Q2024: SMART SURVEY AND DATA QUALITY

LESSONS LEARNED FROM THE NORWEGIAN HOUSEHOLD BUDGET SURVEY 2022

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Abstract

The use of smart surveys in official statistics presents both opportunities and challenges. This paper explores the impact on participation and data quality, using the Norwegian Household Budget Survey (HBS) 2022 as a case study. We will look at engagement, usability, sample bias, data entry method and errors to evaluate the effectiveness of smart survey features.

The key findings highlight that while smart surveys offer innovative data collection methods that may reduce response burden, they also encounter significant obstacles. These include issues of participant engagement, and usability, particularly among the oldest population and lower educated. It also includes challenges with data quality. For the HBS this is associated with both Optical Character Recognition (OCR) and manual recording. Automated editing and machine learning can reduce errors and is expected to be improved moving forward.

Trust concerns has not yet impacted participation noticeably but as awareness of privacy and data security grows, we expect higher respondent expectations. As we progress, it is imperative to further develop our communication on this matter and demonstrate our commitment to these issues through secure logins and robust management of personal information and data.

Lessons learned so far indicate that while smart surveys offer promising advancements in a country like Norway with high levels of digital participation and literacy, they require continuous improvements to address issues of engagement, user experience, and data quality to reduce response burden and ensure inclusiveness to provide good statistics in future smart surveys.

Keywords: Smart surveys, data quality, participant engagement, response burden.

Table of content

1. Introduction

In this paper we will explore the impact of smart survey features on participant engagement data accuracy and quality of expense data recorded in the Norwegian HBS 2022. As not all data analysis for the HBS 2022 is completed, we won't be able to address critical parameters, such as comparative volume of expenses. We will focus on participation and the use of smart features, and the quality of data obtained through OCR versus manual registration. When relevant, we will incorporate qualitative insights from usability tests and evaluation interviews to supplement our analysis. Aspects such as recruitment strategies, data collection method, and overall survey design play a critical role for sample and data quality but will not be covered in this paper.

1.1 Smart survey features

Emerging technologies are modernizing data collection by introducing or improving measurement tools and potentially reducing respondent burden and possibly maintaining response rates. Using smartphones equipped with sensors such as OCR (Optical Character Recognition), GPS, and others enables us to move towards more passive methods of data gathering, possibly significantly reducing the tasks for respondents, and as such the response burden, which is a stated aim for official statistics.

These surveys, termed "smart surveys," extend beyond simple sensor technology like OCR. They incorporate extensive digital functionalities such as hyperlinks, touchscreen interactions, scrolling, swiping, skip logic, search word lists, and personalized customization. We describe these collectively as "smart features" in this paper. Smart features provide a new interactive language, enabling the customization and optimization of survey instruments. They represent a digital evolution from web survey which can enhance the user experience with customizing and incorporating advanced features such as hidden information layers, functional interactivity, push notifications, and dynamic search word lists to assist and guide respondents.

We will explore the impact of smart surveys on data collection quality and efficiency in official statistics using the Norwegian Household Budget Survey 2022 (HBS 2022) as a case.

1.2 Case study: The Norwegian Household budget survey 2022

Statistics Norway (SSB) has monitored Norwegian households' consumptions since 1958 and conducted the household budget survey annually from 1973 to 2009 and one last time in 2012 followed by a 10-year pause. Traditionally, the survey was conducted through a combination of face-to-face interviews and paper diary. In 2012, a proportion of the interviews were done

by telephone. Households had to manually enter all their expenses for 14 days in a physical paper diary or in a web-diary. Still, there was also an option to send receipts to SSB in a separate envelope instead of manually recording them in the diary.

The burden of participating in the HBS survey was considered significant, and prior to the 2022 survey, it was decided to develop a progressive web application (PWA) with a feature which allows automatic optical reading of receipts via a mobile phone or tablet camera. The registration period was reduced from 14 to 7 days.

The household budget survey in 2022 consisted of three parts:

1. A telephone recruitment interview of about 10 minutes.
2. Households registering their private expenses in a PWA for 7 days.
3. A household web questionnaire in the PWA (approx. 30-40 minutes).

The gross sample contained 11 905 households (see Table 1.1 and further details on sample in Appendix C). The households were randomly assigned a week where they were to be contacted for a telephone interview. The registration period was initially the first full week after the interview was conducted, but it was possible to postpone the period for up to five weeks.

After the interview, the household received an e-mail with information about the registration of expenses in the web app. On the first day of the registration period, the household received a text message (SMS) with a link to log in to the PWA. The login took place via the “ID-porten” portal. “ID-porten” is a national two-factor log-in solution used by public services.

All actual payments for private consumption during a 7-day period were to be entered into the PWA. Households had the option of taking a photo of the receipt for optical reading or choose manual data entry of product items. Individuals who did not wish to install the PWA and use it as an app on their mobile phone, could use their internet browser on a tablet or a computer.

One or two days into the registration period, an interviewer called the contact person in the household to ask if any help was needed, e.g. with the installation of the PWA on the mobile. The contact person also received a couple of text messages during the registration period, with tips about registration. After the registration period, respondents received an SMS informing them that by completing the survey in the web app they would receive a gift card of NOK 500.

For a description and illustration of the PWA, see Appendix A, which includes screenshots and a video walkthrough of the workflow in the application.

2. Data analysis and findings

2.1 Participation and engagement

Several factors influence the willingness, access, and ability of individuals to participate in smart surveys. Like in all surveys, recruitment, data collection methods, survey instruments, and respondents' interactions with interviewers and/or the survey instrument, and demographics representation are crucial. In addition, smart surveys require respondents to have a smartphone or similar device, an internet connection, and the ability to use the application.

Over the past 20 years, Norwegians have achieved near universal internet access, and has fully digitalized all public services, including tax reporting, social security, pensions, and banking. 96 per cent of Norwegians own a smartphone, averaging 2.5 hours of usage daily, and 93 per cent of individuals aged 9 years and older use the internet daily. However, internet usage declines with age: 68 per cent of those aged 67 to 79 and only 48 per cent of those aged 80 or older use the internet daily (Norsk mediebarometer 2022). Moreover, 25 per cent of those aged 80 or older do not have electronic contact information registered, and 20 per cent are not registered in the national Contact and Reservation Register used for digitally contacting sampled respondents, see Figure 2.0. We see that the use of text messaging and smart features decreases significantly from the age of 80/85 years[1], with many depending on relatives or friends for online tasks such as tax reporting and healthcare scheduling.[2] We also note that 15 per cent of the population at large consider their digital skills weak, a figure that increases starting from retirement age (HK-DIR 2021).

Nonresponse analyses from surveys like the national Quality of life survey and the European health interview survey indicate that the oldest age groups (80+) are underrepresented, more so in web-based surveys than telephone interviews, with bias increasing with age and lower education levels.[3]

Use of device

In the HBS 2022 approximately 60 per cent of respondents used Apple's iOS, 35 per cent Android, both predominantly mobile devices. Only 5 per cent used Windows or MacOS, on

[1] From 85 years or older 75 per cent use welfare services and 20 per cent reside in institutions. In HBS contact persons 85 years and older is not included.
[2] During the pandemic, about a quarter of the older group 80 years or older did not respond to government text messages offering free vaccines, ref «Eldreombudet slår alarm om eldrevaksinering: – Får ikke svar fra en fjerdedel», VG 17.02.21.
[3] «Eldres representativitet i webundersøkelser», SSB 2023.

desk- or laptops, see Figure 2.1 in the Appendix. Usage was consistent across age groups (see Figure 2.2) and aligning with market shares of ownership of devices in Norway[4]. Qualitative evaluation interviews revealed a strong preference for mobile devices, attributed to the ease of accessing survey links via SMS and OCR done by a smart device. While mobile is the preferred device when answering surveys in general, older participants sometimes opt for larger screens, like tablets or PCs, similar to their preference for managing bank services.

Nonresponse

Table 2 shows key figures from the HBS 2022. The response rate is 29.5 per cent. The main reasons for non-response were that the interviewers were unable to reach many households due to “no answer” and a general reluctance to participate in surveys. A total of 43.2 per cent completed the telephone interview, but nearly one third of these respondents did not complete the entire survey: That is 13.8 per cent dropout from the gross sample after recruitment. The reason for dropout included that they lost motivation, didn't want to or didn’t find the time to participate after all, unfamiliarity with installing a web app, or technical difficulties such as using an outdated mobile. Details about participation and reasons for non-response in HBS 2022, can be found in table 2.3 in the Appendix.

Table 2.1 Key figures from HBS 2022

Key figures	Gross number	Per cent
Gross sample	11 905	100
Non-response	6 758	56,8
Completed telephone interview	5 147	43,2
Partial non-response	1 640	13,8
Completed all parts (net sample)	3 507	29,5

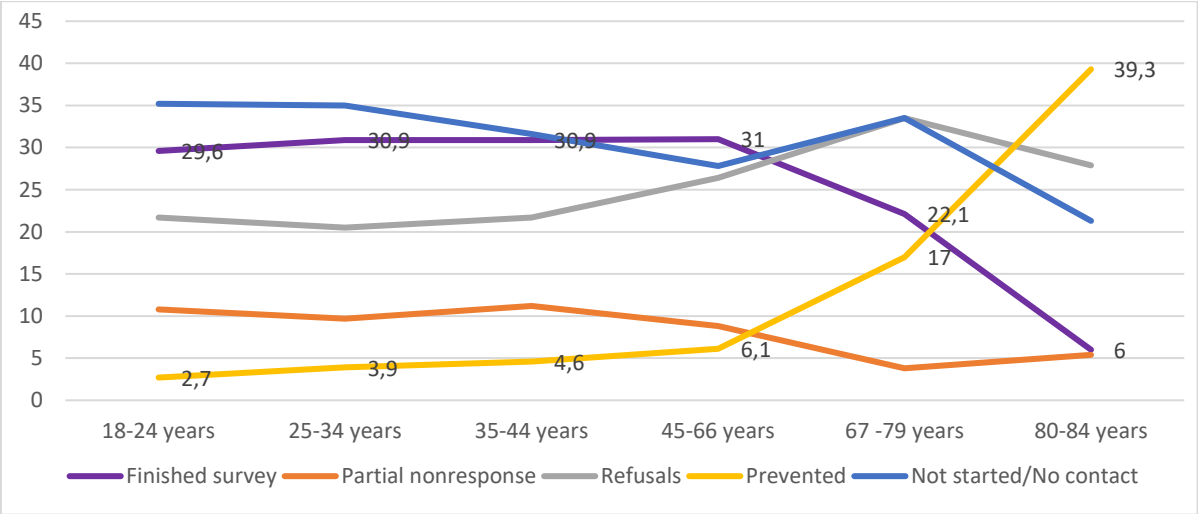
Source: The Household budget survey 2022, Statistics Norway

Figure 2.3 below illustrates participation and reasons for non-response across different age groups. The figure shows that the response rate is relatively stable in households where the contact person is under the age of 67. Beyond this age, response rates decline significantly, with only 6 per cent of those 80-84 years finishing the entire survey. The low response rate in this group is due to both a lack of willingness to participate, health issues, and the survey's exclusive use of a digital format, without a paper diary option, excluding potential respondents. More than half of those 39.3 percent not able to (“prevented”) participate in this segment, reported lack of Internet, PC or technical skills as barriers. The age group 67-79 has the highest

[4] Statista 2023

rate of refusals, but also a considerable percentage that were not able to participate, e.g. because of lack of technical skills.

