



EXPLORING USER-UPTAKE OF DIGITAL CONTACT TRACING (D-CT) APPS

A PRACTITIONER GUIDE

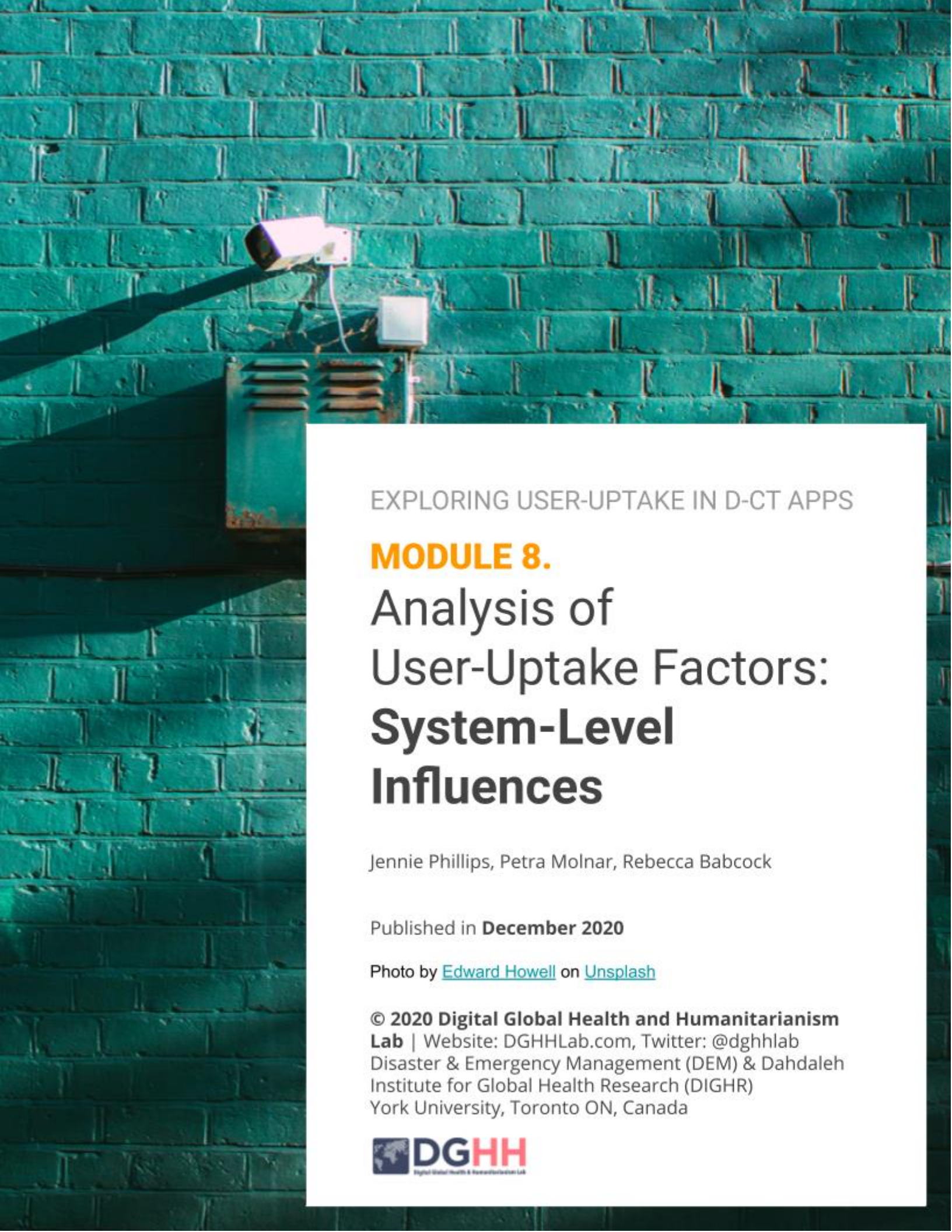
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ABOUT OUR LAB

Our research aims to shed insight into the different ways digital technologies are used in disasters and emergencies, the challenges and risks, and benefits and opportunities associated with digital technology use. We seek to provide strategies for guidance, and support efficacy-focused, ethical, low-risk interventions around the world. Our research adopts systems and complex networked perspectives, where we creating understanding through interconnectivity. We engage experts and organizations, both academic and practitioner, across disciplines to evolve research at the intersection of systems to enhance context-driven understanding.

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EXPLORING USER-UP TAKE IN D-CT APPS

MODULE 8.

Analysis of User-Uptake Factors: System-Level Influences

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8.1. Study Overview

8.1.1 Background

At the onset of the COVID-19 pandemic, Digital Contact Tracing (D-CT) emerged as a complement to Manual Contact Tracing (M-CT) to help enhance the capacity of global health systems to track and control the rapid spread and impact of the virus. This innovative approach to contact tracing attracted global attention due to its immense potential to enable faster and more widespread tracing of the virus among symptomatic and asymptomatic infected populations, while also compensating for lower resource availability and physical distancing rules hindering face-to-face care. D-CT apps and interventions from eBracelets to QR codes surged around the world, in the hope that they would make a substantial impact on curbing the global spread of the virus.

