Analyzing Adoption of COVID-19 Contact Tracing Apps Using UTAUT

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ABSTRACT

Contact tracing apps have been a highly debated topic during the COVID-19 epidemic. Recently released COVID-19 contact tracing apps have been lagging behind in terms of user adoption. As user adoption is crucial to the effectiveness of contact tracing apps, there needs to be a deeper investigation into possible influences on the user adoption of such apps. Therefore, this research will propose a modified version of the Unified Theory of Acceptance and Use of Technology (UTAUT) founded on a systematic literature review. A survey has been conducted with 134 participants based on this modified model. Performance expectancy and perceived credibility have been determined to have a significant impact on the intention to use a contract tracing app. Apart from providing receiving notifications about possible infections, current contract tracing apps appear to not provide a clear benefit to the user and are perceived as somewhat unsafe and privacy-invading. Furthermore, contact tracing apps might turn out to be a failure, as this research finds a low intention to use such apps. This research contributes to understanding user adoption of contract tracing apps and gives insights into possible improvements regarding the development and approach of such apps.

Keywords

Contact Tracing, Adoption Models, Virus Infections, mHealth, COVID-19, UTAUT

1. INTRODUCTION

The COVID-19 outbreak of 2020 caused thousands of deaths and a shutdown of major parts of society, devastating the world's economy. It is highly likely that we will see similar epidemics in the future, therefore a lot of research is done on how to prevent and deal with such outbreaks. One essential condition to avoid restrictions on public life is to be able to trace down and understand infection chains [1]. This allows to quarantine individuals who came in contact with an infected person, preventing further infections. A possible approach to this issue is the use of contact tracing apps, which can be installed on a user's smartphone. These apps automatically keep track of the individuals the user has been in contact with and can notify the user in case it turns out that one of these individuals has tested positive for a COVID-19 infection. While current research and discussion focus on how such an app would be implemented from a technological standpoint, the question of how citizens would accept and adopt such an app remains unanswered. As of April 2020, several countries are considering the possibility to make contact tracing mandatory for all citizens. Conversely, the European Commission prefers a voluntary approach. Citizens which are not using a contact tracing app should not be restricted in their access to third parties' services, e.g. shopping malls, public transportation, or workplaces [2]. Thus, adoption relies on the user's willingness to install and use a contact tracing app. However, for a contact tracing app to be effective, at least 60% of citizens would need to use it [3].

To provide more insight into the aforementioned problem, this research will provide an evaluation framework for contact tracing apps based on the Unified Theory of Acceptance and Use of Technology (UTAUT). This paper will first provide some background information about digital contact tracing technologies as well as adoption models. In a next step, modifications of UTAUT to better fit the use case of contact tracing apps are suggested. A research model is then proposed constructed around this theory, which will be evaluated using a questionnaire. Finally, the results of this evaluation will be discussed, including suggestions for future work.

1.1 Research Questions

This paper will answer the following research questions:

RQ1 What are possible modifications of UTAUT regarding COVID-19 contact tracing apps?

RQ2 Which determinants have a significant influence on the intention to use a contact tracing app?

There already has been a lot of research regarding the adoption of technology by individuals, particularly using the UTAUT theory. However, it is interesting to apply existing research in this field to a new technology trend in an unprecedented situation.

2. BACKGROUND

2.1 Digital Contact Tracing

The practice of contact tracing to identify virus infection paths is not novel. In the past, contact tracing has been carried out manually by medical personnel. However, research suggests that the viral spread of COVID-19 is too fast for manual contact tracing methods to be effective and that the process of contact tracing has to be sped up to contain the disease [4]. As part of the recent developments around COVID-19, there has been a lot of research and development to automize tracing using technology. One major point of discussion is the importance of privacy while designing such digital contact tracing systems. According to Yasaka et al., users' privacy concerns about location data could be a significant barrier to adoption, particularly if government entities are involved in the collection of such data [5]. There are many different frameworks and technologies in active development at the moment and it is not clear yet, which

33rd Twente Student Conference on IT, July 3rd, 2020, Enschede, The Netherlands.

approaches will turn out to be most effective and released to the public. However, it is possible to describe the overall process of a potential contact tracing app, as illustrated in Figure 1.

