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Published in:
International Journal of Social Research Methodology

DOI:
10.1080/13645579.2019.1593340

Publication date:
2019

International Journal of Social Research Methodology

ISSN: 1364-5579 (Print) 1464-5300 (Online) Journal homepage: https://www.tandfonline.com/loi/tsrm20

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To cite this article: Marieke Haan, Peter Lugtig & Vera Toepoel (2019) Can we predict device use? An investigation into mobile device use in surveys, International Journal of Social Research Methodology, 22:5, 517-531, DOI: 10.1080/13645579.2019.1593340

To link to this article: https://doi.org/10.1080/13645579.2019.1593340

Published online: 25 Mar 2019.

INTERNATIONAL JOURNAL OF SOCIAL RESEARCH METHODOLOGY
2019, VOL. 22, NO. 5, 517–531
https://doi.org/10.1080/13645579.2019.1593340

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Can we predict device use? An investigation into mobile device use in surveys

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ABSTRACT

In this study, we investigate whether mobile device use in surveys can be predicted. We aim to identify possible motives for device use and build a model by drawing on theory from technology acceptance research and survey research. We then test this model with a Structural Equation Modeling approach using data of seven waves of the GESIS panel. We test whether our theoretical model fits the data by focusing on measures of fit, and by studying the standardized effects of the model. Results reveal that intention to use a particular device can predict actual use quite well. Ease of smartphone use is the most meaningful variable: if people use a smartphone for specific tasks, their intention to use a smartphone for survey completion is also more likely. In conclusion, investing in ease of use of mobile survey completion could encourage respondents to use mobile devices. This can foremost be established by building well-designed surveys for mobile devices.

ARTICLE HISTORY
Received 28 June 2018
Accepted 7 March 2019

KEYWORDS
Mobile device use; mixed device; technology acceptance; panel survey

Introduction

Online surveys are now mixed-device surveys. More and more people use smartphones and tablets (i.e., mobile devices) to participate in online surveys (Couper, Antoun, & Mavletova, 2017; Toepoel & Lugtig, 2015). Offering multiple ways to respond to a survey is not a new phenomenon: before mixed-device surveys, mixed-mode surveys were already widely used in survey research (de Leeuw, 2005; Dillman, Smyth, & Christian, 2014). One of the advantages of using multiple modes is the possibility to target sample members using their preferred mode (Haan, Ongena, & Aarts, 2014; Smyth, Olson, & Millar, 2014). Mode targeting, offering people the mode they prefer, has shown some promising results: it can reduce the time needed to collect data (Hoffer, Grigorian, & Fesco, 2007) and modestly improve response rates (Dillman et al., 2014). The same advantage could hold for mixed-device surveys. Although there is only one mode in which respondents can participate, the web mode, respondents can complete the questionnaire using a PC, laptop, tablet, or mobile phone, as they choose.

In mixed-mode surveys, a lot of effort is spent on pushing respondents towards a particular mode. This may be for reasons of cost (Dillman et al., 2014), or better measurement properties of one mode over the other. Research shows that respondents can be swayed to participate in a particular mode (Dillman, 2017) if the 'push' factors towards these modes are strong enough (Bianchi, Biffignandi & Lynn, 2017). Not all respondents can be pushed; however, many respondents exhibit mode preferences (Lynn & Kaminska, 2013; Millar, O'Neill, & Dillman, 2009; Smyth et al., 2014)

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The research reported here is focused on mobile device use in mixed-device surveys. In order to be able to target or even push respondents to a device, it is necessary to understand why respondents use a particular device for survey participation. Therefore, this study investigates whether mobile device use in surveys can be predicted by factors that are related to perceptions and use of mobile technology. First, we identify possible motives for device use and develop a model by drawing on theory from technology acceptance research and survey research. Second, we use data of the GESIS online panel survey to test our model.

Background

Most online surveys allow respondents to use the device of their own choosing: PC, laptop, tablet or smartphone. Since it is not always clear for all devices whether they are a tablet, laptop or phone, the distinction between these devices is useful. Smartphones are small devices that respondents carry around, and rely on touchscreen entry as the mode of data entry. Tablets are similar to smartphones, except that they are bigger (6.0 inch is often used as a cut-off level). Laptops are often slightly larger than tablets, but the difference from tablets lies in the fact that data are entered through a keyboard and/or mouse(pad). Hybrid devices (laptops with touchscreens or tablets with an attachable keyboard) exist as well, making the distinction between devices complicated. In this paper, we call a device a laptop when it has a built-in keyboard, and a tablet otherwise.

In most western countries, over half of respondents own a mobile device and/or tablet (Pew Research Center, 2016). Yet, far fewer people use tablets and mobile devices for survey completion (Couper et al., 2017; Tourangeau et al., 2017). Earlier studies on mixed-device surveys have focused on which respondents select mobile devices instead of the traditional PC for survey participation (de Bruijne & Wijnant, 2013; Toepoel & Lugtig, 2014). These studies found that device use can partly be explained by the 'device divide': some groups of respondents (i.e. the young, well-educated with higher incomes) are more likely to own a smartphone, use those more frequently to access the Internet, and are also more likely to use these for completing surveys (Couper et al., 2017; de Bruijne & Wijnant, 2014; Lambert & Miller, 2015). Smartphones are used by young people, while tablets are mostly used by working adults. Antoun (2015) finds that respondents who are younger and well-educated are more likely to use mobile Internet devices and to have a preference for these mobile devices for survey participation when given the choice. Other variables that are associated with mobile device use in surveys are, for example, browsing the internet for longer periods of time (Mavletova & Couper, 2014) or reading emails on a smartphone. Furthermore, mobile device participation is more likely among self-identified early adopters of new technologies (de Bruijne & Wijnant, 2014).

