Exploring digital security and privacy in relative poverty in Germany through qualitative interviews

Anastassija Kostan
Paderborn University

Sara Olschar
Paderborn University

Lucy Simko
The George Washington University

Yasemin Acar
Paderborn University &
The George Washington University

Abstract

When developing security and privacy policy, technical solutions, and research for end users, assumptions about end users' financial means and technology use situations often fail to take users' income status into account. This means that the status quo may marginalize those affected by poverty in security and privacy, and exacerbate inequalities. To enable more equitable security and privacy for all, it is crucial to understand the overall situation of low income users, their security and privacy concerns, perceptions, behaviors, and challenges. In this paper, we report on a semi-structured, in-depth interview study with low income users living in Germany ($n = 28$) which we understand as a case study for the growing number of low income users in global north countries. We find that low income end users may be literate regarding technology use and possess solid basic knowledge about security and privacy, and generally show awareness of security and privacy threats and risks. Despite these resources, we also find that low income users are driven to poor security and privacy practices like using an untrusted cloud due to little storage space, and relying on old, broken, or used hardware. Additionally we find the mindset of a—potentially false—sense of security and privacy because through attacking them, there is "not much to get". Based on our findings, we discuss how the security and privacy community can expand comprehension about diverse end users, increase awareness and design for the specific situation of low income users, and should take more vulnerable groups into account.

1 Introduction

Poverty has been increasing wordwide during the past decades and is divided in two categories: *Extreme poverty* defines an income so low that it is impossible for the person or family to meet basic needs of life including food, shelter, safe drinking water, education, and healthcare. *Relative poverty* defines a household income that is below 60% of the median household income of a state or country, leading relatively poor people to struggle with all sorts of social marginalization [1], where technology use and security and privacy issues are not exempt.

Extremely valuable work by Redmiles et al. has shown that, statistically, low-income populations in the US do not experience *more* theft of personal information, account compromise, non-consensual posting of information, and scamming [2]. However, other aspects of security and privacy—which may be more difficult to study in a census-representative survey such as [2]—may affect low-income users differently, and inequitably. For example, consider the pay-for-privacy business model [3]. While many popular technologies have free versions, some offer better privacy to those who pay (e.g., offering an ad-free version), and others are entirely unavailable without payment (e.g., a paid VPN service). Paying for privacy presents a barrier to security and privacy to those in relative and extreme poverty.

The pay-for-privacy model [3] is not the only reason to consider the effect of poverty on users' security and privacy needs and experiences: prior work has shown that those accessing technology through intermediaries, or using shared technologies—factors which can coexist with poverty—directly face barriers to security and privacy specifically because of their technical practices, which are, in some cases, enforced by their economic situations [4]. This body of literature examines the security and privacy experiences, needs, and barriers of vulnerable or marginalized populations—many (but not all) of whom can experience poverty, e.g., refugees, sex workers [5, 6].

While the lack of resources is a theme in prior work about vulnerable populations, and appears as a factor (direct or indirect) that contributes to vulnerability, there is little work in our field with poverty itself as a primary focus [2], though some have found that certain demographic factors that tend to *correlate* with poverty (such as education) affect security and privacy needs, experiences, and mental models [7, 8].

We observe, thus, that there are many valuable studies that study security and privacy for people who experience poverty, but do not engage *directly* with the idea of poverty as a potential factor in vulnerability. In this paper, we begin to fill

this gap, by directly examining the effects of poverty on one's security and privacy technology use and threat model. In contrast to the valuable body of work about users in *extreme* poverty in the global south (e.g., [4, 9]), we focus on users in *relative* poverty in Germany in order to form a basis for understanding how income and security and privacy relate to each other in a rich country in the global north. We explore threat models and technology use in order to understand how those in poverty define security and privacy, and then to elicit technical and societal barriers to security and privacy. By focusing directly on poverty, we shed light on security and privacy related challenges of the growing number of people living in relative poverty in global north countries where more and more public and private services have moved online [10, 11], especially since during the pandemic internet use has become increasingly important to the population [12, 13], which reinforces income related divides that represent an important realm of social inequality [14, 15, 16].

We address the following research questions:

- **RQ1:** What security and privacy actions and practices do people living in relative poverty in Germany employ in their everyday lives?
- **RQ2:** What is important to them in the context of digital security and privacy?
- **RQ3:** What technology and assets do they use and/or seek to protect?

Through 28 in-depth interviews with relatively poor users in Germany, we find that they generally have a high level of security and privacy awareness—in line with Redmiles et al [2]—but they lack suitable instruments to protect themselves better, especially when it comes to resources like time, money to purchase state of the art hardware, and protective software, as well as resources to gain more specific knowledge about security and privacy. We find, for example, that users in relative poverty use technologies that cost less (e.g. second-hand phones, free cloud storage services) despite either having security and privacy concerns (e.g., about data privacy properties of free storage) or despite the practices putting them, objectively, at risk (e.g., use of second-hand devices that have not been sanitized properly [17, 18]).

We also emphasize that *poverty cannot be solved with technology:* there are underlying power and social structures that enforce generational or situational poverty; technology, even perfectly secure and usable technology, cannot solve these issues. However, we, as computer security researchers, have the obligation to ensure that our community produces technology that equitably distributes security and privacy, and we know, from our work and from prior work, that misalignments in technical design are inequitably distributed, often in ways that align with other forms of societal oppression. We have positioned this paper for the technical computer security community in order to show how many current technical designs

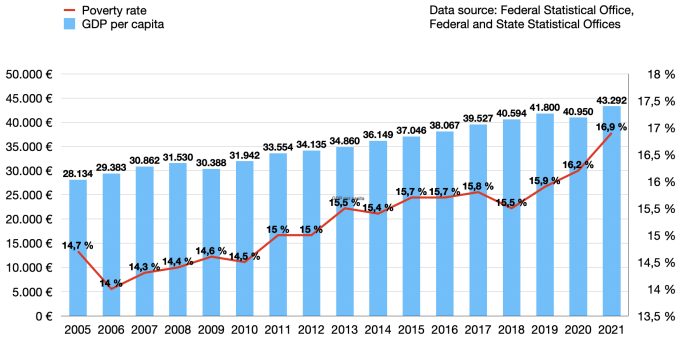

Figure 1: Poverty Rate - GDP per capita.[1]

[1]Retrieved from "Paritätische Gesamtverband", modified in color and format: https://www.der-paritaetische.de/themen/sozial-und-europapolitik/armut-und-grundsicherung/armutsbericht-2022-aktualisiert/#gallery-14783-1, accessed on April 4th, 2023 [25].

and paradigms present systematic barriers to security and privacy for people experiencing poverty, and to encourage this community to adapt to equitably serve people experiencing poverty. We do *not* mean to presuppose that people in poverty *should* be using technology, nor that technology will solve a sociological issue, and we emphasize that in *addition* to ensuring that technical designs align with poor people's needs, we must also advocate for other, non technical changes (e.g., policy changes) in order to address poverty itself.

2 Background

With its important low-wage-industry,[1] Germany is a prime example for the economies of western countries [21], characterized by labor market stratification [22], and increasingly deregulated welfare state policies and institutions [23]. Like other countries in the global north, Germany has a constant gain in poverty although economic performance and the GDP are continuously growing [24], as the latest poverty report indicates (see Fig. 1). The poverty report is published annually by an association of social movements (Paritätischer Gesamtverband) and is based on data from the micro census, which is collected annually by the Federal Statistical Office (Destatis) [26]. According to the poverty report, people are considered "poor" if their income is less than 60 percent of the median income of the country. For a single person living in Germany, this means a yearly income of about 15,000€; for a family composed of two adults and two children, the poverty rate limit is set at 31,500€ [1]. Of the approximately 84,3 million people living in Germany, 14,1 million are considered "poor"; they make up 16,9% of the whole population [27].

[1]More than one in five employees in Germany has a gross hourly wage of less than 11.40 Euros. No other European country with a comparable level of economic development has a low-wage sector that large and persistent: Between 1995 and 2020, the ten percent of the lowest incomes only increased by four percent, while the top ten percent achieved an increase of 50 percent [19, 20].

With some differences regarding the specifics in socioeconomic structure, we argue that overall Germany can be seen as an illustrative case for other countries in the global north, characterized by a strong economy combined with an increasing poverty rate where the population overall has access to technology and the internet, but a growing number of technology users face challenges associated with low income. People affected by poverty generally face barriers and challenges regarding technology and internet access [28]. They also benefit much less from internet use than affluent people [29].

3 Related Work

In this section, we discuss related work in three areas: income status and technology in general, low income in relation to digital security and privacy, and security and privacy behavior, attitudes, and threat models associated with low income.

As early as 2001, Pippa Norris described the entanglement of social, political, and digital inequalities between affluent technology users and users affected by poverty, both within distinct state populations as well as on a global scale [30]. Due to an overall increase in technological penetration and availability across the world [31], questions of technology and internet access are still important but the divide between the rich and poor now takes up plural dimensions that also fuel the interdependence between digital security and inequality [32].

A lot of insightful and valuable research focuses on technology related inequalities in the global south, describing how global digital disparities and access inequalities play out in Bangladesh [33], Georgia [34], the Arab world [35], Mexico [36, 37], Brazil [38], and many other countries. But in countries of the global north like the USA, South Korea [39], UK [40], Italy [41], Canada [42], Japan [43], and Germany [44], income related inequalities are also found to be constantly increasing [45]. These also affect and enforce already present inequalities between genders, age groups, and people living in different geographic locations [46].

Users of low income not only possess less powerful devices but also employ technology and use the internet in ways that give them significantly less financial and social advantages than users of higher income. For example, lower income individuals were shown to be more dependent on their smartphones, to have limited internet access, and to perform less news and information activity than higher income users [47].

Low Income, Security and Privacy: The security and privacy community has increasingly focused on understanding how marginalized and vulnerable populations experience security and privacy, deemed *inclusive security and privacy* [48, 49]. Prior work has focused on the technical use, non-use, needs, mental models, and issues faced by refugees in the US [6], undocumented migrants [50], survivor-victims of trafficking [51], and sex workers [5]—with nuanced findings specific to each group studied, as well as an overall sense that technology and security and privacy in particular do not often fit the needs of marginalized groups [52]. Others have explored the relationships of caretaking and assistance (or lack thereof) with security and privacy and technology, e.g., in libraries [53], during Covid-19 [13, 11], and for the elderly [54]. While many of the groups studied in our field experience poverty, and the lack of financial resources appears for some as connected to security and privacy behaviors, mental models, and experiences, our research community has yet to engage directly, holistically, and qualitatively with the idea of poverty and computer security.

People experiencing poverty are described to be part of "at risk populations" for disproportionate harms and a broad set of attacks like online hate and harassment [52], appear to be forced using less secure software like food sharing apps due to lack of money [55], or face surveillance issues, for instance, related to smart home technologies in public housing facilities [56]. Contrary to the assumption that security and privacy issues lie within the responsibility of low income users who show harmful usage patterns, attitudes, and little literacy, this work shows that security and privacy, moreover, are themselves subject to barriers that need further scrutiny [57].