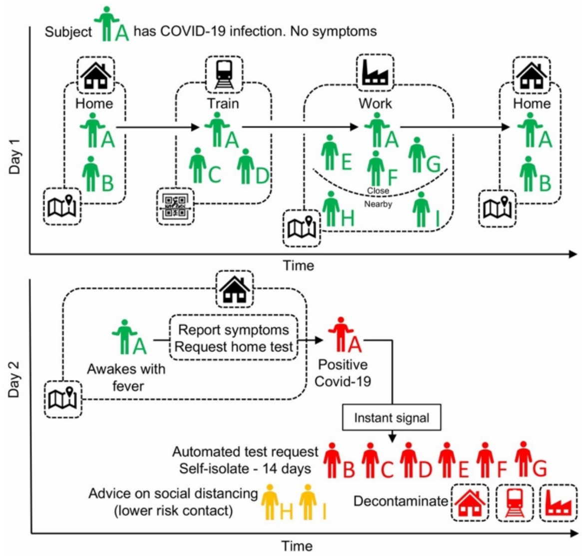

Figure 1. A schematic of app-based COVID-19 contact tracing taken from [6]**.**

Two pioneering mobile contact tracing systems are TraceTogether, which is backed by the Singaporean government, and an unnamed QR Code based system developed by the Chinese government.

2.1.1 TraceTogether

TraceTogether is a contact tracing app that has been released on 20 March 2020 and detects other nearby phones running the same app using Bluetooth. The app stores the user's phone number and a random anonymized user ID. If there are two phones running TraceTogether close to each other, the user ID, encrypted with a private key held by the Singaporean Ministry of Health, is exchanged. Installation of TraceTogether is voluntary and as of June 2020, 2.1 million people downloaded TraceTogether, equivalent to 37% of Singapore's population [7].

2.1.2 Chinese Health QR Code System

Information about the Chinese health QR code system is not completely clear and reliable. According to the New York Times, users can generate a QR code through Alipay and WeChat, two popular apps in China [8]. If the QR code is green, the user is allowed to move freely. Users with a yellow QR code need to stay in self-quarantine for seven days. A red QR code necessitates a 14-day self-quarantine. The calculations behind this QR code are not publicly disclosed. To access infrastructure, e.g. workplaces, subways, and markets, citizens need to have a green QR code. According to the local government of the Zheijang province, 90% of its residents requested a QR code [8].

2.2 Acceptance and Adoption Models

To develop a certain system, in this case a contact tracing app, decision-makers need to understand the influences on users' usage decisions. There are many different technology acceptance and adoption models, which try to explain possible determinants of adoption, each using different approaches. According to Taherdoost, Unified Theory of Acceptance and Use of Technology (UTAUT), Technology Acceptance Model (TAM), and Diffusion of Innovations (DOI) theory appear to be the most commonly used theories in the field of Information Management [9].

2.2.1 Diffusion of Innovations (DOI)

The DOI theory developed by Rogers in 1962 suggests that the spread of a new idea is influenced by communication channels, innovation, time, and social system [10]. Roger separates innovation diffusion into five different changes: Knowledge, persuasion, decision, implementation, and confirmation. Furthermore, he suggests that there are six different types of adopter personalities: Innovators, early adopters, early majority, late majority, laggards, and rejecters.

2.2.2 Technology Acceptance Model (TAM)

TAM is a theory established by Davis et al. in 1989, extending the Theory of Reasoned Action (TRA). It determines perceived usefulness and perceived ease of use as an influence on a users' intention to use and actual use. These perceptions change depending on a variety of external influences, e.g. age and experience with technology [11].

2.2.3 Unified Theory of Acceptance and Use of Technology (UTAUT)

UTAUT is another more recent theory formulated by Venkatesh et al. [12] in 2003 combining several preceding adoption and behavior theories, namely Theory of Reasoned Action (TRA), Theory of Planned Behavior (TPB), Motivational Model (MM), Technology Acceptance Model (TAM), Technology Acceptance Model 2 (TAM2), Diffusion of Innovations (DOI), Social Cognitive Theory (SCT) and Model of PC Utilization (MPCU). It describes four direct determinants of user acceptance and usage behaviors: Performance expectancy, effort expectancy, social influence, and facilitating conditions. Gender, age, experience, and voluntariness of use are considered moderating variables of these determinants.

