluation of experience with regard to installing the measurement software (N=324).

Also installing the measurement app and coming forward was not considered to be an issue. See Table 8.2.

It should be noted that the evaluation survey was send to persons who participated in the actual measurement of their smartphone and/or tablet. They will have a more positive attitude to the recording of the use of their smartphone and/or tablet. As already said in Chapter 3 (research design and representativeness), issues that play a role in the willingness of people to participate are “normal” non-response issues (difficult to influence), privacy concerns (can be partially influenced) and technical problems (can be influenced).

Remarks made by the respondents

In a more subjective way we received 92 comments. Twenty seven were about the technology related to battery drainages and problems with calls. Ten comments were about the report of the research or about what kind of results are achieved. Twelve remarks were about questions in the questionnaire. Nine remarks were about communication during the project. Some remarks were trivial or about that one wants the fee for participation to be donated to a good cause. There were about a dozen remarks that people didn’t notice the app running at all. Only one person mentions that he or she thought it was a scary experience. A number of remarks were about the fact that respondents expect this to be highly relevant research.

9. Conclusions and recommendations

This report presents the results of a project that shows the possibilities of direct smartphone and tablet measurements by installing an app on these devices. The direct measurements were supplemented with two flanking surveys. Although there are limitations, log data collected on smartphones and tablets enables a wide range of statistics and, in combination with the surveys, show that studies making use of multiple research methods for collecting data have a huge potential.

Although the number of observations based on the respondent as a unit of analysis is limited to 232 smartphone and 47 tablet users, the data-point available are quite extensive, and modern data-analyses and visualization tools give tremendous opportunities to present data in al lot of alternative and insight-full views. The results as presented in Chapters 4 to 8 are only an example of what the possibilities are. We refrain from more content related conclusions.

Based on the results of the 2011 and 2012 pilots, the growing need for these kinds of data and the usability for other statistics, it is recommended to investigate specifically if continuation of the smartphone and tablet measurement study is feasible. Possibly, use can be made of co-funding of such a project.

The importance to continue this research (recommendations)

Mobile devices, such as smartphones and tablet computers, are becoming more and more the main personal device for leisure as well as for work. Therefore, it has been found that there is a growing need from policy makers, industry and regulators for data and statistics on the use and impact of these mobile devices on people's lives and on the economy. Until now, data is collected through traditional surveys. Besides the fact that surveys have their limitations, such as self-reporting, current statistics get no further than the production of statistics on the number and type of mobile devices and services used. The use of measurement apps installed on mobile device can bring research an important step further in the direction of use (e.g. frequency and duration) and impact. In addition, also the quality of the data is improved considerably.

The use of software- and sensor-based data will become more and more common practice, taking into account the privacy issues, involved. Consumers are due to the ease of use of current mobile systems, adopting mobile technologies faster and faster and are reinventing use of existing applications, replacing traditional behaviour for instance in the media domain where traditional (distribution) channels are replaced by distribution channels focused on mobile devices. Also in the field of m-commerce, m-payment or sensor based use developments are progressing rapidly.

Therefore, statistics and statistical offices should not remain on the side-line or see this kind of research as an one-off experimental project, but should include this technology as one of the alternatives to do research, either as a stand-alone technology or in combination with traditional surveys. This new innovative way of data collection:

- is important because of the growing relevance of mobile devices and related technologies for the behaviour of people and the economy. By not focusing on mobile access channels statistical offices will lose an important source for understanding economic and social behaviour of their citizens. This not only accounts for the use and impact of mobile services, but also for, for example, for mobility, tourism, time use, social cohesion and internet behaviour. This is underlined by the growing need for these kinds of data by policy makers, industry and regulators.
- can produce new data, which cannot be produced with traditional statistics. These kinds of studies can bring statistical research to the next level. Also mobile software based research as presented in this report will possibly become more and more common practice and accepted. The two pilots in 2011 and 2012 have shown new opportunities and valuable lessons about possible problems for the data collection. It can be expected that sensor related data as collected via smartphone will be the next big thing, for instance in health care.

- will produce data with a higher reliability with less survey burden than questionnaire data, even if factual data is collected.
- can improve the timeliness of statistics.

It is recommended to combine smartphone and tablet measurements with flanking surveys, which focus on issues that cannot be automatically recorded. It has been found in this study that with these two additional survey technologies, a very rich and valuable dataset can be produced.

One of the key issues that remain is the willingness of potential respondents to participate in this kind of research. With this pilot, data was collected for a period of four weeks of almost all mobile behaviour of the respondents. It is important to investigate the factors, that determine drop out and willingness to participate. Willingness to participate could possibly be enlarged by:

- shortening of the period of recording;
- only the recording of the data one needs. In that sense mobility and time use surveys should be able to attract more participants;
- giving full attention to recruitment (e.g. information about the survey, privacy, assistance of participants during the process and redeliver results);
- giving more attention to the technology itself (e.g. battery drainage and conventional operating systems).
- looking into the way incentives are used.

Finally, to make this type of research worthwhile a clear information demand articulation by the users, like the Ministry of Economic Affairs, Statistics Netherlands and other government and related organisations, would help the researchers to focus on relevant economic and societal topics, and really show the potential of mobile handset studies.

Methodological challenges

- *Privacy issues*: the question is how to guarantee that privacy is safeguarded while at the same time privacy concerns are affecting the response and representativeness of the data? On the one hand, smartphone and tablet measurement is a new and innovative way to get insight, for example, into people's surfing behaviour, who they call and when, what applications and telecommunication networks they use, how much data they download and upload and when and where people travel during the day. On the other hand collecting and combining smartphone and tablet data raises a number of privacy issues. In the studies of 2011 and 2012 we, consequently, have followed both privacy regulations and industry and statistical codes of conduct. In addition, the organisational structure was such that the data collection and data analysis was done by separate entities, leaving only anonymised data at the end. See chapter 2.
- *Non-response* is another important factor in any smartphone and tablet measurement study. In this study, there was a considerable drop in terms of the number of people who took part in the first part of the study (the selection questionnaire), but not in the follow-up study (direct measurements), because (1) on closer inspections they did not use a smartphone and/or tablet, (2) they did not respond to the question whether they wanted to participate in the log-data study , (3) they declined to take part for privacy reasons, were not allowed to download software because the smartphone they used was a business phone, were unable to download the software or were worried the software might affect the use of their smartphone and (4) for various other reasons common to any research project. Ultimately, a limited number of respondents agreed to participate in the measurement study (519). However, not all of them actually downloaded, installed and, or used the application for the entire four week period. In the end, we were able to collect usable data from 232 respondents for the smartphone results and 47 for the tablet computer results. Based on the rather small sample fine grained analyses on sub-samples would lead to biased interpretations.

- *Representativeness:* due to the fact that there is no clear weighting model it is hard to assess how the final sample relates to the population of smartphone (and tablet) users in The Netherlands. Neither do we known how smartphone users relate to the general Dutch population. Data from Statistics Netherlands only provides data about mobile phone users, not necessary being smartphone users. Annex 3 presents a possible method to weight the results of this study, if a clear reference frame is available.
- *Technical issues:* another challenge relates to the mobile platforms that can be analysed. In the current research project we focussed on those Operating Systems that are the most common, Android and iOS, both for smartphone and tablets. The current measurement software doesn't support Symbian, Blackberry RIM or Mobile Windows, due to decreasing market share or lack of market penetration. Moreover some older Android Version weren't included as well. These software limitations also affect the number of participants and thereby the representativeness of the results. However it might be expected that with HTML 5 the balance in accessing application via websites or via Operating System defined APIs will change in favour of web based applications. This will lead to less dependency with regard to Operating Systems.
- *Methodological issue:* how to deal with outliers?

Expansion as compared to the study of 2011

This study of 2012 advances beyond what we achieved in 2011 in the following ways:

- We included a larger number of panellists in the study (232 smartphone users; 2011: 128 smartphone users) which allows more statistical inference;
- We included not only smartphones but also tablet computers. It should be noted that getting tablets users to participate in the study is rather difficult, as we only attained 47 participants over the whole period;
- We analysed the data in new ways, including network analysis based on graphs on how panellists browse across different types of websites;
- We showed how self-reports of panellists systematically overestimate their actual usage as observed in the log data. Demographic variables can only partially explain the extent of overestimation. Intensity of use looks to play a major role.

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Annex 1 Selection questionnaire

Onderwerp: selectievragenlijst t.b.v. panel ‘mobile tracking’ Project 18151

Opdrachtgever: TU Delft

Concept vragenlijst 28 augustus

Introductiescherm

Welkom bij dit onderzoek over mobiele telefoons.