As people of low income make up an increasingly vulnerable user group that is subject to intensive data gathering, predictive analysis and policing, comprehensive surveillance, and other frequent security and privacy violations [14, 58]—often lacking legal protection [59]—more research is needed to better understand their situation. Currently, the status quo in security and privacy research and design may marginalize users of a low income, both in their everyday lives and during many types of low wage work like gig work. It is shown that security and privacy issues are amplified by work related and private technology available to low income users as well as their specific usage patterns like a higher reliance on mobile connectivity and a greater social media use [59, 60, 61].

Low Income, Behavior, Attitudes, and Threat Models: Low income related challenges in security and privacy among other things are tied to specific threat models, beliefs, advice sources, and behaviors that depend on one another [7, 62]. Prior work has shown that low income users are very well aware of many security and privacy risks and exhibit at least some protective strategies, but are found to lack fitting instruments and suitable resources to better protect themselves [59]. It was highlighted for example, that security and privacy incidents are not causally tied to a low income but are equally distributed through users with differing socioeconomic status [62]. However, it was shown that people of lower income were more vigilant online than people of higher income [52], which surprisingly increased and amplified their already disadvantageous access and usage patterns, as they declined to use online services [63], thus it is important not to understand low income users as a homogeneous group, but to recognize

the characteristics and features of different members as well as their specific connections to other at-risk factors.

We decided on in-depth interviews for our research approach to gain detailed insights into participants' everyday security and privacy actions an practices, as well as their perceptions, behaviors, and reasoning related to security and privacy. We leveraged 28 in-depth interviews with German low income end users to investigate the broader picture of how security and privacy interacts with poverty in countries of the global north, specifically focusing on what is important to them in the context of digital security and privacy and what technology and assets they use and/or seek to protect.

Security, privacy, and sanitization of second-hand devices: For decades, through changing hardware, software, and UI standards, prior work has shown that when users get rid of computers (phones, computers, harddrives, etc), they do not fully sanitize them [64]. Garfinkel et al. showed, through forensic analysis of 158 harddrives in the early 2000s, that used harddrives are difficult to sanitize properly, citing inherent limitations of physical hardware on spinning disks [18]. A decade later, Glisson et al. analyzed 49 cellphones purchased from auctions and pawn shops, finding personal information on all "despite in some cases deliberate attempts by previous users to delete data" [65]. Recent work has also shown significant personal information left on Internet of Things devices [66], SD cards [67], and phones and tablets [68], with some evidence by the prior user to remove their information [67, 69]. Ceci et al. sampled users and found that users do indeed have security and privacy concerns when choosing whether to getting rid of old devices, and that they sometimes *try* to sanitize the devices, but are unable to do so fully because the tools they used were not sufficient [70]. Participants in our work focus on *acquiring* second hand devices—rather than selling or donating them, as in prior work—due to their significantly lower cost than new devices. Our work builds on this body of prior work, then, by understanding the mental model of those in the market for second-hand devices.

4 Interview Study

In this section, we outline the interview approach including the interview procedure. We will elaborate on the recruitment, the structure of our interview guide, the subsequent coding and analysis steps, as well as on ethical considerations, and potential limitations.

4.1 Study Setup

To investigate different employments, experiences, and concerns with security and privacy of low income technology users, we conducted semi-structured interviews ($n = 28$) with people from various backgrounds, education levels, and employment statuses that had 60% or less of Germany's median income at their disposal between May and September 2022. Because of the exploratory nature of the study, and because we focused our investigation on user trade-offs and behavior when using technology on an everyday basis, we opted for interviews as a qualitative approach. The interview as an instrument allows us to explore participants' experiences and concerns in-depth by asking follow-up questions.

Interview Guide: The interviews were conducted with an established interview guide based on our research questions that were tied back to an examination of previous and ongoing related work. First, participants consented to partake in the study before starting the interview, then we asked what devices, apps and other connected technology they are using on an everyday basis. We then asked the participants to describe important and private data, to talk about account sharing, and to report on possible security and privacy incidents in the past. If not mentioned, the remaining questions focused on perceived challenges with, worries about, and experiences with security and privacy.

The initial interview guide was tested with voluntary contacts from our professional network. After their feedback during the pilot phase, we performed minor changes regarding the question order for a better interview flow, and to improve question clarity. We also added follow-up questions to cover relevant areas in-depth until saturation was reached after the fifth interview.[2]

Recruitment and Inclusion Criteria: We based our recruitment approach around covering a diverse set of participants utilizing Open Source Components (OSCs), and employed multiple recruitment channels to better reach a diverse set of low income technology users from different age, educational, work-related, and national contexts. We recruited 28 participants, slightly over-sampling female participants (60% to 40%), from three different age groups (18-25: 18%; 26-34: 54%; 35-67: 28%), different education levels (no degree 4%; high school 46%; BA 22%; MA 28%), and varied employment statuses (no employment 25%; student 39%; self-employed 8%; employed 28%) offline via our professional network, local NGOs consulting unemployed people in Germany, as well as online through second hand goods advertising mailing lists, poverty related twitter hashtags, and Facebook groups:

1. Offline. For recruiting low income users that may not have high internet and technology literacy, we distributed recruitment posters throughout our professional network, and displayed recruitment material at relevant places like NGO offices.

2. Online. In addition to participants recruited offline, we recruited through a varied set of online spaces like second hand goods mailing lists, Facebook groups, and twitter

[2]The full interview guide can be found in Appendix 7.3

hashtags related to low income, poverty activism, and the experience of poverty.

For an overview of the interviewed participants' demographics see also Table 3 in the appendix. Through an invitation link or by scanning a QR code put on recruitment posters, participants were led to a short demographic Qualtrics survey determining whether they could be included in the study.[3]

Participants qualified if they were older than 18 and their household had at most 60% of Germany's net median income (the definition of relative poverty). Participants who were detected to have more than 60% of the median income were not included in the interview sample. As compensation for their valuable time as interviewees, we offered all participants an allowance of 40 €.

Interview Procedure: We conducted the *28* interviews virtually, mostly via our self-hosted instance, or any other tool of the participant's choice (e. g., *Zoom*), or through a phone call, which we recorded after the participant's consent. On the recruiting material, we advertised the interviews with a duration between 60 and 90 minutes depending on answer duration and scheduled all interviews with Calendly or through messaging via email, Facebook or twitter. All interviews were conducted in German and lasted between 40 and 90 minutes.

Overall, the interviews were based around non-leading, open questions, allowing the participants to develop their thoughts and answers. Each interview section started with general questions, allowing participants to freely state what they had on their mind. We asked follow-up questions to elaborate on specific topics if necessary. To avoid priming, we did not use technical or security and privacy specific vocabulary or suggestive argument patterns, and did not judge the answers regarding specific security and privacy practices.

4.2 Interview Structure

The interviews were structured in five main sections consisting of a set of one or two opening questions as well as follow-up questions. Before starting the interview, we provided participants with a general introduction of ourselves, our research project, and an explanation of our goals and the interview process, as well as the interview's role in that process. We emphasized that participation in the interview is voluntary, and that participants could skip any question for any reason without any negative impact on the interview procedure. We made clear that we were not judging their thoughts and knowledge about, behaviors with, and any reported incidents regarding security or privacy. We pointed out that their personal thoughts and opinions were of interest to us and that there was no right or wrong answer. Moreover, we guaranteed full de-identification of any quotes we might use.

[3] Survey questions can be found in Appendix 7.2.

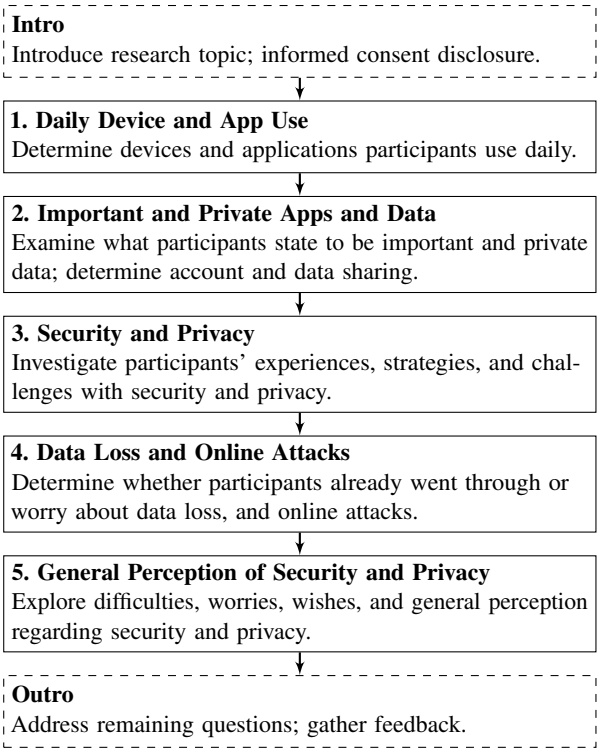

Figure 2: Overview of the interview sequences and procedure. Due to our semi-structured interview approach, participants were allowed to diverge from this interview flow at any time and elaborate on related topics.

After answering and clarifying any remaining questions and obtaining consent for the interview procedure, recording, and data handling, we started recording and began the actual interview with the following structure:

1. Apps and Devices: In the first interview section we asked participants to talk about the devices and apps they use on an everyday basis. This section intends to first gather information on the specificities of low income users' devices and usage patterns. If addressed by the participants, we also discussed old, broken, or already used devices. We report these results in Section 5.1.

2. Important and Private Apps and Data: This section investigates what participants classify as important and private apps and data. It serves to determine which data and apps low income participants describe as important and private, whether they share those data with anyone, and whom they would not want these data and apps being shared with. It also determines participants' experiences and practices of account sharing. We report these results in Section 5.3.

3. Security and Privacy: The third block of questions covers the experiences, behaviors, and challenges with security and privacy participants report about. We asked our interviewees whether they have tried to make themselves more secure

and private in the past, and what makes them sure whether they are secure and private or not. This section serves to determine the security and privacy literacy of low income users as well as their everyday security and privacy strategies. We report these results in Section 5.2.

4. Data Loss and Online Attacks: The fourth section focuses on whether the participants were subject to data loss or online attacks in the past or are worried about online attacks or losing data in the future. Our questions covered aspects such as whether participants worry someone might have access to their important and private data, and if participants think that their person would play a special role regarding online attacks. We also asked how safe and private our participants feel overall and why. We report these results in Section 5.4.

5. General Perception of Security and Privacy: In our final interview section, we investigate our participants' general views on the importance, impacts, and significance of security and privacy in their everyday lives. We were interested in whether our participants would like to change anything regarding their overall security and privacy and how they would make these changes possible. We report these results in Section 5.4.