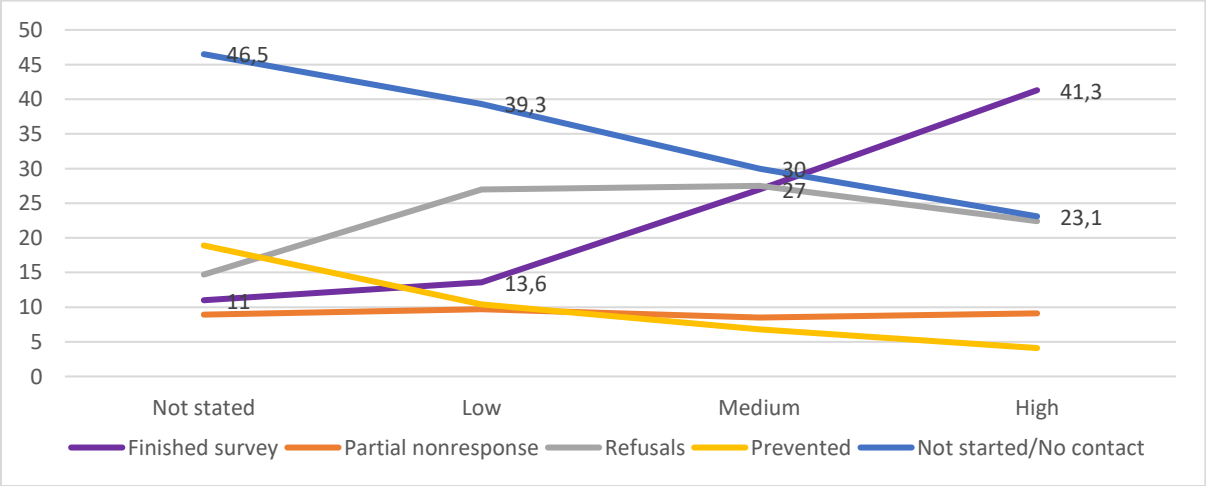
Figure 2.3 Participation and non-response by contact persons' age (per cent)



Source: The Household budget survey 2022, Statistics Norway

Figure 2.4 reveals a notable correlation between the contact persons' level of education and participation. The main reason for non-response in the segment with low or unspecified levels of education, was difficulty in reaching participants. Almost 40 per cent in the group with low education levels and 46.5 per cent of those with unspecified education were unreachable. The group with unspecified level of education has an overrepresentation of immigrants and many lack proficiency in Norwegian. Even though the PWA was available in both Norwegian and English, more than 80 per cent of those not able to participate ("prevented") in this group cited language barriers as the main obstacle to their participation.

Figure 2.4 Participation and non-response by contact persons' education level (per cent)



Source: The Household budget survey 2022, Statistics Norway

Comparing the response rate in HBS 2022 with the last HBS survey in Norway in 2012, it's important to note that there has generally been a significant decline in survey response rates over the last decades (Luiten, Hox and de Leeuw, 2020). The response rate for HBS has declined from 48 per cent in 2012 to 29.5 per cent in 2022. A part of the decline is likely due to a new, self-administered digital data collection method and that we no longer use face-to-face interviews before the registration period starts. Analyses from the 2012 HBS (Holmøy and Lillegård, 2014), shows that a face-to-face interview before the registration period starts, can have a positive impact on the overall response rate.

It is difficult to find similar surveys in Norway to benchmark the results from HBS 2022. The response rate is low compared to the Quality of life survey 2022, a web-survey of about 25 minutes, with a response rate of 38 per cent (Pettersen and Engvik, 2022). This is not surprising given that HBS takes longer and requires more technical skills. Both surveys report notably low response rates among the elderly. For both surveys the main reason for opting out of the survey among the elderly is that they are not able to ("prevented") participate. This is also seen in telephone surveys like the EU-SILC survey on income and living conditions (Strand and Grimstad, 2023).

Young adults (25-34 years) are normally a difficult demographic group to recruit in our surveys, and a trend we also see in the Quality of life survey. In the HBS 2022, however, we are observing a uniform response rate across all age segments up till 67 years. Furthermore, while both surveys show variations in response rates based on level of education, the discrepancy between high and low education levels is more pronounced in the HBS 2022 survey.

Sample bias

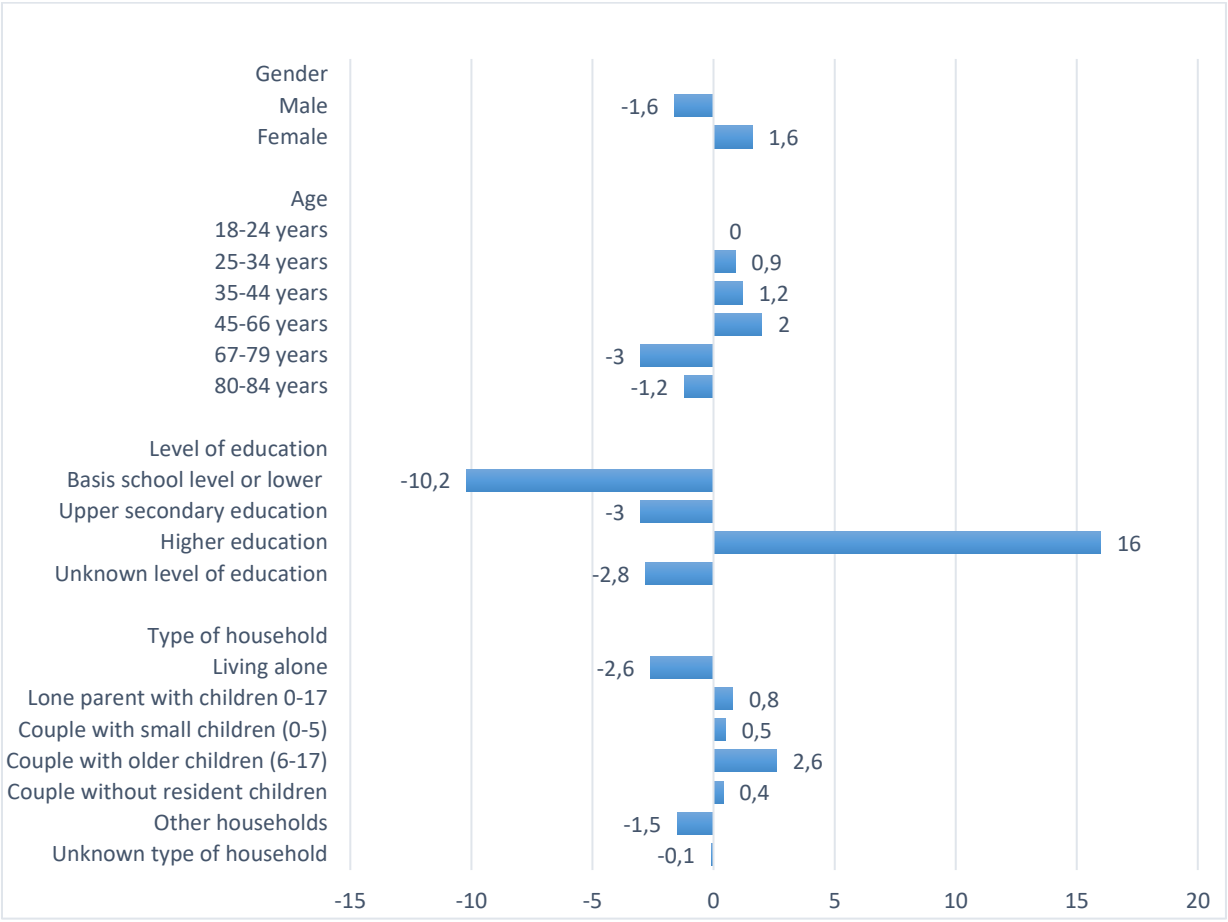
The difference between the gross and net sample[5] is non-response. In this survey, the non-response rate is over 70 per cent. Survey response rate is often considered an indicator of the quality and representativeness of the obtained data. Survey response rate affects two important properties of survey quality: bias and statistical precision (Meterko, M. et al., 2015). Non-response reduces the net sample and leads to larger confidence intervals around the estimates, making them less precise. Problems with non-response can also lead to increased costs, either due to the need for larger samples or because a lot of effort must be put into counteract the fall in the response rate. Non-response may also induce non-response bias (Groves and Peytcheva, 2008). Nonresponse bias happens when those

[5] Gross sample is defined as the proportion of selected sample remaining after those not eligible have been removed. The gross sample is the sample we aim to interview. Conversely, the net sample consists of those individuals in the sample who completed the survey.

unwilling or unable to take part in a survey are different from those who do (Berg, 2010). As a result, the net sample is not statistically representative of the population.

In Figure 2.5 below, bias is measured by the differences between the distribution in the net and gross sample for the contact persons' gender, age and level of education, and type of household. The figure shows indications of bias for all the characteristics. See more details in table 3.1 in the Appendix.

Figure 2.5 Demographic bias. Difference between gross and net sample (per cent)



Source: The Household budget survey 2022, Statistics Norway

Looking at the age of the contact persons, the two age groups 67-79 years and 80-84 years are most underrepresented in the net sample, with 3 and 1.2 percentage points respectively. Because these groups make up such a small proportion of the gross sample, large underrepresentation is particularly problematic. Table 2.2 below shows what percentage the bias represents of the gross proportion of the age group. People aged 80-84 years are underrepresented by about 80 per cent. This bias was 54 per cent after recruitment, indicating a considerable dropout rate in this group.

Table 2.2 Differences between net and gross sample, across different age groups.

	Gross Sample	Net Sample	Difference between net sample and gross sample	Difference Per cent
18-24 years	4,4	4,4	0,0	0,0
25-34 years	19,2	20,1	0,9	4,7
35-44 years	24,4	25,6	1,2	4,9
45-66 years	38,4	40,4	2	5,2
67-79 years	12,1	9,1	-3	-24,8
80-84 years	1,5	0,3	-1,2	-80,0

Source: The Household budget survey 2022, Statistics Norway

Figure 2.5 above also illustrates that persons living alone are underrepresented in the net sample and households with older children are overrepresented. Underrepresentation of persons living alone has also been found in previous HBS surveys in Norway (Holmøy and Lillegård, 2014).

Further, there are major discrepancies when we look at the level of education. Respondents with only basis school or lower are underrepresented in the net sample by 10.2 percentage points, while persons with higher education are overrepresented by as much as 16 percentage points. This bias increased after the telephone interview, because a large part of those who did not finish the survey had low education. This pattern mirrors trends seen in the Quality of life survey (Pettersen and Engvik, 2022) and other web-surveys, but the overrepresentation of respondents with higher education is even more pronounced in the HBS survey.

If the dependent variable has a particularly strong correlation with characteristics unevenly distributed within the sample, weighting the data material can reduce the effect of the biases (Rosendahl, H. et al., 2022 and Lynn, P., 1996). The HBS 2022 data have been weighted to correct biases, particularly those related to major demographic factors. This approach helps to improve the representativeness and accuracy of our findings. However, the specifics of the weighting process will not be detailed in this paper.

User experience and engagement

From our qualitative evaluation interviews[6] we learned that most participants praised the ease of use and the smart features of the web app, and in particular that they could use the mobile to answer. Their user experience with the log on solution and the PWA were positive. No trust issues regarding privacy and data security surfaced neither among participants, starters that

[6] See Berg and Lund, 2024 for description of qualitative user test and follow-up or evaluation interviews done for HBS 2022.

did not complete, nor nonresponse. We suspect we were not able to gather opinions from the most sceptical citizens included in the survey as they are hard to engage. But it was quite clear that even with the new smart set up, time and perceived response burden is perceived at the biggest obstacle for the average citizen.