To date however, little research exists demonstrating the true impact of these tools. Specifically, despite the widespread implementation of these tools, there is little evidence that shows that D-CT tools (most often apps) do more good than harm. Coupled with issues pertaining to human rights, privacy, efficacy, and digital inclusion, one of the major problems faced with D-CT interventions (mainly those that are voluntary) is the low level of user engagement in these apps – engagement meaning uptake of the app (download and registration), but also using and updating the app, reporting a positive diagnosis through the app, and reacting to an exposure alert received through the app (see our four-stage continuum of D-CT app engagement outlined in Module 1). Looking at uptake of D-CT apps alone, rates vary drastically across different contexts. Ireland and Iceland, for example, have the highest rates of countries studied at approximately 43% and 40% respectively, while places like Cyprus or South Africa fall below 1%. And, while many argue that any degree of uptake can make a difference,¹ the dominant perception is that all of these rates are insufficient to make a substantial impact on tracing and controlling the virus. In an effort to better characterize the relationship between user engagement and app effectiveness, taking into account there is currently no magic uptake number, research is needed to understand why user-uptake varies between countries.

Through a preliminary literature review and an interdisciplinary workshop, our research team found this problem can be partly attributed to the lack of recognition and understanding of the target users of these apps. Yet, little is known regarding what incentivizes versus inhibits people from downloading these apps around the world, how context plays a role, as well as the association of perceived benefits and risks with user engagement. As part of [The Digital Global Health and Humanitarianism \(DGHH\) Lab's](#) larger study on the factors impact user-engagement across the four-stage continuum, this study focuses specifically on trying to address this gap by exploring stage 1 – user-uptake of D-CT apps – across various countries.

¹ O'Neill, P. (2020, June 5). No, coronavirus apps don't need 60% adoption to be effective. MIT Technology Review. Retrieved from <https://www.technologyreview.com/2020/06/05/1002775/covid-apps-effective-at-less-than-60-percent-download/>

8.1.2 Methodology

This research asks the following research question:

Why is there higher user-uptake of D-CT apps in some countries over others?

This question is addressed with the following sub-questions:

- i. How does uptake vary across contexts?
- ii. What factors influence uptake across contexts?
- iii. How does risk-benefit perception influence uptake?

To answer these questions, we first established the scope of our research. Our focus is on user-uptake of D-CT apps (the most prevalent form of D-CT interventions worldwide) implemented by governments around the world at the national level, that are voluntary to download, and primarily decentralized in their data collection (a measure that mitigates privacy and human rights concerns that are widely recognized as a factor that deters app engagement).² Second, a multiple case study approach was used to generate country-specific understanding of user-uptake of D-CT apps and address our research questions. Cases selected include: Iceland, Cyprus, Ireland, Scotland, and South Africa. Data was collected through interdisciplinary workshops, interviews, and meta-analysis of existing peer-reviewed and grey literature. Research findings were analyzed through a systems-approach based on Bronfennbrenner's ecological systems theory to identify varied contextual factors that influence uptake (through a risk-benefit lens).³ Bronfennbrenner's theory aims to define user behaviour as a product of intrinsic and extrinsic interactions and influences with different levels in their surrounding system: individual (micro-level), community (meso-level), and system (macro-level). Research findings are presented through a series of modules (identified in Section 8.1.4 below) through an introduction to D-CT and user-uptake; case study; systems analysis of factors identified that influence uptake; and recommendations and future research. For a more detailed overview of our research approach, please see the full methodology.

8.1.3 Overview of Cases & Factors Identified

As will be shown through the five case studies, **eight factors** that can explain uptake across the individual (micro), community (meso), and system (macro) level dimensions have been identified. Each factor is explained below.

1. **Perceptions of Data Collection & Management** - how people perceive actual data collection and management as it relates to privacy and trust; and individual understanding of privacy and security (independent of actual privacy and security measures built into D-CT apps).

² Lomas, N. (2020, April 6). EU privacy experts push a decentralized approach to COVID-19 contacts tracing. TechCrunch. Retrieved from <https://techcrunch.com/2020/04/06/eu-privacy-experts-push-a-decentralized-approach-to-covid-19-contacts-tracing/>

³ Wikipedia Contributors. (2019, February 10). Ecological systems theory. Wikipedia; Wikimedia Foundation. Retrieved from https://en.wikipedia.org/wiki/Ecological_systems_theory

2. **Sense of Community** - the level of shared trust, shared identity, sense of duty, and/or communitarian values individuals have in relation to their community; and the strength of ties/connectedness individuals have with each other.
3. **Communications & Misinformation** - the timeliness, transparency, method, and nature of information provided to the nation alongside the prevalence, spread, and control of misinformation.
4. **Accessibility & Inclusion** - the degree to which D-CT apps are equally accessible to, usable for, and inclusive of, the entire population, as well as the level of discrimination and marginalization that results from interventions that fail to account for the digital divide or socially vulnerable populations.
5. **Trust in Public/Private Institutions** - the widespread level of trust and faith in public institutions (e.g. government, response agencies) and private institutions (e.g. internet corporations like Google, Apple, as well as the developers of D-CT apps).
6. **Policy & Governance** - the use of, and adherence to, policies and governance mechanisms that regulate the development, implementation, and use of the app.
7. **Response Infrastructure** - the ability of the health infrastructure alongside the first-line response and emergency management infrastructure to manage the COVID-19 pandemic (such as access to testing, and the capacity to respond to and treat the virus).
8. **Digital Capability** - the ability of D-CT apps to effectively and efficiently serve their purpose and facilitate the management of the pandemic.