Following the interview sections, we asked our participants if there was any topic we did not address so far as well as for any additional insights and aspects that we might have missed or they wanted to talk about. We also offered them the opportunity for questions and comments, and after completing the interview, we thanked them for their valuable time and the effort they took while participating in the study.

4.3 Coding and Analysis

Before evaluating, we recorded the interviews digitally, and transcribed them via a GDPR-compliant service, and manually reviewed all transcripts for potential mistakes. We analyzed all interview answers in an iterative open-coding approach [71, 72, 73]. One researcher coded the interview recordings and developed an initial codebook based on the interview guide as well as impressions gained during the interview procedure. The codebook was progressively discussed with other team members, and the feedback was implemented in the codebook, resolving conflicts by consensus or by introducing new (sub)codes after each iteration. The interviews were coded according to the codebook in multiple rounds until saturation was reached and no new codes or themes emerged [74, 75]. Although saturation can be problematic when not well defined [76], we felt it fit our data and it was clear to us when no new codes or themes emerged [74, 75]. The presentation of the paper and the research questions evolved together, explaining the similarities in structure. We did inductive coding [77], iteratively defining research questions, codes, and themes during our analysis: We conducted the interviews with open questions, and generated analysis from data. We took memos during the interviews to find themes and discussed them within the research team. We developed analysis from individual codes to interpretation and theorizing through thematic analysis [78]: Once a topic repeatedly appeared in the interviews, it became a theme. For example, participants repetitively report using old, broken and/or already used hardware, as shown in Table 1, which became the theme *old, broken, and already used devices*. Multiple themes contribute to answering research questions. For example, the theme *old, broken, and already used devices* contributes to RQ3, which is aiming to shed light on the technology and assets participants use and/or seek to protect. As surfaced in the interviews, the use of old, broken and/or already used hardware leads participants to mix private and work related device use (Section 5.1), and to opt into distrusted cloud services (Section 5.2), or into Google services although they mostly do not feel good about it (Section 5.4), because old hardware does not have enough storage space. Also, broken hardware influenced participants' evaluation of assets they seek to protect: As their data is either stored by untrusted cloud services or on hardware tending to break easily, as it is old or already broken, participants show resignation towards protecting their data.

Themes correspond with our results section: use of second hand devices out of necessity; ubiquitous use of broken or/and old devices; mix of private and work devices; Google as a quandary (e.g. little storage space forces into cloud computing); insufficient security and privacy resources other than money related to poverty; a strong feeling of being tracked; false feeling of safety a) because of living in Germany and b) until a security or privacy issue happens; high impact of data loss despite of low risk. Our approach does not necessitate the reporting of intercoder agreement, as each conflict was resolved in situ when it emerged, which resulted in a hypothetical final agreement of 100% [79]. The final codebook of 81 items is included in Appendix 7.1.

4.4 Ethical Considerations & Data Protection

Our study was realized following the ethical principles for computer security and privacy research involving information and communication technologies outlined in the Menlo report [80], and was positively reviewed by our institution's ethics board and data protection office. The research plan, study procedure, and all involved research parties adhered to the strict German data and privacy protection laws, as well as the General Data Protection Regulation (GDPR). All data was collected, handled, and stored in compliance with the EU GDPR; personally identifiable data was stored using a secure cloud collaboration software. To transcribe the interviews, we commissioned an EU-based, fully GDPR-compliant transcription service.

We provided the participants thorough information about our study procedure and data handling, and offered to answer

any questions they might have before signing up for interviews. We stressed that participants could skip any question for any reason such as not knowing an answer, not wanting to answer, not being allowed to answer, or not feeling comfortable with the question, and told them that they could drop out of the interview process at any time.

To protect participants' identities, we did not ask for granular demographic data: in our pre-survey, we only asked for age groups, and income brackets (monthly, related to the German median income). However, many participants mentioned more granular income data unprompted during the interviews. We asked participants their gender, and did not systematically ask for race or migration history; again, many participants shared this information unprompted during the interview. We similarly did not ask for but often received information on chronic diseases, disabilities, as well as other circumstances and life events relevant to participants' socioeconomic status.

4.5 Limitations

Our study has several limitations that are typical for this kind of interview study, including potential over- and under-reporting, self-report, recall, and social-desirability biases, as well as sampling bias. Our sample is a convenience sample which may not be representative of the larger population of low income technology users. As many participants were recruited online, we may not have studied low income users that do not use the internet on an everyday basis or do not possess technological devices.

The household sizes ranged from one person households, families with up to 1 child to two or multiple adults living without children. Following the qualitative and explorative nature of the study, the demographics are not representative of people living in poverty in Germany. We sampled relatively highly educated people, and we were unable to reach people that do not use technology.

Interviewees who agreed to participate in our study might be more or less aware of the overall problematic revolving around living with a low SES, as some were members of Facebook groups or twitter hashtags tackling poverty as a social problem to be solved.

We conducted our interviews in German, so we have no insight into non-German-speaking low income technology users. As German is the de-facto "common language" in Germany, we consider this to be a negligible drawback still allowing us to reach a meaningful set of low income technology users. We attempted to mitigate social desirability bias by emphasizing that there are no right or wrong answers to our question about security and privacy, and that what matters is the everyday practice and experience of the respective user. We made clear that we were not going to judge the participants or their answers in any way but were genuinely interested in their experiences and thoughts. At any suitable moment, we also reminded our participants that they could skip questions without giving a reason.

5 Results

Our data focuses on how relative poverty affects (or does not affect) one's threat model and technology usage. As discussed, prior work finds that certain sub-populations experiencing poverty encounter certain barriers to security and privacy that are anecdotally related to poverty; our work engages, deeply and qualitatively, with specific reasons that poverty can present a barrier to security and privacy: old and second-hand hardware may have insufficient storage space (Section 5.1) or may be technically unsupported or improperly sanitized (Section 5.1), the use of untrusted software because it is free (e.g., free cloud backups of personal data, Section 5.2), and the feeling that poverty lowers the value of their data to a potential attacker (reflecting a misunderstanding of how and why many identity theft and cyber attacks occur, Section 5.3). We also explore how participants conceptualize *adversaries* (Section 5.4), amplifying their concerns about ad tracking and being unable to pay for privacy by using products for which they do not feel they trade privacy for access/cost (Section 5.4). Finally, also lacking financial, time and emotional resources related to poverty may impede security and privacy (e.g. participants don't want to deal with something they cannot afford anyway (Section 5.4)).

5.1 Hardware: Mixed Use, Typically Older, Secondhand, or Cheap Hardware

Although new smartphones, tablets, and laptops cost hundreds or thousands of euros (a significant fraction of the annual 15000€ income of someone in relative poverty in Germany), they are effectively required for modern day life in a rich industrialized country like Germany. Employers may require workers to be available via telephone and computer without providing either device. Additionally, social technology use is a critical part of our personal lives and exclusion from technology use (e.g., exclusion from social media, connections with far-away loved ones) can be painful [81]. We thus begin by exploring the *hardware* ownership and usage of people in relative poverty, for whom the cost of hardware may be a burden. We observe that both *mixed use* and *second hand* devices can present security and privacy risks to users and prior owners, since they are often improperly sanitized.

We observe that the hardware they use is influenced by poverty as most interviewees rely on old, used, and broken hardware because they cannot afford new devices. The hardware influences what is important to them and what they seek to protect: Although they find pictures, work and health related documents, and private communication data important, interviewees report that they cannot afford to protect them properly. They try their best to protect data that is important to them but always choose the cheapest options. One participant

explicitly and unprompted stated to use a hard drive regularly (P4). Finally, they simply accept the idea and the occurrence of losing data. Additionally, their devices must be affordable and thus do not have much storage space, which forces them to opt into cloud solutions they do not really trust.

Old, Broken, and Already Used Devices: Few participants report using new devices. Most participants report to take over old, broken or already used devices (Table 1) from friends and family members or to buy second hand hardware online, as they prioritize buying food, clothing, and saving for unexpected expenses (P9; P12; P18; P20), like a broken fridge or washing machine (P26). Participants also report often replacing their acquired devices as they break easily, which influences them not to trust the hardware they use:

> "*You must know that I have a very stupid history if you look at the last four or five years. My biography with smartphones is not particularly good, because I never get a new one, but always used ones. And then they usually don't last.*" — *P19*

We find that relying on broken, used, or old devices fills an important connectivity gap for low income users, giving them an opportunity to stay connected professionally and privately (P2; P26). However, these previously used devices can present a security and privacy risk. Prior work has shown that phones and other devices are often improperly sanitized before being passed to a second owner, presenting risks of malware and unwanted programs from the prior owner, and putting the onus on the new owner to ensure that all settings, accounts, data are *their* own in order to avoid tracking between owners. Additionally, Roberts et al. showed that pre-owned devices can contain illegal data or evidence of crimes, which could implicate second owners [17]. Older devices also can present security and privacy concerns, as there is a point at which developers stop issuing security updates, or the old hardware cannot run the newest versions of software.

Mixing Private and Work Related Smartphone Use: Most participants report to use their smartphones for almost everything, including online banking (P10), or even to rely on smartphone use exclusively (P18). Some participants distinguish hardware use between professional and private (P19), but almost every participant mixed private and professional device use (P24). A reason for mixed use is the technical insufficiency of participants' old devices, as P2 reports:

> "*I do have a work laptop, so to speak, but connecting to the office server doesn't work so well and that's why I actually use my own laptop for everything. But that's also why I'm using my cell phone right now, because I don't have a webcam on my old laptop and that's why I've always used the work laptop for Zoom.*" — *P2*

While the mix of work and personal use is not uncommon, as a number of employers expect employees to use their own phones and computers for work—particularly during the pandemic—it can be dangerous for both employee and employer. Employees may be required to sign invasive contracts that give employers control over *all* the data on their device (subjecting them to loss of personal data if the employer exercises the option to wipe the device), while employers' company data may become compromised from something the employee does on their personal time, on their own device.

5.2 Software: Shared Paid Streaming Accounts, Coerced Free Cloud Storage, Online Second Hand Platforms

Not all software and services are free and so those that are not can create a financial burden for relatively poor people. We find that participants' use of *free* communication apps and social media is not remarkably different: all participants report to mostly use communication apps like mailing, WhatsApp, Signal, Telegram, as well as social media apps like Instagram and Facebook. However, we find that in response to the need to back up and store their personal data, participants may turn to free cloud storage services because they are unable to buy hardware with an appropriate amount of storage space. Significantly, they *may not trust these free cloud services to not violate their privacy* but use them because they are free. Additionally, we find that participants frequently use online second hand platforms that require sharing private information with strangers. This may adversely impact their privacy, and even physical safety.

