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**The (Lacking) User Adoption of COVID-19 Contact Tracing Apps –
Insights from Switzerland and Germany**

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ABSTRACT

COVID-19 contact tracing apps are one of the best tools we currently have available to avoid a potential second wave of COVID-19. However, sufficient critical mass in terms of uptake is required for these apps to be effective. Given the low adoption rate, a better understanding of the users' perspective is important to define measures to drive their adoption. Building on the privacy calculus, this study analyses the adoption of COVID-19 apps as a benefit-risk trade-off and provides empirical insights for Germany and Switzerland, which have been among the more successful adopters. Interestingly, we find many commonalities between both countries, which may be explained by their geographic and cultural proximity, but also with the similarities in app design and launch. However, we observe significant differences in benefit and risk perception between different groups of the population, which we classify as advocates, critics, and undecided. The findings reveal that all groups recognize the benefits of COVID-19 apps and confirm that reservations about privacy are the biggest hurdle to uptake. For the undecided and critics, our empirical data also confirms the privacy paradox, i.e. the differences between general attitudes and concrete behaviour.

Keywords: Contact tracing, COVID-19, privacy calculus, adoption, proximity tracking, benefits-risk trade-offs, mobile apps

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INTRODUCTION

COVID-19 contact tracing apps are, undoubtedly, one of the best tools we currently have to avoid the second wave of COVID-19, further incidence spikes and a return to lockdown. Experts estimate that a critical mass threshold of 60% of the country's population would be required to ensure these apps are effective (University of Oxford 2020). If uptake levels remain below, currently the case without exception, then COVID-19 apps will have to serve as a complementary solution or as part of the solution in combination with other means of combatting COVID-19, but not offer a complete solution to the current dilemma. The introduction of COVID-19 apps has been accompanied by controversial debates about the privacy implications of usage, location sharing and concerns over population monitoring (Cho et al. 2020; Redmiles 2020; Trang et al. 2020). Based on this trade-off between utility and privacy, COVID-19 apps have yet to overcome challenges associated to obtaining true consent from users (Raskar et al. 2020). Despite the low adoption rates, experts acknowledge that hope still rests on COVID-19 apps to help contain the epidemic and "sustain a version of normalised social and economic life after the pandemic lockdown in many countries" (Von Wyl et al; 2020). To enable uptake, a better understanding of the users' perspective on COVID-19 apps and the factors that drive their adoption is required. Our study builds on the large body of research in IS literature that has studied information privacy (Bélanger and Crossler 2011; Smith et al. 2011; Xu et al. 2011) to explain the dynamics of underlying user participation in the light of privacy concerns. Based on the privacy calculus (Dinev and Hart 2006), we view adoption as a benefit-risk trade-off, which the user undergoes, when deciding whether or not to adopt. More specifically, we ask the following research question: *What are users' perceptions on the benefits and risks of COVID-19 contact tracing apps?*

Based on representative samples in Germany (n = 1,022) and Switzerland (n =1,006), which are among the more successful adopters of COVID-19 apps, our study reveals commonalities between both countries. Based on actual usage, we distinguish three groups of users, as suggested by Trang et al. (2020), and draw attention to the significant differences in benefit and risk perceptions between them: respondents that are pro-usage of COVID-19 apps (advocates), who are against usage (critics), and the large group of users who are still undecided.

The remainder of this paper is structured as follows: First, we provide a background on COVID-19 apps emphasizing privacy concerns. We then develop a research model and present our research approach. Afterwards, we present the empirical results and discuss our findings.

BACKGROUND

COVID-19 Contact Tracing Apps

Contact tracing is a key control measure in the battle against infectious diseases. According to the World Health Organization contact tracing denotes "the process of identifying, assessing, and managing people who have been exposed to a disease to prevent onward transmission" (WHO 2018, p. 2). In the case of COVID-19, contact tracing requires identifying people who may have been exposed to the virus and following up with them daily for a period of at least 14 days from the last point of exposure (Ahmed et al. 2020). The fact that symptom onset may only occur days after infection makes it difficult for traditional approaches to map the network of potential exposure traces and thus control the transmission rate of the virus. Therefore, advanced techniques are required for effective contact tracing for COVID-19.