3. MODIFYING UTAUT

UTAUT is a combination of different theories and offers one of the most complete attempts to explain technology adoption yet. Therefore, this research will focus on modifying this already very mature theory by investigating further influences, which could be particularly relevant for contact tracing apps.

Wolfswinkel et al.'s [13] grounded theory approach has been used to conduct a systematic literature review regarding the adoption of contact tracing apps and possible modifications of UTAUT. Scopus and Google Scholar have been selected to search through academic databases. The literature review took place in May 2020. An overview of the selection process can be seen in Table 1. After a preliminary selection, abstracts of papers have been read to determine the relevance of articles to this research. Based on the abstracts 21 articles were included in the final selection.

At the time of this research, there has been barely any research available yet regarding the adoption of contract tracing apps particularly using existing technology adoption and acceptance theories. However, research suggests that privacy and credibility play a major role in the adoption of location-based services [14]. This concern about privacy appears specifically relevant in the context of government involvement, as privacy concerns rise with increased government involvement [15]. Most contact tracing apps are being actively supported by the government, therefore privacy and credibility should be investigated as a possible influence on the intention to use a contract tracing app. As part of a large-scale cross-country survey, researchers found that support of contact tracing apps is determined by concerns about privacy and cybersecurity, together with trust in the government [16]. Yu [17] proposes perceived credibility as a construct to cover these concerns while applying UTAUT to the adoption of mobile banking applications.

Table 1. Overview of systematic literature review

Search query	Scopus results	Scopus selected	Google Scholar results	Google Scholar selected	Total results	Total selected
"COVID-19" and "technology" and "adoption"	16	4	20000	5	20000	9
"adoption" and "government" and "location"	370	2	2040000	0	2040370	2
"contact tracing" and "adoption"	27	1	3680	4	3707	5
"healthcare" and "app" and "adoption"	87	0	55000	0	55087	0
"mhealth" and "adoption"	578	1	20400	0	20978	1
"UTAUT" and "mHealth"	22	3	1100	0	1122	3
"UTAUT" and "contact tracing"	0	0	8	1	8	1
"UTAUT" and "mobile apps"	19	1	1770	0	1789	1
"UTAUT" and "privacy"	89	2	12700	0	12789	2
"UTAUT" and "government"	237	2	13300	0	13537	2
"UTAUT" and "healthcare" and "app"	2	0	1440	0	1442	0

Moreover, Compeau et al. [18] introduce the concepts of self-efficacy and anxiety, which are often used as moderating variables in the UTAUT context. Self-efficacy refers to the ability of the user to use a technology by himself. Anxiety is defined as the hesitation of a potential user to use a certain technology. Additionally, the attitude toward technology has been previously used as a moderating construct in UTAUT, which has originally been introduced by Ajzen & Fishbein [19].

Furthermore, existing constructs can be extended based upon preceding research regarding contract tracing app adoption in an effort to better suit the COVID-19 context. While research about contact tracing apps is scarce, there has been a survey investigating influences on contact tracing adoption in the UK [20]. While many of the discovered determinants are quite similar to the UTAUT constructs, they can provide further information about additional factors influencing the constructs. It identifies increased anxiety about the COVID-19 epidemic as one of the main barriers to adoption. A main reason for adoption is the feeling of protecting family and friends. These factors fit into the anxiety and social influence constructs respectively.

4. METHODOLOGY

4.1 Research Model

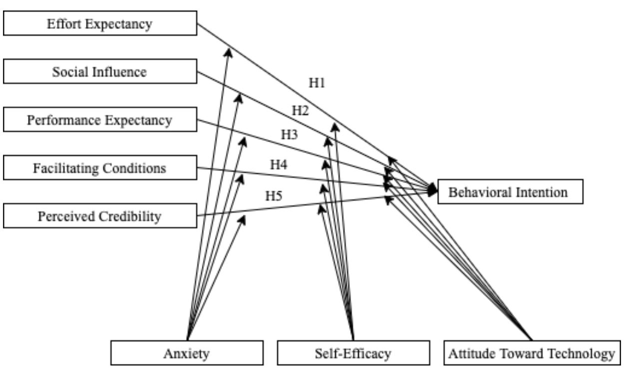

Figure 2. Illustration of research model.