The Risks of Online Secondhand Goods Trading Services: Almost all participants report using online platforms for secondhand goods trading on an everyday basis because they cannot afford new merchandise (P3, P5, P6, P13, P17, P22, P26, P28). Platforms like Vinted, Kleiderkreisel, or Ebay Kleinanzeigen connect a buyer and a seller of secondhand goods, offering a shipment or a personal pickup option, as well as an option to pay through the platform's own payment system or via PayPal, banking, and in cash. There is also the option to give away things for free. To use these platforms, participants must create an account, filling in personal information like the home or any other shipment address, telephone number and email as well as banking or banking app data. Sharing this information with strangers is usually based on the mutual trust that everybody will only use shared data to complete the trade in question and for no other reasons.

One person reported to only search for giveaway things that they pickup in person as they could never afford to buy anything through these platforms including shipment costs.

Table 1: Daily technology use reported by participants. "Old" and "new" as subjectively reported by participants.

	Smartphone	Laptop	PC	Tablet
Old	P1, P2, P5, P7, P16, P18, P20, P21, P23	P4, P10, P16, P21, P23	P16, P18, P21, P26, P28	P3, P16
Used	P19, P25	P3	-	-
Little storage	P7, P11, P20, P25	P21, P25	-	-
Broken	-	P21	P7	-
New	P15, P24, P28	-	P15, P19	P8, P17, P25

To them, this is also part of a security and privacy action: for picking up free handouts, they never expose their own personal information like banking data or their home address, which gives them increased anonymity, security, and privacy *because* they are poor:

> "*I: Do you pass on your bank account details? P: No, no bank account details. I only pick these things up. I: And then you just hand over cash? P: Yes. But I mostly look for things to give away. I'm unemployed, so there's not much to buy.*" — *P26*

Little Storage Space Forces Users into Cloud Computing: The use of old, broken, and pre-owned hardware (Section 5.1) may push users towards more frequent or thorough backups of their personal data (P3; P8) because they are afraid the hardware will break, or because the hardware has minimal storage (P9; P13). Participants expressed that they lack storage space on their smartphones and notebooks, forcing them to either delete data on a regular basis, to store data on external hard drives, or to use cloud services (P9; P13). Some participants perceived physical or offline storage as the best way to protect data from unwanted access—though other participants report not to use cloud systems at all due to safety reasons (P14, P16, P23, P27).

> "*I don't use cloud systems; I don't upload my personal data to iCloud or similar programs and service providers now. Yes, of course it's nice, but then Apple just has all your pictures all the time. And you don't know what they do with them. And why would you also upload the photos there?*" — *P14*

However, although they distrust cloud services like Google Cloud or iCloud, they report that physical hard drives are a financial burden, and so cloud services are the go-to opportunity to receive free or affordable extra storage (P6; P7; P9; P10; P18; P20; P25). This is why they choose to put their data in a cloud or simply do not disable the automatic cloud backup pre-set on their smartphones (P6, P18, P20, P25), but report that they would not use cloud services if they could afford it financially:

> "*If I had more money to buy hard drives, I would change to that and quit the cloud.*" — *P20*

Other interviewees state that the benefits of greater storage space outweigh the costs of potential privacy loss:

> "*My laptop is full, now I can put new stuff on it again. That's the only reason I did this.*" — *P6*

In the face of their mostly cheap and old hardware that does not have much storage space, opting into cloud services seems to be the only solution to store data. Additionally, other interviewees describe that their data is automatically backed up and stored by Google, whether it is private photos, photos of important documents, important files, or (artistic) work files, and that it is impossible or very complicated to shut down this automated backup (P18; P20; P22; P23; P26). Either they describe it as a burden because they cannot access their data offline (P20), or they wish for a "Google-free" phone that they cannot afford (P18):

> "*It would be cool to get a Google-free phone, at all, with a lot of storage space. There are people who can do that.*" — *P18*

> "*Well, my cell phone does that automatically. Yes, I turned this function on myself. And my photos are saved on my Google account. On Google Cloud. And if I don't have internet and want to open photos from 2015, 2016, that doesn't work. I always have to be connected to the internet because it's stored on my Google account.*" — *P20*

Participants' skepticism of cloud storage for privacy reasons is in line with prior work on user attitudes towards cloud storage [82, 83]. While it is beyond the scope of this paper to comment on the security and privacy practices of any one cloud provider, complete deletion [84] and isolation [85] of data in distributed systems are difficult due to data replication and shared hardware. Additionally, prior work shows that cloud UIs can be confusing, and lead users to improperly delete or retain data [86, 87].

5.3 Data: Loss of Personal Data Considered Low Risk but High Impact due to Poverty

Separate from software and hardware is *data*, and how poverty affects what people consider to be their assets (and non-assets), as well as how they perceive threats to their data privacy like data breaches, tracking, and identity theft. We find that participants, in general, consider their personal data as important assets, but in many cases assign it low value specifically because they themselves are poor. The sense that they will not be "worth" an attacker's time because they do not have expensive assets was pervasive. This betrays a potentially dangerous incomplete mental model about how and why data breaches occur: they may be targeted, and user-centric, but they also often occur en masse, by no fault of the user's own, as an online service is breached (and therefore the financial assets of the user are no consideration) [88, 89]. Yet participants explained that if they *did* experience a data breach, e.g., identify theft, the impact would be *high*, also directly because of poverty. Here, we report the *types* of data assets and non-assets that users defined, and discuss their perceived sensitivity and value; we discuss the feeling of "not much to get" further in Section 5.4.

Photos, Mailings, Messages: We find that participants report photos, mailings and messages as important and private data. They consider some photos low-value assets, or even non-assets, while others are considered high value assets. Participants report disuse of social media in response, in line with some prior literature and philosophical non-use [90].

> "*I have the feeling that there is a lot of sharing or oversharing. ... That's already a habit.*" — *P25*

Indeed, pictures showing children mark a threshold and are considered to be extremely sensitive content to avoid posting online (P26). The same applies to photos showing party pictures (P11) or nudes including faces (P20). Generally, oversharing posts and photos through social media was considered an undesirable tendency (P25). A sufficiently secure and private alternative for sharing sensitive photos either does not exist or does not feel usable to participants (e.g., it is not already used by their social group, it costs money, they are skeptical of it). We observe, however, that participants' use of self-deleting messages shows a positive example of a security and privacy feature addressing their concerns and being used.

Banking Data: All participants mentioned their online banking accounts to be important, but were ambivalent regarding the idea of losing their banking data or being scammed (P11; P19; P20; P21). While some participants described feeling safe because they do not have a lot of money and thus do not think of themselves as attractive targets, at the same time they fear losing all their money at once (P2; P3; P6; P11). This is directly related to poverty, as participants have exactly one (instead of multiple) bank accounts, and have no savings nor other financial fallbacks.

> "*I think that's very unlikely for me, because there's not much to get. For example, that someone has the access data for my PayPal account and then somehow steals money from me for small amounts or something.*" — *P3*

> "*Well, if someone stole all my money, I mean, it's not that much. But then of course I'd have a problem and then I'd have no more money. ”* — *P3*

Even though there are legal protections and insurances for the loss of data from a bank [91], and users would likely get their money back in a few days, it is reported to be a source of strong discomfort (P2; P3; P7; P8; P9; P11; P21; P28) because of the lack of financial fallback possibilities that those with higher (relative) income may not experience.

> "*So even if that could be arranged somehow, it's just not a situation I want to get into in the first place. Unfortunately, I only have one account and that's where most of the money is. And if that's gone, then it's not fun. Even if it's only a few days.*" — *P15*

Non-banks, such as PayPal, are not regulated in the same way, and thus a breach can lead to financial loss; however, they remain commonly used for purchasing items, e.g., from online swap/sale sites, and are also used between friends and partners. Interviewees reported PayPal-like phishing emails leading them to uninstall PayPal completely (P11; P21). One participant reported a friend for whom getting money back was impossible after the account has been hacked (P20):

> "*A few months ago, someone hacked into a friend of mine's PayPal account and stole a lot of money from her. And that made me feel pretty insecure about using PayPal. I think she contacted PayPal and they followed up on it. And they said it would take a few months. I don't know yet whether she got her money back.*" — *P20*

We observe that financial regulations *do* protect people from loss if their bank account is breached. However, people experiencing relative poverty may be unable to fulfill their everyday needs—e.g., buying food, paying rent—while they wait for the bank to return their money to their account. We also observe that the use of money-sharing apps, only some of which are regulated as banks, contribute to financial loss that relatively poor people cannot easily withstand, and we bookmark both as opportunities for improvements in technology and policy to protect poor users.

5.4 Adversaries and Risk Perception: States, Criminals, and Companies don't Come for Me

Complementary to hardware, software, and data *assets* and *non-assets* are *adversaries*. We now turn to the *actors* and *adversaries* in participants' threat models, as well as the level of risk that participants believed they posed to their previously defined assets. Participants define different adversaries including state regimes, criminals, and companies crawling data. While many express a high awareness of these adversaries as threats in general, at the same time they do not see themselves personally at risk. Reasons to personally feel safe included living in Germany, which is perceived to be a safe country, as well as not to possess financial means or sensitive data worth getting stealing (in line with their discussion of *non*-assets, in Section 5.3). These threat models may lead to a false feeling of safety. Also we find that participants report financial, emotional and time reasons prohibiting them from gathering more information about security and privacy that would enable them to better protect themselves.

Government Actors: Living in Germany is Perceived to be Safe: Some interviewees have expressed not to perceive any given government-related security and privacy risks while living in Germany. Drawing comparisons to other countries, like the persecution of LGBTQI+ people in Poland (P2), the political system in Iran (P20) or Russia (P12), and the strong social control systems in China (P16; P18), participants reported to feel free in Germany while performing tasks like critical journalism (P5), being unemployed (P16), or politically engaging to move freely through the internet (P18). Others voiced concerns about nation states like Russia influencing the votes in Germany, pointing out that incidents like these were at least publicly discussed (P9). This leads participants not to engage deliberately in security and privacy action like anonymizing their personal data or traces surfing the internet, as the following citation exemplifies. Asked whether they would take action to increase their online security or privacy, P12 replies:

> "*It would have to be something bad where I say: 'No. I can't go on; I have to make myself anonymous now.' In China or Russia, people do it because they know that their data is completely controlled, and here in Germany, at least I don't think that's the case, I think our data is free.*" — *P12*

The feeling of being safe and secure that is connected with living in a democratic constitutional country like Germany might lead to an inaccurate or incomplete assessment of personal security and privacy, as every government may unjustifiably gather personal information or violate digital security of its residents. Also, data gathered can have an unproblematic status now and become a threat in the future, e.g. when the political system undergoes substantial changes.

Targeted Attacks by a Non-State Criminal: Feeling Safe as There is Not Much to Get—Unless Something Happens: Participants generally felt well protected from targeted criminal attacks because of the simple fact that there is "not much to get" from them because they do not possess large amounts of money or important data or information (P13; P15; P19; P22; P23; P25; P27; P28). Participants hypothesized that cybercriminals would be more likely to target public figures, people with significantly more money, or people with substantial social media followings (P2; P8; P9; P14; P16; P17; P18; P23), assuming that "*if this data somehow gets to someone, they cannot do anything with it*" (P16).