These findings give the impression that the use of mobile devices in surveys is perhaps mostly related to familiarity with the device, ownership, and frequency of using mobile devices. Toepoel and Funke (2018) demonstrate that it is not the experience with a mobile phone in general but the specific frequency of mobile phone use for survey completion that predicts respondents' satisfaction with the online survey.

Beyond socio-demographic characteristics, few studies have examined which variables can predict device use. There is however some literature on having a 'mode preference'. Smyth et al. (2014) predict mode preference by developing a four-category classification system connected to the respondent's ability and comfort of using a survey mode. In their study, familiarity and access to a mode are the strongest predictors for mode preference. Other studies advise to be cautious when interpreting results based on questions about mode preference (Baghal & Kelley, 2016; Dillman et al., 2014; Lynn & Kaminska, 2013; Millar et al., 2009). Analyzing longitudinal data, Baghal and Kelley (2016) find that mode preference can be influenced by contextual factors; self-reported mode preference is affected by the response mode in which respondents participate.

If we want to understand why respondents use a particular device for survey participation, we find two broad factors identified in earlier studies: on the one hand there are some respondent characteristics that may predict device ownership and device use, while on the other hand respondents' attitudes may explain why – under the condition that respondents have access to different devices – they have a device preference. Familiarity and attitudes towards technology have been suggested earlier to be linked to device preference and device use (de Bruijne & Wijnant, 2014; Mavletova & Couper, 2014; Smyth et al., 2014). This paper aims to develop a more encompassing theory on device preference, and uses that theory to explain why respondents use a particular device in a longitudinal survey.

Factors explaining device use

The Technology Acceptance Model (TAM) may help to understand respondents' motives for using a particular online device. This model, originated in the theory of reasoned action and planned behavior, is used for understanding the potential adoption, acceptance, and rejection of information technology (Davis, Bagozzi, & Warshaw, 1989; Venkatesh & Davis, 2000). The TAM consists of two core constructs: perceived usefulness and perceived ease of use. Perceived usefulness is defined as '*the degree to which a person believes that using a particular system would enhance his or her jobs performance*' (Davis et al., 1989, p. 320). Perceived ease of use is defined as '*the degree to which a person believes that using a particular system would be free of effort*' (Davis et al., 1989, p. 320). These constructs can be used in building a model for understanding mobile device use in surveys.

In order to use the TAM model for mobile device use, we relate the constructs of usefulness and ease of use to the context of online survey participation (see Figure 1). Furthermore, we add 'opportunity' to our model which is operationalized as device ownership. In light of mobile device use in surveys, we expect that owning a device (opportunity), feeling positive about IT technology (usefulness), and being comfortable with using mobile devices (ease of use) can explain why respondents have a higher intention of using a particular device for survey participation. A strong intention to use a particular device will then explain how often respondents use such devices in practice. Thus, we expect that the effects of usefulness, ease of use and opportunity only have an indirect effect on device use. The TAM model generally hypothesizes that effects are mediated through 'intention to use', yet leaves the possibility that effects on device use are both indirect and direct open. These direct effects are depicted by the dotted lines in Figure 1 and will be tested in the current study.

Methods & data

Data collection

For this study, data from the open probability-based mixed-mode GESIS Panel are used. The Panel infrastructure is controlled by GESIS – Leibniz Institute for the Social Sciences in Mannheim (Germany). This Panel is fully operational since the beginning of 2014. The target population of this Panel contains German-speaking individuals aged between 18 and 70 years who are permanently residing in private households in Germany. Panelists are recruited from a random sample drawn from the municipal population registers (n = 4938). The recruitment rate (or RECR, similar to AAPOR RR5) is 31.56%. The online profile rate (or PROR; defined as the proportion of respondents who completed or partially completed the welcome questionnaire of all respondents who were sent an invitation to the welcome questionnaire) is 78.78%. The entire codebook and survey data are available at www.gesis.org. More details about the sampling and recruitment procedure can be found in Bosnjak et al. (2017).

On a bi-monthly basis, a survey of about 20 min is administered to the panelists. The GESIS survey is developed for academic research purposes. Therefore, each wave consists of a part that is