Mobile technology enables easier and faster contact tracing than traditional methods. Governments and health authorities over the world therefore promote COVID-19 apps to continuously track user's proximity and to notify them in the event of possible COVID-19

exposure for self-isolation (Legendre et al. 2020). Mobile tracing mechanisms rely on smartphone's absolute location (in the case of location-based contact tracing using the Global Positioning System / GPS) or relative location (in the case of proximity-based contact tracing via Bluetooth Low Energy / BLE). Since privacy concerns represent barriers to adoption for a large number of potential users and reservations in using authority-designed apps (Cho et al. 2020), governments around the world have been continuously evaluating and enhancing the different implementation options of contact tracing apps (Table 1). However, the critical mass adoption threshold of 60% of the population remains unattainable worldwide (University of Oxford 2020).

Table 1. Overview of Contact Tracing Apps (as of October 12th 2020)

	App	Launch Date	Number of users	% total population	Technology
	TraceTogether (Singapore)	March 20th	+2.4M	~45%	based on legacy BLE
	COVIDSafe (Australia)	April 26th	+7M	~28%	based on legacy BLE
	StopCOVID (France)	June 2nd	+2.3M	~3%	ROBERT (centralized based on legacy BLE)
	Corona-Warn-App (Germany)	June 16th	+19.3M	~23%	Apple-Google Exposure Notification
	SwissCOVID (Switzerland)	June 25th	+1.6M	~19%	DP-3T and Apple-Google Exposure Notification

Among the first countries to develop and launch a proximity-based app was Singapore with TraceTogether. As of mid-October 2020, the app has 2.3 million users indicating around 40% adoption rate (tracetogether.gov.sg). Based on the same framework, the Australian app (COVIDSafe) boasts a user base of around 7 million, representing over a quarter of the Australian population (Norman 2020). In Europe, uptake in most countries remains under expectations. France, pursuing a centralized approach, has only 3% adoption of their StopCOVID app (launched on June 2nd) (Rowe 2020) and was heavily criticized. Germany and

Switzerland are two countries that are witnessing a higher rate of adoption in Europe; they launched their apps in June 2020 and both follow a decentralized approach. Germany's Corona-Warn-App has over 19.3 million users (over 23% of the population) 4 months after the launch (RKI 2020). Switzerland's SwissCOVID app has reached 2.5 million downloads in October 2020, thereof 1.8 million (19% of the population) are classified as active users (FOPH 2020). In the US, COVID-19 apps fall into the responsibility of each state's public health authority. Currently, 10 US states are supporting Google/Apple Exposure Notification, as a prerequisite for a decentralized contact tracing approach, with New York and New Jersey being the latest to launch COVID-19 apps (Leswing 2020).

Users' Privacy Concerns for COVID-19 Apps

The major obstacles to achieving broader adoption for COVID-19 apps are often cited as reservations about data privacy, possible identification or privacy infringements via location tracking and fear of citizen monitoring by the state (Ahmed et al. 2020; Legendre et al. 2020). COVID-19 apps require active information disclosure and sharing of sensitive data, such as personal information, health information, contacts and possibly location information, which results in privacy concerns. Fears arise around states establishing Corona maps like South Korea has done (Klatt 2020), showing the movement of COVID-19 patients, whereby the health authorities have access to everything from credit card information to CCTV camera footage. Since privacy concerns represent barriers to adoption for a large number of potential users (Cho et al. 2020), governments around the world have been continuously evaluating and enhancing the different implementation options. There is a preference for applications that are privacy-preserving and do not reveal any Personally Identifiable Information (PII) about their users (Ahmed et al. 2020), which can put them at risk of being tracked or under government

surveillance. This in turn aims at fostering the adoption of the apps and reaching a critical mass. Walrave et al. (2020) highlight the ethical and legal user concerns for digital contact tracing, calling for transparent relationship with the user and clear processing of their information.