<STANDAARD INVULINSTRUCTIES>

Gebruik mobiel internet en profiel

1.0 Heeft u vorig jaar deelgenomen aan deze studie?
DP instructie: single
Enq. instructie:
1. Ja Check of hetzelfde ID nummer van verleden jaar gebruikt kan worden
2. Nee

2.0 Bent u in het bezit van een mobiele telefoon?
DP instructie: single
Enq. instructie:
1. Ja
2. Nee → exit

3.0 Is uw mobiele telefoon een smartphone?
DP instructie: single
Enq. instructie:
1. Ja
2. Nee →

4.0 Bent u in het bezit van een tablet computer, bijvoorbeeld een iPad of een Samsung Galaxy?
DP instructie: single
Enq. instructie:
1. Ja
2. Nee → exit

5.0 Maakt u via uw mobiele telefoon of via een tablet computer wel eens gebruik van mobiel internet?
DP instructie: single
Enq. instructie:
1. Ja
2. Nee → exit

6.0 Hoe intensief maakt u gebruik van onderstaande mobiele telefoon diensten?
How often do you use the following mobile services?

1. Mobiele telefonie
Mobile voice calling
Hoeveel minuten belt u doorgaans op een door de weekse dag?
How many minutes do you usually call on a weekday?
Hoeveel minuten belt u doorgaans op een dag in het weekend?
How many minutes do you usually call on a day in the weekend?

2. SMS: Tekstberichten via een mobiel toestel (van een persoon naar een ander)
SMS: Tekst messages from a mobile device (person-to-person)
Hoeveel SMS berichtjes verstuurt u doorgaans op een door de weekse dag?
How many SMS messages do you usually send on a weekday?
Hoeveel SMS berichtjes ontvangt u doorgaans op een door de weekse dag?
How many SMS messages do you usually receive on a weekday?

Hoeveel SMS berichtjes verstuurt u doorgaans op een dag in het weekend?
How many SMS messages do you usually send on a day in the weekend?
Hoeveel SMS berichtjes ontvangt u doorgaans op een dag in het weekend?
How many SMS messages do you usually receive on a day in the weekend?

3. Email: Lezen / verzenden van mobiel e-mail via een mobiel toestel en/of via een tablet
Email: Reading / sending mobile email via a mobile device and/or tablet

Hoeveel Emailtjes verstuurt u doorgaans met uw mobiele toestel en/of tablet op een door de weekse dag?
How many email messages do you usually send with your mobile device on a weekday?
Hoeveel Emailtjes ontvangt u doorgaans met uw mobiele toestel en/of tablet op een door de weekse dag?
How many email messages do you usually receive on your mobile device on a weekday?

Hoeveel Emailtjes verstuurt u doorgaans met uw mobiele toestel en/of tablet op een dag in het weekend?
How many email messages do you usually send with your mobile device on a day in the weekend?
Hoeveel Emailtjes ontvangt u met uw mobiele toestel en/of tablet doorgaans op een dag in het weekend?
How many email messages do you usually receive on your mobile device on a day in the weekend?

4. Twitter Twitter
Hoeveel minuten besteedt u op een doordeweekse dag gemiddeld aan Twitter?
How many minutes do you usually spend on Twitter on a weekday?
Hoeveel minuten besteedt u op een dag in het weekend gemiddeld aan Twitter?
How many minutes do you usually spend on Twitter on a day in the weekend?

7.0 Met welke regelmaat gebruikt u onderstaande diensten? How often do you use the services below? (Daily, weekly, few times per month, I have tried it, Never used)

DP instructie: Grid, scale: Dagelijks, Wekelijks, Paar keer per maand, Ik heb het geprobeerd, Nooit gebruikt

1. Mobiele Video telefonie, bijvoorbeeld Skype via mobiel of tablet
   Mobile video telephony, e.g. Skype via mobile or tablet
2. Nieuws en weer informatie via uw mobiele telefoon of tablet
   News and weather information via your mobile or tablet
3. `Surfen' over het internet (bv informatie opvragen met behulp van een browser) met een mobiel toestel of tablet
   Browsing the internet (e.g. requesting information through a browser) with a mobile device or tablet
4. Kleine betalingen via een mobiele telefoon (m-payment) (drankautomaten, buskaartjes en andere betalingen)
   Small payments via a mobile phone (m-payment) (vending machines, bus tickets and other payments)
5. TV kijken via een mobiel toestel TV via a mobile device
   Watching mobile TV
6. TV kijken via een tablet TV via a tablet
   Watching TV via a tablet
7. Spelen van Games op uw mobiele telefoon of op uw tablet?
   Playing games on your mobile device or tablet
8. Lokalisatie diensten: lokalisatie van een bepaald doel (kantoor, café, hotel etc.) met behulp van mobiele telefoon of een tablet
   Localization services: localizing a certain target (office, bar, hotel etc) using a mobile phone or tablet
9. Navigatiediensten via mobiele telefoon of tablet, bijvoorbeeld mbv Google Maps
   Navigation services via mobile device or tablet, e.g. Google Maps
10. Mobiele sociale netwerken, communities: delen van (contact) informatie (LinkedIn, Hyves, Facebook)
    Mobile social networks, communities: sharing (contact) information (LinkedIn, Hyves, Facebook)

11. Mobiele Messaging Services en Chat (bijvoorbeeld MSN, Ping en Whatsapp)
Mobile messaging services and chat (e.g. MSN, Ping and Whatsapp)
12. Specifieke bedrijfsapplicaties zoals agenda functies en andere productiviteits bevorderende applicaties
Specific business tools like agenda functions and other productivity enhancing applications

8.0 Over welk type toestel beschikt u momenteel voor het gebruik van mobiel internet?
DP instructie: Toestellijst MarketResponse (16774)
DP instructie: Single
Enq. instructie: *Indien u op meerdere toestellen gebruik maakt van mobiel internet, kies dan het toestel dat u het meest gebruikt voor privé-doeleinden*
1. <LIJST>
2. Anders, namelijk..
3. Weet niet

DP instructie: Indien geen smartphone of weet niet → exit

9.0 Van welk besturingssysteem maakt uw telefoon gebruik?
Enq. instructie:
1. Android
2. iOS
3. RIM (Blackberry)
4. Symbian
5. Windows mobile / Windows Phone
6. Anders
7. Weet niet

DP instructie: Indien 5.0= <Windows mobile / Windows Phone> → exit
DP instructie: Indien 4.0= <Nokia> → exit

10.0 Van welk besturingssysteem maakt uw tablet gebruik?
Enq. instructie:
1. Android
2. iOS
3. RIM (Blackberry)
4. Weet niet

11.0 Via welke provider belt u en maakt u gebruik van mobiel internet?
DP instructie: single
Enq. instructie: *indien u gebruik maakt van meerdere providers*
1. KPN
2. T-mobile
3. Vodafone
4. Anders
5. Weet niet/ wil niet zeggen

Selectie

DP instructie: Display
De mobiele telefoon neemt een steeds grotere plaats in in het leven van consumenten. Er wordt mee gebeld en gesms't, er worden foto's mee gemaakt, er worden afspraken in bijgehouden etc.

Voor veel bedrijven is het belangrijk om te weten hoe consumenten hun mobiele telefoon gebruiken. Bijvoorbeeld waar men de telefoon zoal gebruikt om te bellen, of welke websites men via de mobiele telefoon bezoekt, en welke functies op telefoons juist helemaal niet worden gebruikt.

De Onderzoek Groep voert daarom regelmatig onderzoek uit over dit onderwerp. Dit doen we doorgaans via vragenlijsten, zoals u van ons gewend bent. Maar er zijn ook andere manieren waarop dit mogelijk is.

De Onderzoek Groep werkt momenteel aan een nieuwe manier van onderzoek om meer te weten te komen over de wijze waarop consumenten hun telefoon gebruiken. Door middel van een speciaal ontwikkelde 'app' (een programmaatje voor op uw telefoon) kan inzicht verkregen worden in het gebruik van uw telefoon. Het onderzoek wordt uitgevoerd in samenwerking met de Technische Universiteit Delft en het Centraal Bureau voor de Statistiek. We willen met een aantal leden van De Onderzoek Groep deze nieuwe onderzoeksmethode gedurende gebruiken. Het project loopt tot en met half november 2012.

DP instructie: Display

Wat houdt het onderzoek in?