8.1.4 Practitioner Guide Outline

The findings of this study are presented through eleven modules including:

Module 00 – Executive Summary

Module 0 - Methodology

Module 1 - Digital Contact Tracing (D-CT) and User-Uptake: A Primer

Module 2 - Case Study: Iceland

Module 3 - Case Study: Cyprus

Module 4 - Case Study: Ireland

Module 5 - Case Study: Scotland

Module 6 - Case Study: South Africa

Module 7 - Analysis of User-Uptake Factors: Individual- & Community-Level Influences

Module 8 - Analysis of User-Uptake Factors: System-Level Influences

Module 9 - Recommendations & Future Research

8.2. Module Overview

This module aims to explore the system-level factors identified in our research in more depth through comparative analysis across case studies. We explore five factors – 1) Accessibility & Inclusion; 2) Trust in Public/Private Institutions; 3) Policy & Governance; 4) Response Infrastructure; and 5) Digital Capability –

identified as potential influencers of app-uptake at the system (macro) level. Discussion will begin with a brief summary of user-uptake across case studies to provide context. We then briefly describe how each factor fits within the system-level before exploring the research findings across the five case studies. We then situate these findings within the global scope (i.e. what these factors look like beyond the case studies) alongside broader discussion and emerging research on D-CT uptake in relation to risk and benefit perception.

8.3. Summary of Uptake Across Case Studies

User-uptake varied considerably across our five case studies (Iceland, Ireland, Scotland, Cyprus, and South Africa). The following is an overview of each of these case studies in terms of uptake rates,⁴ the name, description, design, and implementation approach of their apps (see Table 8.1.0 for a summary).

Uptake rates for each country were determined by using a combination of media outlet statements on D-CT app download numbers and/or uptake rates alongside manual calculations based on a country's estimated population. Ireland's *COVID Tracker Ireland* had the highest uptake rate at 43%⁵ (although if considering just active users that percentage drops to 28% of the population or 34% of the adult population),⁶ followed by Iceland's *Rakning C-19* at 40%.⁷ Scotland's *Protect Scotland* had 27.5%⁸ user-uptake, meanwhile South Africa's *COVID Alert SA*⁹ and Cyprus' *CovTracer* hovered around 1%.¹⁰ All apps were implemented by the national government and developed through collaborative partnerships between the government and public, private, and/or academic organizations. Ireland, Scotland, and South Africa use a Bluetooth-based approach to D-CT as required when using the Google Apple Exposure Notification (GAEN) Application Programming Interface (API). Meanwhile, Iceland uses an open-source GPS-based app and Cyprus uses a combination of Bluetooth and GPS for their app which is based on MIT's free, open-source SafePaths Platform. The mobile operating system requirements for these apps span iOS 9.0 and up for Cyprus and Iceland to iOS 13.0 and up for Scotland to iOS 13.5 and up for Ireland

⁴ Uptake rates are framed as a percentage representing the number of app downloads for the national population size in this section of the study. In case studies, uptake rates also are described as active users over downloads (as this measure is deemed to more accurately represent uptake) where data exists. Uptake rates also are situated in different populations including: the population that meet the age requirements to download the app (age appropriate uptake); the population that uses the internet on mobile phones (digital uptake); and the population that have Android or iOS smartphones (digital capability uptake).

⁵ Hawkins, L. (2020, September 25). NearForm's privacy-first contact tracing app has high uptake. Healthcare Global. Retrieved January 27, 2021 from <https://www.healthcareglobal.com/telehealth-and-covid-19/nearforms-privacy-first-covid-tracking-app-has-high-uptake>

⁶ Department of Health. (2020, October 21). Ireland is one of the first countries to link contact tracing apps with other EU Member States. Government of Ireland. Retrieved from <https://www.gov.ie/en/press-release/2dc55-ireland-is-one-of-the-first-countries-to-link-contact-tracing-apps-with-other-eu-member-states/>

⁷ Johnson, B. (2020, May 11). Nearly 40% of Icelanders are using a covid app—and it hasn't helped much. MIT Technology Review. Retrieved from <https://www.technologyreview.com/2020/05/11/1001541/iceland-rakning-c19-covid-contact-tracing>

⁸ Scottish Government. (2020, November 5). Protect Scotland app compatible with English and Welsh app. Scottish Government. Retrieved from <https://www.gov.scot/news/protect-scotland-app-compatible-with-english-and-welsh-app/>

⁹ Nortier, C. (2020, October 13). COVID Alert SA app: The fine balance between public health, privacy, and the power of the people. Maverick Citizen. Retrieved from <https://www.dailymaverick.co.za/article/2020-10-13-covid-alert-sa-app-the-fine-balance-between-public-health-privacy-and-the-power-of-the-people/>

¹⁰ Financial Mirror. (2020, April 7). COVID19: Thousands download Cyprus COVTRACER app. Financial Mirror: Cyprus: Life & Style. <https://www.financialmirror.com/2020/04/07/covid19-thousands-download-cyprus-covtracer-app/>

and South Africa. For Android users in Cyprus and Iceland, the OS must be 5.0 and up whereas in Ireland, Scotland, and South Africa the OS must be 6.0 and up.