Confirming what we observed in the net sample bias, we also had reports from the interviewers and our Support service that participants from retirement age (approx. 67 years) and older faced more technical challenges and together with participants with lower education they had a high risk of dropout. We experienced that interviewer assistance and technical support was crucial for older age groups to complete the survey. The seniors, as opposed to the segment with lower education and younger participants, displayed in our qualitative evaluation interviews a strong commitment to completing the survey. The commitment kept them trying and helped them learn how to navigate through the web app and complete the survey. This dedication drops with high age and reduced health. Groups with lower education do not have this commitment and were tougher to engage and stop from dropping out.

2.2 Data accuracy and editing

In this section, we take a closer look at errors and omissions discovered in OCR and manually entered receipts in the HBS 2022, and what the main sources of errors for the two different types of data entry are. We also look at the number of errors and whether they are manually or automatically corrected, or values are imputed in the data processing. We have used our colleague Marius Rønningen Larsson's calculations in this chapter, which have given valuable insights to the quality of manual versus OCR registration data.

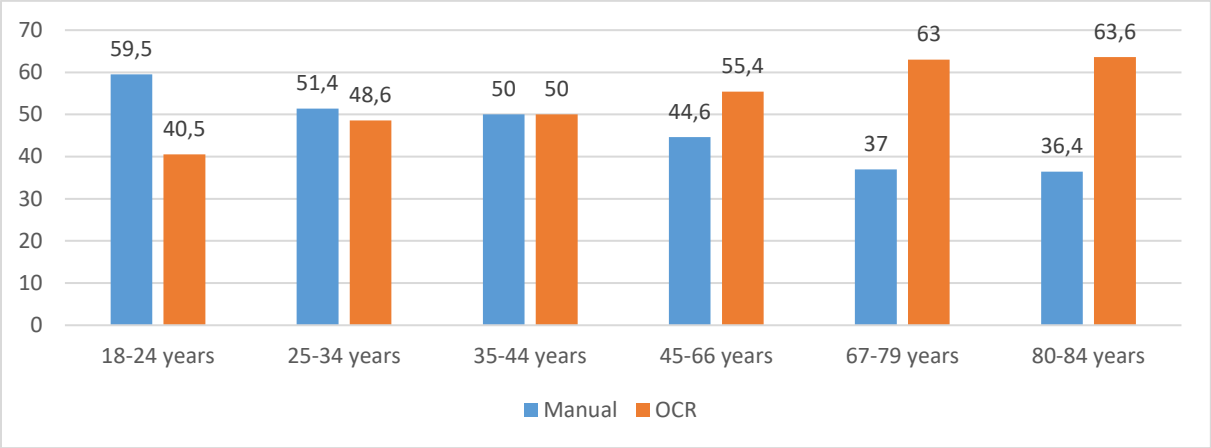
As mentioned in the introduction of the HBS setup, see chapter 1.2, we prioritized simplicity and user-friendliness in the PWA. The app neither requires nor facilitates editing tasks. There is a trade-off between simplicity for the respondent and achieving good quality of data entries.

OCR and manual data entry

Despite the anticipated ease-of-use and potential of OCR technology, adoption was mixed among respondents. While 53 per cent of *receipts* were scanned (OCR), manual entry (47 per cent) was also widely used (see Figure 2.6 in the Appendix). Especially younger users under 35 years used manual registration more than OCR, see Figure 2.7 below. This is possibly due to missing receipts, a lower degree of willingness and dedication to follow instructions, and/or lower consumption in smaller (single) households. We note that if we look at *product item level* 85 per cent was done by OCR, while manual registration accounts for the remaining 15 per

cent of registered product items, see Figure 2.8 in the Appendix. It may seem that respondents might choose the most efficient method for their purchases, OCR for long receipts and manual registration for shorter ones.

Figure 2.7 OCR vs manual data entry for receipts by age of contact person (per cent)



Source: The Household budget survey 2022, Statistics Norway

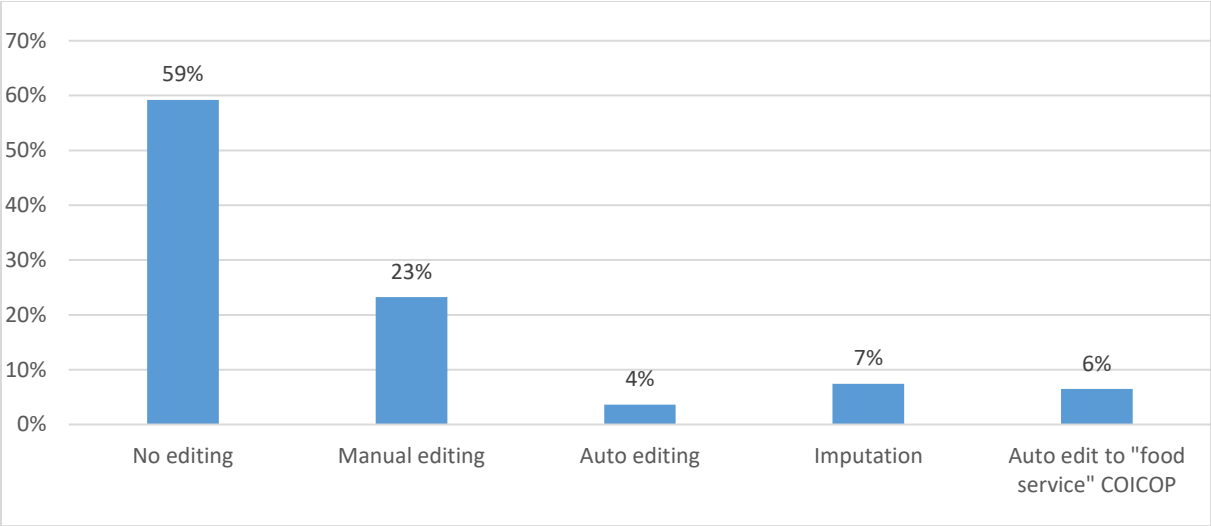
Volume of editing

Data editing is defined as the process involving the review and adjustment of collected survey data. The purpose is to control the quality of the collected data.[7] Data editing can be performed in-app or in house. It can be done automatically or manually, or a combination of both.[8] Manual editing in-app is typically performed by the user, whereas in-house editing is conducted by the surveyor or institute.

In the HBS 2022, receipts were automatically selected for editing if there were errors in one or more of the product item lines on the receipt, or if the total sum was incorrect. As shown in figure 2.9 below, more than 40 per cent of the receipts have been processed through an editing application. Of the 18 000 receipts that were edited, the scanned receipts made up the majority. Manually entered receipts accounted for approximately 17 per cent.

[7] Data editing | UNESCO UIS.
[8] Statistics Canada.

Figure 2.9 Registered receipts categorized by status of editing (per cent)



Source: The Household budget survey 2022, Statistics Norway

The receipts were categorized in the five following editing statuses:

- **No edit**: 59 per cent of the receipts were automatically approved and sent further in the production process. A few of them have errors and omissions, but the majority are of good quality.
- **Manual edit**: A total of 23 per cent of the receipts have been through the editing application and have been manually edited.
- **Auto edit:** The editing application automatically corrected 4 per cent of the receipts.
- **Impute**: 7 per cent of the receipts have imputed values. Over 90 per cent of these receipts are entered manually in the PWA. Respondents have written generic words in a single product item line, e.g. "groceries", "vegetables", "food", or lists: "bread, milk, beer, snuff, sweets", "toilet paper and dinner". In these cases, we have imputed values based on purchases from similar households. The imputation process is not described here.
- **Auto food service**: The editing application automatically assigned COICOP "food service", based on the name of the shop or restaurant the registration comes from, to 6 per cent of the receipts, e.g, if McDonalds is in the store name, the receipt automatically ends up in COICOP category "11.1.1.2 Restaurants, cafés and the like – with limited service".

Why edit receipts in the HBS 2022?

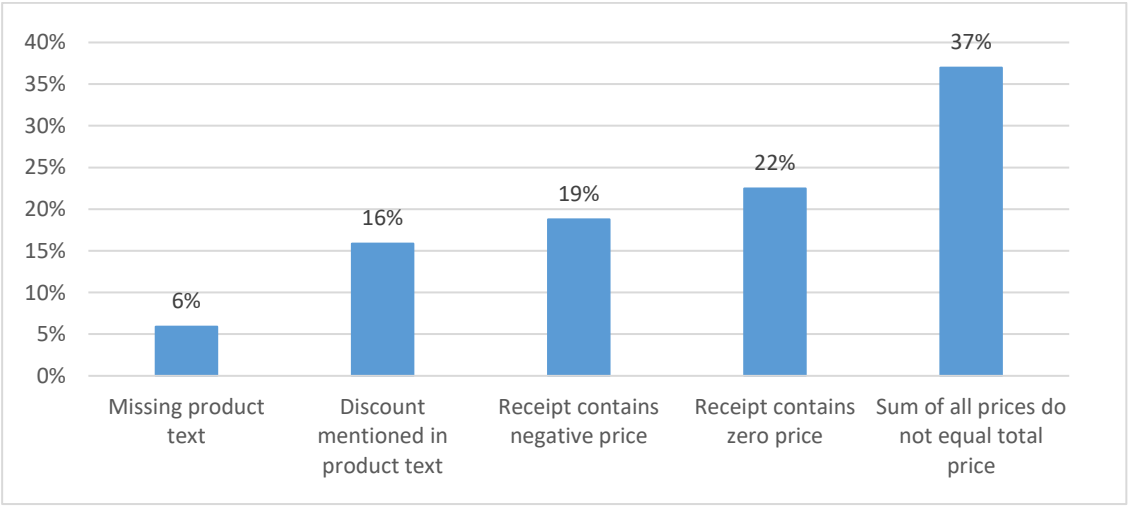
During the review of the receipts, these were the main causes why the receipts were selected for editing:

- Product item text is missing completely or has fewer than three letters.

- Registration of several products in one product line, e.g. receipts where the respondent has written generic words, such as “groceries”, or several items in one line such as “milk, bread, jam, apples”.
- “Discount” is mentioned in product text. The receipt has text indicating that there is a discount. Receipts with a discount are very often recorded incorrectly. Since discounts can often be calculated on the total sum of a receipt, requiring respondents to correct this can significantly increase the response burden.
- Negative value in at least one item line in a receipt, e. g. a discount. Sometimes this it is correct, for example, the product item line is a bottle deposit return or other return, but very often negative values are caused by incorrect OCR or manual data entry.
- Zero price in at least one of the prices in a receipt. Zero prices are very often because of incorrect registration. Sometimes it is legitimate, if they have used coupons or equivalent, but it is very rare in our data.
- Sum of all prices in a receipt do not equal total price on the receipt (prices multiplied with weight/quantity). If the sum of all prices multiplied by quantity or weight is not within ± 2 per cent of the total amount on the registration/receipt, it was automatically sent for editing.

There are differences between OCR and manual data entry when it comes to reasons for editing. As shown in figure 2.10, the main problem with OCR receipts is that the sum of all product prices does not equal the total price on the receipt. It may be poor image quality or that the OCR does not understand the calculation of for example price per kilogram or quantity, discounts, or a bottle deposit return. A large proportion of the receipts also contains zero or negative prices.

Figure 2.10 Types of errors in OCR receipts. Per cent of the total number of errors



Source: The Household budget survey 2022, Statistics Norway

When it comes to manual data entry, the big problem is cases of several products being registered in one line e.g. “groceries” or a list of products like e.g. "butter, milk, jam, juice ". 98 per cent of all errors in manual data entry were due to this problem.