Thus in general, we found that participants do not see the urgency or necessity to protect themselves better as long as nothing specific happened to them (P2; P3; P7; P10; P13; P18) — thinking that "*the probability that someone will attack*" would be "*one in a million*" (P28). On the other hand, some interviewees also refer to this perception as an "*illusion of security,*" letting them "*feel safe"* generally, but only "*as long as no one tells me, 'Oh, you've been hacked',*" or until an incident really happens.

Companies: Personalized Ads Lead to a Strong Feeling of Being Tracked: Participants had substantial concerns about online ad tracking and the invasion of their privacy (P10; P18), echoing prior work about user concerns with personalized ads [92]. However, some concerns were technically inaccurate (e.g., ad tracking very likely does not occur due to apps secretly listening via the phone's microphone [93]) and revealed inappropriate coping mechanisms e.g., only rejecting cookies, or changing their behavior in an irrational way:

> "*What actually bothers me is that the algorithm is now so blatant that there is this 'eye tracking' thing or whatever it's called. You can google it. And since then, I've been like no, I no longer look there. It actually stresses me out.*" — *P6*

Another interviewee protected themselves against tracking through rejecting all cookies which "*didn't help much*" (P2) and another put their "*phone on airplane mode during sex because I don't want my privacy to be exploited*" (P20). While these strategies may give them some protection, the myriad strategies that online trackers use for advertising content has extreme depth and will rarely be thwarted by one simple trick. We observe, at a high level, that participants are deeply uncomfortable with tracking, and also are ill-equipped to avoid it, both because of inaccurate mental models regarding how it happens, and because they cannot "buy" their privacy.

Getting personalized ads is often described in relation to big online companies like Instagram, Youtube, Amazon, and Google (P2; P14; P20) and is reported to fuel a strong discomfort due to personalized content being displayed without prior action: Eight participants believed private conversations were tracked by their smartphones (P2; P6; P7; P13; P20; P23;

P26; P27) as they have been shown personalized content after talking with a friend about a product without having actively interacted with the smartphone, e.g., googling for the product.

Some users think it is standard to be tracked by their smartphones, either worrying because they heard about it—"*You keep hearing rumors about how cell phone microphones listen. For example, if you talk about a certain product, you later get advertisements for it or something similar*" (P27)—or because they believe they experience it (P2; P23; P26):

> "*If you think about the fact that I'm talking to a friend on WhatsApp about, I don't know, let's say, foot cream, and then the advertising for foot creams pops up directly on social media. ... We only talked about it via WhatsApp. ... There was no other way. Interestingly enough, the advertising was then displayed to me on Amazon as well.*" — *P26*

We find that mostly Android and a few iOS users reported experiencing situations making them think they were being "eavesdropped" (P2; P6; P7; P20; P23; P26; P27, see: Table 4 in the Appendix). We observe that there is no evidence that modern apps listen for content to feed into advertising algorithms without being otherwise turned to "listen" mode [93].

Google as a Trade-Off: Out of 28 participants, 21 talked about Google unprompted, mostly reporting ambivalent feelings about it, which is why we choose to elaborate on that matter in more detail. Interviewees report using Google as a search engine, saying that 'googling something' is an integral part of their everyday technology use (P13; P16; P18). At the same time, participants voice a general feeling of unease using Google, because it is gathering and harvesting their data (P2; P3; P7; P12; P23; P25).

> "*I also know that companies like Meta and Google or whatnot make their profits by exploiting data. And I still support them, I'm basically giving them the data even though I know it and that bothers me.*" — *P7*

While all participants say that Google is very user friendly and has generally a high amount of usability, some of them are generally convinced that using Google is not safe (P7; P17; P23). Other participants express that leaving Google is the only option that would make their data safer and more private. One participant expresses complete abstinence from Google as an effective security and privacy practice: "*I don't have Google Play Store on my phone. I use a 'Shiftphone' and I have consciously tried not to use Google services*" (P4).

At the same time, leaving Google is reported to be a difficult endeavor, as using Google services is often described as a necessity on four levels: the technical level for Android smartphone users who have to use a Google account in order to use the Play Store (P23; P28). Second, interviewees report that it is very difficult to get rid of Google and shut Google services down, both because either Google trackers are enabled again or because they don't manage to shut off Google connectivity (P14; P15). Third, Google services are reported to be highly usable, participants express to be too 'lazy' to use something else as this would be more complicated (P22; P23) and fourth Google services are connected with many other services the interviewees use in their everyday technology use (P1; P18):

> "*I first tried to uninstall it, to see whether I can uninstall it ... uninstalling is not enough, because you are in this so to speak ... And I tried to write an email and there have been totally complicated answers ... I already talked to people who also have the problem. It's super hard to get out of Google again.*" — *P18*

Even interviewees who manage to shut down Google trackers on a technical level report that they are automatically re-enabled at some point again which one interviewee reports to have been "*annoyed by very much*" (P23). The default Google backup function leaves interviewees wondering why their data are automatically sent to Google which makes them feel uncomfortable and unsafe (P26).

Insufficient Financial, Emotional and Time Resources While Managing Uncertainty: All interviewees self-evaluate to lack deeper knowledge about digital security and privacy and state they could use improvement in knowledge, skill, and protective strategies. Participants connect financial, emotional, and time resources with their security and privacy behavior. Some describe never caring about security and privacy except "*for financial reasons or something like that*", for instance if their banking account would be at risk (P6). Other participants report not to *"have the energy"* to learn more about (P26) or to have *''too much on their plate*" to invest more time in security and privacy although they think that it would be important (P20; P25), as P25 explains below:

> "*I certainly have no good conscience about it, so it's not that I say I feel totally good or something! In the back of my head, I always think that it is actually not so good, but I have just other priorities in life somehow, than to put so much time into it, although it is super important, that is clear to me.*" — *P25*

The interviewees also give other emotional or mental reasons to desist security and privacy action. Many participants report not wanting to think too much about security and privacy as they fear to become "paranoid" about it (P2; P3; P4; P8; P10; P11; P14; P16): "*The more you read into it, the more you drift off into some paranoid conspiracy theories*" (P11). Other participants report not being able to discern whether they appropriately assess security and privacy issues they

read, hear, or know about (P3; P12; P13; P14) which leaves them with a feeling of unease and incompetence, wondering whether "*everything is actually that bad or just okay as it is* " (P12; also P3; P11; P13; P14). Another interviewee linked their lack of engagement with security and privacy directly to their financial situation: They stated that in order to inform themselves more about digital security and privacy, they would "*have to deal with things that I can't afford. And that makes me sad, so I don't do that*" (P26). While poverty is certainly not the only barrier to having an accurate and complete threat model and being able to match one's actions to that threat model, we thus observe, again, directly, that *poverty itself is a barrier to security and privacy*.

6 Discussion

Persistent social structures often prevent upward social mobility [94], especially in Germany [95]. Even for those leaving poverty, the effects of security and privacy practices adopted during times of poverty may persist (e.g., data being hard to remove from the cloud). Our findings, through 28 interviews with low-income users in Germany, show that poverty directly and indirectly impacts security and privacy needs, experiences, and mental models, and that poverty influences what is important to users in the context of digital security and privacy, and what technology and assets they use and seek to protect. We now synthesize key *technical* and *research* recommendations from our work, towards better supporting and understanding those experiencing poverty.

Securing the Use of Old and Second-Hand Devices As we found that the everyday security and privacy actions and practices of people living in relative poverty in Germany are often tied to the use of old, broken or pre-used hardware, we suggest to improve the security of old and second-hand device use. There is extensive prior work showing that old and used devices can be sources of potential security and privacy harms because users often do not properly sanitize their discarded devices, and there is no guarantee that even a wiped device is completely reset and e.g., malware free [96, 18, 17, 64, 65, 67, 70]. An already-used device may also lead to unwillingly sharing identification information like in taking over the Apple ID from a previous user who failed to properly uninstall their information, and certain hardware identifiers that may be used for (ad) tracking cannot (easily) be changed. Additionally, hardware and software ceases to be supported at some point [97, 98], and old devices will not be supported with security updates, leaving potentially exploitable vulnerabilities forever.

We urge manufacturers to expand the lifetime of security update availability, since deprecated operating systems and hardware disproportionately affect low-income users. As relying on old and used devices is standard among low income users, we also recommend developing and establishing usable practices for digitally sanitizing devices before use. We observe that to truly sanitize a device, the functionality must be implemented at the OS level rather than by a third party, and thus strong sanitization practices, with cross-OS usability and recognizability for users, requires coordinated industry support.

However, there are also other actors that may be able to support (or nudge) users and manufacturers into better sanitization practices: there is space for policy to require sanitization, or an agreement of non-sanitization, between old and new device owners, as well as a discussion of non-sanitized data. We also imagine that second hand goods trading platforms may play a role in enforcing and enabling sanitization.

Ensuring Cloud Security is (and Feels) Sufficiently Secure, Private, and Usable: Participants expressed that they use free cloud storage for data because physical (personally owned) hard drives are financially out of reach. However, some participants also expressed discomfort with storing their personal data on a corporately owned and managed cloud, uncomfortable with the access that gives the cloud provider to their personal data. We observe two key tensions that arise here. First, there is a tension between *free* and *not private* manufactured by the business model of free cloud storage. Second, it is tempting to simply recommend technology and policy that puts users in charge of their data when it is in the cloud (e.g., how GDPR allows users a right to be forgotten), yet we recognize that such technology and policy will inherently burden users who are already busy and may not have technical expertise. As our interviews show that people living in poverty are vulnerable at this point, because they *have to* opt into cloud services *and* do not have sufficient resources to ensure (or generate the feeling of) secure cloud use, we recommend researchers technologists and policymakers consider how to move towards improving *secure and usable free cloud services*, as a public utility. More concretely, for example, tools exist to encrypt one's data and move them to the cloud, but there remain open questions about their use, usability, and in-practice security and privacy properties.

Empowering Users With Accurate and Complete Threat Models: Prior work shows that financial poverty does not necessarily correlate with information-poverty or capability [99], and our data also demonstrates that low income users may very well be highly educated and possess a high amount of tech literacy. But this still is not enough to always have adequate security and privacy strategies implemented in their everyday technology use, not only because what users consider important assets they seek to protect is—at least in part—shaped by the scant hardware and software available to them. Also, we observe that poverty may make users feel a false sense of safety because there is "not much to get."

We thus remark on the importance of supporting users in developing accurate and complete threat models including, for example, an understanding of how data breaches happen *to companies* in addition to individuals [88, 89] and thus, for untargeted attacks, "not much to get" should not affect one's mitigation strategies. While a recommendation for user education ultimately puts the burden on users, we argue that it also empowers them to take collective, non-technical action for themselves: to pressure technologists, researchers, and policy-makers through democracy, to take legal action against those who mishandle data, and to boycott services that mistreat users without the intention of doing better. We observe, however, that the burdens of user education can be variable, and with proper design, we would hope they would be manageable.