Research Gap

COVID-19 apps represent true innovation and understanding what drives their adoption is of paramount importance for societies globally. Therefore, for obtaining an increased uptake, it is crucial to understand the user's perspective on digital contact tracing (Redmiles 2020). Existing studies on COVID-19 apps has mostly focused on the technology design for privacy preserving apps (Ahmed et al. 2020; Cho et al. 2020; Yasaka et al. 2020). The few studies that have investigate the user perspective (e.g., Trang et al. 2020) were conducted before these apps were launched; they therefore lack the perspective from actual users and actual designs. This has resulted in calls for research, for instance by Von Wyl et al. (2020), on the acceptability of COVID-19 apps and adherence by the target population. A clear understanding of the benefit structure (Trang et al. 2020) of COVID-19 apps is required, and the associated concerns should be further explored. Understanding whether individuals are willing to share their data, and under which circumstances, is vital for improving the app uptake within general populations.

RESEARCH MODEL

To understand the user's perspective, we build on theoretical concepts from privacy literature on user adoption as a result of the end-user's risk-benefit trade-off. The privacy calculus framework (Dinev and Hart 2006) has gained popularity within IS research in understanding an individual's willingness to share personal information as well as location information (Naous et al. 2019; Sun et al. 2015; Xu et al. 2009). It has also received attention in terms of explaining this trade-off process in the intention to use mHealth technology (Anderson

and Agarwal 2011; Rahman 2019; Zhang et al. 2018). The privacy calculus is therefore well positioned to study the adoption of COVID-19 apps that are at the cusp of two domains within IS research, namely location-based services and mHealth. Based on the privacy calculus model, perceived benefits positively impact use of COVID-19 apps with perceived risk negatively impacting adoption (Figure 1). No matter how well the risks of COVID-19 apps are minimized, no risks are justified if they are not balanced by benefits (Martinez-Martin et al. 2020).
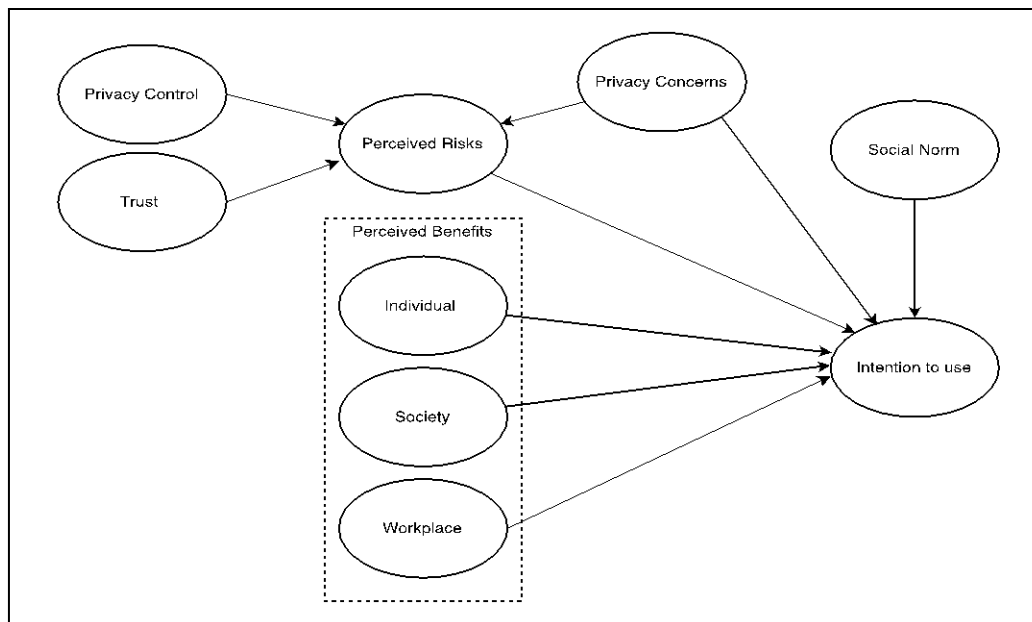

Figure 1. Privacy Calculus Model for Contact Tracing Apps

For understanding the benefit structure of COVID-19 apps, we build on and extend Trang et al.'s (2020) benefit types, namely related to self and society. To also consider the professional context, we distinguish benefits based on safety considerations at three levels: individual (or self), society and workplace. First, individual safety benefits correspond to the app being able to detect possible encounters with an infected person and receiving exposure notifications. Individual benefits may also include getting notifications about safe places, i.e., identification of hotspots and safe zones similar to MIT's SafePlaces app. However, location sharing is a pre-requisite to enjoy the benefit of safe places. Second, societal safety benefits whereby, in case the user tests

positive for COVID-19, the app notifies their recent contacts, thus protecting family, friends and public from infection. Societal benefits also comprise the benefit of generating epidemiological insights with the goal of improving the quality of reporting on COVID-19 and performing research that can help in curbing the spread of the virus. Third, workplace safety benefits, which correspond to employers being able to monitor cases of COVID-19 amongst employees and take necessary actions to implement safety measures within the company. For instance, in Singapore, employers are encouraged to ensure that their employees have TraceTogether installed and activated if they cannot work from home, as part of safety measures.