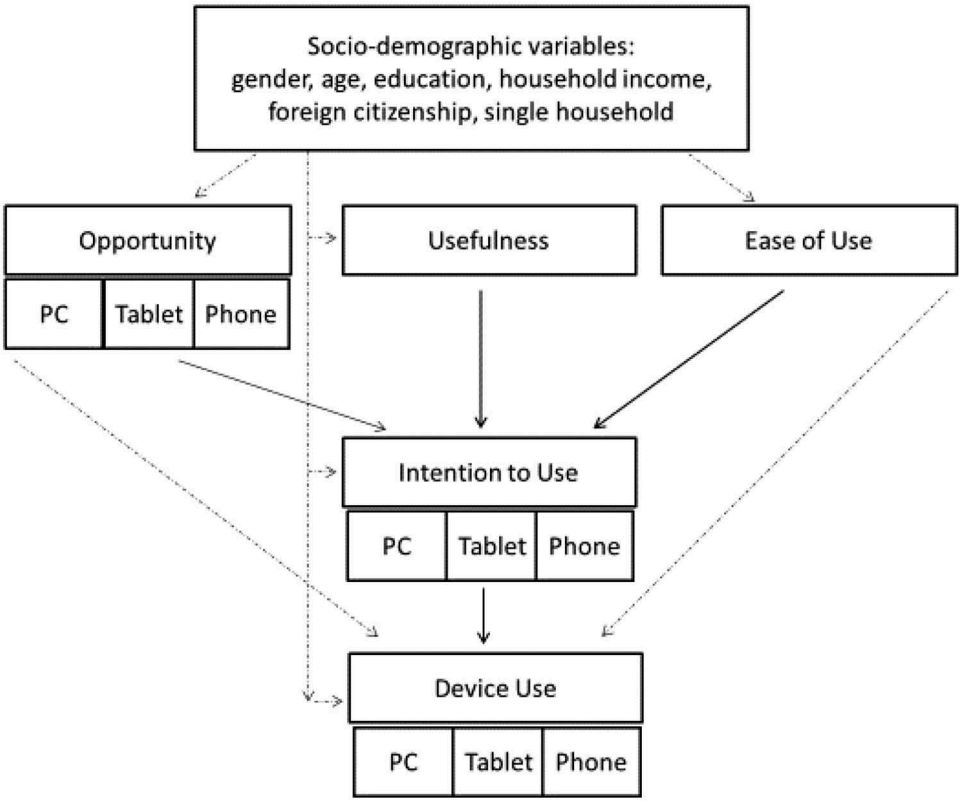

Figure 1. Theoretical model for device use in surveys (based on Davis et al., 1989; Venkatesh & Davis, 2000).

focused on academic studies (15 min), and a second part that focuses on a longitudinal core study developed by GESIS (5 min). Questionnaires are not optimized for mobile completion. Questions are however shown page-by-page which reduces respondents' burden because the need for scrolling is minimized.

At every wave, panelists are invited by mail and receive an unconditional incentive of 5 euros. They can either participate online or offline (paper-and-pencil). The mode for survey participation is chosen by the panelists during the recruitment phase; respondents cannot switch from online to the offline mode between waves. About two-thirds of the panelists complete the survey online (web-based survey), and one third participates offline through a mail survey (paper-and-pencil survey).

Analytical sample

For this study seven waves of the GESIS panel are used to analyze respondents' device use, starting with wave 'BF' that was fielded from December 2014 to February 2015. For the BF wave, 4344 panelists were invited: 3882 participated of whom 2589 online and 1293 offline. Retention is 91.07% (the number of active panel members at the time of the wave BF out of all active panel members; GESIS, 2015). Respondents who completed this wave of the GESIS Panel questionnaire offline are not included in the analysis. Of the 2589 online respondents, 2546 completed the entire questionnaire of wave BF.

Device use indicators

GESIS panelists can use the device of their own choosing to participate in an online wave. To study device use, we analyzed the user agent strings. We use a Javascript parser (www.uaparser.org) to classify the user agent string. Devices were divided into PC/laptop (devices with a keyboard), smartphones (screen <6.0 inches) or tablets. Also, respondents were questioned about their behavioral intention with a question asking: 'If you were able to choose from different survey participation modes, would you use the following mode for participating in the GESIS GesellschaftsMonitor Surveys?', with four possible response options: Paper, PC/laptop, Tablet or Smartphone. To measure 'opportunity' we used the following question: 'Do you own the following devices?' with four possible responses: PC, Laptop, Tablet or Smartphone. For the variable 'usefulness' attitudinal questions about affinity with technology were used (e.g., interest in technology, the importance of the Internet, and the effects of technology on humanity). 'Ease of use' was measured by items on frequency of smartphone use, smartphone navigation applications, and media usage.

We further investigate six different demographic covariates which have earlier showed to be predictive of device use (Lugtig, Toepoel, & Amin, 2016; Struminskaya, Weylandt, & Bosnjak, 2015; Toepoel & Lugtig, 2014): household income measured in 9 categories, education measured in 10 categories, whether someone lived in a single household, possession of foreign citizenship, age, and gender. All questions and their wordings are included in Appendix A.

Data analysis

Descriptive analyses of device use in the GESIS Panel are based on the seven waves of data collected between December 2014 and December 2015 (i.e., waves BF to CF). We use SPSS 24.0.1 (IBM Corp, 2016) to analyze patterns of device use over this period within every respondent who completed wave BF. We also report descriptives on device ownership, device use across subgroups, and device use across waves when owning a device.

In order to explain why respondents choose to use a specific device, we test the model in Mplus 8.0 as shown in Figure 1 with a Structural Equation Modeling approach (Muthén & Muthén, 2017). We test whether our theoretical model fits the data by focusing on measures of fit, and by studying the standardized effects of the model.

First, we study the two-factor models for the operationalization of 'ease of use of phones' and 'usefulness of IT'. For ease of use, we used four indicators that each ask respondents whether they ever use the smartphone: 1) to navigate in the car, 2) to navigate by foot, 3) for watching media (video), and 4) the general frequency of smartphone use. A Confirmatory Factor Analysis (CFA) of these four items showed that the third and fourth indicator had strong correlations between the unique variances. We decided to leave out the fourth indicator because this item was less specific compared to the other indicators. The CFA with the remaining three items was fully identified (df = 0), standardized factor loadings for items 1–3 were .80, .69, and .80, respectively.