Prior work has found that people learn cybersecurity behaviors and threat models socially, through their communities [100] as well as in their workplaces or school [62], and in apps [62, 101]. Thus, looking beyond social sources of cybersecuity advice [100], we turn to employer/school practices [62], apps [101], and any other sources of cybersecurity knowledge that people have access to. Prior work has found that IoT device manuals and support pages communicate cybersecurity advice [101], but IoT may be prohibitively expensive for those experiencing poverty, or, as our dataset showed, users may reject IoT for privacy cocnerns, but then also not learn new technical behaviors and mental models through the installation process.

More Work is Necessary to Understand and Alleviate the Impact of Poverty on Security and Privacy: Finally, we implore computer security and HCI researchers to continue to study poverty, particularly employing participatory and qualitative methods, and having an emphasis on doing research *with*, not *about* low income users. Despite tackling a topic that may seem "abstract," we observe that by asking people—experts in poverty through their lived experiences—*directly* about the effects of poverty, they told us *directly* what the effects were.

We also imagine numerous directions for technical and measurement research to measure and further elucidate the effects of poverty on security and privacy, as well as to support users with better technologies. In order to better support poor users, we must first understand the technical security and privacy properties of the platforms they use. Future work could measure and analyze the security and privacy properties of technology that poor people depend on, e.g., government services, second-hand goods trading platforms, third-party payment services. Mixed use device policies ("bring-your-own-device (BYOD) policies") may also be of interest. Such measurement and analysis will provide a basis on which to develop policy and technology that empowers users rather than puts them at risk and makes them feel discomfort.

We emphasize that anything that alleviates the burdens of poverty, including increasing access to security and privacy mechanisms and mental models, helps decrease the marginalization caused by poverty.

7 Conclusion

Although not only internet access and technology penetration but also poverty rates are growing, low income end users are not well studied but make up a growing set of end users with specific experiences, behaviors, and challenges in security and privacy. To address some of these challenges, and to elaborate on experiences, and strategies with security and privacy as well as on threat models low income users have, we conducted *28* in-depth, semi-structured interviews. Focusing on the everyday security and privacy actions and practices of users living in relative poverty in Germany, on the technology and assets they seek to protect, and on what they find important in the context of digital security and privacy, we find that our participants are subject to a series of possible security and privacy threats related to their low income. Because they rely on old, used, and broken devices, frequently engage in online second hand trading, possess little storage space, do not perceive themselves as attractive S&P targets, they may thus falsely feel safe, and do not have the financial, emotional, and time resources to improve their security and privacy, we offer recommendations to the research community, developers, and policy makers that can help better protect low income users and make security and privacy affordable to everybody.

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Appendix

Below we present supplementary data and tables for our work.

Table 2: Penetration rate of selected information and communications technology devices among private households in Germany from 2014 to 2022 [102].

	2014	2015	2016	2017	2018	2019	2020	2021	2022
Mobile phone	93.6%	93.5%	95.1%	95.5%	96.7%	97%	97.5%	97.6%	98.1%
Internet connection	78.8%	88.2%	89.3%	91.1%	92.7%	93.5%	94.3%	94.7%	95.5%
PC total	87%	88.3%	88.6%	90%	90.4%	91.6%	91.9%	92.3%	92%
Smartphone [1]	—	—	—	—	—	—	—	—	88.1%
Mobile PC (laptop, netbook, tablet)	68.3%	73.5%	75.4%	79%	81.2%	82.4%	83.4%	84.8%	85.2%
Landline phone	91.5%	91.5%	91%	90.9%	84.9%	86.4%	85.3%	84.3%	82.9%
Desktop PC	54%	51.3%	49.4%	48.6%	44.2%	44.6%	44%	44%	42.9%
Navigation device	48.3%	49.7%	50.8%	50.6%	45.8%	46.2%	44.4%	41.2%	39.3%

[1] There is no data available regarding the penetration rate of smartphones among private households in Germany from 2014 to 2021.

	Men		Women		Total	
	No	**%**	**No**	**%**	**No**	**%**
Age	11	40	17	60	28	100
18-25	1	4	4	14	5	18
26-34	6	22	9	32	15	54
35-67	4	14	4	14	8	28
Education	11	40	17	60	28	100
No degree	0	0	1	4	1	4
High School	5	17	8	29	13	46
Bachelor's	2	8	4	14	6	22
Master's	4	14	4	14	8	28
Employment	11	40	17	60	28	100
Student	4	14	7	25	11	39
Unemployed	3	11	4	14	7	25
Self-Employed	1	4	1	4	2	8
Employed	3	11	5	17	8	28

Table 3: Participant demographics.

Smartphone Total participants N=28	**iPhone** N=13	**Android** N=14	**Shift-Phone** N=1
Feeling tracked	1	7	-
No mention of feeling tracked	12	7	1

Table 4: Reported feelings of being tracked by their Smartphone.

7.1 Codebook

Code	Description	Example Quotes
Security & Privacy	Represents the protection and sensitivity of data from the participants	P5: *"I would encrypt my devices, which I am not doing right now. [...]"*
Important data	Significant data of participants	P1: *"So clearly online banking app, my Citizen app, and my WhatsApp. Because I actually have photos and stuff there, too. So I also try to download them and then delete them again so that they don't stay there, for example. (unclear) that someone can look at them quite freely."*
(No) allowance to see	Except for the participants themselves, no one else has access to their data	P4: *"Here, too, it varies greatly what kind of data it is. So in general, it should not be any person, group of persons, or criminal institutions that have, so to speak, harmful or damaging or otherwise any criminal intentions. But also in terms of other personally sensitive data, I don't think it's good if, as I said, insurance institutions, other government institutions, or private institutions that provide some service or something like that get more data from me than they need. [...]"*
Photos	Various (private) pictures on participants' devices	P4: *"Pictures too. Yes. Also a good point now. I gave a seminar at university on the topic of deep fake. And there, the topic of "Revenge Porn" came up, that people often took pictures of their partners and used them to present sexualized content to harm the partner, the ex-partner. But independently of that also a classical thing, politicians, about which simply many picture media exist, that the picture files were also used by self-learning programs, to produce new languages or picture contents. [...]"*
Children photos	Pictures of (own) children on devices	P26: *"First and foremost, children have no place on the Internet. It's a difficult time these days and I don't think kids should be on the internet until they can foresee what it means to have their photo on the internet. I'm pretty ambivalent about all this anonymity on the Internet, even though I use it, I'm not so sure it's always such a good thing. Because when I think about trolls, I sometimes find such a mandatory verification with an ID card, I find perhaps also quite useful. [...]"*
Nudes	Intimate pictures on devices	P27: *"The camera of a friend of mine was actually hacked by a - I have to say, former classmate, the young man who then got expelled from school - has been hacked by a classmate who made recordings in her room. Of course, that had criminal consequences. But that's... when you can't feel safe in your own home anymore, that's very, very bad. I wouldn't wish that on anybody. I have a sticker over it that's easily removable. That means that even if someone were to try to do that, you only get to see the back of the sticker. That is rather unexciting. It has already happened to various friends of mine that photos were published in revenge after the breakup. I don't wish that on anyone."*
Deep Fake	Realistic-looking media content that has been modified by artificial intelligence	P22: *"[...]. AI has gotten to the point where it can work with data sets and create real-looking files, and all those things. That is also very difficult to distinguish. Even for forensic experts, it's not that easy to detect a difference. And these are, of course, problems that are there - or potential problems."*
Feeling of (in-)security	Participants' description of what/who protects their devices or data	P2: *"Nobody tells me, "Oh, you've been hacked," so how safe is that? Not very sure. Well, I would also say that it's more of an illusion of security that I'm willing to believe as long as it doesn't affect my everyday life."*
Politics	Related to posts on social media and General Data Protection Regulation (GDPR)	P18: *"Yes. Well, I've also written a few political things. It might be good if that wasn't ... Well, you know. But just personal diary entries, I just don't want others to read them. I don't care who it is."*

Activism	Having fair interaction on the internet	P26: *"[...]. But alone after my ZDF interview, in which I am now to see completely and also my double chin and my weight, that was already Bodyshaming par excellence. Is inconsistent. On Twitter then yes partly. Well. Me. I block pretty quickly, I also block with foresight. I like to look at Ricarda Lang's tweets and block them blithely. Oke. Alright, but what it is. I think it's disgusting how low-level and under-complex people react. Just to want to take someone down for no reason. And I don't give that fuel. I am overweight, but I have no problem with it. That's just the way it is and if others have a problem with it, that's theirs."*
Person (un-)important	Probability of being attacked related to persons or participants themselves	P2: *"Because I don't have that much money? So of course, if somehow addresses are hacked for spam, you can also be affected by that. Yes, that's true. You're not immune just because you don't have any money."*
Data loss	Participants describe the effect if they lose their data through various circumstances	P8: *"Boah, so that would be something really bad, I must say. Really, photos are one of the most important things on my phone. But I've also made sure that I have everything on my laptop and I make backups and I don't know what, because that would really be the most terrible thing, because those are memories, moments, something else. That's almost the most important thing on my phone, I have to say."*
Personal responsibility	Related to participants not giving much data or how to protect them	P28: *"Security means that the accounts are protected with passwords. That is the security that I can bring in."*
Shared accounts	Using apps and accounts with others while giving access to them	P20: *"Yes, I have Disney Plus and I use that with a friend."*
Usability	Describes the benefits of technology and the internet	P26: *"That is actually quite simple. I have the e-mail address of the job center, I write to it and I have a case worker who does this without any problems, even without this internal job center system, but really simply via an e-mail address. And that is actually a very practical thing."*
Personalized content	Related to participants' social media threads	P6: *"Yes, I look extra not and stay extra long on other pages. I don't know, somehow that doesn't work so well. With Tik Tok, you could get used to it relatively quickly. Two or three years ago I used Tik Tok a little bit and I was able to adapt the algorithm to me really quickly and it took maybe a few days. But now I feel like it's persistent with these videos."*
Privacy	Private (sensitive) data that participants do not would share with others	P23: *"I would say photos. Perhaps also very private conversation histories. They are still visible because they can still be accessed in the messenger apps."*
What is important	Represents participants' thoughts regarding privacy	P12: *"I'll put this in order: The important data that no one else should know. I'm most likely to have it on my laptop. So social security number, tax identification number, stuff like that, actually not password protected. I didn't even bother to secure it or anything like that. Otherwise, the financial services programs, because it's important to me that only I know how much is on there and what goes back and forth. So now in the news. I don't have any important messages that only I'm allowed to know. Of course, privacy and so on, but I think that's protected enough by the fact that the cell phone is simply locked."*
Private data	Various significant and sensitive data	P9: *"Yes, access to social media. We don't need access to that because it's on the phone. On my social media, I wouldn't be so cool with somebody going in there. And my banking apps. It's meant now in my 'accounts' so to speak or in general?"*
YouTube history	Classified as private data that others should not have access to	P23: *"Then I think I would also classify my online banking and also my YouTube history as private, where I just wouldn't be interested in anyone else following that."*
Correspondence	Describes writing apps to contact others	P16: *"Yes, my privacy, of course. As far as WhatsApp is concerned, of course. So that's my privacy, it's nobody's business. And if someone accesses my photos - okay, I have nothing to hide in that sense, but it doesn't have to be. I think everyone can understand that. Photos and communication - that that's just privacy issues and the rest. I don't want anyone to open my GMX program either, of course. [...]"*