Table 8.1.0: D-CT App Overview Across Case Studies¹¹

	Cyprus	Iceland	Ireland	Scotland	South Africa
Name of the App	CovTracer	Rakning C-19	COVID Tracker Ireland	Protect Scotland	COVID Alert SA
Developer(s)	Cyprus' Deputy Ministry of Research, Innovation and Digital Policy; the Research Centre of Excellence on Information and Communication Technologies in Cyprus; the Massachusetts Institute of Technology, XM.com, Prountzos & Prountzos LLC	Department of Civil Protection and Emergency Management; the Directorate of Health	Nearform	Nearform; NHS Scotland	Developer: Discovery Health SA Publisher: South African National Department of Health
Bluetooth, GPS, Both, Other	Both: GPS and Bluetooth	GPS-based	Bluetooth	Bluetooth	Bluetooth
Type of App: GAEN or Other	Other: MIT's free, open-source SafePaths platform	Other: GPS-based, open-source app	Google Apple Exposure Notification API	Google Apple Exposure Notification API	Google Apple Exposure Notification API
Mobile Requirements: e.g. iOS, Android, version	iOS 9.0 and up Android 5.0 and up	iOS 9.0 and up Android 5.0 and up	iOS 13.5 and up Android 6.0 and up	iOS 13 and up Android 6.0 and up Mobile phones must be 2015 or newer	iOS 13.5 or later Android 6.0 or later
Alternate functionality?	Symptoms checker, news function	Chat features for users to speak to public health officials additional information for tourists	Provides users with Irish COVID statistics; optional daily health check in for users	N/A	N/A
Data Deletion period	1 year	14 days for data on user's phone 14 days for data uploaded (with consent) to a centralized database	14 days for diagnosis keys, and exposure notification service identifiers; 28 days for daily symptom check-in	72 hours for submitted data to Gov.UK; 14 days for diagnostic keys (on mobile phone)	14 days

¹¹ Please note that data collected by the app and by third parties is not shown in this summarizing table. Please see individual case studies (Modules 2-6) for more specifics.

While the apps across the case studies use a decentralized method of data storage, once a user is positively diagnosed with COVID-19, all apps provide the opportunity for the user to upload the data collected by the app to a centralized source for epidemiological follow-up, manual contact tracing, and/or sending out exposure notifications. Across four of the countries (Iceland, Ireland, Scotland, and South Africa), data is stored on the app for 14 days. The exception in Ireland is the symptom check-in data which is stored for 28 days. Meanwhile, Cyprus' app stores its data for 1 year. In terms of the data collected by the centralized database (should a user upload their data), the period before data is deleted is typically the 14 days except for Scotland where the data is deleted after a 72-hour period. Only some apps offer alternate functionality beyond contact tracing. For example, Iceland's app provides a chat feature that enables users to speak with public health officials; there is also additional information for tourists. Ireland provides users with COVID-19 statistics as well as the option for daily health diagnostic check-ins. Similarly, Cyprus offers symptom checker functionality with their app.

8.4. Macro Analysis

8.4.1. Factor 4: Accessibility & Inclusion

Accessibility and inclusivity appear to have widespread influence on the ability and decision to download and use D-CT apps. Here, the notion of the digital divide (a factor frequently highlighted in the literature) has a substantial impact on uptake. This factor is considered a system (macro) level factor as it directly influences individual and community capability as a product of socio-economic (e.g. access to education, gender divides, marginalization, household income), political (e.g. political priorities) and digital information and communication technology infrastructure (e.g. internet access) contexts.

Across case studies, three main themes were identified that may explain the link between accessibility and inclusivity and uptake of D-CT apps. The first theme is **digital constraints**. Specifically, uptake is frequently impacted by mobile phone constraints, i.e. populations with older phones, out-of-date operating systems, insufficient storage space, and/or no access to phones at all are unable to download the app. Collectively, these issues are expected to impact upwards of an estimated 2 billion people globally.¹² Across case studies, iOS requirements span iOS 9.0 up to 13.5 and Android 5.0 to 6.0; individuals with prior versions are unable to download the app. In response to these challenges, there has been some discussion in Ireland, for instance, of supplying individuals with phones or other alternative tech to reduce health disparities and enhance uptake.¹³ Yet, little to no movement has occurred since the

¹² Bradshaw, T. (2020, April 20). 2bn phones cannot use Google and Apple contact-tracing tech. Retrieved from <https://www.ft.com/content/271c7739-af14-4e77-a2a1-0842cf61a90f>; Doffman, Z. (2020, April 20). Apple and Google Contact-Tracing Surprise: 2.5 Billion Users Will Miss Out. Retrieved from <https://www.forbes.com/sites/zakdoffman/2020/04/20/apple-and-google-major-contact-tracing-surprise-25-billion-users-lose-out/?sh=4e912629190a>

¹³ Clarke, V. (2020, September 25). Covid-19: Half of Ireland moving in the wrong direction, expert warns. *Irish Examiner*. Retrieved from <https://www.irishexaminer.com/news/arid-40054628.html>

topic was broached early on in the pandemic.¹⁴ Uptake also is impacted by internet connectivity constraints. In South Africa, a region where internet penetration is 62%,¹⁵ *COVID Alert SA* has been designed to require very little phone space (only 3MB) and mobile services companies have zero-rated the app so that people are not charged for the data required to download the app.¹⁶