Perception of accuracy

We have shown that there were obvious simplifications in the data recorded by the respondents. We have no quantitative measures of omissions or underreporting of expenses, but most of the participants in the qualitative evaluation interviews said that their data entries reflect their consumption patterns. This was influenced first of all by their perceived effort and diligence involved in reporting. Admitted inaccuracies mostly related to missing receipts, omission of smaller expenses for other household members, small purchases (through other channels than stores/services), and multiple purchase items bundled into one sum when recording manually. Respondents would justify imprecise reporting when receipts were missing (which often meant forgotten), receipts were too detailed/long to record, or if purchase recorded matched respondent’s typical or habitual expenses.

3. Learnings and future directions

The integration of smart features in survey processes is aimed at modernizing the data collection process, enhancing data quality, and improving the efficiency of the process, as well as reducing the response burden for participants. Our analysis reveals that smart surveys and smart features also can present challenges, particularly in user engagement and, more surprisingly, data accuracy.

Participation

For most participants, the survey format and the web application were well-received. The web app improved accessibility, reduced the experienced response burden, and did not reduce engagement. Still, we see a significantly lower response rate than 10 years ago and in other less demanding surveys today, mainly due to the perception that the survey task is too demanding. It seems motivation or indulgence to engage is lower today, even though the registration period and web questionnaire is reduced.

Regarding the use of smart features, we note a gap among respondents. From the age of retirement and especially adults aged 80 and older, and for the segment with lower education, lower digital engagement is impacting participation rates and sample bias. These groups were less technically skilled and reluctant to use mobile and open hyperlinks to launch the PWA. And they struggled more often with interactive elements and OCR and were more likely to

encounter technical issues. Smart features for many in these groups seemed more a dropout reason than an ease of response burden.

Trust

Concerns regarding trust and data security were minimal and did not significantly influence the average participants' willingness to engage with the smart survey. Most participants recognized SSB's compliance with privacy laws, and trust was as strong as it is for other of our surveys. Yet, we do not know the attitudes of potentially more critical citizens refusing to take part in the survey. However, with the increasing societal awareness of privacy and online security, it is crucial that SSB continuously builds trust through maintaining a secure login solution and clear communication about privacy and data use when moving forward.

Data accuracy and quality

Respondents' registration of expenses - whether by OCR or manual registration - was prone to errors necessitating substantial in-house editing to reduce errors. Respondents' manual entries failed to capture the granularity that OCR could achieve automatically. OCR on the other hand, despite the use of machine learning, had specific errors in image interpretation that required substantial in-house editing. As such, both methods leave data accuracy and the need for data editing at a far from desirable level.

In the qualitative evaluation interviews participants said they recorded meticulously and believed their recordings gave an accurate picture of their expenses and economy. Our editing need indicates that respondent's accuracy is not as good as desired. And based on our findings and observations, we fear that the HBS underestimates household expenses. More analysis is needed to assess this. Enhancing user-friendliness usually also improves data accuracy, but in our case regarding editing, user-friendliness and data accuracy appear to be conflicting concerns. In developing our PWA we prioritized user-friendliness over the need for accurate data. We had hoped to use more advanced automatization in-app, in terms of push notifications and an evolving search word list improved by machine learning during data collection, than what we managed to achieve. We were hesitant to rely on in-app editing by respondents, as we did not want to add to the respondent's survey task and risk dropout. Looking ahead, we need to assess and balance our option in advancing smart features and use of machine learning and level of human intervention - both in-app and in-house.

Conclusion

The learnings gained from the HBS 2022 have highlighted the value of tailored recruitment strategies and the ability to use interviewers to address and alleviate concerns, thereby

legitimizing the survey process and helping respondents complete the survey. Moving forward it is crucial to continue working on our recruitment strategies, improving survey communication and support, refining the PWA with improved OCR, push notifications, and smart search features to better engage all segments of society, also elderly and persons with a low level of education. Additionally, we need enhancing OCR reading, data processing, and machine learning models to improve operational efficiency and data quality in future smart surveys such as the HBS.

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Appendix A: Description and illustration of SSB's HBS app

The HBS 2022 app is a Progressive Web App (PWA), accessible via a web browser link on mobile phones, tablets, or PCs. Users can easily add the app to their device's home screen, making it highly accessible.

SSB opted for a PWA to simplify access; users can launch the app with a single tap and authenticate using ID-porten or BankID, Norway's national login solutions for public online services. This approach eliminates the need to download the app from the Apple Store or Google Play, addressing concerns some users had about app installations. A PWA solution allowed users to select preferred device, or switch between devices.

A key innovation in the HBS app is the inclusion of an Optical Character Recognition (OCR) feature, which allows the automatic optical reading of receipts via a mobile phone or tablet camera. This smart function is designed to reduce the response burden by streamlining data entry. However, it requires a "smart" device equipped with a camera. While users without such devices can still participate by manually entering data or transferring scanned receipts from a camera-enabled device to a PC, this workaround approach detracts from the intended convenience of the technology.

To effectively reduce the response burden, users are encouraged to utilize the OCR option in the app. However, this requires keeping receipts, a practice that is becoming increasingly uncommon in Norway. Despite this trend, the convenience offered by the OCR feature is expected to motivate respondents to retain their receipts, particularly for longer grocery receipts. For purchases involving fewer items, manual registration remains a user-friendly alternative.

Concerning privacy, respondents have the option to obscure sensitive information on receipts before scanning them by using white-out physically or editing the images in their mobile's photo archive. Extensive testing revealed that users expect a seamless "scan & go" experience with minimal need for review or editing. Consequently, we prioritized simplicity and user-friendliness in the app's design by limiting editing requirements and omitting tools for cropping or editing. Therefore, the app neither requires nor facilitates editing tasks. However, respondents who prefer to maintain greater control over their privacy can choose to manually enter data, allowing them to decide what information to include or omit.

Below we illustrate the PWA used for HBS 2022 in screen shots and videos of workflow.

Screen shots of web application:

Figure A 1 Home screen HBS-app

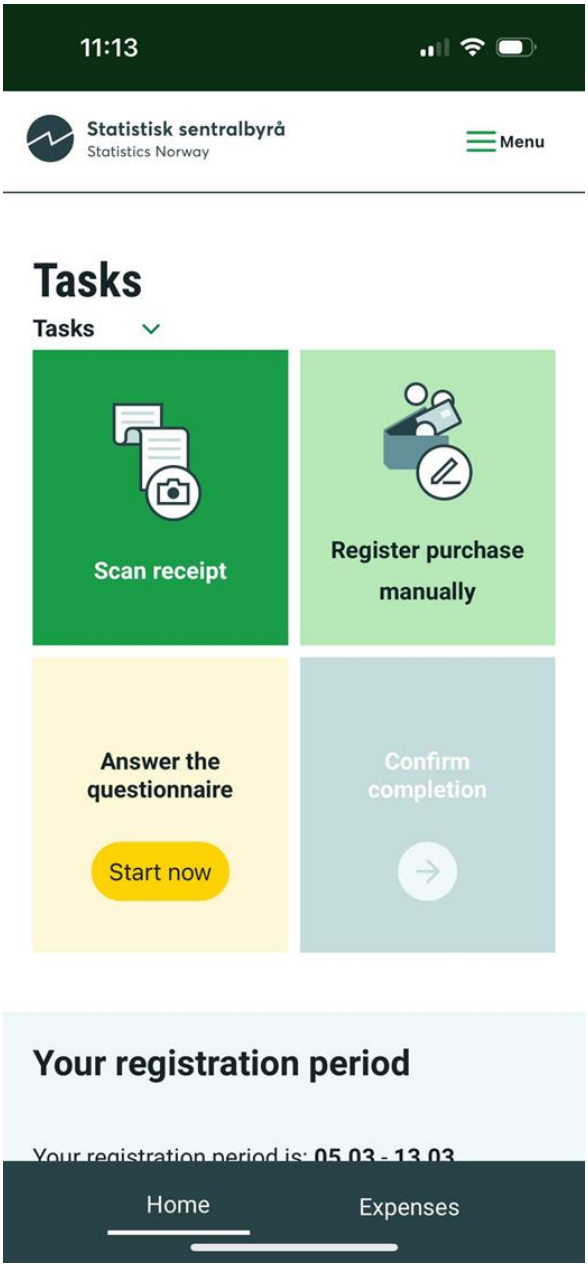


Figure A 2 Open app (PWA) in an internet browser and add to start screen (like a native app)