The risks related to COVID-19 apps for the individual user largely revolve around disclosing sensitive information. Sharing contact information can generally result in identification of users through their social graphs (Legendre et al. 2020). Infected users might be particularly concerned since they share their health status information to facilitate exposure notification. Moreover, sharing location information on the app can result in identification of mobility patterns that can serve as diagnostic representation of sensitive demographic information such as religious or political affiliation (Gambs et al. 2011). Privacy concerns may impact both risk perception and intention to use. Based on the Concerns for Information Privacy (CFIP) framework by Smith et al. (1996), the first two areas of concerns may be relevant for COVID-19 apps, i.e. the misuse of the information by app providers, and unauthorized secondary use of data by identifying personal aspects as social graphs and mobility patterns (Legendre et al. 2020).

Two main constructs can help mitigate perceived privacy risks: privacy controls and trust. Privacy settings on the app are a key measure for achieving information privacy (Malhotra et al. 2004) and allow users to feel in control over their data sharing, in terms of both extent (how

much personal data are being shared, when and where, and for what period) and type of information shared (Ahmed et al. 2020; Trang et al. 2020). Trust is key for voluntary utilisation, especially in places where it is difficult to enforce top-down (e.g., in well-functioning democracies) (Gupta and De Gasperis 2020), and it can affect risk mitigation. Building on Dinev and Hart's (2006) definition, it represents an individual's belief that personal information shared on the app will not be used opportunistically by a counterparty. It is a multi-dimensional construct comprising trust in app providers based on treatment of data, and trust in the government based on the relevant regulations as privacy assurance mechanisms. Finally, social pressure or social norms (Min and Kim 2015) can have an impact on the use of CT apps.

RESEARCH APPROACH AND SURVEY INSTRUMENT

We chose Germany (Corona-Warn-App) and Switzerland (SwissCOVID) for the purposes of our study as they are part of the "best-in-class" countries in Europe when it comes to COVID-19 app adoption rates to date (cf. Table 1). We conducted an online survey with representative samples from both countries, Switzerland (n = 1,006) and Germany (n = 1,022), during the post-launch period of the national COVID-19 apps, to ensure that participants had the possibility to access the app and gain first-hand experiences. Participants were recruited from a commercial online panel via mailings. The respondents were smartphone owners and existing or potential COVID-19 app users. We only included respondents who have at least heard about the COVID-19 app and have basic knowledge of its functionalities. In Germany, we collected the responses between June 25th and 28th after the launch of Corona-Warn-App on June 16th. For Switzerland, responses were received between the 7th and 12th of July, also post app launch of SwissCOVID app on June 25th. Uptake during this initial post-launch period was substantial but

has flattened out since. The study setup was examined by the Ethics Committee within our academic context, to guarantee anonymous participation and confidential data treatment.

Our questionnaire is composed of two parts: Part 1 comprises a series of questions pertaining to demographics (age, gender, residence and questions related to smartphone apps usage). Part 2 involves questions on users' perceptions of benefits and risks associated to COVID-19 app use, opinions concerning usage and sharing of information via the app, opinions related to app providers and regulations in country of residence, and questions related to mobile app usage and potential misuse of data. Questions in Part 2 were assessed on a seven-point Likert scale (between 1 = *strongly disagree* and 7 = *strongly agree*).

RESULTS

Sample Characteristics

Our survey sample of both populations is representative across gender and age groups. A moderate level of privacy consciousness is evident within both samples. In terms of smartphone usage, over 75% of respondents use social networking apps and over 65% use navigation apps.