The second theme identified is **app usability**, i.e. the extent D-CT apps are designed and implemented in a way that populations have equal opportunity and capability to use the apps. App usability can impact vulnerable groups most, including people living with disabilities; individuals with vision, literacy, language, and digital literacy challenges; and elderly populations. Usability is heavily impacted by compliance with accessibility standards. For instance, while Scotland's app is compatible with Apple and Google screen readers, Scotland's Equality Impact Assessment Report found that further consideration was required for those in the deaf and blind community, those who use British Sign Language, and people with learning disabilities.¹⁷ Relatedly, it is unclear how *COVID Tracker Ireland* and Cyprus' *CovTracer* leverage smartphone assistive technology. In addition, an app's language options impact usability. Iceland launched their website in eight languages¹⁸ while *COVID Tracker Ireland* released an instructional video in sign language on how to use the app,¹⁹ both of which are important steps in broadening access to the app. In Scotland however, support for additional languages is pending. Furthermore, in South Africa, the app is only provided in English²⁰ despite the country having 11 official languages and only 1 in 10 people using the English language at home.²¹ Specific measures to include elderly populations also have had an impact on usability. Many elderly persons, like those reported in Cyprus,²² have been struggling to adapt to the new digital landscape that COVID-19 has ushered in. Beyond simply not having access to these technologies, most elderly Cypriots are not tech savvy and also do not have children nearby to help them.²³ One interview in Iceland unveiled similar findings – that older parents relied on their children to

¹⁴ Ibid.

¹⁵ Kemp, S. (2020). Digital 2020: South Africa. *DataReportal – Global Digital Insights*. Retrieved from

<https://datareportal.com/reports/digital-2020-south-africa#:~:text=There%20were%2036.54%20million%20internet>

¹⁶ COVID Alert SA App. (2020, September 1). Why are COVID Alert SA app users South Africa's new superheroes?. COVID-19 South African Online Portal. Retrieved from <https://sacoronavirus.co.za/2020/09/01/why-are-covid-alert-sa-app-users-south-africas-new-superheroes/>

¹⁷ Digital Health & Care Scotland. (2020a). Interim national equality impact assessment - Protect Scotland app. Protect Scotland. Retrieved from <https://www.protect.scot/resources/docs/EQIA-17-september-2020.pdf>

¹⁸ Bishop, T. (2020, May 17). COVID-19 lessons from Iceland: How one Nordic country has all but stopped the virus in its track. *GeekWire*. <https://perma.cc/RKS6-LG4G>

¹⁹ Our Health Service. (2020). COVID-19 Deaf and Hard of Hearing Communications Resources. Retrieved from <https://www.hse.ie/eng/services/news/newsfeatures/covid19-updates/partner-resources/covid-19-irish-sign-language-isl-resources/covid-19-irish-sign-language-isl-resources.html>

²⁰ Editor. (2018, June 28). WORLDVIEW: Few South Africans speak English, so why is it the language of business and politics. *BizNews*. Retrieved from [https://www.biznews.com/premium/2018/06/28/english-language-business-politics#:~:text=According%20to%20Statistics%20South%20Africa,%2C%20and%20Setswana%20\(8.9%25\)](https://www.biznews.com/premium/2018/06/28/english-language-business-politics#:~:text=According%20to%20Statistics%20South%20Africa,%2C%20and%20Setswana%20(8.9%25))

²¹ Alexander, M. (2018, July 18). The 11 languages of South Africa. *South Africa Gateway*. Retrieved from <https://southafrica-info.com/arts-culture/11-languages-south-africa/>

²² Browne, B. (2020, November 8). Tech push leaving the elderly behind. *CyprusMail*. Retrieved from <https://cyprus-mail.com/2020/11/08/tech-push-leaving-the-elderly-behind/>

²³ Ibid.

help them download the app.²⁴ In Scotland's Equality Impact Assessment Report,²⁵ findings in relation to age revealed that those aged over 85 as well as people aged under 16 (due to app age restrictions) may be excluded from using the app. Given that South Africa, Ireland, and Cyprus require those who download the app to be aged 13+, 16+, and 18+ respectively, evidence suggests that younger populations are being excluded from using the app. Finally, in Scotland's Equality Impact Assessment Report, when looking at race "it was also unclear what the differences may be between a BME (Black and minority ethnic) older person and a white Scottish older person."²⁶ In South Africa, it does not appear that the government has taken steps to make the app more inclusive to the elderly, the visually impaired, or other marginalized communities.

In some instances, inclusivity also has impacted uptake in the form of **discrimination** – the third theme. For example, following a recent spike in COVID-19 cases across 11 universities in Scotland, students are being forced to download and use the *Protect Scotland* app. Although universities claim students are not required to download the app, the institutions say they will "take a strict 'Yellow Card/Red Card approach to breaches of student discipline."²⁷ According to the leader of the Scottish Labour Party, Richard Leonard, "students [are] being required to download test and protect app-unlike any other group in society"²⁸ and he has asked the Scottish Human Rights Commission to look into possible violations of students' human rights.²⁹ In this case, although user-uptake is forced, the inherent lack of inclusivity in encouraging app-engagement alongside the forced participation of a specific group of individuals is perceived to hinder motivations for uptake within broader communities. Meanwhile, as mentioned in Module 7, Section 7.5.1: Factor 2, systemic inequality in South Africa between black and white and rich and poor may result in inherent discrimination that continues to exclude groups of people from accessing and using the app on the basis of socio-economic status or race.