For 'usefulness', we used 10 indicators. These items ask respondents whether: 1) modern technology should be seen as having a positive impact, 2) the future will be better due to scientific progress, whether 3) they have a personal interest in technology, 4) they have problems working with machines, 5) they find computers uninteresting, 6) find it important to have the newest computer, 7) they can keep up with new media, 8) believe it is a social disadvantage not to have internet, 9) they feel more informed because of the Internet, and 10) they find the Internet fascinating.

After carrying out a first CFA, two items were deleted. The fourth item and eighth item showed low factor loadings (<.2). A CFA with the remaining eight items showed an acceptable model fit when the unique variances of several items were allowed to correlate. The wording of some items in the scale is very similar, and so we allowed correlations for items 1 and 2, 3 and 6 to correlate.

After this the Chi-square for model fit still showed the model did not fit well ((chi-square (18) = 81.27, <.01). However, further correlations between items were all estimated to be .10 or lower (as shown in Expected Parameter Change), and fit values for RMSEA (.053) and CFI (.890) were acceptable.

Second, we study whether the model as a whole fits the data by looking at the model fit, summarized in values of Chi-square and relative fit: TLI/CFI and RMSEA (Kline, 2015). In case our model does not fit our data, we will amend the model in two possible ways. First, we add paths to ameliorate the model fit, and second, we trim paths to make the model more parsimonious. We added only paths to our model that made sense theoretically and would improve our measure of model fit substantially. When trimming paths, we deleted paths with a p-value >.01.

Not all respondents completed all seven waves. We use the 2546 respondents completing wave BF as our baseline. Because of the fact that all our variables are asked in wave BF, missing data mainly occur in our dependent variable. Missing values in device use, as well as item missings on other variables are dealt with using the Full Information Maximum Likelihood algorithm (Enders, 2010).

Results

Descriptives

We start by looking at device use over the seven waves. In Table 1 the rows display the waves and the columns display the device used. PC/Laptop remains the dominant device over seven waves, but its use in the GESIS panel decreases by 10% over a 12-month period. Tablet use decreases after wave BF, but in later waves, its use increases again. Smartphone use increases somewhat with a small drop in the summer of 2015. Nonresponse increases over time to 8.9% of the 2546 tracked respondents, 82.8% participated in all seven waves (n = 2107).

Overall, 63.2% (n = 1609) of the panelists always use a PC or laptop, 2.8% (n = 72) always uses a tablet, and 5.1% (n = 130) always use a smartphone to participate in the survey. Some respondents use different devices over the waves: 7.1% (n = 182) use PC and tablet, 16.4% (n = 417) use PC and smartphone, 2.2% (n = 55) use tablet and smartphone, and 3.2% (n = 81) complete the survey at least once using a PC, tablet or smartphone.

Table 2 shows the device use across the following socio-demographic variables: gender, age, education, household income, foreign citizenship, and single household. The rows display the socio-demographics and the columns display the device use. For gender we find a significant difference in device use between females and males. Females tend to use mobile devices more for survey participation than males, which is in line with previous research (Cook, 2014; Lugtig et al., 2016). We also find a significant difference in device use for age. Young people more often choose to use the smartphone as the dominant device for survey participation than other age groups. This result is in line with previous literature as well (Couper et al., 2017; de Bruijne & Wijnant, 2014; Lambert & Miller, 2015). Younger respondents also combine PC and smartphone use more often, while middle-aged and older respondents often only use the PC for survey participation. Tablet

Table 1. Percentages of device use per wave (n = 2546).

	PC/Laptop	Tablet	Smartphone
Waves			
BF – Dec. 2014	79.5	8.4	12.1
CA – Feb. 2015	76.1	7.8	11.9
CB – April 2015	74.9	7.5	12.1
CC – June 2015	72.5	7.8	12.1
CD – Aug. 2015	72.5	8.3	11.5
CE – Oct. 2015	72.3	7.8	12.3
CF – Dec. 2015	69.8	7.7	13.6

Table 2. Percentages of device use across gender, age, education, household income, foreign citizenship, and single household.

	Always PC	Always Tablet	Always Phone	PC-Tablet	PC-phone	Phone-Tablet	All	N
Gender[a]								
Female	58.8	3.8	7.4	6.4	17.9	2.4	3.4	1278
Male	67.7	1.9	2.8	7.9	14.8	1.9	3.0	1265
Chi-Square Test[b] $\chi^2(3) = 42.44$ $p < .001$								
Age								
Young (≥1980)	42.3	2.1	10.9	5.1	32.1	3.3	4.3	726
Middle (1960–1979)	66.1	3.0	3.7	8.7	12.9	2.4	3.1	1121
Old (<1960)	82.3	2.5	1.0	7.0	5.5	0.0	1.6	674
Chi-Square Test $\chi^2(6) = 281.81$ $p < .001$								
Education								
Low	67.8	2.7	5.5	6.5	14.7	1.7	1.0	292
Middle	65.4	3.6	6.1	5.3	13.7	2.4	3.4	787
High	61.1	2.5	4.5	8.7	17.7	2.1	3.5	1385
Chi-Square Test $\chi^2(6) = 18.81$ $p < .005$								
Household Income								
Low	63.7	2.5	6.6	5.4	17.8	1.7	2.3	650
Middle	65.7	3.7	3.9	7.1	14.7	2.1	2.9	1168
High	61.3	2.3	2.9	13.5	13.2	2.3	4.4	341
Chi-Square Test $\chi^2(6) = 17.26$ $p < .01$								
Foreign Citizenship								
Yes	55.6	2.7	9.6	5.3	21.4	2.1	3.2	187
No	63.9	2.8	4.7	7.3	15.9	2.2	3.2	2343
Chi-Square Test $\chi^2(3) = 10.94$ $p < .05$								
Single Household								
Yes	60.9	1.6	5.4	6.5	18.8	1.9	4.9	368
No	63.6	3.0	5.1	7.3	16.0	2.2	2.9	2172
Chi-Square Test $\chi^2(3) = 4.03$ $p = .258$								

[a]Three people did not respond to the item on gender. These people participate either always by PC (n = 2) or PC and smartphone combined (n = 1).