Table 2. Sample Demographics & Privacy Consciousness

Variable	Level	Switzerland (n=1006)	Germany (n=1022)
Gender	Male	49,5%	50,2%
	Female	50,5%	49,8%
Age	18-25	12,2%	11,9%
	26-35	19,6%	17,9%
	36-45	19,6%	16,2%
	46-55	21,6%	21,8%
	56-65	17,6%	18,8%
	66-75	9,4%	13,3%
Mobile App Usage	social networking apps	77,4%	75,3%
	navigation apps	71,3%	67,8%
	banking apps	62,5%	52,8%
Privacy Consciousness	not informed	40,9%	44,5%
	moderately informed	47,5%	45,3%
	well informed	11,6%	10,2%

We asked respondents what best describes their current situation related to the COVID-19 app in their country of residence. Based on the results (see Figure 2) and utilizing terminology from Trang et al. (2020), we classify the population into advocates, critics and undecided, with undecided representing the largest of the three groups, comprising 49.7% of the German survey population and 46.1% of the Swiss survey population. We consider all respondents who are following the news or have downloaded and tried the COVID-19 app in their respective country, but do not use it as undecided. We designate all those currently using the COVID-19 app as advocates, representing 26.8% of Swiss and 23.7% of German survey respondents. Critics are classified as all respondents who have decided not to use the app or are simply not interested in it, representing approximately 26.6% of the German survey population and 27.0% of the Swiss.

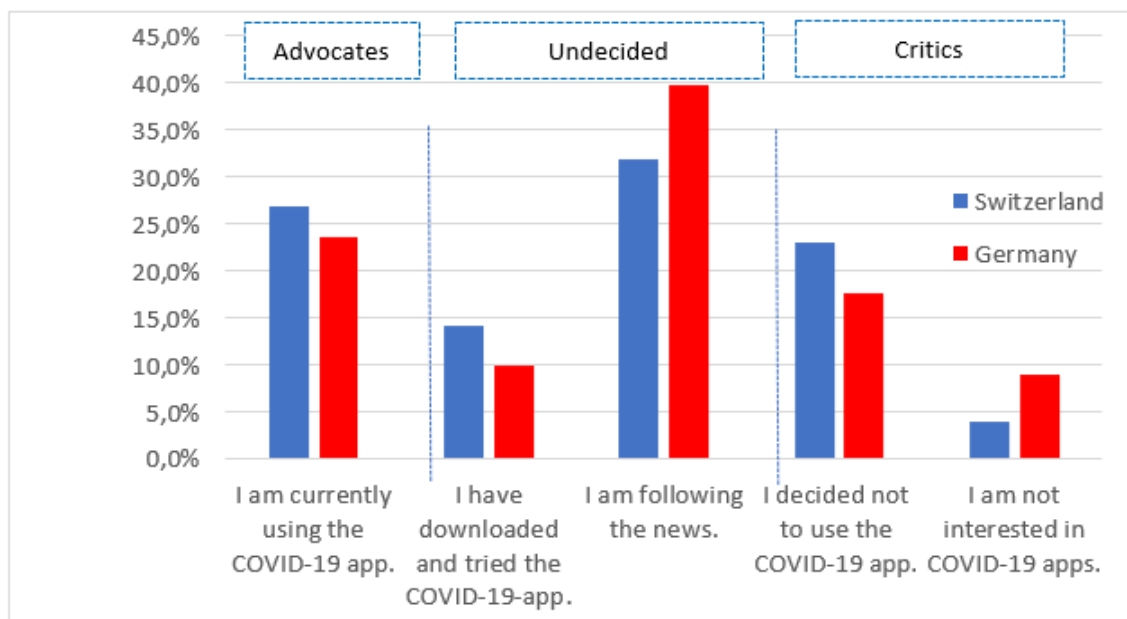

Figure 2. Attitudes towards use of COVID-19 apps for Swiss & German survey populations