The model of Venkatesh et al. determines effort expectancy, social influence, performance expectancy, and facilitating conditions as influences on the intention to use a system. We expand this model based on the preceding literature review by introducing perceived credibility as an additional variable. Furthermore, we introduce anxiety, self-efficacy, and attitude towards technology as moderating variables. Actual use has been excluded from the research model, as most countries have yet to introduce a contact tracing app at the time of this research. An illustration of the research model is shown in Figure 2.

4.2 Hypotheses

Based on the aforementioned research model we can form several hypotheses.

H1 Effort expectancy has a positive and significant impact on user intention to use contact tracing apps.

H2 Social influence has a positive and significant impact on user intention to use contact tracing apps.

H3 Performance expectancy has a positive and significant impact on user intention to use contact tracing apps.

H4 Facilitating conditions have a positive and significant impact on user intention to use contact tracing apps.

H5 Perceived credibility has a positive and significant impact on user intention to use contact tracing apps.

5. EVALUATION

To evaluate the aforementioned hypotheses a questionnaire has been designed based on the UTAUT model. In the first section, the participant was introduced to the basic principles of contact tracing apps, in case the participant never used such an app before. The following section asked for demographic information of the participant, including age, gender, nationality, and experience in using mobile apps. The third section consisted of questions taken from Venkatesh et al. [12], which have been adapted to fit the use case of contract tracing apps. Furthermore, an additional indicator has been added to the "Anxiety" and "Social Influence" construct to take into account the special context of the COVID-19 pandemic based on the preceding literature research. Additionally, questions regarding the perceived credibility have been taken from Yu [17]. Participants answered these questions on a 5-point Likert scale. The questionnaire has been conducted online with 134 participants using qualtrics.com starting from 27 May 2020 until 9 June 2020. Participants have been recruited using public posts on LinkedIn and Facebook in addition to the author's network. Responses have been analyzed using SPSS 26 and SPSS Amos 26.

Table 2. Demographic profile of respondents.

Variable		Frequency	Percent
Gender	Male	66	49.3
	Female	67	50.0
	Other	1	0.7
Age	Under 18	2	1.5
	18-24	83	61.9
	25-34	38	28.4
	35-44	6	4.5
	45-55	3	2.2
	Over 55	2	1.5
Nationality	German	40	29.9
	Dutch	39	29.1
	American	9	6.7
	British	8	6.0
	Others	38	28.4
Mobile app experience	<1 year	2	1.5
	1-2 years	1	0.8
	3-4 years	7	5.2
	5-6 years	28	20.9
	7-8 years	48	35.8
	9-10 years	20	14.9
	>10 years	28	20.9
Used contact tracing app before	Yes	17	12.7
	No	117	87.3

The demographic profile of the research participants appears to mainly consist of young adults from Germany and the Netherlands, with at least 5 years of experience in using mobile apps. Most participants have never used a contact tracing app before.

Table 3. Model fit indices

Fit index	Recommended value	Actual value
x^2/df	<3	1.737
AGFI	>0.8	0.759
RMSEA	<0.08	0.074
NFI	>0.9	0.837
CFI	>0.9	0.922

x^2/df, RMSEA, and CFI indicate a good model fit, while AGFI and NFI are slightly deviating from the recommended values, indicating a bad fit.

To test for convergent validity the average variance extracted (AVE) is used, as well as the composite reliability (CR). According to Hair et al. [21], a construct is valid if CR is above 0.7 and AVE is above 0.5.

Table 4 shows that only the EE, PC, and BI constructs pass the AVE benchmark. Furthermore, all constructs except SI have a high enough CR to be considered reliable. Therefore, the overall convergent validity and reliability is lacking to some extent. Particularly the validity and reliability of SI is concerning, as this construct failed the AVE benchmark as well as the CR benchmark.