- U installeert de app op uw telefoon. Het programma draait vervolgens continu op de achtergrond, dit heeft geen gevolgen voor de werking van uw telefoon.
- Tot en met 16 novemberwordt vastgelegd welke functies van uw telefoon u gebruikt.
- Uw gebruiksgegevens worden anoniem en op totaalniveau geanalyseerd, uw privacy wordt uiteraard gewaarborgd.
- De app verbruikt ongeveer 0,5 MB dataverkeer per week. U ontvangt voor deelname een onkostenvergoeding van 10 euro.
- Als u in het buitenland bent, worden er geen gegevens verzonden: u heeft dus geen extra roaming kosten
- Door de applicatie kan uw batterij iets eerder leeg zijn, dit effect is niet groot
- Tijdens de onderzoeksperiode ontvangt u op uw mobiele telefoon maximaal 1 maal een vragenlijst met maximaal 3 vragen. U kunt zelf beslissen of u hieraan mee wilt doen.
- Tussentijds ontvangt u via email een uitnodiging om deel te nemen aan een evaluatie aan het onderzoek.
- Na afloop van het onderzoek ontvangt u een herinnering om de app te verwijderen. Dit mag op 16 november

Op de website van De Onderzoek Groep **<DP: link in ander venster laten openen>** vindt u meer informatie en antwoord op veelgestelde vragen over deze nieuwe manier van onderzoek.

12.0 Wilt u deelnemen aan dit onderzoek?

DP instructie: single

1. Ja voor mijn mobiele telefoon
2. Ja voor mijn tablet
3. Ja, voor zowel mijn mobiele telefoon als tablet
4. Nee

DP instructie: indien 12.0= nee

13.0 Uiteraard heeft De Onderzoek Groep er begrip voor dat u niet wilt deelnemen aan dit onderzoek. Omdat uw mening belangrijk is voor de ontwikkeling van nieuwe onderzoekstechnieken zijn we benieuwd waarom u niet wilt deelnemen aan dit onderzoek. Wilt u toelichten waarom u niet wilt deelnemen aan dit project?

DP instructie: Indien geen deelname, open, groot scherm

Enq. instructie:

1. …
2. weet niet

DP instructie: indien 12.0= ja

14.0 Fijn dat u wilt meewerken aan dit onderzoek.

DP instructie: Indien deelname
Om de app te installeren op uw telefoon en/of tablet vragen we u onderstaand uw telefoonnummer in te vullen.

U ontvangt hierna een SMS bericht van ons. Het bevat een link om de onderzoeksapplicatie, genaamd “Mobile life”, op uw mobiele telefoon te installeren.

Zorg dat uw telefoon de juiste internet instellingen heeft, en geef de applicatie de gevraagde toestemmingen tijdens de installatie. Kies op alle vragen `ja’ of ‘uitvoeren’.

DP instructie: Indien I-Phone
Wanneer u de applicatie opent en op MY INFO drukt, wordt u gevraagd enkele vragen te beantwoorden. De antwoorden op deze vragen zijn nodig om de koppeling van Mobil Life met De Onderzoek Groep te maken. Uw antwoorden worden enkel gebruikt voor dit onderzoek. Na het beantwoorden van de vragen gaat u deelnemen aan het onderzoek.

DP instructie: Indien geen I-Phone
Tijdens het installeren wordt u gevraagd enkele vragen te beantwoorden. De antwoorden op deze vragen zijn nodig om de koppeling van Mobil Life met De Onderzoek Groep te maken. Uw antwoorden worden enkel gebruikt voor dit onderzoek. Na het beantwoorden van de vragen en het vervolgens openen van de applicatie gaat u deelnemen aan het onderzoek.

Op de website van De Onderzoek Groep **<DP: link in ander venster laten openen>** vindt u meer informatie en antwoord op veelgestelde vragen over deze nieuwe manier van onderzoek, bijvoorbeeld over roaming (indien u in het buitenland bent wordt de app automatisch afgesloten voor de periode dat u in het buitenland bent) Of andere onderwerpen.

Heeft u tijdens het onderzoek vragen of opmerkingen, dan kunt u uiteraard contact met ons opnemen via mobile@deonderzoekgroep.nl

Telefoonnummer: 0800 - 022 0706

Afsluiting

Annex 2 Evaluation questionnaire

Onderwerp: evaluatievragenlijst 'mobile tracking' Project XXXXX

Opdrachtgever: TU Delft/CBS

Concept vragenlijst November 2012

Introductiescherm

Welkom bij deze afsluitende vragenlijst van het onderzoek naar het gebruik van tablet computers zoals iPads en smartphones.
<STANDAARD INVULINSTRUCTIES>

Ongeveer een maand geleden heeft u aangegeven deel te willen nemen aan een onderzoek naar het gebruik van uw mobiele telefoon. Ter afsluiting hebben we nog een aantal vragen die we u voor willen leggen zodat we beter inzicht krijgen in gedrag van smartphone gebruikers. Daarnaast stellen we een aantal vragen om in het vervolg dit type onderzoek te kunnen verbeteren. Ook als u uiteindelijk niet mee heeft gedaan aan het onderzoek of tussentijds de app heeft verwijderd, willen we u vragen deze vragenlijst in te vullen.

Aan het slot van de vragenlijst vragen wij u om uw rekeningnummer, zodat we de 5 euro compensatie naar u kunnen overmaken.

Blok A. Vragen over keuze en gebruik van uw smartphone en tablet

De volgende vragen gaan alleen over uw mobiele telefoon.

15.0 Heeft u een zogenaamd 'flat fee' mobiel internet abonnement? Flat fee houdt in dat u onbeperkt gebruik kunt maken van mobiel internet voor een vast bedrag, bijvoorbeeld 10 euro per maand voor ongelimiteerd internettoegang.

DP instructie: Single

1. Ja, ik kan onbeperkt data gebruiken
2. Ja, maar met een specifieke datalimiet (bv max 150 MB per maand), namelijk ... MB
3. Nee, ik betaal per MB die ik verbruik

16.0 Wat betaalt u (afgerond in hele euro's) per maand aan uw mobiele telefonie-abonnement/prepaid kaarten?

DP instructie:

1. Circa ..... euro per maand
2. weet niet/ wil niet zeggen

17.0 Wat is uw mening over de volgende stellingen? Geef bij elke stelling het alternatief aan dat het beste past bij uw mening.

DP instructie: Stellingen random, schaal Zeer mee eens, mee eens, eens/noch oneens, mee oneens, zeer mee oneens

1. Ik vind mijn mobiele operator eerlijk
2. Ik vind dat mijn mobiele operator zich verantwoordelijk gedraagt
3. Ik vind dat mijn mobiele operator klanten begrijpt
4. Ik vind dat mijn mobiele operator zich om mij bekommert

18.0 Hoeveel applicaties (apps) heeft u voor uw smartphone het laatste half jaar gemiddeld per maand gedwonload? Bijvoorbeeld: uit de iStore (Apple), Android Market, of Windows Marketplace of een onafhankelijke app store.

DP instructie: aantal
- Gratis applicaties: .... gemiddeld per maand (geen = 0)
- **Tegen betaling**: .... gemiddeld per maand (geen = 0)

7.0A Om de hoeveel minuten gebruikt u doorgaans uw mobiele telefoon?
…. aantal minuten

Route: Als geen tablet dan 8 anders 5.0B

5.0B Hoeveel applicaties (apps) heeft u voor uw tablet het laatste half jaar gemiddeld per maand gedwonload? Bijvoorbeeld: uit de iStore (Apple), Android Market, of Windows Marketplace of een onafhankelijke app store.

DP instructie: aantal
- Gratis applicaties: .... gemiddeld per maand (geen = 0)
- **Tegen betaling**: .... gemiddeld per maand (geen = 0)

7.0B Om de hoeveel minuten gebruikt u doorgaans uw tablet?
…. aantal minuten

8.0 We willen u nu een aantal uitspraken voorleggen over bruikbaarheid, gebruiksgemak en (toekomstig) gebruik van **Mobiel Internet**. Wilt u aangeven of u het hier zeer mee oneens bent of zeer mee eens of ergens daar tussenin?