Perceived Benefits

With regard to the population's perception of the benefits of COVID-19 apps (first panel in Table 3), we consider the three groups introduced above and analyse their level of agreement on individual, societal and workplace safety. Both advocates and undecided have high levels of

agreement (about 90% and 70%, respectively) concerning the benefits of proximity tracking on individual safety, and their opinion is distinct from the critics. Indeed, the latter tend to disagree that COVID-19 apps will reliably notify them upon exposure to the virus. When it comes to informing about safe places where no COVID-19 cases have been detected, only about half of the advocates and undecided agree on this benefit. However, this may also be explained by the fact that this feature requires disclosing GPS traces and is not compatible with the privacy-aware app design in Germany and Switzerland. A large share of the undecided population value societal benefits, i.e., the notification of recent contacts, to the same high extent as proximity tracking. Conversely, only one out of three of the critics agree on this benefit. Like the perception of individual benefits of safe places, the apps' support to help employers improve workplace safety is less valued: even among advocates, less than half of the respondents agree on the proposed item. Finally, more than 85% of the advocates and a large majority of the undecided trust that the app allows authorities to better monitor the spread of COVID-19. For critics in Germany, we find the lowest level of agreement (18.8%) of any above measure.

Perceived Risks and Concerns

Regarding perceived privacy risk and privacy concerns from the COVID-19 app (panel "risk" in Table 3), less than 10% advocates feel that using the app is risky. On the other hand, more than half of the critics perceive strong privacy risk. Only between 9% and 15% of advocates in Switzerland and Germany are concerned about misuse of personal information, user identification through mobility patterns, and exposure of social interactions. However, critics express important privacy concerns and are particularly concerned about the misuse of information with 59% agreeing on that statement. Throughout the proposed items, we

observe that the undecided are positioned in the middle between advocates and critics. While they clearly recognize the benefits, about one third of them perceive privacy concerns.

Perceived Control & Trust

While 78% of the advocates in Germany perceive that they control the data through privacy-preserving settings in COVID-19 apps, this level only reaches 66% in Switzerland. However, only about one in ten of the critics believe they are able to control their data. They express a similarly low level of trust in government regulations or the app providers. On the contrary, advocates in both countries strongly agree (shares of around 80%) that government regulation protects from information misuse and that app providers are trustworthy and do not misuse information. Regarding the undecided population, we observe that the group is split in two either agreeing or disagreeing on the data control and trust items.

Social Norm & Government Actions

Respondents' perception of social norms (last part in Table 3) indicate positive effects of social circle, family and influencers on user's intention to use the COVID-19 app. Close to half of the advocates in Switzerland and approximately two thirds of the advocates in Germany agree on the social pressure. We read that many users support COVID-19 apps out of social norms. Regarding government actions, more than 80% of advocates are in agreement with government actions in both countries. Even in the groups of undecided and critics, a large share agrees with the government. Nevertheless, enforcing the use of the app is only acceptable for roughly two thirds of the advocates, every third respondent of the undecided and about tenth of the critics.

Table 3: Survey Results for Germany and Switzerland

	Switzerland			Germany		
	Advocates	Undecided	Critics	Advocates	Undecided	Critics
Benefits						
Individual Safety - Proximity Tracking: I trust that the COVID-19 app notifies me on exposure to the virus.	90,7%	70,5%	33,5%	91,7%	68,9%	25,4%
Individual Safety - Safe Places: I trust that the COVID-19 app informs me about safe places where no COVID-19 cases have been detected.	44,8%	50,4%	22,4%	52,9%	52,2%	22,8%
Societal Safety: With the COVID-19 app, I am able to notify my recent contacts in case of infection with COVID-19.	79,6%	68,3%	33,8%	84,3%	70,7%	32,7%
Workplace Safety: With the COVID-19 app, my employer is able to implement safety measures within the company.	47,0%	43,3%	21,7%	46,3%	48,2%	21,3%
Epidemiological Insights: I trust that, with the COVID-19 app, authorities are able to better monitor the spread of COVID-19.	85,6%	66,8%	30,9%	86,8%	63,4%	18,8%
Risks						
Perceived Privacy Risk: I feel that using the COVID-19 app is risky.	9,3%	26,9%	50,7%	7,9%	28,7%	54,4%
Privacy Concerns - Misuse: I am concerned that with the COVID-19 app my personal information could be misused.	14,4%	36,4%	58,5%	9,5%	37,6%	59,2%
Privacy Concerns - Mobility Patterns: I am concerned that with the COVID-19 app others can identify myself through my mobility patterns.	14,8%	33,8%	54,4%	13,2%	40,2%	51,8%
Privacy Concerns - Social Interactions: I am concerned that the COVID-19 app exposes my social interactions.	12,6%	31,5%	44,9%	9,1%	31,1%	49,6%
Control and Trust						
Perceived Control: Privacy-preserving settings present in COVID-19 apps allow me to have full control over the data I provide.	66,3%	43,3%	12,1%	78,1%	41,5%	10,7%
Trust - Regulations: Government regulations protect me from any misuse of my information on the COVID-19 app.	75,9%	48,5%	15,1%	81,8%	48,2%	11,4%
Trust - App Providers: I trust that COVID-19 app providers are trustworthy and will not misuse any of my information.	78,1%	50,2%	14,0%	80,2%	42,5%	11,8%
Social Norm & Government Actions						
Social Norm: I feel that I should use the COVID-19 app because everybody else seems to be using it.	47,8%	38,6%	8,8%	64,9%	37,4%	7,4%
Agreement with Government Actions: To which extent do you agree with government's actions regarding COVID-19?	84,8%	74,6%	48,5%	88,4%	70,7%	44,5%
Enforcement of COVID-10 app: Do you think that the use of the COVID-19 app should be enforced by the government?	66,3%	35,8%	12,9%	63,2%	37,2%	10,3%