Accessibility and inclusivity is frequently highlighted as a major factor hindering uptake across the literature and complementary research. Interestingly, despite New Zealand's reasonably high app-uptake percentage of 53% as of February 16 2021, it is not accessible to those who are visually impaired.³⁰ This example highlights that an app may have higher uptake should it be inclusive to all. Digital literacy and the ability to adequately comprehend the app, including linguistic issues that arise when apps are only available in one or two languages in a multilingual society, impacts user-uptake. For instance, India has increased accessibility by making their app available in 12 languages (the Indian Constitution recognizes

²⁴ Personal communication, October 9, 2020

²⁵ Digital Health & Care Scotland. (2020b). Interim National Equality Impact Assessment Protect Scotland App. Digital Health & Care Scotland. Retrieved from <https://www.protect.scot/resources/docs/EQIA-17-september-2020.pdf>

²⁶ Digital Health & Care Scotland. (2020c). Interim National Equality Impact Assessment Protect Scotland App. Digital Health & Care Scotland. Retrieved from <https://www.protect.scot/resources/docs/EQIA-17-september-2020.pdf>

²⁷ Universities Scotland. (2020). Preventing spread of coronavirus in universities. Retrieved from <https://www.universities-scotland.ac.uk/preventing-spread-of-coronavirus-in-universities/>

²⁸ Kersley, A. (2020). Scottish Labour: Covid inquiry in Scotland must investigate university chaos. Labour List. Retrieved from <https://labourlist.org/2020/10/scottish-labour-says-covid-inquiry-must-investigate-university-chaos/>

²⁹ Ibid.

³⁰ RNZ. (2020, May 25). Covid 19 coronavirus: Tracing app "unusable" for the blind and those with low vision. *NZ Herald*. Retrieved from <https://www.nzherald.co.nz/nz/covid-19-coronavirus-tracing-app-unusable-for-the-blind-and-those-with-low-vision/RM4LQCBX5O54PATZXZRLNAHE/>

22 official languages).³¹ Moreover, social stratification and the differential experiences of groups as they interact with D-CT technologies is a recurrent theme that also must be taken into consideration when analyzing user-uptake and engagement with these apps. For example, groups like the Citizen Lab have raised concerns about the difficulty of certain Canadian populations gaining access to the app, specifically “marginalized groups who are often the most affected by the pandemic, including Black people, Indigenous people, people of colour and those from lower socio-economic brackets.”³² The Canadian Civil Liberties Association also noted how socio-economic factors exacerbate whether a person is able to gain access to a device capable of running the app, let alone be able to use it effectively.³³ In places like India, with growing socio-economic inequality, large swaths of the population are simply unreachable for D-CT apps.³⁴ Yet, the government has taken a hardline approach to contact tracing and made the app mandatory for workers in specific sectors as well as for all people living within certain districts.³⁵ Experts and government officials in the United Kingdom also have stressed that millions of residents will be excluded from the contact tracing app due to the digital divide.³⁶

Finally, in certain contexts, the digital gender divide also plays a role in up-to-date and accurate population tracking.³⁷ Access to smartphones also is coded along gender lines,³⁸ meaning women and people who identify as women may not be able to download and use D-CT apps if only one phone is available for the male head of the household. Also, populations that are at an increased, disproportionate risk of surveillance – such as racialized communities, sex workers and victims of domestic violence, migrants and refugees, and stateless persons – also may be less willing and able to use and download government-based D-CT apps for fears of data sharing with authorities.³⁹

8.4.2. Factor 5: Trust in Public & Private Institutions

Trust has been observed to be a prolific influencer of behavior from the individual level (discussed as perceptions of data collection) to the community level (shared trust, resilience) and also the system level, i.e. trust in private institutions (like big tech firms and app development agencies) and public institutions

³¹ Wikipedia Contributors. (2020, January 16). Languages of India. Retrieved from https://en.wikipedia.org/wiki/Languages_of_India

³² Wells, N. (2020, August 3). COVID 19 Alert app faces accessibility criticism for older Canadians, marginalized groups. *Global News*. Retrieved from <https://globalnews.ca/news/7247362/covid-19-alert-app-accessibility-criticism/>

³³ Wells, N. (2020, August 3). Rollout of COVID Alert app faces criticism over accessibility. *CBC*. Retrieved from <https://www.cbc.ca/news/politics/covid-alert-app-accessibility-1.5672881>

³⁴ Raina, P. (2020). Problems Follow India's Virus Tracing App. *US News & World Report*. Retrieved from <https://www.usnews.com/news/best-countries/articles/2020-06-08/indias-poor-left-out-by-governments-coronavirus-contact-tracing-app>

³⁵ Clarence, A. (2020, May 14). Aarogya setu: Why India's Covid-19 contact tracing application is controversial. *BBC*. Retrieved from <https://www.bbc.com/news/world-asia-india-52659520#:~:text=The%20app%20%2D%20Aarogya%20Setu%2C%20which,raises%20huge%20data%20security%20concerns.;>

Singh, P. (2020, July 16). India's Aarogya Setu becomes world's most downloaded contact-tracing application. *WION*. Retrieved from <https://www.wionews.com/india-news/indias-aarogya-setu-becomes-worlds-most-downloaded-contact-tracing-app-313748>

³⁶ Hern, A. (2020, May 15). Millions risk being locked out of Covid-19 contact tracing app. *The Guardian*. Retrieved from <https://www.theguardian.com/technology/2020/may/15/millions-risk-locked-out-covid-19-contact-tracing-app>

³⁷ Rowntree, O. (2020). The Mobile Gender Gap Report 2020. *GSMA: Connected Women*. Retrieved from <http://www.oecd.org/digital/bridging-the-digital-gender-divide.pdf>

³⁸ Ibid.