[b]The following groups are used for the Chi-square tests: always pc, always tablet, always phone, combined device use (PC-Tablet, PC-Phone, Phone-Tablet, and All).

use seems to be more popular among the middle-aged respondents compared to the other groups. For education, we find a significant difference for device use as well. It is remarkable that higher-educated respondents switch devices the most. The results of household income show that respondents with a lower income more often use a smartphone as the dominant device for survey participation compared to the other income groups, this also is in line with previous literature (Cook, 2014). Respondents with a higher income switch more between devices. Furthermore, respondents who possess citizenship of a foreign country use a smartphone as the dominant device, while respondents who only possess German citizenship more often use a PC as the dominant device for survey participation. We find no significant differences for the single household variable.

In wave BF, respondents are asked which device(s) they own. We find that 36.8% (n = 936) of the respondents own all devices (PC or laptop, tablet, and smartphone). Many panelists, 37.0% (n = 943), own a PC/laptop and a smartphone (i.e. not a tablet), 5.0% (n = 127) own a PC/laptop and a tablet, and 0.6% (n = 16) own only a tablet and a smartphone. There are also respondents who own one device only: 18.9% (n = 481) owns only a PC/laptop, 0.5% (n = 14) a tablet, and 0.8% (n = 20) only a smartphone. Finally, 0.9% (n = 9) reports that they own none of the devices.

Table 3 shows how ownership and device use relate to each other. The rows display which device the respondents own and the columns display the device use. Outcomes show that when respondents own all devices, PC/laptop is the device used most often. We also find that some panelists use devices for survey participation that they do not own. For example, 8.2% of respondents who report to only own a PC, actually use a different device in one or multiple waves. We expect these respondents participated at work or used a device of someone else for survey participation.

Table 3. Percentages of device use across waves when owning a device.

	Always PC	Always Tablet	Always Phone	PC-Tablet	PC-phone	Phone-Tablet	All	N
Ownership								
Only PC	91.7	-	0.8	1.2	6.0	-	0.2	481
Only Tablet	7.1	35.7	7.1	21.4	14.3	7.1	7.1	14
Only Phone	5.0	-	50.0	5.0	40.0	-	-	20
PC-Tablet	62.2	3.9	1.6	21.3	7.9	0.8	2.4	127
PC-Phone	67.2	0.1	6.2	2.2	21.8	0.5	1.8	943
Tablet-Phone	6.3	25.0	25.0	6.3	12.5	12.5	12.5	16
All	47.6	6.1	5.3	13.1	16.9	4.8	6.1	936
None	66.7	-	-	-	22.2	11.1	-	9
N								2546

Model for explaining device use

When fitting the full model as shown in Figure 1 we found the model to have an acceptable fit (chi-square(181) = 1845, $p < .01$, RMSEA = .06, CFI = .87). We also found that many of the paths we tested were nonsignificant, especially for the socio-demographic control variables and the contextual factors (ownership, usefulness, ease of use) directly to behavior. The TAM model hypothesizes that these direct paths should be 0 when indirect effects are accounted for, and we find that this holds in our model too. We trimmed these insignificant paths step-by-step, each time trimming the path with the highest p-value. We continued this procedure until all variables in our model were significant with $\alpha < .01$.

While doing this, we found three variables (single household, ownership of a smartphone and the 'usefulness' factor) not to be structurally related to any of the variables in the model anymore. We therefore deleted these variables from the model entirely. The full model specification can be found in Table B1 (Appendix B). All standardized effects larger than .2 can be found in Figure 2.

The Structural Equation Model provides insight into what determines device use (see Table B2). First, we see that when respondents use a PC more often for completion of GESIS panel surveys, they are much less likely to use smartphones and tablets. To some degree, this is a logical consequence of the fact that we only coded one device for each wave respondents participated in. However, we see that there is no large correlation between smartphone and tablet use. This reflects the fact that respondents who use tablets in some waves are likely to use smartphones in some other waves, just as we found in Table 2.

A second important finding is that someone's intention to use a particular device predicts actual use quite well. Standardized correlation coefficients are between −.21 and .41. This is also the only strong predictor of device use. The effects of ownership, usefulness, and ease of use are all indirect.

Ownership is not a strong predictor for device use. There are no direct effects of ownership on device use and only one indirect effect of owning a tablet. Usefulness does not affect device use, nor the intention to use a specific device. The only contextual variable that is very meaningful in our model is the ease of smartphone use. If people use a smartphone for specific tasks, their intention to use a smartphone for survey completion is also more likely. The standardized indirect effect of this variable on the three outcome variables are −.30 (predicting use PC), .07 (use tablet) and .20 (use smartphone).

Earlier studies have looked into how socio-demographic variables correlate with device use (Lugtig et al., 2016; Struminskaya et al., 2015; Toepoel & Lugtig, 2014). Despite the fact that we find these correlations as well, there are almost no strong effects when demographic variables are incorporated into a model explaining device use. Only household income has a medium size effect for predicting device use. All other effects are really small, and indirect: demographic variables explain only to some degree whether people own a particular device, and intent to use a particular device.