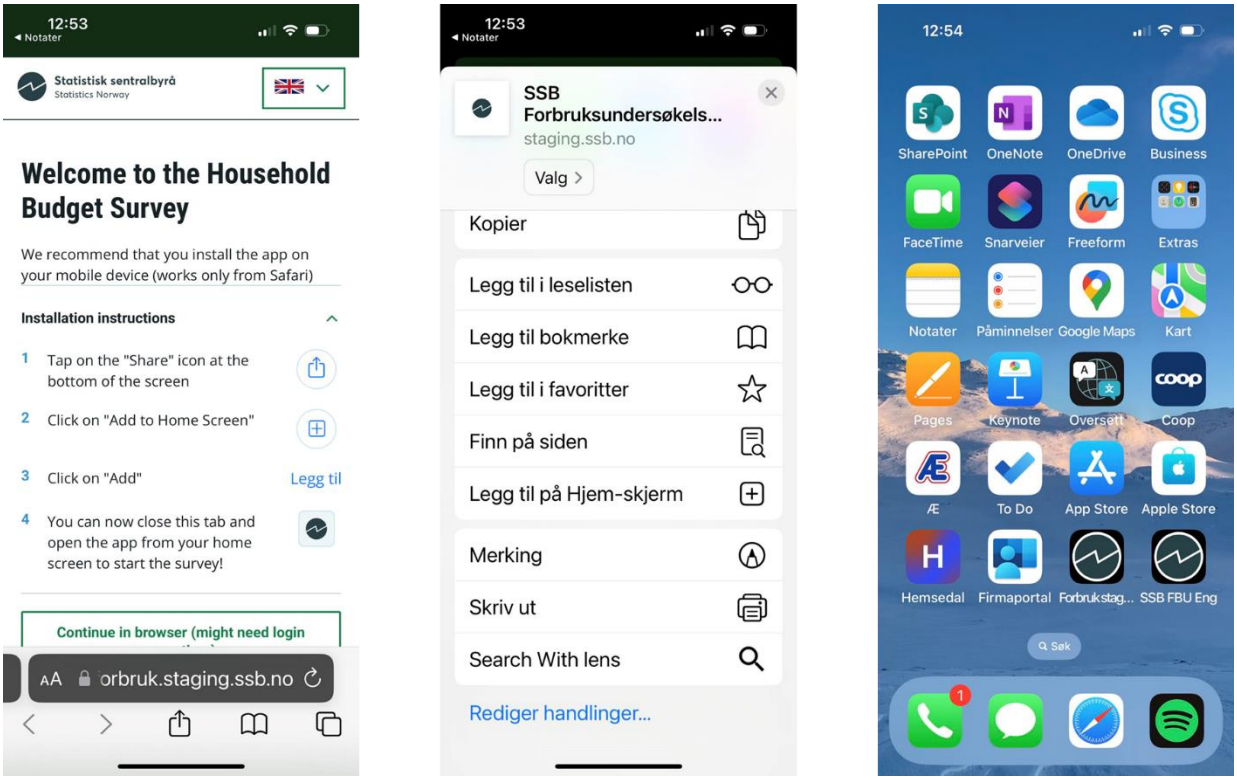


Figure A 3 Login once with the national ID-porten for secure login

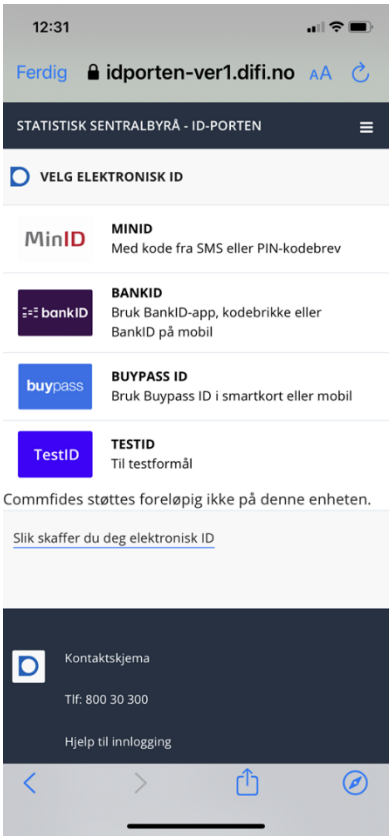


Figure A 4 Onboarding or "get started" instructions with consent

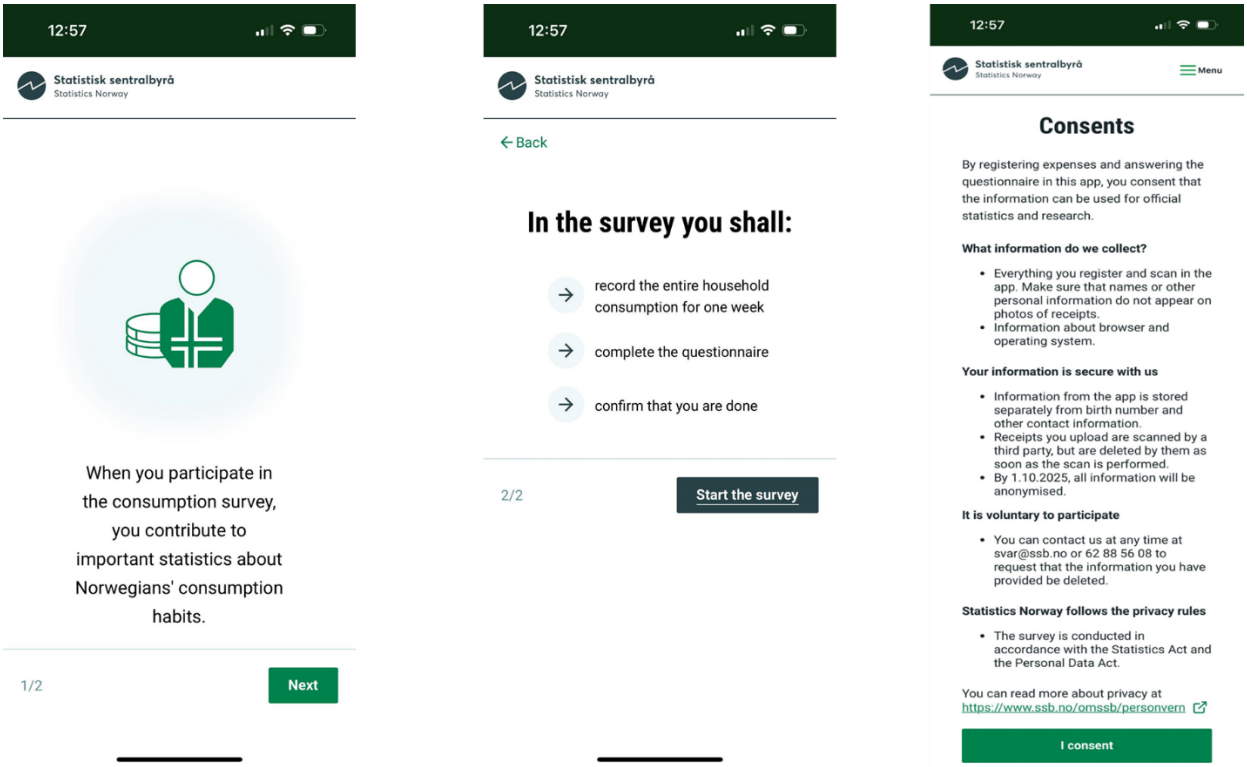


Figure A 5 Popup tutorial when respondent login (one time – can be found under Help later)

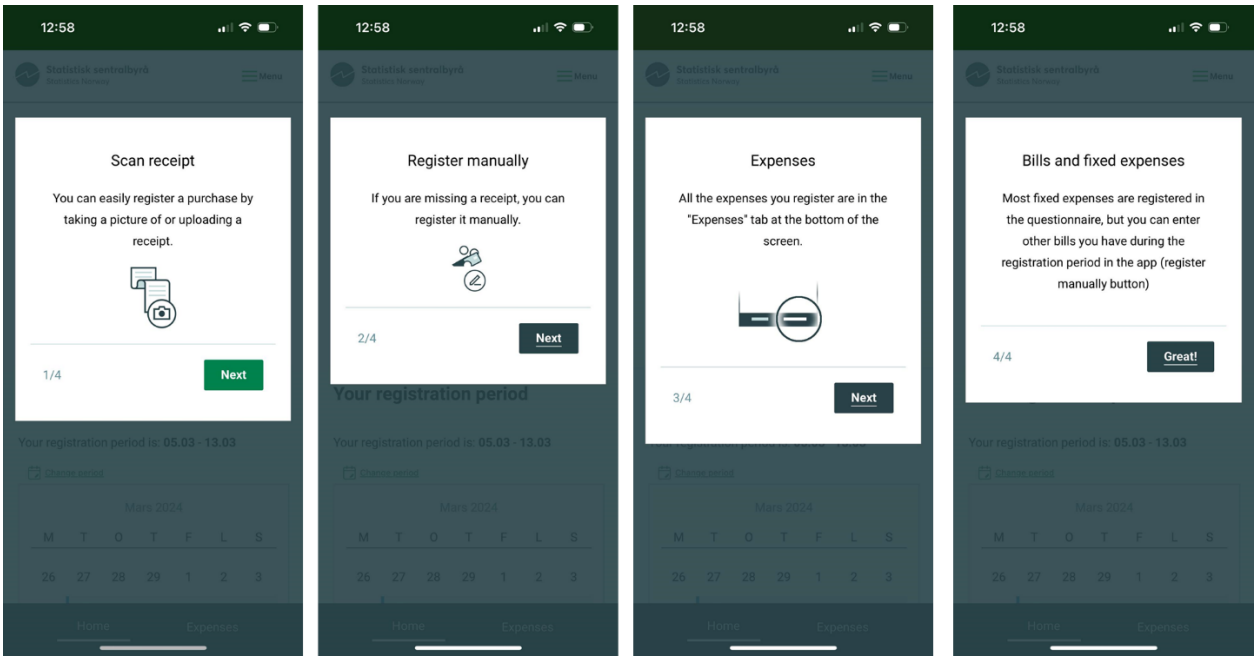


Figure A 6 Home screen with and without drop-down menus open for task and for calendar