³⁹ See generally <https://www.nytimes.com/2020/04/15/opinion/coronavirus-surveillance-privacy-rights.html>

(any entity established by local, provincial, or federal governments). Trust in public institutions also broadly includes trust in government, i.e. the degree to which residents view their government as responsive, reliable, fair, open, and possessing integrity.⁴⁰ At the system level, trust is perceived to be a product of the behaviours and regulations set forth by both public and private institutions in combination with socio-economic influence.

Themes identified in the case studies that may contribute to the level of trust in public and private institutions include, first, the **role of government in developing D-CT apps**. Comparing Ireland to Cyprus, for example, Ireland leveraged partnerships with Nearform (a privacy-centric developer with a history of developing open-source solutions) to develop and implement their app. The Ireland app also was donated to Linux Foundation Public Health (an open-source software initiative between developers, technology companies, and academics to help combat COVID-19) which, according to the subject matter and context-specific experts the DGHH Lab interviewed, is perceived to be a trust building solution.⁴¹ Meanwhile, although Cyprus leveraged MIT Safepaths (an academic initiative for D-CT app development), the app was developed and implemented with heavy government involvement. The app has been associated with the Cyprus Deputy Ministry of Research, Innovation, and Digital Policy and was developed by the government-funded RISE research centre. Furthermore, publicly available information about data protection and oversight mechanisms is unclear (see Module 7, Section 7.4.1: Factor 1 for more information). As discussed in the aforementioned section, a majority of Cypriots lack trust in their government,⁴² so the course of action taken in developing and implementing the app, alongside the lack of transparency, may negatively influence user-uptake.

The second theme is linked to the **role of politics in the country's COVID-19 response**, i.e. a political approach versus an apolitical, scientific approach. Iceland experienced a 96% citizen approval rating of the COVID-19 response by Icelandic authorities.⁴³ Research shows this high approval may be in part because the government placed scientific expertise at the forefront during the pandemic,⁴⁴ with the government taking a back seat to medical experts in leading the response. This finding aligns with Bhatia *et al.* (2020) who suggest that science-focused strategic communications that are transparent and expert-driven are a contributing factor to public cooperation with contact tracing and containment measures.⁴⁵ Along the same lines, Scotland stressed that the government's COVID-19 advisory group were all experts and the

⁴⁰ OECD. (n.d.). Trust in Government - OECD. Retrieved from <https://www.oecd.org/gov/trust-in-government.htm>

⁴¹ Personal communication. (2020, November 3)

⁴² Hadjioannou, B. (2020, February 20). Eurobarometer: Cypriots distrust political parties, tend to trust the army more than other institutions. In-Cyprus.Com. <https://in-cyprus.philenews.com/eurobarometer-cypriots-distrust-political-parties-tend-to-trust-the-army-more-than-other-institutions/>; Financial Mirror. (2020, February 20). Cypriots trust the army more than politicians. Retrieved from <https://www.financialmirror.com/2020/02/20/cypriots-trust-the-army-more-than-politicians/>; Cymar. (2018, March 22). Trust and satisfaction with Institutions in Cyprus. Cymar. <https://www.cymar.com.cy/en-gb/results/cyprus-institutions/>

⁴³ Askham, P. (2020, April 21). COVID-19 in Iceland: Tenth death, new government package announced. *Grapevine*. Retrieved from <https://grapevine.is/news/2020/04/21/covid-19-in-iceland-tenth-death-new-government-package-announced/>

⁴⁴ Hjelmgaard, K. (2020, April 10). Iceland has tested more of its population for coronavirus than anywhere else. Here's what it learned. *USA Today*. Retrieved from <https://www.usatoday.com/story/news/world/2020/04/10/coronavirus-covid-19-small-nations-iceland-big-data/2959797001/>

⁴⁵ Bhatia, D., Morales-Vazquez, M., Song, K., Roerig, M., Allin, S., & Marchildon, G. (2020). COVID-19 Case and Contact Tracing: Policy Learning from International Comparisons. Toronto: North American Observatory on Health Systems and Policies. *Rapid Review* (No.25).

group's names and academic affiliations were released to the public.⁴⁶ Ireland had a similar advisory board of doctors, epidemiologists, and researchers that have been heavily engaged in the process, i.e. were placed on the advisory group for the D-CT app.⁴⁷ Similarly, in Cyprus, the government refused to politicize science and established a two-way relationship between government authorities and scientific experts: "the politicians truly listened to the scientists and the scientists gave them a correct strategy."⁴⁸ Conversely, In South Africa, while the country's COVID-19 response has been driven by science, politics still seems to be ever-present and influential. For instance, the government's history as an abusive state during the apartheid era and its historical corruption and fraud within and between political parties continue to exist and have plagued the country's COVID-19 response, thereby continuing to perpetuate individuals' distrust in the government and ultimately, decrease user-uptake of *COVID Alert SA*.⁴⁹