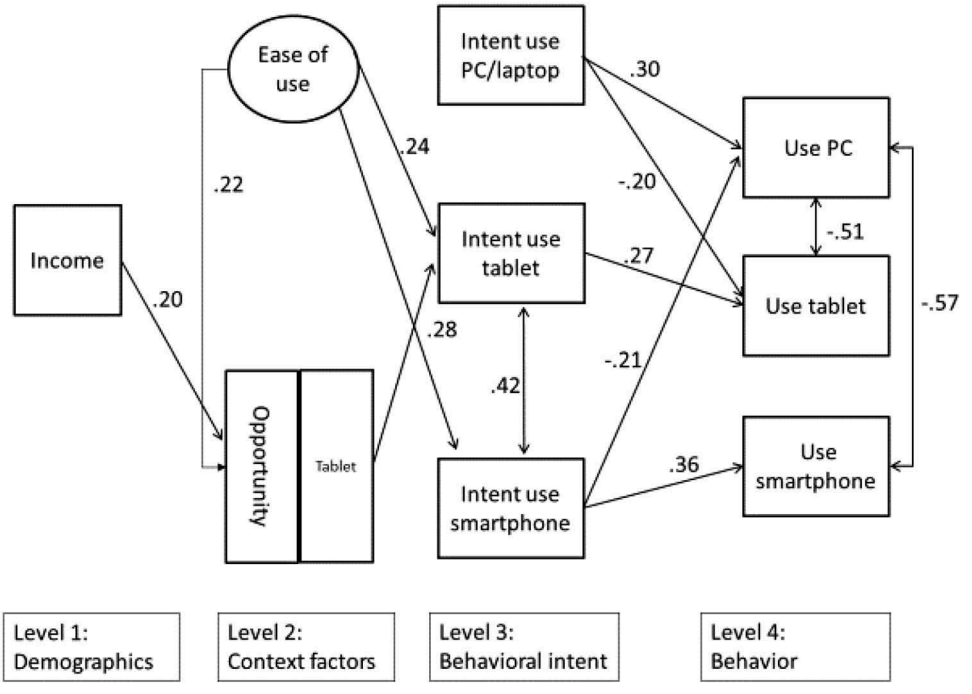

Figure 2. All standardized effects (>.20) for final model.

The explanatory power of the model is of medium strength. We can explain 28% of the variance in PC use, 20% in tablet use, and 25% in smartphone use as denoted by R^2. These values imply that although we can explain some of the variances in our outcome variable, between 70% and 80% of the variance remains unexplained. Either the model we have used is not adequate to explain device use or respondents to a large degree select the device they use for survey completion at random. Either of these explanations has implications for how we should prepare surveys for the mobile era. Now we turn to this issue in discussing the implications of the findings.

Conclusions and implications

In this paper, we focused on mobile device use in online surveys. We have investigated whether mobile device use can be predicted by factors related to perceptions of and use of mobile technology. We developed a model based on theory from survey research and technology acceptance research and tested this model using data of the GESIS online panel.

Based on our descriptive analyses we find that particular subgroups of respondents are more likely to always use a mobile device (e.g., young people, females, those in possession of foreign citizenship, lower-income households) for survey completion. However, we also find that many respondents use different devices over the course of seven waves of the German GESIS panel (e.g., well-educated respondents, higher income households).

The model is focused on explaining why respondents make decisions to use a particular device. Our results reveal that people who find it easy to use modern technologies are more likely to report that they would be willing to use both tablets and smartphones. This attitude determines whether people are more likely to intend to use smartphones for survey completion, and not the ownership of such devices. It should be noted that we used frequency measures as a proxy for easiness, which could have influenced the results. Replication in future studies will have to show whether this finding persists.

We also find that people who want to use a PC/Laptop will not use a tablet. Apparently, there are two respondents groups: those keen to use PC will use a PC, and those keen to also use tablets or smartphones use both tablets and smartphones and switch devices between waves. Furthermore, a higher intention to use a device is strongly related to actually responding on that device. This finding can be related to prior studies in which self-reported questions on mode preference are affected by the response mode in which respondents participate (Lynn & Kaminska, 2013; Al; Baghal & Kelley, 2016). We also investigated the effects of six socio-demographic variables to this end and found that only income has a medium size effect for predicting device use.

Our findings indicate that device ownership of a PC/laptop or smartphone does not predict device use. Only tablet ownership is important for device use: people owning a tablet report they are more likely to use a tablet and then do so. The analysis also shows that some respondents use devices that they do not own. There are several explanations for this finding. People may use devices of others, like a family member or colleague. Alternatively, they have purchased the device after the wave (wave BF) in which the question on device ownership was included.

In conclusion, our model shows that ease of use is the strongest predictor for device use in online surveys. The other variables, ownership, and usefulness, did not predict device use. These results have implications for online surveys in general in which respondents can complete the survey using a mobile device. If survey methodologists would like respondents to use mobile devices, they should invest in the ease of use of mobile survey completion. They should give respondents the confidence that mobile device completion is indeed easy. This trust should foremost be established by building well-designed surveys for mobile devices. The GESIS panel questionnaires are not optimized for smartphone completion. Although mobile completion is possible, the survey is not optimized to be 'mobile first'. Doing so will probably lead to a higher intention to complete surveys by smartphones, and increasing use in the future.