Table 4. Convergent validity

Construct	Indicator	Factor Loading	CR	AVE
Effort Expectancy (EE)	EE1	0.664	0.849	0.587
	EE2	0.893		
	EE3	0.947		
	EE4	0.895		
Social Influence (SI)	SI1	0.913	0.667	0.340
	SI2	0.936		
	SI3	0.322		
	SI4	0.453		
	SI5	0.133		
Performance Expectancy (PE)	PE1	0.715	0.768	0.405
	PE2	0.619		
	PE3	0.763		
	PE4	0.582		
Facilitating Conditions (FC)	FC1	0.799	0.717	0.409
	FC2	0.846		
	FC3	0.759		
	FC4	0.337		
Perceived Credibility (PC)	PC1	0.949	0.902	0.666
	PC2	0.911		
	PC3	0.873		
	PC4	0.846		
Behavioral Intention (BI)	BI1	0.940	0.955	0.877
	BI2	0.889		
	BI3	0.978		

To test the discriminant validity of each construct, the squared inter-factor correlation of each construct is calculated and compared to the square root of AVE. A construct is discriminately valid if the square root of AVE is higher than the squared correlations between constructs [21].

Table 5. Discriminant validity

Construct	SI	PE	PC	FC	EE
SI	0.583				
PE	0.604	0.637			
PC	0.307	0.397	0.816		
FC	0.017	0.376	0.100	0.639	
EE	0.025	0.289	0.179	0.713	0.766

The square root of the AVE of SI is less than the value of the correlations with PE, as can be seen in Table 5. Furthermore, the square root of the AVE of FC is less than the value of the correlations with EE. Therefore, it is not possible to definitely confirm discriminant validity.

The results of the SEM seen in Figure 3, illustrate that the individual's intention to use a contact tracing app is significantly influenced by their performance expectancy ($\beta=0.21$, $p<0.05$) and their perceived credibility ($\beta=0.21$, $p<0.05$). Effort expectancy, social influence, and facilitating conditions do not appear to have a significant influence on the intention to use a contact tracing app. Based on these results H1, H2 and H4 can be rejected, while H3 and H5 can be supported.

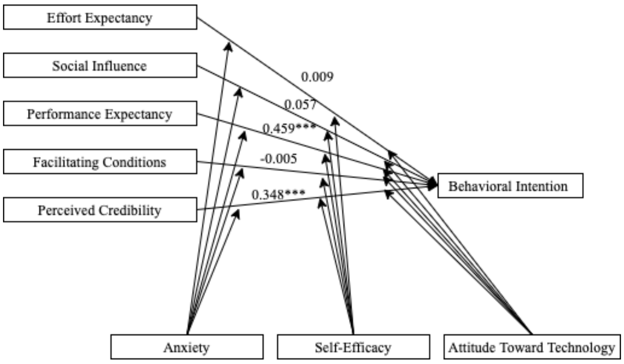

Figure 3. Results of Structural Equation Model (SEM). *, **, and * indicated that p-values are significant at 1%, 5%, and 10% levels, respectively.**

According to Venkatesh et al. [12] performance expectancy is the expected benefit the user gains from using a certain technology. In the case of contract tracing apps, a benefit can be improved health or receiving information about infections faster. Therefore, performance expectancy having a significant and positive influence on the intention to use a contract tracing app indicates that if a contract tracing app provides a clear advantage to the user, he is more likely to use the app. The perceived credibility construct is representing individual security, privacy, risk, and trust concerns of the user [17]. Thus, a user has a stronger intention to install a contact tracing app if he perceives the app as secure and trustworthy, without any risks or privacy violations associated with its use.

Table 6. Descriptive statistics of Performance Expectancy, Perceived Credibility and Behavioral Intention

Questionnaire Item	Mean	Std. Dev.
PE1	2.92	1.202
PE2	2.01	0.934
PE3	3.05	1.222
PE4	3.10	1.246
PC1	3.38	1.225
PC2	3.39	1.232
PC3	3.55	1.180
PC4	3.22	1.172
BI1	3.31	1.305
BI2	3.13	1.362
BI3	3.41	1.316