SUMMARY AND DISCUSSION

With this study, we contribute to the call for research on the users' perspective on COVID-19 apps (von Wyl et al. 2020). Building on the privacy calculus, our study sees COVID-19 app adoption decisions as benefit-risk trade-offs and provides empirical insights from representative samples in Germany and Switzerland. Interestingly, we find many commonalities between both countries, which may be explained by geographic and cultural proximity, as well as similarities in app design. In both countries, the empirical data reveals significant differences in benefit and risk perceptions between different segments of the population, which can be related to the three groups (advocates, critics and undecided) outlined in Trang et al.'s (2020) experimental study conducted in the pre-launch phase.

Our study adds to understanding the users' perspective on COVID-19 apps by exploring benefits-risk trade-offs for these three groups: In line with the privacy calculus concept, all three groups agree on individual, societal and epidemiological benefits. However, the perceived risks offsets the benefits especially for the critics, and to a lesser extent for those undecided. Advocates are characterized by a high level of agreement with the benefits and a lower awareness of privacy risks and concerns. On the other end of the spectrum are the critics, who do not fully neglect the app's benefits, but are very risk aware and concerned about misuse or exposure of sensitive data. We have been very strict in our definitions of advocates and critics, therefore leaving the remainder, with close to 50% of the respondents in both countries, as undecided. While they clearly acknowledge the benefits, they are more aware of risks - although they feel in control of their data and trust app providers and regulations. This means a large portion of both populations are undecided whether or not COVID-19 apps are a good or a bad thing for society in facing the COVID-19 threat.

The user perspective we have provided here confirms that reservations about privacy are the biggest hurdle to user critical mass of COVID-19 app uptake amongst the countries' populations. For the undecided and critics, our empirical data also confirms the privacy paradox, i.e., the differences between general attitudes and concrete behaviour: Despite their risk awareness and privacy concerns, 3 in 4 critics use social media apps, which expose much more sensitive personal information than the COVID-19 apps.

The micro or individual perspective on COVID-19 apps that we take in this study has important implications: Understanding the user perceptions helps in addressing their privacy concerns, mitigate their risk perceptions through dedicated measures for increasing the adoption. First, it seems logical that it will prove difficult to sway the critics towards acceptance. The less arduous task will be to convince the undecided and should be the immediate goal of app providers and responsible governmental authorities. If presented with lockdown as an alternative to use the country-respective app, people would certainly choose the lesser of the two evils, i.e., data privacy versus freedom and health (Rowe 2020). Retaining existing advocates and closing the gap from number of downloads to number of active users is also key. A multiplier effect could potentially be realized in having advocates advocate for more advocates, but our findings also underpin that social norm is only relevant for approximately 40% of the undecided.

We acknowledge two main limitations of our study: The first limitation stems from the reliance on the privacy calculus model, which views privacy-related-decision-making as a rational process. While this model works well for explaining adoption by advocates and critics, the group of undecided seems to have a less rationale behaviour. The second limitation is that our sample is representative for Germany and Switzerland that have similar governmental regulations and app designs, but may not be generalizable to other settings. Therefore, a cross-

country lens can provide additional insights into the user's risk-benefit trade-off, which is

governed by contextual and situational circumstances in their country.

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