Another method is to literally ease respondents into using smartphones by creating instructions or an example video on how to use smartphones. Alternatively, survey practitioners can employ interviewers to guide respondents who do not feel comfortable using smartphones for surveys. Arguably, using interviewers is expensive. However, mobile phones offer additional measurement capabilities beyond traditional web surveys (e.g. using GPS sensors, or accelerometers). Other types of surveys, like online diary studies or studies using experience sampling, can only really be conducted on mobile phones. For those respondents who are less familiar with smartphones or do not own a smartphone, simply giving them a smartphone to participate in the study is probably not enough. If we want respondents to use apps for social science data collection, we should invest more to ease the particular subgroups of respondents in using smartphones for surveys.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendix A: Items used for descriptives and structural equation modeling

Device use

Based on user agent strings

Item Behavioral intent

Likelihood of participation bfzi105a-bfzi108a
7-point scale 0=No, in no case – 6=Yes, in any case

If you were able to choose from different survey participation modes, would you use the following mode for participating in the GESIS GesellschaftsMonitor surveys?

Paper
PC/laptop
Tablet-PC
Smartphone

Items Ease of use of phones

Route planning: Mobile navigation application when by foot baag056a
7-point scale 1=does not apply at all – 7 = fully applies

When walking in a foreign city, I use a navigation application on my smartphone (or a mobile navigation system) to orient myself and to find my route.

Smartphone with a navigation application baag059a
Quoted/Not quoted scale

Do you have one or more of the following devices?
A smartphone with navigation application.

Media usage: cellphone/smartphone bezf048a
7-point scale 1=never – 7=daily

How often do you use the following media or opportunities?
A cellphone/smartphone

Frequency of use: Smartphone bfzi097a
7-point scale 1=several times a day – 7=never

If you own one or more of these devices, how frequently do you use them?
Smartphone

Items Usefulness

Affinity for technology a11c040a-a11c049a
7-point scale 1=fully disagree – 7 = fully agree
Modern technology has more positive than negative effects.
Due to technological progress, humanity is continuously moving towards a better future.
I am interested in technology and technological issues.
It is sometimes difficult for me to operate appliances, such as ticket vending machines and cash dispensers.
I take no interest in computers.
It's important for me to have a state-of-the-art computer at my disposal at home.
I feel I can't keep up with developments in the area of new electronic media, such as the Internet and mobile communications.

In the future, people who do not have access to the Internet will be at a disadvantage in our society.
The Internet fundamentally contributes to improving levels of knowledge and information in society.
I think the Internet is fascinating.

Item Opportunity

Device ownership bfzi090a - bfzi093a
Yes/No scale

Do you own the following devices?
PC
Laptop
Tablet-PC
Smartphone

Items Socio-Demographics

Gender bfzh069a
Nominal scale – 2 categories

Are you male or female?
Female
Male

Age bfzh070c
Year of birth

When were you born?

Education
bfzh076a: Nominal scale - 10 categories

What is your highest general degree of education?

bfzh079a: Nominal scale - 5 categories

Do you have a university degree?

Citizenship bfzh072a
Yes/No Scale

Do you possess the citizenship of a foreign country?

Single household bfzh084a
Nominal Scale – 2 categories

How many people, you included, regularly live in your household?

Household income bfzh089c
Nominal Scale – 9 categories

And how high is the average net income of your household, meaning the sum of all net incomes and social security/ welfare benefits of people living inside your household?

Appendix B: Structural Equation Modeling

Table B1. Model trimming for device use in GESIS panel.

Path trimmed	Chi-square	Df	RMSEA	CFI
(1) Basic model	1845	181	.06	.87
(2) Age -> Use of smartphone	1846	182	.06	.87
(3) Income -> Intent to use smartphone	1846	183	.06	.87
(4) Own smartphone -> Use of tablet	1846	184	.06	.87
(5) Ease of using smartphone -> Use of tablet	1846	185	.06	.87
(6) Age with education	1846	186	.06	.87
(7) Single household -> Intent to use smartphone	1846	187	.06	.87
(8) Useful -> Intent to use tablet	1846	188	.06	.87
(9) Single household -> Use of PC	1846	189	.06	.87
(10) Age ->Intent to use smartphone	1846	190	.06	.87
(11) Age -> Ease of using smartphone	1846	191	.06	.87
(12) Education -> Use of tablet	1846	192	.06	.87
(13) Own smartphone -> Intent to use PC	1846	193	.06	.87
(14) Single household -> Intent to use tablet	1846	194	.06	.87
(15) Single household -> Intent to use PC	1846	195	.06	.87
(16) Single household -> Useful	1847	196	.06	.87
(17) Age -> Own PC	1847	197	.06	.87
(18) Own smartphone -> Intent to use smartphone	1847	198	.06	.87
(19) Own PC with ease of using smartphone	1848	199	.06	.87
(20) Single household with education	1848	200	.06	.87
(21) Single household with own smartphone	1848	201	.06	.87
(22) Single household with foreign	1849	202	.06	.87
(23) Age with gender	1850	203	.06	.87
(24) Education -> Ease of using smartphone	1851	204	.06	.87
(25) Education -> Own PC	1851	205	.06	.87
(26) Own tablet -> Use of smartphone	1852	206	.06	.87
(27) Age -> Own smartphone	1853	207	.06	.87
(28) Single household with gender	1853	208	.06	.97
(29) Useful -> Use of tablet	1854	209	.06	.87
(30) Single household -> Use of tablet	1855	210	.06	.87
(31) Income -> Use of PC	1857	211	.06	.87
(32) Foreign -> Own PC	1858	212	.06	.87
(33) Education -> Intent to use tablet	1859	213	.06	.87
(34) Own tablet -> Intent to use smartphone	1860	214	.06	.87
(35) Intent to use tablet	1861	215	.06	.87
(36) Foreign with income	1862	216	.06	.87
(37) Foreign -> Intent to use PC	1864	217	.06	.87
(38) Foreign -> Use of PC	1865	218	.05	.87
(39) Own smartphone -> Use of smartphone	1866	219	.05	.87
(40) Single household -> Use of smartphone	1868	220	.05	.87
(41) Remove own smartphone	1627	202	.05	.88
(42) Income -> Use of smartphone	1628	203	.05	.88
(43) Income -> Use of tablet	1630	204	.05	.88
(44) Foreign -> Intent to use tablet	1632	205	.05	.88
(45) Age with foreign	1633	206	.05	.88
(46) Foreign -> Use of smartphone	1635	207	.05	.88
(47) Income -> Ease of using smartphone	1637	208	.05	.88
(48) Useful -> Use of smartphone	1639	209	.05	.88
(49) Useful -> Intent to use smartphone	1641	210	.05	.88
(50) Education -> Own tablet	1643	211	.05	.88
(51) Foreign -> Use of tablet	1646	212	.05	.88
(52) Foreign -> Useful	1648	213	.05	.88
(53) Foreign -> Own tablet	1651	214	.05	.88
(54) Useful -> Intent to use PC	1654	215	.05	.88
(55) Gender -> Own tablet	1656	216	.05	.88
(56) Gender -> Intent to use tablet	1658	217	.05	.88
(57) Age -> Intent to use tablet	1660	218	.05	.88
(58) Age with single household	1663	219	.05	.88
(59) Income -> Useful	1666	220	.05	.88