Analyzing the descriptive statistics of the questionnaire items of each significant influence, there are a few observations worth mentioning. A value of 1 indicates strong agreement, while a value of 5 indicates strong disagreement. Overall, there seems to be a slight agreement to statements regarding the performance expectancy. The mean of PE2 ("Using contact tracing apps enables me to receive information about possible infections more quickly.") stands out, as participants agreed with this statement noticeably more than with other statements of this construct. This indicates that while participants tend to believe that they will be informed about infections faster if they use a contract tracing app, they do not think that the app will be useful in daily life, improve their health or decrease the chance of a COVID-19 infection. Participants tended to disagree slightly to statements about the perceived credibility of contact tracing apps. The statement of all significant constructs, which participants disagreed the most with, is PC3 ("I believe my privacy would not be breached, when using contact tracing apps."). Therefore, many participants think their privacy would be invaded if they would use a contract tracing app. Moreover, participants appear to somewhat distrust contact tracing apps and deem them as unsafe. It is interesting to note that both constructs, which have a positive and significant influence on the intention to use a contact tracing app, are not perceived positively by most participants.

Furthermore, looking at the descriptive statistics regarding the behavioral intention, we notice that according to the mean most people do not intend to use a contact tracing app within the next six months.

Table 7. Descriptive statistics of Behavioral Intention

	Strongly agree (1)	Somewhat agree (2)	Neither agree nor disagree (3)	Somewhat disagree (4)	Strongly disagree (5)
BI1	8.96%	22.39%	22.39%	21.64%	24.63%
BI2	10.45%	32.09%	14.93%	19.4%	23.13%
BI3	9.7%	17.16%	23.13%	22.39%	27.61%

As shown in Table 7, even if we assume BI2 as the best-case scenario only 42,54% of participants strongly or somewhat agree to the statement "I predict I would use a contract tracing in the next 6 months.". Agreement to BI1 ("I intend to use contact tracing apps in the next 6 months.") and BI3 ("I intend to use contact tracing apps in the next 6 months.") is even worse, with only 31,35% and 26,86% strongly or somewhat agreeing to the statements. If we assume that the intention to use a contract tracing app would directly translate to the actual use of these apps, contract tracing apps might turn out to be a failure. As mentioned in the introduction, at least 60% of the population would have to use a contact tracing app to decrease the chance of a COVID-19 infection [3]. At the time of this research, it does not appear likely that an adoption of 60% will be reached. This is further backed up by the fact that TraceTogether has only been installed by 37% of Singapore's population and has yet to reach an adoption of 60% although it was one of the first contact tracing apps to be released to the public [7]. Another example is the recently released German contact tracing app, which has been released on 17 June 2020 and has only been installed by 16% of Germany's citizens as of 26 June 2020, despite the app featuring an extraordinarily privacy-preserving design [22].

6. CONCLUSION

This research analyzed different influences on the intended use of contact tracing apps using a modified UTAUT research model. Performance expectancy and perceived credibility have been identified to have a positive and significant impact on the intention to use contract tracing apps. As these constructs have been shown to not be positively perceived by the research participants at the time of this research, future contact tracing developments should focus on providing a clear benefit to the user as well as ensuring the user's privacy and safety to improve adoption. There have already been major improvements concerning privacy since the launch of the first contact tracing apps, however, even the German contact tracing app, which put a major focus on privacy and security, is still struggling in terms of its adoption rate. As the German app has been released very recently it might take time for the perception about the credibility of contact tracing apps to change in a positive manner and for adoption to increase. Nonetheless, at this point, it is to be doubted that contact tracing apps will be a success, especially if there are no further efforts made toward improving performance expectancy and perceived credibility. As of now, the minority of people would install a contact tracing app. Governments need to ensure that their citizens are informed about how a contact tracing app could provide an advantage to them and how safety and privacy are ensured while using such apps. If governments want to ensure high adoption and therefore high effectiveness of contact tracing apps, they would need to consider taking an approach similar to China by essentially forcing citizens to use the app though the introduction of restrictions to public life for non-users. However, such actions are conflicting with the moral values of our western society, thus it is unlikely that measures similar to Chinas will be established.