DP instructie: Zeer mee eens, mee eens, eens/noch oneens, mee oneens, zeer mee oneens

1. Ik wil dezelfde diensten gebruiken op mijn mobiele telefoon en/of tablet als op mijn pc
2. Ik gebruik dezelfde diensten op mijn mobiele telefoon/tablet als op mijn pc/lptop
3. Doordat ik internettoegang heb op een mobiele telefoon en/of een tablet kijk ik minder TV
4. Doordat ik internettoegang heb op een mobiele telefoon en/of een tablet gebruik ik mijn pc/laptop minder
5. Doordat ik internet toegang heb op een mobiele telefoon en/of een tablet gebruik ik andere media minder
6. Door het gebruik van smartphones/tablets raakt mijn werk en prive leven steeds meer verweven
7. Het gebruik van smartphones/tablets leidt tot stress
8. Smartphones/tablets zijn verslavend
9. Ik kan me het leven zonder smartphones/tablets niet meer voorstellen
10. Smartphones/tablets zijn onmisbaar voor het functioneren in onze maatschappij

11. Door het gebruik van smartphones/tablets heb ik veel meer contact met vrienden en bekenden
12. Door het gebruik smartphones/tablets neemt het fysieke contact met vrienden en bekenden af.
13. Door het gebruik van smartphones/tablets ben ik veel sneller geïnformeerd over het nieuws
14. Mijn dagelijks leven is veranderd door het gebruik van smartphones/tablets
15. Mijn dagelijkse handelen wordt mogelijk gemaakt door smartphones/tablets
16. Het gebruik van smartphones/tablets past in mijn dagelijkse routines

Blok B Het gebruik van uw smartphone of tablet als tweede scherm

9.0 Heeft u een televisie?

DP instructie:

1. Ja, dan 10
   Is dit een smart of een connected TV?
   1. Ja
2. Neen, dan einde blok

10.0 Hoeveel minuten televisie per dag kijkt u doorgaans op een doordeweekse dag?
…. aantal minuten

Hoeveel minuten televisie per dag kijkt u doorgaans in het weekend?
…. aantal minuten

12.0 We willen u nu een paar vragen stellen over het gebruik van uw smartphone en tablet in relatie tot televisiekijken. Via uw smartphone of tablet kan u gebruik maken van tweede schermapplicaties of diensten. Via tweede schermapplicaties of diensten kan u meer informatie te vinden over het specifieke programma waar u naar kijkt, vragen stellen, actief stemmen of zelfs het verloop van het programma beinvloeden. Voorbeelden zijn de thuiscoach van the Voice of Holland, de heartbeat app. van X- factor, sidekick by eredvisie live, of tweedescherm.nl bij sportwedstrijden.

Maakt u gebruik van tweede schermapplicaties of diensten?

DP instructie:

1. Ja, dan 13
2. Neen, dan 15

13.0. We willen u eerst een aantal uitspraken voorleggen over tweede scherm applicaties

DP instructie: Zeer mee eens, mee eens, eens/noch oneens, mee oneens, zeer mee oneens

1. Ik verwacht dat ik tweede scherm applicaties ofdiensten ook in de toekomst gebruik
2. Ik verwacht dat tweede scherm applicaties het leven aangenaam maakt
3. Ik ga tweede scherm applicaties zeker gebruiken
4. Ik vind dat anderen tweede scherm applicaties ook moeten gebruiken
5. Door de tweede scherm applicaties kijk ik steeds meer televisie
6. Het gebruiken van tweede scherm applicaties lijkt me makkelijk
7. Tweede scherm applicaties zijn eenvoudig om te gebruiken
8. Het lijkt me makkelijk om met tweede scherm applicaties te doen wat ik wil
9. Hoe de interactie met tweede scherm applicaties verloopt lijkt me duidelijk
10. Ik vind tweede scherm applicaties leuk om te gebruiken als ik TV kijk
11. Ik ben enthousiast als ik mee doe met een tweede scherm applicatie

12. Ik geniet meer van TV kijken door mee te doen via tweede scherm applicaties

14.0 Op welk type apparaat gebruikt u deze tweede schermapplicaties of diensten voornamelijk? Tablet / Smartphone / Laptop / Anders ……. (omcirkel één apparaat dat het meest van toepassing is)

Route: naar 16

15.0 Waarom maakt u geen gebruik van tweede schermapplicaties of diensten?

DP instructie: multiple antwoorden

1. Ik weet niet van het bestaan van tweede schermapplicaties of diensten
2. Ik weet niet hoe ik tweede schermapplicaties of diensten moet gebruiken
3. Tweede schermapplicaties of diensten vind ik niet interessant
4. Geen van deze

16.0 In hoeverre zou u van onderstaande tweede schermapplicaties of diensten **in de toekomst** gebruik willen maken?

DP instructie: Grid, scale: Zou ik absoluut gebruiken, zou ik waarschijnlijk gebruiken, ik weet het niet, zou ik waarschijnlijk niet gebruiken, zou ik absoluut niet gebruiken

1. Informatie, bijvoorbeeld achtergronden bij een documentaire of statistiek bij een sportwedstrijd
2. Deelnemen of volgen van discussies over programma's via sociale media (bijvoorbeeld Twitter, Facebook, of de website van een programma)
3. Spelletjes, bijvoorbeeld quizen
4. Aankopen van producten die in het programma worden getoond
5. Het gebruik van uw smartphone of tablets als afstandsbediening, bijvoorbeeld om de camerapositie van een voetbalwedstrijd te kiezen
6. Het actief deelnemen aan een programma door te stemmen of deelnemer te worden in een spelshow

Blok C M-Commerce

We willen u nu een paar vragenstellen over het gebruik uw smartphone als middel om privé aankopen te doen.

18.0. Heeft u uw smartphone en/of tablet de in de laatste 12 maanden gebruikt om privé aankopen te doen?

DP instructie: single

1. Ja, dan vraag 19
2. Nee dan naar 21
3. Wil niet zeggen/Weet niet, dan naar vraag 21

19.0. Welke producten of diensten heeft u in de laatste 12 maanden voor privé gebruik via uw smartphone en/of tablet gekocht?

DP instructie: Als 12 is ja, multiple

Enq. instructie: Meerdere antwoorden mogelijk

1. Levensmiddelen, cosmeticaproducten en schoonmaakmiddelen
2. Medicijnen
3. Films of muziek
4. Papieren boeken, tijdschriften of kranten
5. Electronische boeken, tijdschriften of kranten
6. Kleding of sportartikelen
7. Electronica, zoals computers, mobiele telefooon e.d.
8. Reizen (vervoer en hotel)
9. Kaartjes voor evenementen
10. Apps en software
11. Digitale studie- of leermateriaal
12. Goederen voor het huishouden, zoals meubels, speelgoed en wasmachine
13. Tweedehandsartikelen van bijvoorbeeld Marktplaats
14. Geen van deze
15. Weet niet

20.0 Wat was het totale bedrag aan goederen die u voor privé gebruik via uw smartphone en/of tablet heeft gekocht of besteld in de *laatste drie maanden*?

DP instructies: single

1. Minder dan 50 euro
2. 50 tot 100 euro
3. 100 tot 500 euro
4. 500 tot 1000 euro
5. Of 1000 euro of meer?

Route: naar 22

21.0 Kunt u aangeven waarom u in de afgelopen 12 maanden geen goederen of diensten via uw smartphone en/of tablet heeft besteld of gekocht. Was dat omdat:

DP instructies: multiple

1. Het niet nodig was
2. U er de voorkeur aan gaf om zelf te winkelen en daar te betalen
3. U niet wist hoe het moest of er te weinig ervaring mee had
4. Relevante informatie over de goederen of diensten op de website moeilijk te vinden was
5. Het problematisch was om de goederen thuis te ontvangen
6. U de risico's van mobiel kopen en betalen te groot vindt
7. Ik zie het nut van mobiel betalen niet
8. Geen van deze

22.0 We willen u een aantal uitspraken voorleggen over mobiel betalen

DP instructie: Zeer mee eens, mee eens, eens/noch oneens, mee oneens, zeer mee oneens

1. Ik zou het prima vinden om mijn smartphone te gebruiken voor betalingen
2. Het gebruik van een smartphone voor betalingen is prettiger dan het gebruik van debet- of creditcards
3. Er zijn te grote risico's verbonden aan mobiel betalen
4. Ik ben alleen geïnteresseerd in mobiel betalen als daar een vergoeding tegenover staat

Blok D Evaluatie studie

Tenslotte willen we nog een paar vragen stellen over de smartphone studie.

23.0. Ongeveer een maand geleden heeft u aangegeven deel te willen nemen aan een onderzoek naar het gebruik van uw mobiele telefoon en/of tablet. Na het invullen van uw telefoonnummer

ontving u een sms met daarin een link naar een pagina om de applicatie te downloaden en vervolgens te installeren. Heeft u deze sms ontvangen?