(*Continued*)

Table B1. (Continued).

Path trimmed	Chi-square	Df	RMSEA	CFI
(60) Foreign -> Ease of using smartphone	1669	221	.05	.88
(61) Income -> Own pc	1672	222	.05	.88
(62) Education -> Intent to use PC	1676	223	.05	.88
(63) Intent to use PC with intent to use smartphone	1680	224	.05	.88
(64) Remove useful	173	75	.02	.99
(65) Single household with own tablet	178	76	.02	.99
(66) Single household -> Ease of using smartphone	183	77	.02	.99
(67) Own PC -> Intent to use tablet	188	78	.02	.99
(68) Own PC -> Intent to use smartphone	191	79	.02	.99
(69) Age -> Own tablet	196	80	.02	.99
(70) Remove single household	167	66	.03	.99

Notes: all paths shown are trimmed one-by-one in consecutive models, and only when the *p*-value > .01

Table B2. Full results for final model (after trimming).

Relation	B	s.e.	Beta (standardized)
Gender -> Ease	−.241	.053	−.11
Gender -> Use of PC	.261	.039	−.12
Gender -> Use of tablet	.157	.057	.05
Gender -> Use of smartphone	.439	.063	.12
Gender -> Intent to use PC	−.177	.057	−.06
Gender -> Intent to use smartphone	.316	.086	.07
Gender -> Own a PC	−.019	.006	−.06
Age -> Use of tablet	.006	.001	.11
Age -> Intent to use PC	−.003	.001	−.06
Education -> Use of PC	.070	.021	.05
Education -> Use of smartphone	−.060	.018	−.06
Education -> Intention to use smartphone	−.068	.025	−.05
Owning PC -> Use of PC	1.77	.281	.11
Owning PC -> Use of tablet	−.559	.192	−.05
Owning PC -> Use of smartphone	−1.04	.210	−.09
Owning PC -> Intent to use PC	1.59	.202	.17
Owning tablet -> Use of PC	−.530	.081	−.11
Owning tablet -> Use of tablet	.560	.064	.18
Owning tablet -> Intent to use PC	−.334	.066	−.11
Owning tablet -> Intent to use tablet	1.42	.10	.28
Income -> Intent to use PC	.046	.016	.07
Income -> intent to use tablet	.104	.024	.08
Income -> Owning a tablet	.049	.006	.20
Foreign -> Intent to use smartphone	−.478	.161	−.05
Ease -> Use of Pc	−.356	.047	−.16
Ease -> Use of smartphone	.261	.039	.16
Ease -> Intent to use PC	−.185	.031	−.15
Ease -> Intent to use tablet	.526	.057	.24
Ease -> Intent to use smartphone	.844	.057	.40
Intent to use PC -> Use PC	.517	.030	.30
Intent to use PC -> Use tablet	−.217	.020	−.20
Intent to use PC -> Use smartphone	−.233	.023	−.19
Intent to use tablet -> Use PC	−.095	.021	−.10
Intent to use tablet -> Use tablet	.169	.014	.27
Intent to use tablet -> Use smartphone	−.056	.015	−.08
Intent to use smartphone-> Use PC	−.216	.022	−.21
Intent to use smartphone-> Use tablet	−.082	.014	−.12
Intent to use smartphone-> Use smartphone	.275	.016	.36
Own tablet <-> Ease	.122	.015	.22
Intent to use PC <-> Intent to use tablet	.240	.062	.08
Intent to use tablet <-> Intent to use smartphone	2.08	.124	.42
Foreign <-> Gender	−.008	.003	−.06
Use tablet <-> Use PC	−1.45	.065	−.51
Use tablet <-> Use smartphone	.375	.044	−.18
Use PC <-> Use smartphone	−1.77	.074	−.56