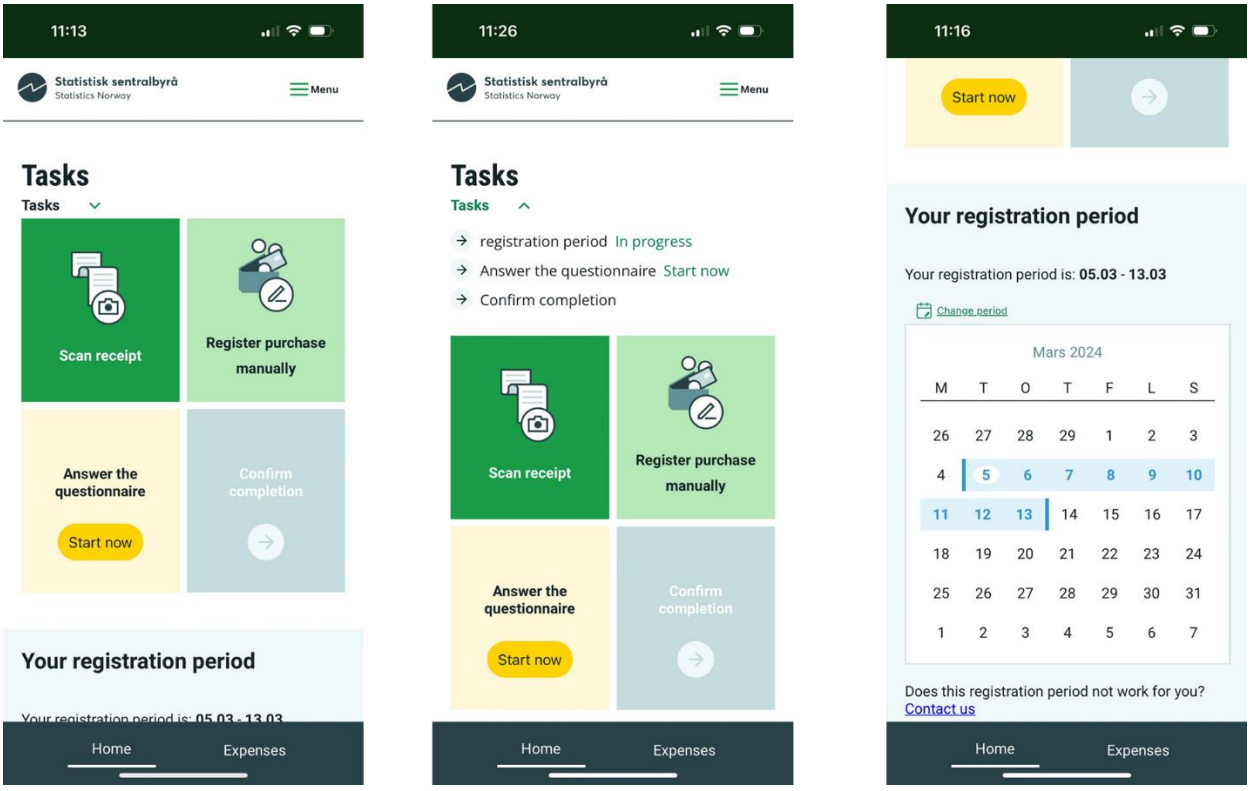


Figure A 7 Receipt scanning

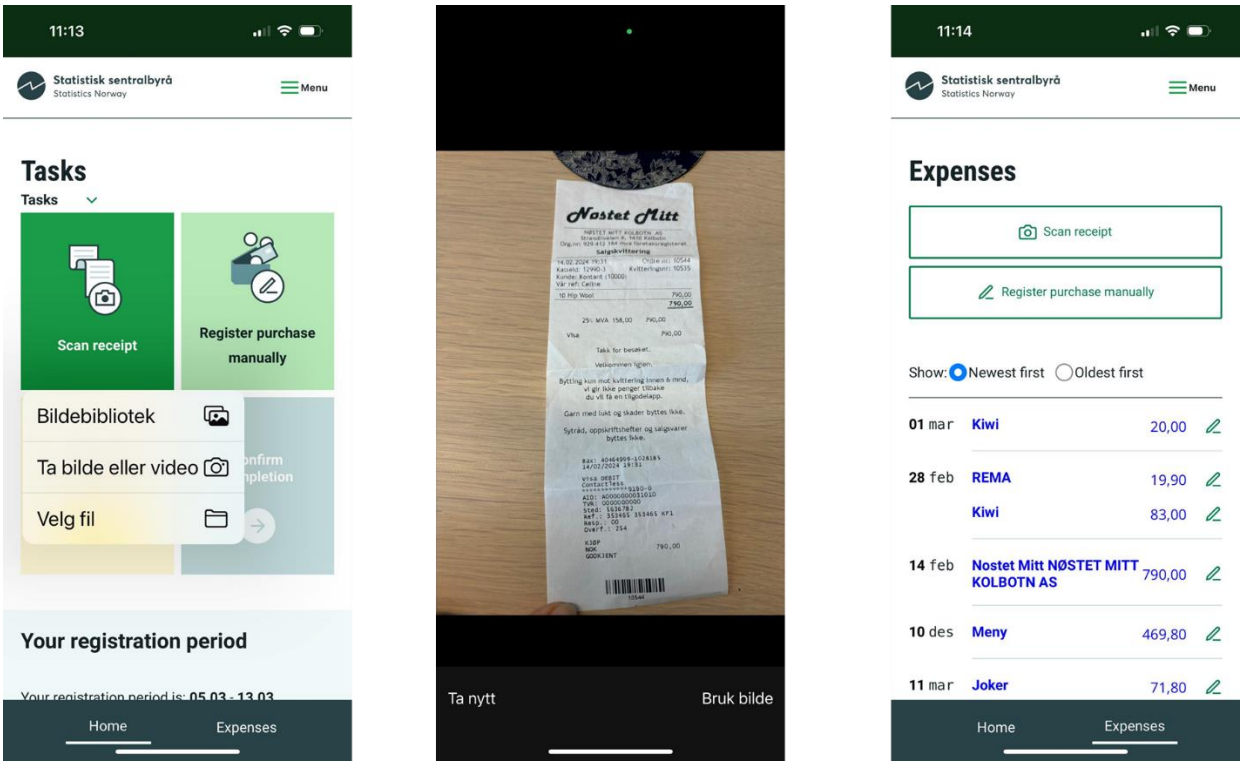


Figure A 8 Manual registration of purchase, part 1

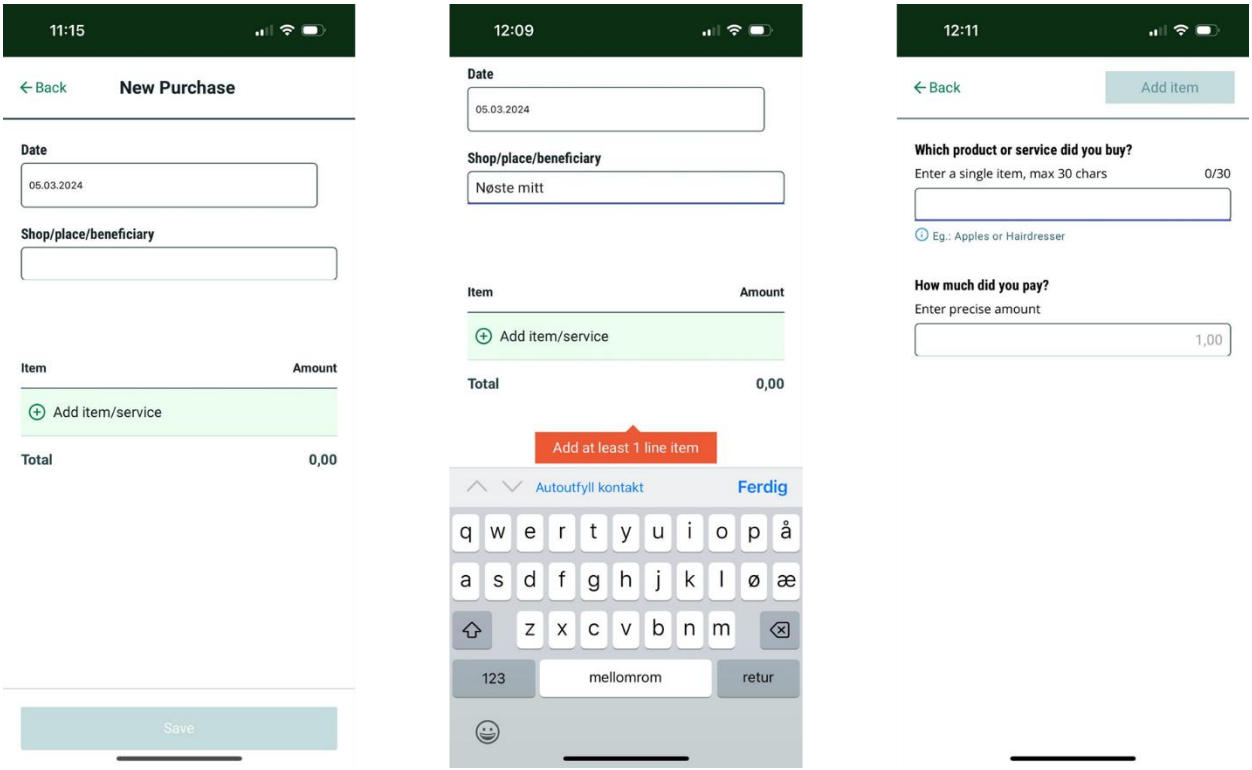


Figure A 9 Manual registration of purchase, part 2

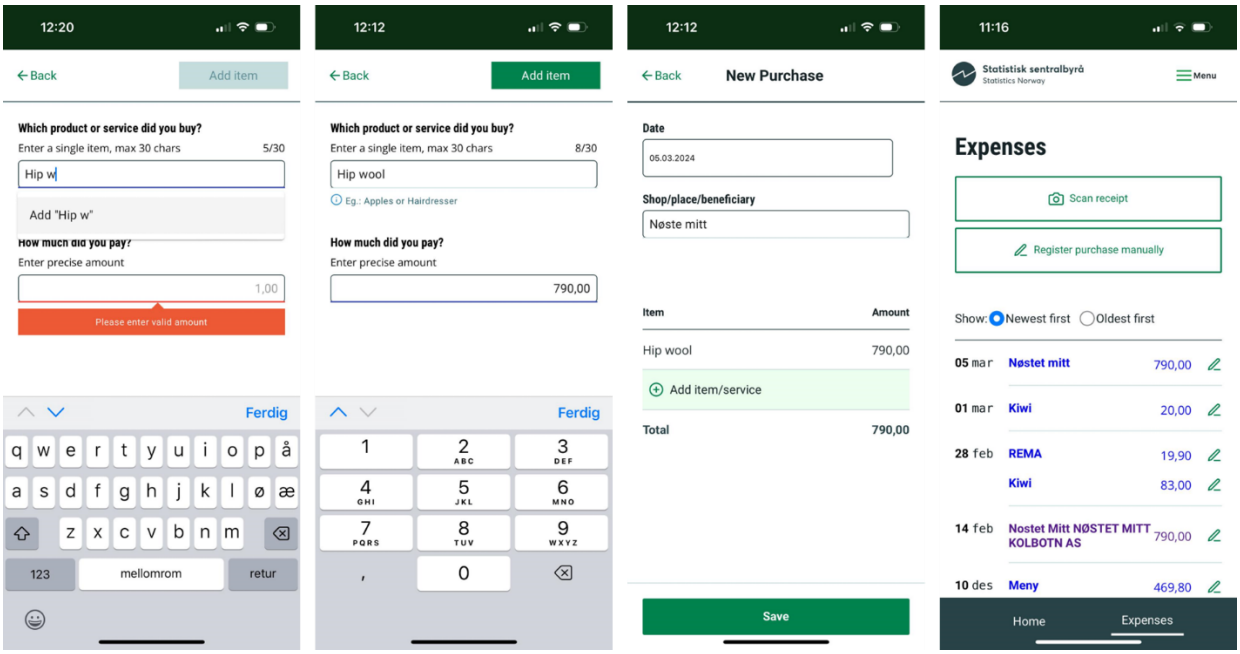


Figure A 10 Optional edit of OCR vs. manual registration screen

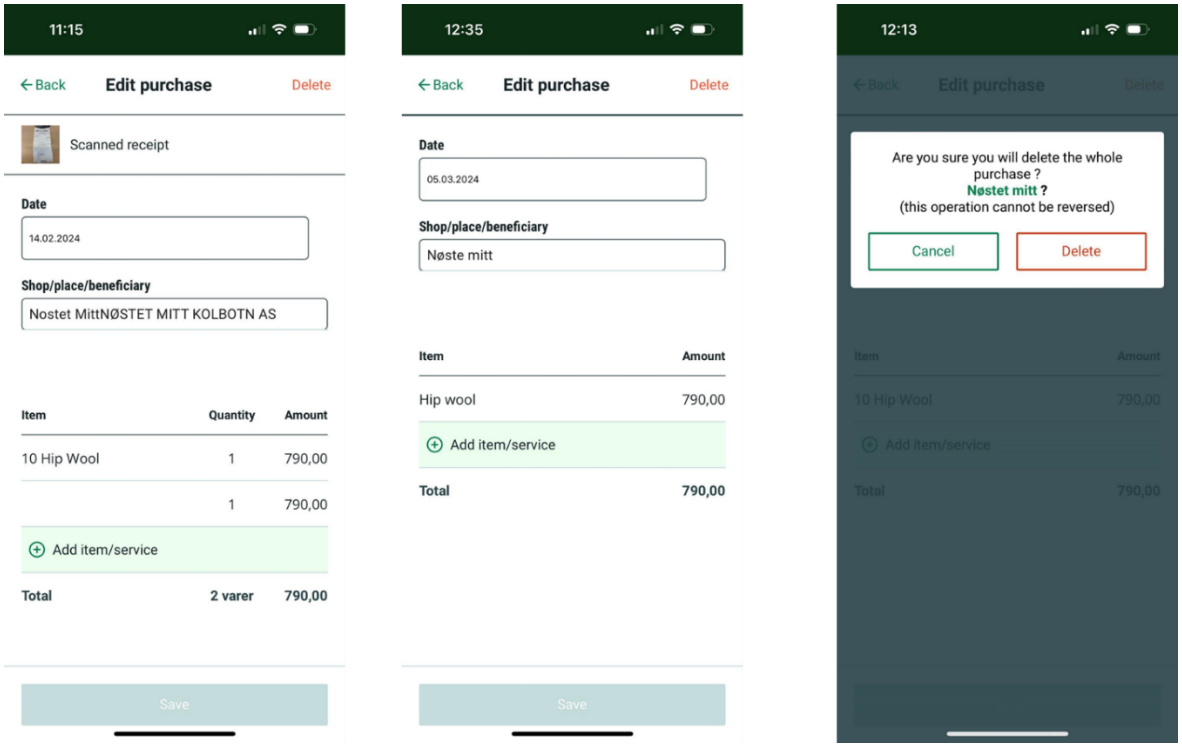


Figure A 11 Overview of registered expenses

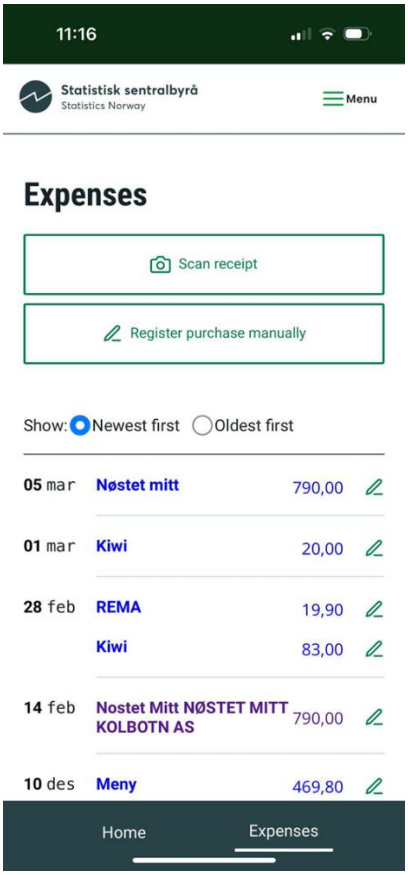


Figure A 12 Intro text for the questionnaire section of the app

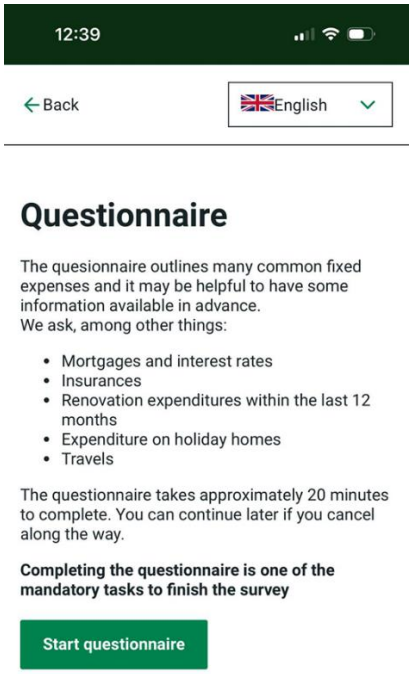
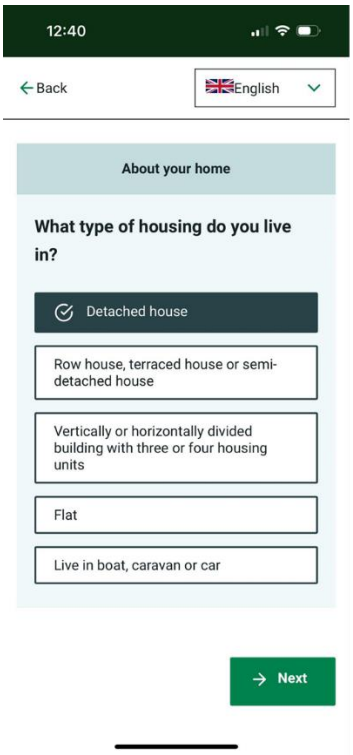
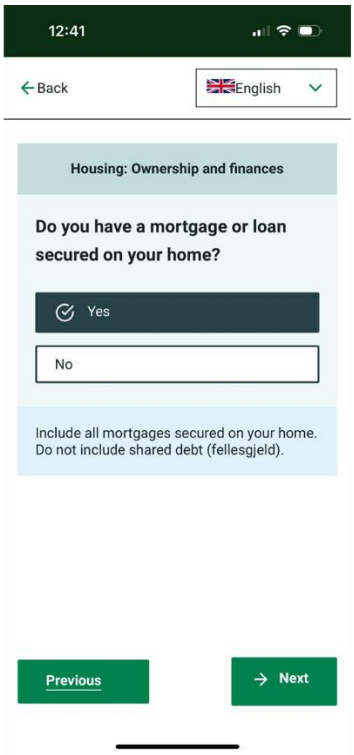
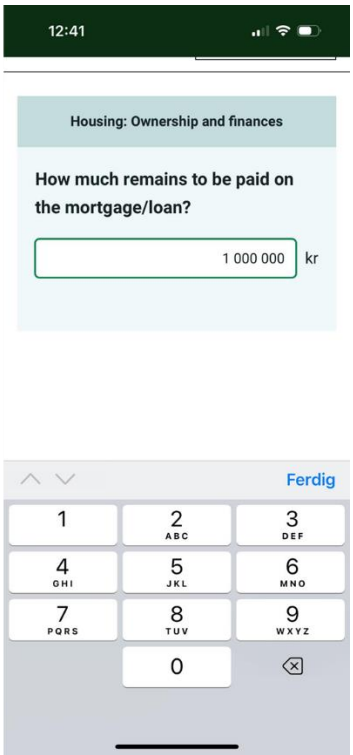


Figure A 13 The layout of random questions in the questionnaire section of the app







Appendix B: Screen videos of workflow

4. Login:
   Test login & onboarding

5. Receipt that will clear in the OCR:
   Receipt (clear) Rema1000 (groceries)
   Scanning Rema1000 (clear) video
   Manual reg McDonalds video

6. Receipt that need editing due to incorrect # of prod items due to discount:
   Receipt (edit) Kiwi (groceries)
   Scanning Kiwi (edit) video
   Editing Kiwi (edit) video

7. Find Expense overview:
   Expense overview screen
   Find Expense overview

Appendix C: Population and gross sample

The target population in the Household budget survey, is all private (cost) households in Norway. A household includes all persons who are permanently resident at the same address and who have a common food budget. Institutional residents are not included. The survey population was limited to households that contained at least one person born in the period 1938–2004.

The sample consists of 12 000 households, stratified in six types of households[9] as shown in table C.1. Some types of households, e.g. lone parents, are overestimated and some are underestimated, e.g. people living alone. During data collection, 95 households was defined as not eligible because the contact person was living in an institution, dead or immigrated. The gross sample is therefore 11 905 households.

Table C.1 Population and gross sample by type of household

	Population (November 1, 2023	Population per cent	Gross sample	Gross sample per cent
I alt	2 559 581	100,0	12 000	100,0
01 Living alone	1 060 732	41,4	2 600	21,7
02 Couples without resident children	525 547	20,5	2 200	18,3
03 Couples with small children (0–5 years)	224 082	8,8	1 900	15,8
04 Couples with older children (6–17 years)	264 298	10,3	2 000	16,7
05 Lone parent with children (0-17 years)	120 439	4,7	1 500	12,5