DP instructie: Single

Enq. instructie:

1. ja
2. nee
3. weet niet meer

24.0. Heeft u de applicatie vervolgens gedownload?

DP instructie:

Enq. instructie:

1. Ja, dan naar 25
2. nee, omdat ik een foutmelding ontving, dan naar 28
3. nee, om een andere reden, namelijk…, dan naar 28

25.0. Heeft u de applicatie vervolgens geïnstalleerd?

DP instructie:

Enq. instructie:

1. Ja, dan naar 26
2. nee, omdat ik een foutmelding ontving, dan naar 28
3. nee, om een andere reden, namelijk…, dan naar 28

26.0. Heeft u de installatie afgelopen maand stopgezet en niet meer aangezet en/of verwijderd?

DP instructie: Indien ja 27, anders 28

Enq. instructie:

1. ja
2. nee

27. Wat was hier de reden voor?

DP instructie: Open

1. ….

28. Wat is uw mening over de volgende stellingen? Geef bij elke stelling het alternatief aan dat het beste past bij uw mening.

DP instructie: Indien 17 is ja

DP instructie: Schaal Zeer mee eens, mee eens, eens/noch oneens, mee oneens, zeer mee oneens, weet niet/niet van toepassing

DP instructie: stellingen random

1. Ik zou in de toekomst weer meedoen aan een soortgelijke studie met smartphones
2. Ik zou anderen aanraden om aan soortgelijke studies mee te doen
3. Privacy was geen issue om aan de studie deel te nemen
4. De installatieprocedure van de software en het aanmelden leverde geen problemen op.

29.0. Om u de compensatie van 5 euro over te kunnen maken, willen we u vragen onderstaande gegevens in te vullen:

DP instructie:

1. standaard rekeningvragen.

30.0. Heeft u nog opmerkingen over of suggesties ter verbetering van de smartphone studie waar u aan heeft meegedaan?

DP instructie:

1. ….
2. nee

Dit is het einde van de vragenlijst. Hartelijk dank voor het invullen van de vragenlijst en voor uw deelname aan de smartphone studie.

Annex 3 Proposed method to weight the results

J.A. Daalmans, Statistics Netherlands

1. Introduction

There are three stages in the research where representativeness plays a role. In all three cases it must be demonstrated that the group of respondents in a particular stage is representative of the group of all the smartphone and tablet users in the Netherlands, or that the results can be weighted so they can be made representative.

1. The results of the selection survey and then especially the group who own a smartphone and/or a tablet. This selection survey is a random sample of the overall panel of Market Response, so-called de Onderzoeksgroep. The main objective of this survey is to recruit respondents for the direct smartphone and tablet measurement study, but it also includes questions about the type and use of mobile phones and/or tablets, etc. The net response of this survey and then again especially the group of people with a smartphone and/or a tablet should present a representative picture of all the smartphone and tablet users in the Netherlands. In the case of non-response this should be weighted towards the part of the smartphone and/or tablet users of the random sample of the overall panel of Market Response, de Onderzoeksgroep.
2. The results of the actual smartphone and tablet measurements log data themselves. The number of people, which eventually participated was reached by several stages, where people dropped out at each step of the way. The remaining group of actual participants should be representative for all the smartphone and tablet users in the Netherlands.
3. The results of the evaluation survey, which was sent to all the people who said they downloaded and installed the measurement application on their smartphone and/or their tablet, not necessarily being all the participants which were used in the analysis of the log data (2). For various reasons some of them dropped out between the commitment to participate and the final implementation of the research. The group of respondents should also be representative for all the smartphone and/or tablet users in the Netherlands.

2. Linear weighting as a method for reducing bias

Linear weighting can be used to reduce a possible bias in the case of non-response (Bethlehem, 2008). This means that the population is divided in a number of groups (strata), on the basis of auxiliary variables. Next, correction weights are determined in order to ensure that the distribution over the response groups are equal to that of the target population.

Suppose, there are 1,000 people living in an imaginary country: 500 men and 500 women. 180 persons are asked to participate in a survey and 100 people actually do. Of these 100 persons, there are 60 male and 40 female. In this example, the men are over-represented in the response: 60% of the participants are male, compared to 50% in the population. To correct for the bias in the sample men will get a lower weight than women. The weight of a man is then 4/5 and that of a woman 6/5. So, every man in the response counts for 4/5, while every woman counts for 6/5.

In the above example, there is only one auxiliary variable. Linear weighting can also be applied when multiple auxiliary variables, such as gender, age and income, are in play. In the case of multiple weighting variables, it is not so easy - as in the example above - to determine the weighting factors, but formulas can be applied from the literature (Bethlehem, 2008). Statistics Netherlands has special software available (BASCULA) to tackle these kinds weighting issues.

For each of the auxiliary variables the distribution over the categories on the level of the target population must be known. For example, when using sex as an auxiliary variable, the percentage of men and women in the population of all Dutch smartphone and/or tablet users must be known. This should also be known for the respondents. In the previous example it must be known what the sex is of each participant in the study.

The method is most effective when auxiliary variables are chosen that are strongly related to the response behavior and the target variables (that is the use of smartphones and/or tablets). So, when choosing the auxiliary variables, this should be taken into account.

In practice it often happens that a set of auxiliary variables is available. In that case, it is useful to select the best possible variables. To make this selection, different methods can be used. For example, the use of a logistic regression model to explain whether people do or do not respond and thereby use a "stepwise inclusion" or "backward elimination" method to choose the most relevant explanatory variables. Both methods are available in standard statistical software such as SPSS. Stepwise inclusion is preferred over backward elimination. In Bethlehem (2012) a simple selection criterion is applied, based on Cremer's V. Another possibility is to calculate the response fractions for the different categories of the auxiliary variables (e.g. the response groups for men and women). The auxiliary variables for which these fractions differ the most, are the most relevant. Another simple method is to calculate correlation coefficients. The auxiliary variables that are most correlated with the response behavior and the target variables are the most important in order to be used in the weighting model.

All the above methods are applicable when auxiliary information is available for the gross sample (i.e. the responding and non-responding units in the sample).

An issue to be taken into account in practice, is that the correction with auxiliary information only gives an accurate result when each category of the auxiliary information appears often enough in the response. As a general rule, a minimum of five is used.

If non-response occurs, a proper weighting procedure can remove (or reduce significantly) the bias of the estimated response fractions . However, it must be clear that it only reduces the bias with respect to the selected background variables. It is not possible to ascertain to which extent the distortion is eliminated. Indeed, the undistorted outcomes are not known.

3. Improving the representativeness of the smartphone and tablet measurements

As explained in the introduction:

- the response of the selection survey with smartphone and/or tablet users;
- the response of the evaluation survey;
- and the measurement log data of the actual participants

should be made representative for the population of all the Dutch smartphone and/or tablet users.

To do so, we propose a three-step procedure for weighting, that is:

- the group of participants of the selection survey are weighted towards the population of all the Dutch smartphone and tablet users (step 1) ;
- the group of the evaluation survey are weighted towards the group with a smartphone and/or a tablet of the selection survey (step 1);
- the group, which participated in the recording of their smartphone and/or tablet use, are weighted towards the respondents of the evaluation survey (step 2).

If there is no sampling frame for all the smartphone and/or tablet users in the Netherlands, only a sampling frame could be used for all the smartphone users in the Netherlands. In that case the assumption is that we there are no major differences between smartphone users and tablet users.

Below we elaborate on the three steps described above.

Step 1: Weighting of the participants of the selection survey towards the population of all the Dutch smartphone and/or tablet users.

We distinguish between two situations:

a) When background characteristics are available on the population of all the Dutch smartphone and/or tablet users (or only smartphone users). It should concern background characteristics that

were recently measured. In addition, the background variables should have some correlation with the target variables. They should say something about the use of smartphones and/or tablets. The background variables should also be available for the group of respondents of the selection survey, which owns a smartphone and/or tablet.

When the above-mentioned background variables are available, the group of respondents of the selection survey, which owns a smartphone and/or a tablet, can directly be weighted towards the population of all Dutch smartphone and/or tablet users. This will require a weighting model with background variables that are:

1) strongly related to the response behavior of the selection survey;

2) strongly related to the target variables, that is: the use of smartphones and/or tablets.

The result of the weighting is a set of weights for the group of respondents of the selection survey, who owns a smartphone and/or a tablet.