Period tracking	Review and observe menstruation cycle	P10: *"[...]. Now I remember something about this cycling app. I've been looking for a long time to find one where I felt they weren't selling my data. Now I have one that seems pretty 'old-school', but from what I've read, they don't seem to sell the data. Given that, I'd imagine not a whole lot of people use it."*
Fitness/ Nutrition apps	Refers to tracking diet or the fitness status	P9: *"[...]. Adidas Running. [...]"*
Eavesdropping	Related to getting personally associated advertisements	P27: *"You always hear rumors about how cell phone microphones listen. For example, if you talk about a certain product, you'll get ads for it later or something similar. [...]"*
Trust	Participants' description of feeling unwell regarding using various devices or programs	P24: *"No, there is always the possibility that something could happen. So I don't think the technology is that safe. It can happen again and again. Even with a newer device. Maybe even sooner."*
Knowledge of no privacy	Collecting various data sources that are used by large companies	P6: *"[...]. I know that I am relatively public. [...]"*
Examination recording	Describes programs that observe students during exams to detect any deception	P8: *"So definitely this exam. I found this program absolutely not cool, that we had to do it somehow like that because I also saw a lot of people who wrote their exams differently under the same conditions without such things. I didn't really understand that and I just kind of surrendered and went along with it. Otherwise, somehow - I don't know - when I get the notification from my laptop that so and so many viruses or something else have been blocked, then I just trust it."*
Copoing with knowledge of tracking	Because of data collection, participants modify their internet usage behavior	P4: *"Yes, how can I know that? I must say, my user behavior of digital media has also changed so much... For example, I don't really want to be logged in to various services on the Internet or have profiles. I prefer to use the profiles and registration structures of my roommates or the social field, so to speak. And that's exactly why I'm not registered with 'Netflix' or 'Amazon' or other providers."*
Security	Participants' thoughts and description	P18: *"Yes, in any case, it means a lot to me. So that's also one reason why I use Signal, mainly. Because that's where the communication is, or at least I rely on it, or many people in my environment rely on it. [...]"*
What is important	Participants describe which data are significant and how they should be protected	P12: *"Particularly important: WhatsApp in any case, for many contacts. Instagram too, actually, but why that's important to me, that's actually mostly a waste of time honestly: "I'll say, for entertainment purposes, that's important to me too." And then email services and the browser, I mean you just need that!"*
Police	Related to getting help in case of a cyber-attack or data collection for criminal prosecution	P6: *"That they project that onto my Instagram algorithm or Tik Tok or WhatsApp. I don't think I'm being followed by the police or anything and that's just a very small, very short, small interest of mine and then some people already know a lot about it or something, and that bothers me a bit."*
Password	Participants using any kind of password manager to save their passwords	P28: *"Yes, but then I chose a more difficult password. I did the encryption on certain accounts when data traffic. This HTTPS mode, so the data transfer between my phone and the server of Facebook and so on is encrypted. And then that's a little bit harder to read for the hacker."*
Touch ID	One way of two-factor authentication for more protection	P20: *"I think not so satisfied because I actually do not protect so my data. Only my banking data and so I protect it with a password or fingerprint. That's the only thing I really protect, I think."*
Face ID	Another way of two-factor authentication for more protection	P12: *"This is also a requirement of the bank. It has to be like that. And depending on when you want to make transactions, you need another security procedure via SMS or another TAN app or something like that."*
Threat situation	Related to cyber attacks	P3: *"[...]. I don't know if this is interesting in any way, but there was once a case at the beginning of my studies when I was in my early 20s when a friend approached me and said: "Yes, I registered on a dating app. And there was this profile of you." And I was like: "What? No. I never registered there." And he also said that there was a photo of me where I was supposed to be smiling lasciviously or something. And to this day I'm not sure who misused my photo. Yes, that was crass. That was really, really bad."*

Threat scenarios	Related to cyber attack situations where participants also doubt the protection of their data	P20: *"You can make fake accounts with it if someone has all my data. Especially online banking accounts, actually that's even more important. Or PayPal. If someone has my data, they can steal my money or exploit my personal data. I think you can even create fake IDs. A lot of things you can do with that."*
Attacker	Various thoughts on which persons hack or do cyber attacks in general	P22: *"Of course, hackers, who now, purely theoretically, somehow . . . Blackmail me with it. So of course I'm worried about my data, but I'm probably already doing something about it to a certain extent, so I'm not acutely worried. But initially, there was actually that concern, otherwise, I wouldn't have handled it that way. So in terms of how companies tap into my data or advertising companies. Yes, that is a point. But that brings us back to the contract with the devil. If you want to take part in digital life - which means life today - you have to enter into it. Unfortunately, that means releasing data."*
Protection Practices	Whether and how participants protect their data	P10: *"Yes. I have settings in Firefox ... I attended a data security workshop years ago, and since then I've made sure that Firefox has the appropriate settings, or that I use some programs at all, so that, for example, I use 'Start Page' for googling rather than Google. I also have email encryption, but I don't use it much in a private context."*
Darknet	Participants express their experiences in browsing	P18: *"But the two things I mentioned, well, those would definitely be the topics. I was also interested in the darknet, because I just wanted to know how it is and so. But well, I haven't done that for a long time now."*
Omission	Describes participants' motivation to deal with cyber security	P5: *"[...]. There is a lot of room for improvement, but also no will to deal with it further or no more than necessary to at least be able to assess the roughest security gaps and thus make an informed decision."*
Wishlist	Participants mention what they would like to change regarding using their devices or the internet	P22: *"Yes. I would like to be able to feel that I'm using a device where I have a mode where really none of the data is being used in any way. That borders on impossible there. So apps have to work, on giving them data also in their functionality."*
Social Media	Represents entertainment and communication apps	P8: *"So, first and foremost, I communicate with friends via WhatsApp and with family. And then - I would say - as a second frequent use, whether private or university, is definitely Instagram."*
Family abroad	Apps or tools participants use to stay in touch with their family members	P20: *"[...]. And the communication app for me. So WhatsApp especially is very important for me, because my family lives abroad and I absolutely have to be in contact with my mother somehow and talk on the phone from time to time. That's why it's difficult without WhatsApp."*
Facebook	Clarifies whether participants use the app	P21: *"[...] I very rarely show interest in Facebook or anything. I really don't post photos or haven't for a long time."*
Time wasting	Some applications that participants do not use often	P6: *"No, it was actually the case that I spent far too much time on it and sometimes I didn't even realize how much time I had. I think with Netflix or YouTube you can already estimate a little bit and Insta, as I use it, is just too exhausting for me after a while. Because when I get so many messages or something, not from Friends, but from the world, then it's just kind of exhausting to read so many things. Then I just stop with Insta. Unless these animal videos come along. That's how they want to get me to spend more time. And with Tik Tok, it's just infinitely just the same and I spent way too much time with it. I spent too many hours on Tik Tok all of a sudden."*
Consumerism	Participants explain their thoughts regarding owning many devices	P19: *"Money and with more and more also ecological aspects. I just bought a bicycle now, to illustrate that, and at first, I thought I'd buy a new one. But I find it schizophrenic to somehow talk about the climate crisis and then constantly get new products. And not every cell phone I've lost, I say, with foresight, or was usually surprised when it broke. And if you then ask around in the circle of friends and acquaintances and find out, statistically speaking, now my personal statistics, each person still has two halfway suitable devices lying around in the household. I think that's stupid. That's just an expression of consumerism."*

Few apps	Only use apps that are necessary	P16: *"I don't have the need for that somehow. For example, I used to have an app - which corresponds to my interests now - an astronomy app, where you could scan the starry sky and have something displayed there. And then I have a game app, Backgammon, and at the end of the day, there's not too much on it."*
The online world is not real	Participants prefer the real world	P21: *"I don't. So for some things, it declines a little bit. So I wish that the online world doesn't run so fast and go so fast, and doesn't develop so fast."*
Intervention in life	Related to social media that represents the personal lives of humans	P2: *"Maybe in terms of social media: It's kind of cool and kind of nice, but it definitely gets on my nerves. So right now also for work - I don't like doing it, I find it super annoying. But I already have the feeling that this makes everything somehow even more to the surface and everything is somehow commercialized and maybe not money, but click numbers just somehow become super important. Sure, that's cool for the exchange of information and so, but different would be somehow better, maybe without that people always want to earn money or have to."*
Analog live	Significant data are not available digitally	P18: *"I once tried to get away from all this crap by just getting one of those analogs, in quotes, phones."*
Posts too much	Related to too many posts from others on social media	P25: *"I have the feeling that there is a lot of sharing or over-sharing. I think that's something my generation, the Millenials. This meme culture and you process some things with a certain humor and with certain images. That's already a habit. [...]"*
Information overload	Describes the feeling of overload due to too much information	P22: *"The first impulse is actually how this affects my life, and what is done with the data has not affected my life now as directly as the fact that this simply made no sense to me, the added value just wasn't there and I, therefore, didn't use it. Because of information overload and selective information from this level, and then in second place, there is also this data aspect, but that was not the reason."*
Google	Application to browse the internet	P13: *"[...]. From there, of course, I also google a lot. I also use Google and Safari on the iPhone a lot. I can't really say what I google specifically. Anything to find out anything that interests me. [...]"*
Google Drive	Beneficial for sharing documents with others and saving documents	P5: *"[...] Google is a company that has a great understanding of what the needs of people who need to work on the go are. Journalists actually relate to that as well. Or working collaboratively on documents. That's not so one-sided either. There is, after all, a way to use this platform for creativity, and a lot is being done. In other words, they simplify joint thinking just as much as you create dependency relationships."*
Google Mail	Using the application for communication	P18: *"So I have Posteo now. Previously I also had GMX and well, this Gmail runs to a halt, stupidly I did that at some point. That was also again such a well, never mind, but I hardly use that actually. And Posteo is secure. I notice that really little spam arrives and exactly, I'm not so littered with advertising and so on. So I had earlier also when I used GMX, also all these porn sites, which then suddenly have me totally amazed: What have I done now moderately? So what I have actually not at all more, so totally unwanted and things."*
Cloud-Services	Alternative for saving data or backups	P14: *"I don't use cloud systems, I don't upload my personal data to iCloud or similar programs and service providers now. But of course, my phone is connected to the Internet. That's why there is theoretically the possibility that someone pulls the pictures from my phone. But as I said, I regularly try to save the pictures on a hard drive."*