06 Other types of households	364 483	14,2	1 800	15,0

Source: The Household budget survey 2022, Statistics Norway

In each of the households, a contact person was chosen. For households consisting of two or more persons, the reference person was determined according to the following rules:

- In families with children living at home (single-family households), the reference person was chosen in different ways in the samples for the first and second half of the year.
    - In the first half of the year, the youngest parent was chosen as a reference person. Consequence: we got more female than male as reference persons. Exception: If both parents was above 70 years of age, the oldest child became a reference person.

[9] The sample is drawn from Statistics Norway's cost household register. In this register, households are classified in 23 categories. This classification was used to define six types of households, used in the stratification.

    - In the second half of the year, the reference person was chosen randomly among the parents. Exception: If only one parent was under 70 years old, the youngest was chosen, and if no one was under 70, the oldest child was selected.
- For couples without children living at home (single-family households), as well as multiple-family households, the reference person was chosen randomly among household members who were between 18 and 69 years of age. If no one in the household was under 70 years of age, the youngest person in the household became the reference person.

The sample was linked to the Contact and reservation register[10] for information on mobile phone numbers and email. In addition, another source was used to obtain even more telephone numbers, especially for the elderly. Tabel C.2 shows the percentage of households for which we found telephone numbers and emails, by the contact person's age. Those without an email, received information about the survey by mail. They were later asked about their email in the telephone interview.

Table C.2 Percentage with phone number and email, by contact persons' age (per cent)

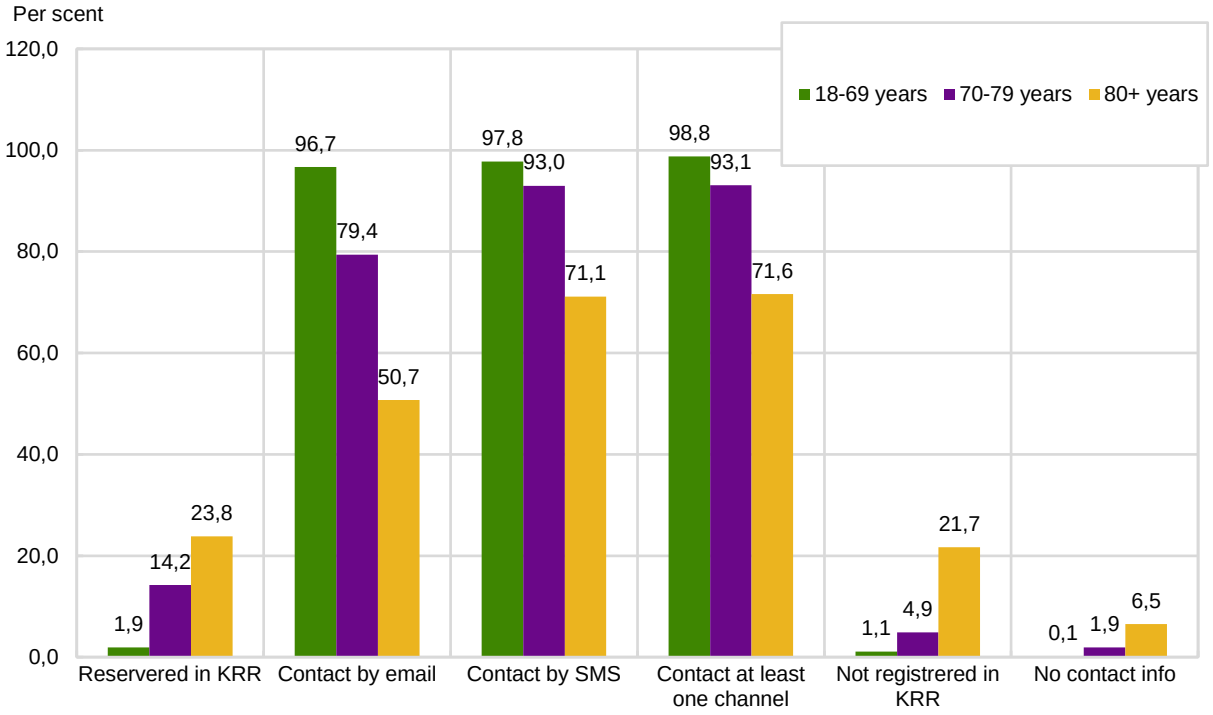
Age-group	Respondents with telephone	Respondents with email
18-24 years	96,7	96,7
25-34 years	98,4	95,9
35-44 years	98,2	95,8
45-66 years	97,9	94,9
67-79 years	95,7	80,7
80-84 years	90,1	50,4

Source: The Household budget survey 2022, Statistics Norway

[10] The Contact and Reservation Register is a register of citizens' digital contact information, and the status of citizens' reservations against digital communication with the public administration.