To get the sampling frame of background variables of all the smartphone and/or tablet users in the Netherlands other surveys could be used. Until now it has not been easy to find a source with data with sufficient quality.

b) If no suitable sampling frame with background variables of the population of all the Dutch smartphone and/or tablet users is available.

In that case we can weight the total response to the selection survey towards the group of all panelists of MarketResponse. There are many background variables available of the panel of MarketResponse. As explained above, it is important to choose background variables that are strongly related to the response behavior of the selection survey and the target variable the use of smartphones and/or tablets.

This method provides weights for *all* respondents of the selection survey. Under the assumption that the panel of MarketResponse is representative of the Dutch population, we can use these weights to weight the response of the selection survey to the Dutch population.

However, we are not interested in all the respondents of the selection survey, but only in that part which owns a smartphone and/or a tablet. Indeed, the respondents who do not own a smartphone and/or a tablet are not included. We will therefore only use the weights of the group of respondents with smartphones and/or tablets.

Thus weights are calculated for the entire response, but only the weights of smartphone and/or tablet owners are used in the weighting. Here is implicitly assumed that the response behavior of the smartphone and/or tablet users is not different from that of other persons invited to fill in the selection survey.

Step 2: Weighting of the group of persons who participate in the evaluation survey towards the group of participants with a smartphone and/or a tablet of the selection survey

The response of the evaluation survey consists of persons who have agreed to participate in the actual measurement of their smartphone and/or tablet. This group is larger than the actual group of participants. In this step we will weight the participants in the evaluation survey towards the group of respondents of the selection survey, which owns a smartphone and/or a tablet.

Firstly, it must be investigated which background variables can be used in a weighting model. This may be information which is asked in the selection survey (e.g. self-reported use of the smartphone and/or tablet, smartphone type etc.), but also background characteristics that are available from the panel of MarketResponse (e.g. income, age etc.).

As explained above, it is important to select the background characteristics that:

1) explain the most which kind of people with a smartphone and/or a tablet from the response of the selection survey, ultimately also participated in the evaluation survey;

2) are strongly related to the target variables, i.e. the use of the smartphone and/or tablets.

The selected background variables are then used to weight the response of the evaluation survey towards the group of respondents of the selection survey, which owns a smartphone and/or a tablet.

Step 3 Weighting of the group of participants of the smartphone and/or tablet measurements towards the group of the evaluation survey.

In this step, we will weight the group of participants providing actual measurements of their smartphone and/or tablet towards the group of respondents of the evaluation survey. Again, a solid sampling frame should be found with auxiliary variables that:

1) explain what part of the response of the evaluation survey actually took part in the measurement of their smartphone and/or tablet;

2) are strongly related to the target variables of the study.

For the weighting, auxiliary variables are available from:

1) the panel of MarketResponse (e.g. gender and position in the household);

2) the answers provided in the selection survey (including self-reported use);

3) the answers provided in the evaluation survey.

With the selected background variables, the response data of the actual participants are weighted towards those of the group of respondents of the evaluation survey.

In the above three-step procedure, three sets of weights are derived:

w_1: weights to weight for the respondents of the selection survey (who own a smartphone and/or a tablet) towards the group of all Dutch smartphone and/or tablet users (or the described alternative);

w_2: weights to weight for the response of the evaluation survey towards the part of the group of the selection survey which owns a smartphone and/or tablet;

w_3: weights to weight for the participants in the smartphone and/or tablet measurements towards the group of respondents of the evaluation survey.

These three sets of weights are derived from three weighting models, which can be different among each other. That is to say that different explanatory variables may be used.

It is also very useful to look at the size of the weights. When there are many weights that differ strongly from 1, this means that there is a great risk of selectivity.

The weights are derived in order to make groups of respondents representative for all the Dutch smartphone and/or tablet users:

- if we want to make the group of participants of the selection survey more representative for the group of all the Dutch smartphone and/or tablet owners we use weight w_1;
- if we want to make the group of respondents of the evaluation survey more representative for the group of all the Dutch smartphone and/or tablet owners we use the weights: w_1*w_2;
- if we want to make the group that actually participated in the smartphone and tablet measurement more representative for the group of all the Dutch smartphone and/or tablet owners we use the weights: $w_1*w_2*w_3$.

Below we give a simple example of the proposed weighting method.

An example

To explain how the weighting works, we deliberately choose a very simple example, with just one explanatory variable: sex. In practice, it is of course advisable to use several explanatory variables in the weighting model. We also choose fictitious population numbers, which are rather unrealistic in practice. We have the following information:

1) The population of the Dutch Smartphone owners: 500 men and 500 women (1/2 male);
2) The response of the selection survey: 200 men and 100 women (2/3 male);
3) The response of the evaluation survey: 84 men and 56 women (3/5 male);
4) The group of actual participants in the smartphone and/or tablet measurements: 40 men and 10 women (4/5 male).

This results in the following weights for w_1, w_2 and w_3:

- the weight w_1 for weighting from 2) towards 1): 3/4 for a man and 3/2 for a woman;
- the weight w_2 for weighting from 3) towards 2): 10/9 for a man and 5/6 for a woman;
- the weight w_3 for weighting from 4) towards 3): 3/4 for a man and 2 for a woman.

To illustrate the model, we explain the weight w_2 for the man. In the response of the selection survey 2/3 is male and in the response of the evaluation survey, this proportion is 3/5 (= 84 / (84 +56)). By giving each man in the evaluation survey a weight of 10/9, the proportion of men in the selection survey is then equal to: (10/9) * (3/5) = 2/3.

When we, for example, want to make the evaluation survey (referred above as 3)), representative for the population of all the Dutch smartphone and/or tablet owners (referred above as 1)) we use the weights w_1*w_2, i.e.: 5/6 for a man and 5/4 for a woman. Or, if we want to make the actual participants in the smartphone and tablet measurement (referred above as 4)) representative for the population of all the Dutch smartphone and/or tablet owners (referred above as 1)) we use weights: w_1*w_2*w_3: 5/8 for a man and 5/2 for a woman. It can be noted that there are four times as many men than women that participated in the study (40 to 10). In the overall population, however, there are as many men as women. In this example women must therefore get a weight four times as large as the men.

4. Afterword

In the above the necessary steps are proposed to improve the representativeness of the results of the research, that is the selection survey, the measurement log data and evaluation survey. In addition, however, the size of the number of participants is also of interest in order to obtain accurate estimates. Last year the number of participants with usable results for the actual measurement was 128. In 2012 this figure reached 233 participants. Although these are high numbers for this kind of research, for making solid statistics this is rather small. In such situations, there is a chance that outliers can skew the results. Given the number of participants, margins can be calculated for the results. The theory of sampling methods provides possibilities to calculate these margins, see e.g. Banning et al (2010).

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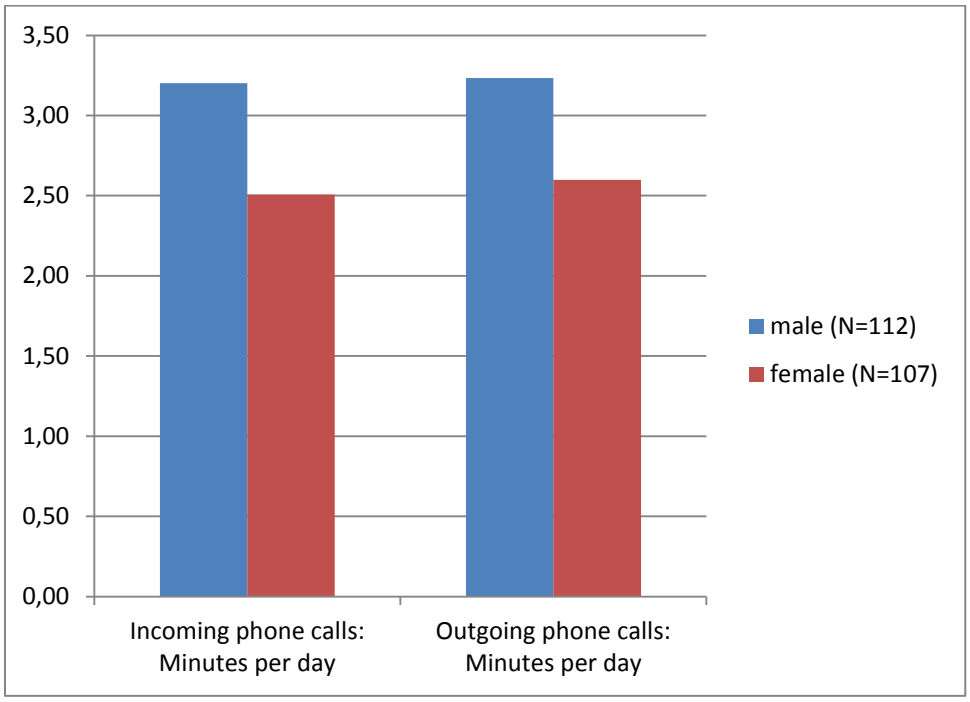
Annex 4 The reponse of the three rounds of recruitment.