Online Banking	Describes whether participants use it and feel protected enough	P17: *"I would say that online banking is quite practical. Of course, I can also make a transfer at the bank and go there and hand in all my transfer slips. But I think that's an extreme advantage, that it really does feel very different. Shopping as well, especially online shopping, is very different from normal, real life. I think both have advantages and disadvantages. Online I just find practical, of course, you do not have to somehow push through the crowds and then stand in the fitting room, try on, and is also exhausting. But the danger is just always, order way too much and send half back again, then it does not fit. And it's just also, the people who have to carry it out. It's kind of unfair if you then order 20 things in different sizes, just to try them on at home. That's not entirely environmentally friendly and resource-friendly. But sometimes real shopping is really exhausting and often more expensive, I think. And if you have specific ideas about what you want, you can often find it better on the Internet than in stores."*
Klarna	Is used for shopping by the participants	P21: *"It is not so bad. For example, I have had a problem with Klarna. Klarna I also have. There I have the problem that I ordered at some point for a friend. They have her name saved that quasi my account is in the name of my friend. She can order because there is her name. But I don't really care because, she's a good friend and she wouldn't do it, hopefully."*
PayPal	Some participants do not trust this application or mention their experiences	P11: *"I had once with Paypal somehow a funny situation where they have written me also so somehow that they want somehow so and so much money from me or so. I had actually never used Paypal so right. That was for sure just spam. But since then I no longer use it, because I feel somehow too uncomfortable."*
Schufa	Describes the forwarding of personal data to Schufa	P26: *"[...]. I find it, for example, I see it very skeptically, what all is forwarded to Schufa, for example."*
Not much to get	Participants mention not having much money in their account, therefore an attacker can not get much of their account	P8: *"I don't know. So somehow I can imagine it so super bad. I mean, I'm a student. With me I have the feeling, there is somehow not so much to get. And it's somehow still such an unimaginable thought and somehow that a stranger does something like that and somehow so much distance anyway, that I can imagine that really super bad."*
Poverty Security & Privacy	Participants mention their income status	P9: *"I think if I had a lot of reserves, I would definitely want to keep that a secret."*
Outdated software	Participants use devices or programs that are not updated	P18: *"Yes, I have that one. But that's so really old now and I bought that a very long time ago."*
Outdated hardware	Participants use old or used devices	P10: *"I really don't have that many programs, I also have a relatively old cell phone and that's why I can't fit that much on it."*
Full memory	Participants complain about full memory and mention their struggles or alternatives	P25: *"Yes, unfortunately. My iPhones also always have very little memory."*
Classifieds	Participants use various classifieds since they are cheaper	P3: *"[...] eBay classifieds look for any tables for the balcony [...]"*
Trial subscription	Participants avoid trial subscriptions and use programs for free	P24: *"No, I have a free Spotify account."*
Advertisement	Negative perception of the participants	P16: *"[...]. But I've already deleted them because the ads are so annoying with most apps - the free ones. [...]"*
Stocks app	Describes how significant stocks are for the participants and whether they protect them	P12: *"I have my investments there. It's just different brokers where you can then have different stocks. Cryptos and shares with different providers."*
Authorities	Participants use various programs regarding insurance etc.	P23: *"[...]. Because such a picture or such a conversation is documented. And if it gets into the wrong hands, it's there and can be used for whatever. As far as certain things for authorities are concerned, this will probably result in annoying clarification work, as well as at work."*

Tax	Participants have problems while using the program for tax declaration	P11: *"[...] Whether it's tax returns or something like that, I often don't feel so confident with such details and bureaucratic German, I would say, and I have the impression that it's still easier for me to talk briefly to a real person somehow so that they can explain to me what exactly you want now or maybe I can explain to you in more detail what my details actually are or something like that, then to sit in front of forms and not understand what a phrase is now. I think that's a kind of feeling of being overwhelmed. Not so much because of the form, but more because of the content. And then, in addition, this digitized form is just a bit more difficult for me. I think that's the difference between everything that's so authority, insurance, something with "It could be problematic and it's connected with a lot of bureaucracy." That I then somehow have the impression that digitization doesn't make it any easier for me."*
Check24	Participants compare insurance prices through this application	P21:*"I use Check24 for my insurance and all sorts of things. And it's all done online."*
Health insurance	Using the insurance app	P2: *"Yes, I have now downloaded the Barmer app because I really have such paperwork allergy problems throwing my sick note in the mailbox and now I can just take a picture of it and upload it."*
Corona app	Participants used this app for their general welfare	P17: *"I think that somehow it had an overriding meaning. It was also a bit about the common good. And the more people used it, the better you could control it. Or you could get a grip on the whole thing. But I don't think it was that well received."*
Sports tracking	Participants track their sport status	P17: *"Then a tracking app like that, when you do sports and go cycling, you can then take that with you and look at it afterward, how far you've gone, how fast and stuff like that. That every now and then."*
Health apps	Describes tracking various health status	P16: *"I don't see this necessity. Everyday processes through an app - there's also a trend for everything to be optimized and recorded, for example, health apps. I take a very critical view of these."*
Apprenticeship	Using various programs for studying	P21: *"So with Untis, we have the timetable and also as a messenger in groups, and then we can write to the teachers, sort of among ourselves. It's like a messenger or like a chat. You can write privately or write in a group."*
JGU app	Provides attendance control and other functions such as timetables, etc.	P4: *"No, that's basically a 'gatekeeping app' man. I don't know if it's still done that way, but you always had to log in if you wanted to go into the library, for example, or if you went onto campus. Or if you went to the dining hall, you always had to log in and out personally. And for that, JGU provided this app. "*
BAföG	Participants apply for financial aid related to studies	P23: *"That was actually quite straightforward. I haven't received an answer yet, so I don't know if they were satisfied with it. But just simply submitting a document is actually much less complicated than sending it by mail."*
Employment office	Participants can submit applications online and offline, prefer more offline	P4: *"[...]. And as far as authorities are concerned, I can only think of the employment office. There, you also have to maintain an online profile, so to speak. Now with Covid or because of Corona in general, I have communicated with health offices or the vaccinations in any case also about it, with offices, the health office.[...]"*
"Normal"	Refers to the feeling of security while applications are filled out or requested online	P24: *"I actually felt relatively safe filling out applications online as well, for example."*

7.2 Survey Protocol

Introduction and Consent Form Brief description of the research project and the purpose of the survey.

You have read the consent form and agreed to the terms and conditions for the interview.

The participation is voluntary.

Demographic questions:

Age Please indicate your age: (18 - 25; 26 - 34; 35 - 40; 41 - 53; 54 - 67; 67+)

Gender Please indicate your gender: (man, woman, non-binary, self-describe)

Household How many people live with you in your household? (1 person (only me); Single parent (1 adult and 1 child); 2 persons (2 adults and 0 children); 3 persons (2 adults and 1 child); 4 people (2 adults and 2 children); 4+ persons (2 adults and 2+ children); 2+ adults (0 children))

Income Please tell us your (approximate) monthly net household income.
For 1 person (only me) (1200€ or less; 1201€ - 3900€; 3901€ or more)
For 2 persons (2 adults and 0 children) (1800€ or less; 1801€ - 5850€; 5851€ or more)
For 3 persons (2 adults and 1 child) (2160€ or less; 2161€ - 7020€; 7021€ or more)
For 4 people (2 adults and 2 children) (2520€ or less; 2521€ - 8190€; 8191€ or more)
For 4+ persons (2 adults and 2+ children) (2880€ or less; 2881€ - 9360€; 9361€ or more)
For 2+ adults (0 children) (2400€ or less; 2401€ - 7800€; 7801€ or more)

Education What is your highest educational qualification?

- Still in school
- No school diploma
- Secondary school diploma
- Advanced technical college
- High school diploma
- University of Applied Sciences degree
- Bachelor's degree
- Master's degree
- Magister
- Diploma
- Doctorate

Apps and devices

- Which devices that are connected to the Internet do you use professionally and/or privately?
- What do you mainly use your devices for?
- What apps, applications and services do you use with the devices?

7.3 Interview Protocol

Introduction
Brief description of the interviewer, the research project and the purpose of the interview.
You have read the consent form and agreed to the terms and conditions for the interview.
Once again, as a reminder: participation is VOLUNTARY

- the interview lasts 60-90 min
- there is an expense allowance of 40€, I will hand out the form after the call
- the recording will be transcribed by an external transcription service
- you agree with the recording of the interview

Apps and devices used

- What kind of internet connected devices do you use in your daily life?
- Do you distinguish professional and personal use?
- What apps or programs do you use regularly?
- What do you do with the programs and apps?
- Do you correspond with government agencies, insurance companies, or lawyers using apps, applications, and services?
- Are there services you know offline that make you feel different online? More secure / insecure / convenient?

Important and private data/ apps

- Are there any apps that are particularly important?
- Which ones?
- How do you deal with important services and apps in everyday life (professionally?/ privately?)?
- Is there a special application/service/app that you use that you think not many others use?
- Are there any applications/ apps that are important to you that no one else is allowed to use them except you?
- Do you have data in the apps that is very important... and very private?
- What kind of data is it?
- What is most important to you in connection with this data and apps?
- What would happen if you lost that data?
- Is there data that no one else should see that needs to stay private?
- What data do you want to protect most?
- Who should ideally not see it?
- What would happen if someone did see it?
- Do you share this data with anyone? With whom?
- Are there also apps or services that you share with others?
- What kind of services are they?
- With whom do you share this data and services?
- What do you use them for together?
- Do you also share the access data?

Experiences, Behaviors, Challenges with security and privacy

- What does security and privacy of your services, apps and data mean to you in practice?
- What do you use to determine that you are secure?
- What do you do to achieve this?
- Have you ever tried to make yourself more secure and private?
- What was the situation?
- How did you go about it?

- How did it work?
- Did anything bother you in the process?
- Is there anything that bothers you about using it?
- Have you ever felt uncomfortable or unsafe with apps and services?
- What exactly was there?
- What did you do then?

Data Loss and Online Attacks

- Are you worried about losing data?
- Or about someone seeing it who shouldn't?
- Who could have an interest in this data of yours?
- Who are you afraid of?
- What could happen to you?
- What would you do then?
- Do you think that your person plays a special role in this?
- What else are you worried about in connection with digital services and internet-connected devices?
- Overall, how safe and competent do you feel in using the important and private services and apps?
- Have you ever had any problems using them?
- What happened?
- What did you do?
- Are you happy with how you protect your data?
- What could you do wrong?
- What do you do right?

General Thoughts about Security and Privacy

- What would you like to have differently?
- How could you be supported?
- What would make it easier for you?
- What would you like to be able to do?
- What would you like to know more about?
- If you could wish for something, what would it be?

Concluding Remarks

- Do you have any questions, is there anything else you would like to say?
- Is there anything else you want to share/ share?
- How was the interview?