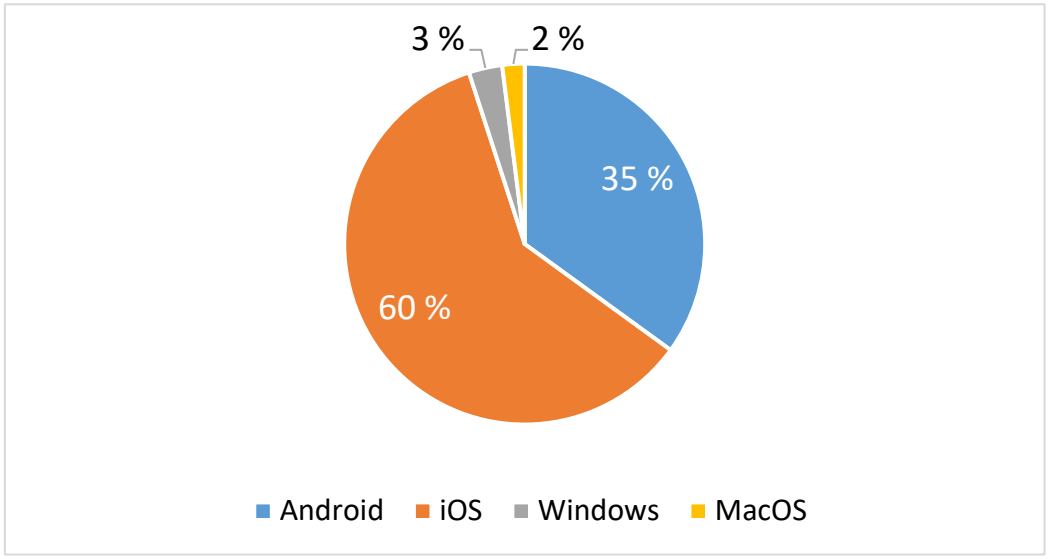
Figures

Figure 2.0 Share of contact from the national Contact and reservation register



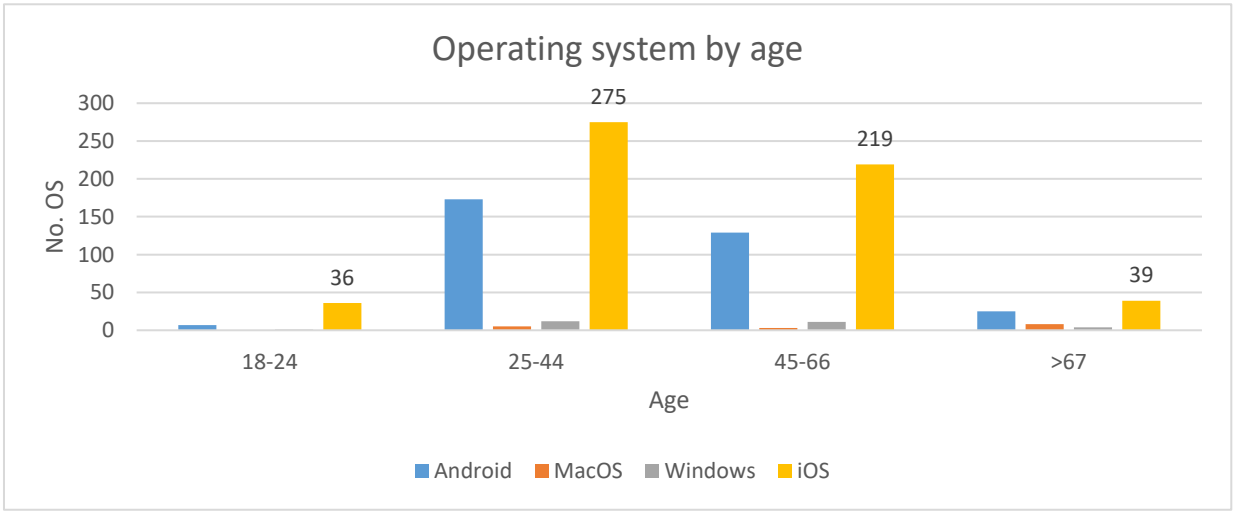
Source: The Quality of life survey 2023, Statistics Norway

Figure 2.1 Operating system used Q1/2022



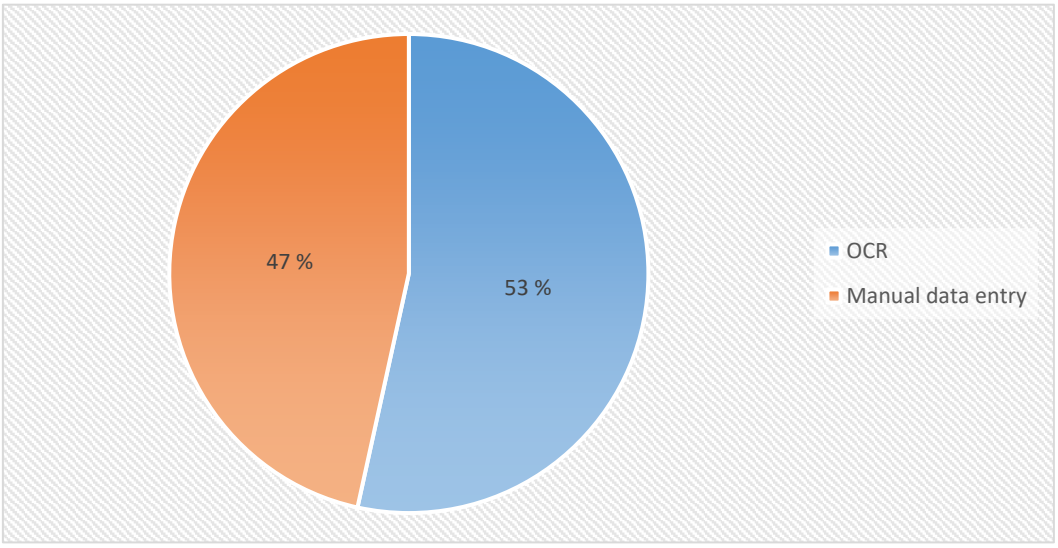
Source: The Household budget survey 2022, Statistics Norway

Figure 2.2 Operating system by age Q1/2022



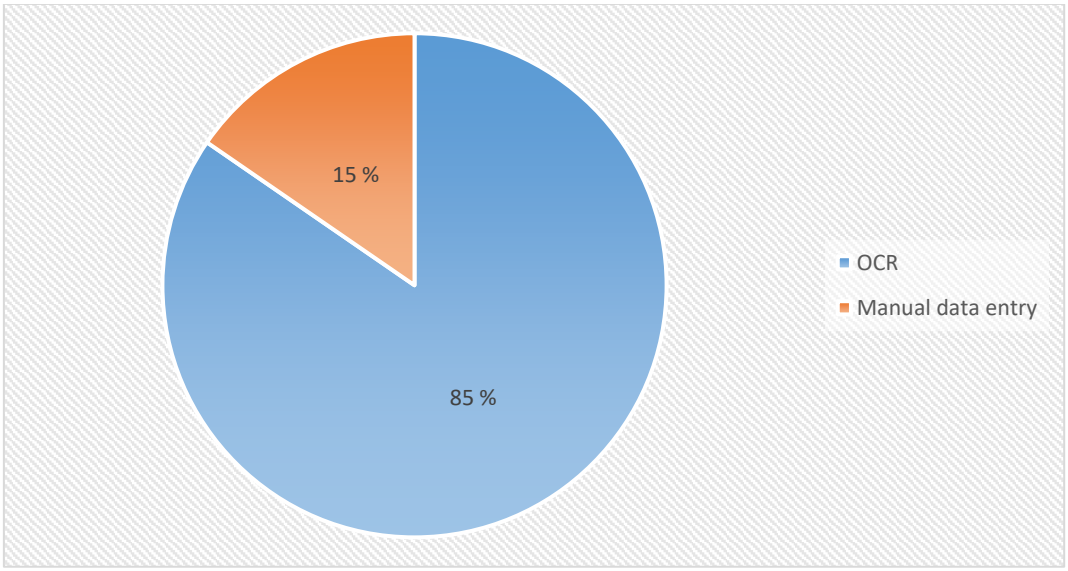
Source: The Household Budget Survey 2022, Statistics Norway

Figure 2.6 Share of registration method for receipts in total in per cent (N=44 595)



Source: The Household budget survey 2022, Statistics Norway

Figure 2.7 Share of registration method for product items in total in per cent (N=182 086)



Source: The Household budget survey 2022, Statistics Norway

Tables

Table 1.1 Differences in gross and net sample, by some demographic variables (per cent)

	Gross sample	Net sample	Difference
Total (N)	11 905	3 507	
Gender (contact person)			
Man	39,1	37,5	-1,6
Woman	60,9	62,5	1,6
Age-group (contact person)			
18-24 years	4,4	4,4	0,0
25-34 years	19,2	20,1	0,9
35-44 years	24,4	25,6	1,2
45-66 years	38,4	40,4	2,0
67-79 years	12,1	9,1	-3,0
80-84 years	1,5	0,3	-1,2
Type of household			
Living alone	21,6	19	-2,6
Lone parents with children	12,5	13,3	0,8
Couples with small children	15,9	16,4	0,5
Couples with older children	16,7	19,3	2,6
Couples without resident children	18,3	18,7	0,4
Other	14,8	13,3	-1,5
Unknown	0,1	0,0	-0,1
Level of education (contact person)			
Basis school level or lower	19,0	8,8	-10,2
Upper secondary education	36,6	33,6	-3,0
Higher education	39,8	55,8	16,0
Unknown	4,5	1,7	-2,8
Region (contact person)			
Oslo and Viken	36,7	37,4	0,7
Innlandet	6,8	6,3	-0,5
Agder and Sør-Østlandet	13,6	13,1	-0,5
Vestlandet	25,2	25,2	0,0
Trøndelag	8,8	9,5	0,7
Nord-Norge	8,9	8,6	-0,3

Source: The Household budget survey 2022, Statistics Norway

Table 2.3 Response rate and causes of non-response, by some demographic variables (per cent)

	Finished survey	Partial non-response	Refusal	Prevented	No contact	Other non-responses	N
Total	29,5	9,0 [11]	24,8	6,3	29,8	0,7	11905
Gender (contact person)							
Male	28,2	10,4	26,8	5,7	28,2	0,7	4659
Female	30,3	8,0	23,5	6,7	30,8	0,7	7246
Age-group (contact person)							
18-24 years	29,6	11,2	21,6	2,3	35,2	0,4	520
25-34 years	30,9	9,8	20,6	3,7	35,0	0,2	2284
35-44 years	30,9	11,2	21,7	4,1	31,6	0,5	2907
45-66 years	29,1	7,7	27,9	5,6	27,8	0,7	4566
67-79 years	22,1	4,2	34,5	15,2	23,6	2,4	1437
80 -85 years	6,0	4,1	28,6	32,2	21,3	5,8	183
Level of education (contact person)							
Basis school level or lower	13,6	9,7	27,0	9,4	39,3	1,0	2265
Upper secondary education	27,0	8,5	27,5	6,0	30,0	0,8	4363
Higher education	41,3	9,1	22,4	3,7	23,1	0,4	4740
Unknown level of education	11,0	9,0	14,7	18,5	46,5	0,4	536
Type of household							
Living alone	25,9	7,9	24,3	8,5	32,2	1,2	2575
Lone parent with children (0-17)	26,5	9,0	25,3	5,5	33,2	0,5	1490
Couple with small children (0-5)	31,3	10,3	21,5	4,6	31,9	0,4	1893
Couple with older children (6-17)	30,3	12,0	22,2	4,6	30,4	0,5	1993
Couple without resident children	34,0	10,0	24,4	4,0	27,2	0,3	2183
Other households	30,0	5,8	30,0	9,0	24,2	1,0	1757
Unknown type of household	7,	0,0	7,1	0,0	85,7	0,0	14
Region							
Oslo and Viken	30,0	9,8	24,8	6,3	28,3	0,8	4368
Innlandet	27,3	9,3	25,4	6,4	30,5	1,1	808
Agder og Sør-Østlandet	28,5	9,3	27,4	7,2	26,9	0,7	1614
Vestlandet	29,4	8,0	24,4	6,6	31,0	0,6	3000
Trøndelag	31,7	8,4	20,8	5,0	34,0	0,2	1050
Nord-Norge	28,2	8,2	25,2	5,4	32,3	0,8	1065

Source: The Household budget survey 2022, Statistics Norway

[11] This number (9,0) differs from the 13,8 per cent partial non-response in table 2,1. The reason for this is that some of those who were recruited and who later dropped out of the survey, have later been coded to refusal or prevented from participating. The 9 percent listed here are those who still have the "recruited" or “started” status code.

List of figures

List of tables