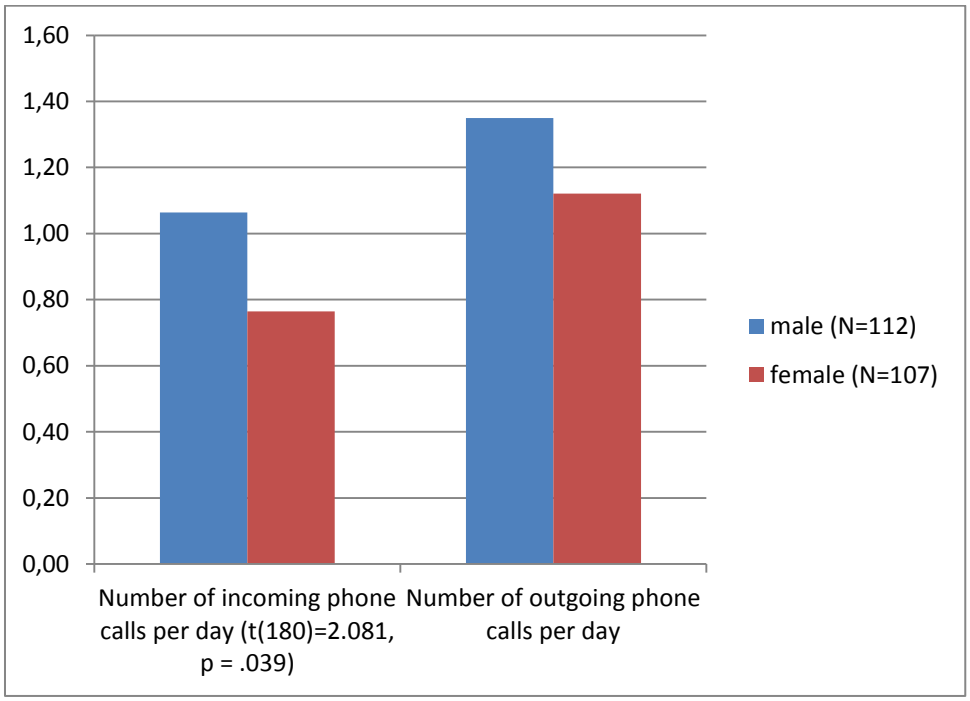
Selection	N	%
1. Gross Sample	2443	100
- contacts	1263	52
- Internet link not used	1180	48
No of contacts	1263	100%
- Project specific non response	367	29
- No smartphone and/or tablet	646	51
- Internet stopped	40	3
- Internet refusal	86	7
Net response	124	10%
2. Boost Sample		
Gross Sample	2143	100
- contacts	1649	77
- Internet link not used	494	23
No of contacts	1649	100
- Project specific non response	934	57
- No smart Phone and/or tablet	263	16
- Internet stopped	49	3
- Internet refusal	132	8
Net response	271	16
3. Participants 2011		
Gross Sample	247	100
- contacts	196	79
- Internet link not used	51	21
No of contacts	196	100
- Project specific non response	50	26
- Internet stopped	12	6
- Internet refusal	8	4
Net response	126	64

Source: Market Response

Annex 5 Additional crosstabs

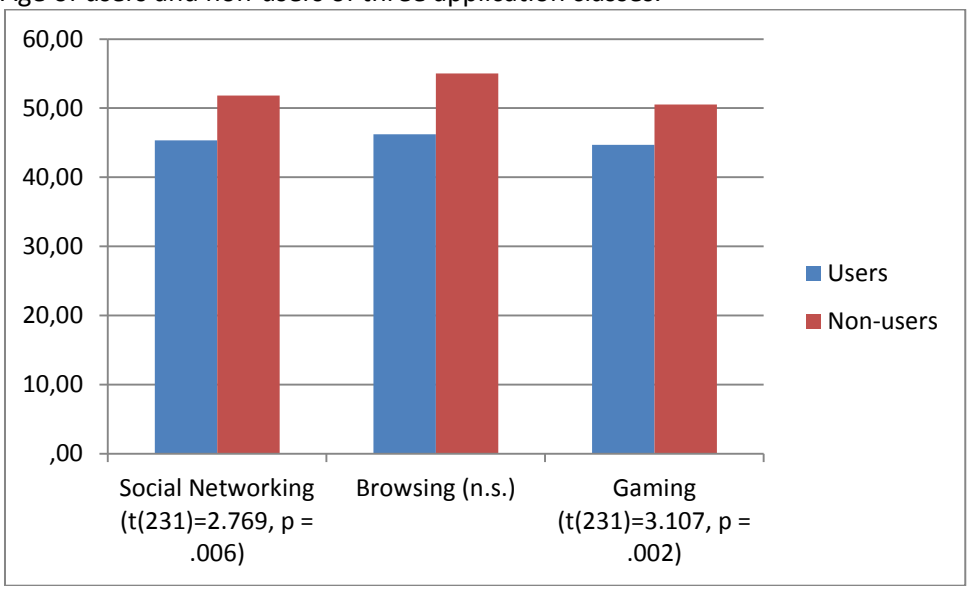
Phone calls





Apps: Browsing, Gaming, Social Networking

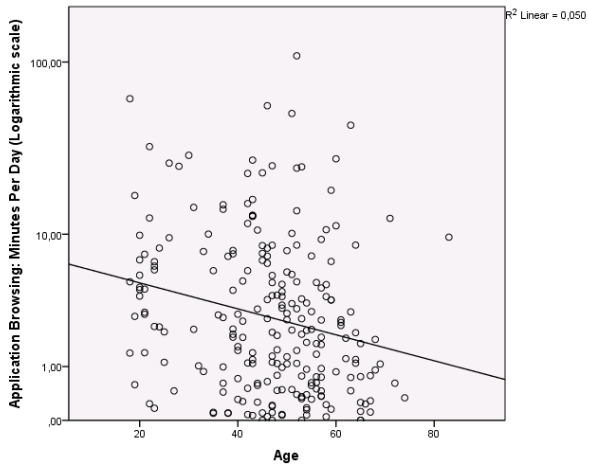
Age of users and non-users of three application classes.