There are several points for improvement for this research as well as future research. First of all, not all constructs were shown to be completely reliable and valid. There would need to be a further investigation about why this has been the case. A higher number of participants, as well as a rephrasing of some parts of the questionnaire, might improve validity and reliability. Furthermore, it has to be considered that at the time of this research many governments have not released their respective contact tracing apps yet. Therefore, the actual usage behavior, which usually is a part of UTAUT, could not be taken into account. As part of this research, information about moderating variables has been collected but remained unused. These moderating effects could be investigated in future research. Moreover, perception of contact tracing apps might change once individuals have the possibility to actually use such apps and gain more knowledge about the technology itself. In general, the situation around contact tracing apps can be described as very dynamic, as we are not only gaining new knowledge about the coronavirus itself each day, but there has also been a lot of pioneering steps in the area of contact tracing technology as well. Lastly, the demographic profile of the research participants is not representative for the whole population. Most participants have been students from Germany and the Netherlands. However, the technologies and general approaches to contract tracing apps differ a lot between countries, influencing the participant's perception of this technology. Furthermore, younger participants might have different opinions about contact tracing apps compared to older participants.

All in all, this research should be considered as a snapshot of the early stages of contract tracing apps. It would be of interest to conduct similar research based on UTAUT with a more representative sample at a later point of time, at which most governments have released their respective apps and the general public has had time to familiarize themselves with this technology. Another potential area worth investigating in further research are the differences in adoption between different countries.

7. ACKNOWLEDGEMENTS

I would like to express my sincere gratitude to my supervisor Ton Spil for his valuable feedback and personal motivation during this research.

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9. APPENDIX

Table 8. Adapted UTAUT questionnaire

Performance Expectancy	
PE1	I would find contact tracing apps useful in my daily life.
PE2	Using contact tracing apps enables me to receive information about possible infections more quickly.
PE3	Using contact tracing apps improves my health.
PE4	If I use contact tracing apps, my chance of being infected with COVID-19 is decreased.
Effort Expectancy	
EE1	My interaction with contact tracing apps would be clear and understandable.
EE2	It would be easy for me to become skillful at using contact tracing apps.
EE3	I would find contact tracing apps easy to use.
EE4	Learning to operate contact tracing apps is easy for me.
Attitude Toward Using Technology	
AT1	Using contact tracing apps is a good idea.
AT2	Contact tracing apps make daily life more interesting.
AT3	Using contact tracing apps is fun.
AT4	I like using contact tracing apps.
Social Influence	
SI1	People who influence my behavior think that I should use contact tracing.
SI2	People who are important to me think that I should use contact tracing apps.
SI3	By using a contact tracing app, I would protect the health of people that are important to me.
SI4	The government has been helpful in the use of contact tracing app.
SI5	In general, the government has supported the use of contact tracing apps.
Facilitating Conditions	
FC1	I have the necessary smartphone to use contact tracing apps.
FC2	I have the knowledge necessary to use contact tracing apps.
FC3	Contact tracing apps are compatible with other systems I use.
FC4	A specific person (or group) is available for assistance with difficulties when using contact tracing apps.
Self-Efficacy	
SE1	I could use contact tracing apps, if there was no one around to tell me what to do while using it.
SE2	I could use contact tracing apps, if I could call someone for help if I got stuck.
SE3	I could use contact tracing apps, if I had a lot of time to get familiar with the app.

SE4	I could use contact tracing apps, if there would be a usage tutorial included within the app.
Anxiety	
AN1	I feel apprehensive about using contact tracing apps.
AN2	It scares me to think that I might cause incorrect tracing by misusing contact tracing apps.
AN3	I hesitate to use contact tracing apps for fear of making mistakes I cannot correct.
AN4	Using a contact tracing app would make me anxious about being infected with COVID-19.
AN5	Contact tracing apps are somewhat intimidating to me.
Perceived Credibility	
PC1	I believe my information is kept confidential, when using contact tracing apps.
PC2	I believe my personal information is secure, when using contact tracing apps.
PC3	I believe my privacy would not be breached, when using contact tracing apps.
PC4	I believe it is safe to use a contact tracing app.
Behavioral Intention	
BI1	I intend to use contact tracing apps in the next 6 months.
BI2	I predict I would use contact tracing apps in the next 6 months.
BI3	I plan to use contact tracing apps in the next 6 months.