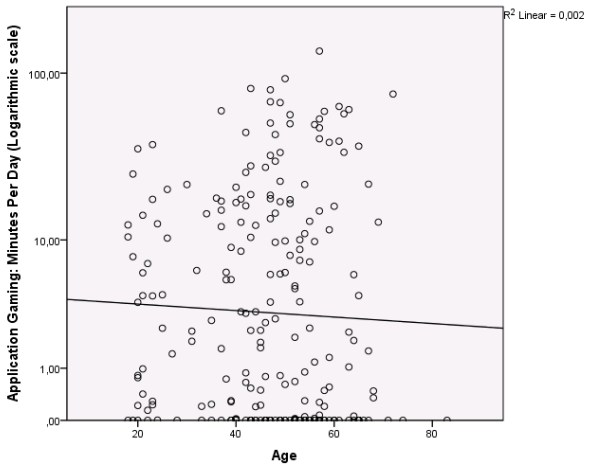


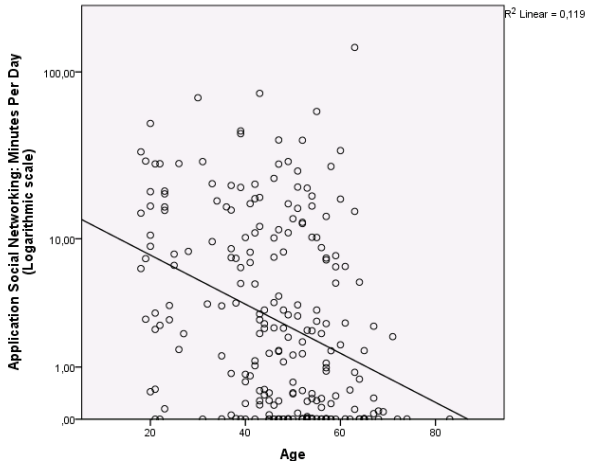
Users and non-users of gaming apps

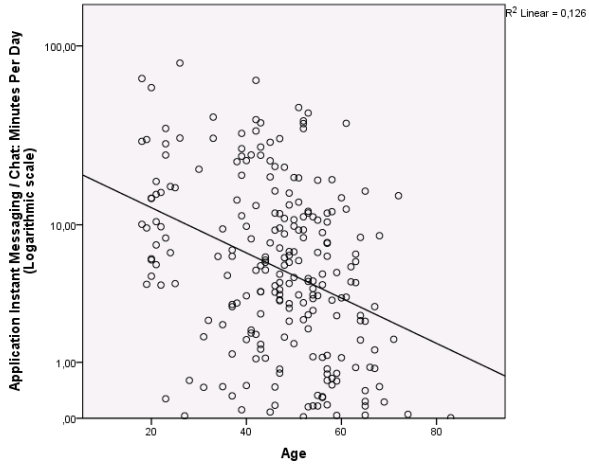
		Percentage that used at least once
Gender ($\chi^2(1)=20.79$, p = .000)	Male (N=122)	57%
	Female (N=111)	85%
Position in household ($\chi^2(4)=16.69$, p = .002)	Working (N=139)	61%
	Not working (N=63)	86%
	Child (N=29)	79%
Income (n.s.)	Lower than modaal (N=30)	83%
	Modaal (N=57)	65%
	Higher than modaal (N=138)	69%
Education level (n.s.)	High (N=143)	71%
	Medium (N=79)	68%
	Low (N=10)	80%

App usage and age

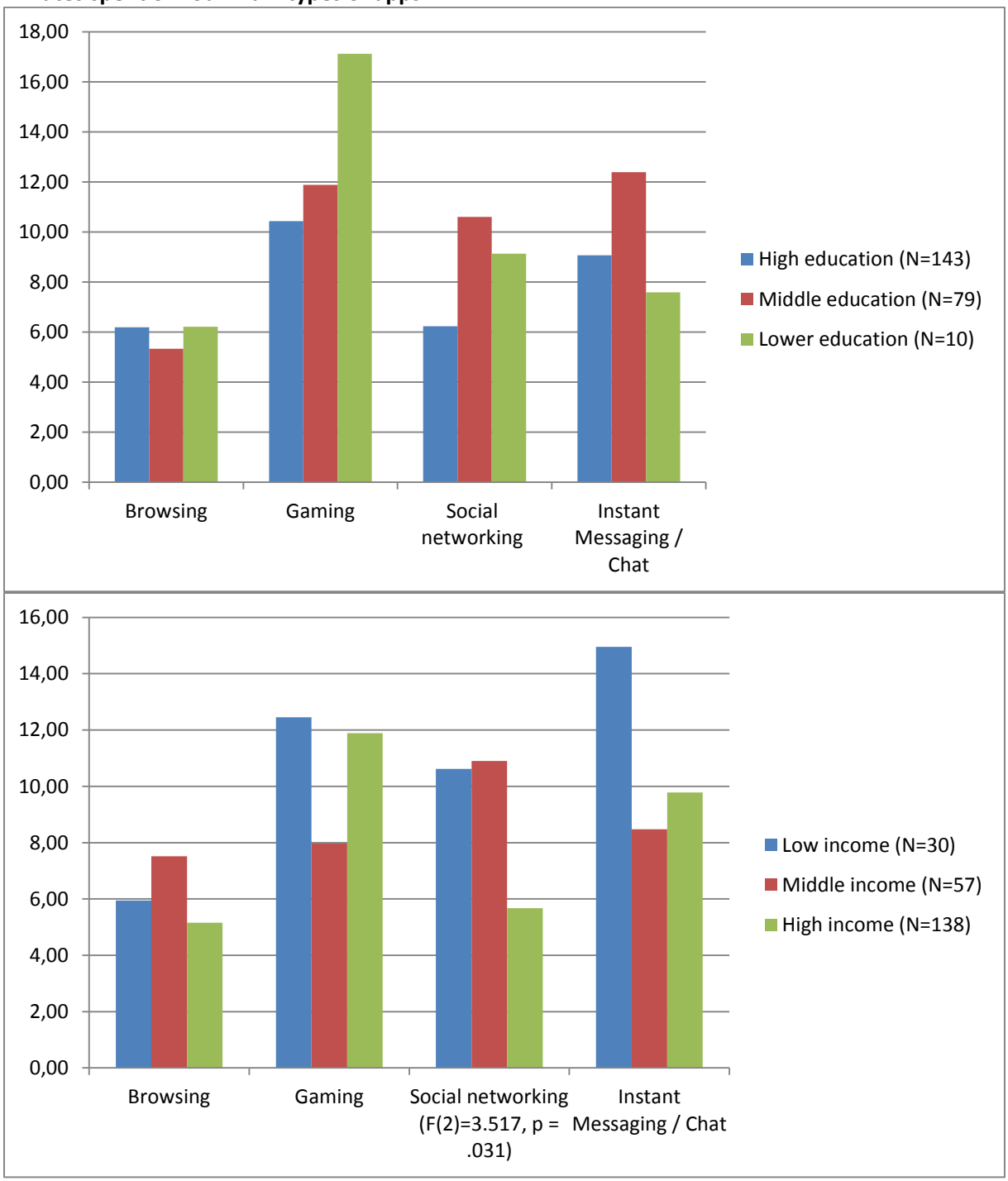


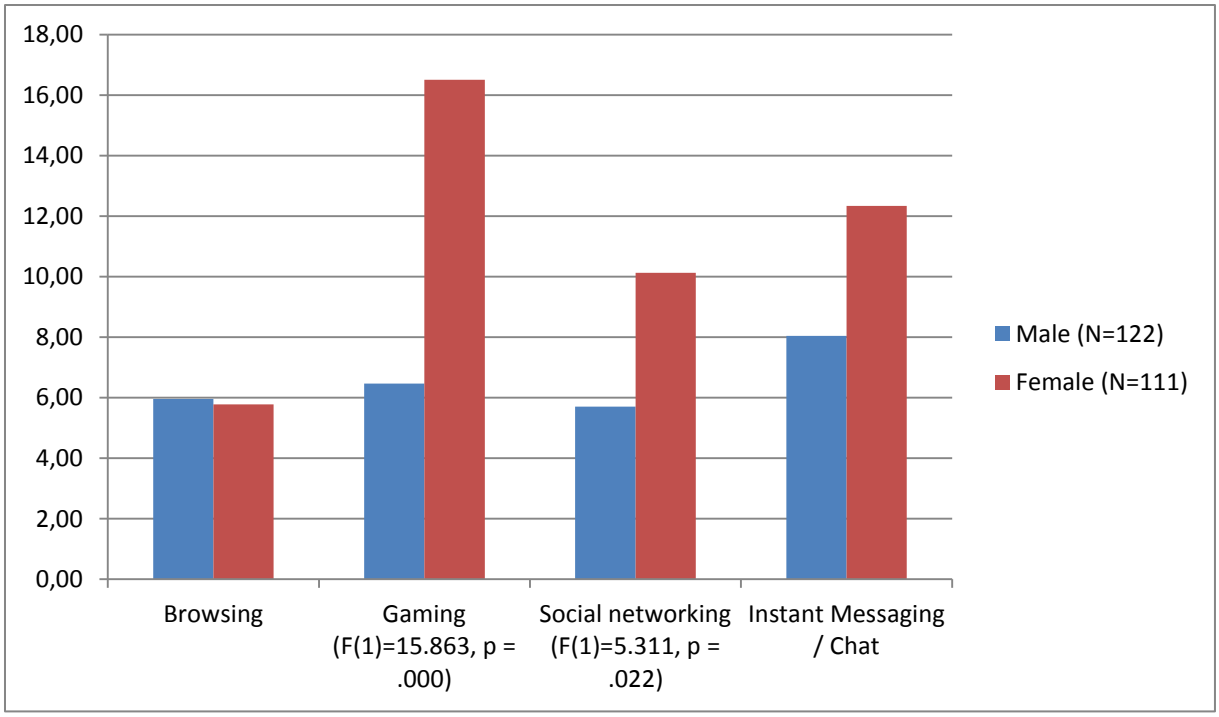






Minutes spent on four main types of apps




18,00
16,00
14,00
12,00
10,00
8,00
6,00
4,00
2,00
0,00
Browsing
Gaming (F(1)=15.863, p = .000)
Social networking (F(1)=5.311, p = .022)
Instant Messaging / Chat
Male (N=122)
Female (N=111)