The third theme identified is the **D-CT app development approach** governments and implementers use, e.g. a privacy-by-design approach. All countries studied either adopted the Google Apple Exposure Notification (GAEN) API (Ireland, Scotland, and South Africa) or open-source (Iceland and Cyprus) approaches to their backend as a privacy-preserving measure. Regarding the former approach, according to the Google website, the GAEN API is built "to enable the use of Bluetooth technology to help governments and health agencies reduce the spread of the virus, with user privacy and security central to the design."⁵⁰ Alternatively, an open-source backend is believed to be more secure as it limits the risk of vulnerabilities or hidden backdoors in the code, while also providing transparency and openness in the data collection process. Although these measures are not immune to privacy risk, such apps help to ensure better privacy than many of the less-privacy centric apps like those used in Bahrain, Kuwait, or Norway.⁵¹

Beyond countries studied, the factors above are seen to be influential in other countries. For instance, Denmark is regarded as leading a science-based response rather than a political one. The country has taken a two-step approach in launching its contact tracing app to provide evidence to its residents that the app is effective in order to ultimately gain their trust to download the app.⁵² This approach may have

⁴⁶ Government of Scotland. (2020). Scottish Government COVID-19 Advisory Group. Government of Scotland. Retrieved from <https://www.gov.scot/groups/scottish-government-covid-19-advisory-group/>

⁴⁷ Personal communication. (2020, November 3)

⁴⁸ Hadjicostis, M. (2020, April 22). Cyprus. In Fighting Virus, Politicians Listened to Experts. ABC News. Retrieved from <https://abcnews.go.com/International/wireStory/cyprus%E2%80%90fighting%E2%80%90virus%E2%80%90politicians%E2%80%90listened%E2%80%90experts%E2%80%90070293442>

⁴⁹ Stone, J. (2020, September 21). What Security Experts Say About Downloading The "COVID Alert SA" App. 2oceansvibe News. Retrieved from <https://www.2oceansvibe.com/2020/09/21/what-security-experts-say-about-downloading-the-covid-alert-sa-app/#ixzz6eCF0uVtu>

⁵⁰ Google. (2020, April 10). Apple and Google partner on COVID-19 contact tracing technology. Google.com. Retrieved from <https://blog.google/inside-google/company-announcements/apple-and-google-partner-covid-19-contact-tracing-technology/>

⁵¹ Amnesty International. (2020, June 16). Bahrain, Kuwait and Norway contact tracing apps among most dangerous for privacy. Amnesty International. Retrieved from <https://www.amnesty.org/en/latest/news/2020/06/bahrain-kuwait-norway-contact-tracing-apps-danger-for-privacy/>

⁵² Trendall, S. (2020, May 7). How Denmark aims to 'create trust' in contact-tracing tech. PublicTechnology.net. Retrieved from <https://www.publictechnology.net/articles/features/how-denmark-aims-%E2%80%98create-trust%E2%80%99-contact-tracing-tech>

influenced user-uptake, which is currently around 24% as of December 18 2020.⁵³ On the contrary, the politicized response to COVID-19 in the United States may partially explain the lack of user-uptake across the country's many D-CT apps.⁵⁴ There are other factors influencing uptake in relation to trust in public and private institutions. In South Korea where contact tracing initiatives are highly invasive – with tracking occurring via apps, credit card history, CCTV footage, and other methods⁵⁵ – the country's residents remain trusting of the government. This trust may exist due to the government's transparency about the surveillance⁵⁶ as well as the implementation of publicly-supported legislation to provide health authorities with "CCTV and smartphone location data on infected citizens" in order to prevent a failure like the one the country experienced with the MERS outbreak.⁵⁷ Public understanding around government app effectiveness and the prioritization of public trust also plays a role in uptake, particularly in countries with relatively robust privacy protecting legislation. Finally, trust in public and private institutions involved in developing and deploying D-CT apps is largely tied to meaningful safeguards, accountability, and oversight mechanisms that are grounded in protecting fundamental human rights, including the right to privacy and non-discrimination. For instance, Australia and Switzerland implemented legislation regulating how their respective contact tracing app data will be collected, protected, stored, used, and deleted. This regulation may in part explain these countries' moderate app-uptake percentages which are at roughly 24%⁵⁸ and 29%⁵⁹ respectively. Policy and governance will be discussed in detail in the following section.⁶⁰

8.4.3. Factor 6: Policy & Governance

User-uptake is also likely to be influenced by the existence of robust policies and governance mechanisms that foreground human rights concerns, including the right to privacy and non-discrimination and access to meaningful oversight and accountability mechanisms. This is considered a system (macro) level influence on individuals that is the product of both political and socio-economic spheres of influence.

⁵³ The Local. (2020, September 24). What you need to know about technical error with Denmark's Smittestop Covid-19 app. The Local dk. Retrieved from <https://www.thelocal.dk/20200924/what-you-need-to-know-about-technical-error-with-denmarks-smittestop-covid-19-app>

⁵⁴ Hart, P. S., Chinn, S., & Soroka, S. (2020). Politicization and Polarization in COVID-19 News Coverage. *Science Communication*. <https://doi.org/10.1177/1075547020950735>

⁵⁵ Kluth, A. (2020, April 22). If we must build a surveillance state, let's do it properly. *Bloomberg*. Retrieved from <https://www.bloomberg.com/opinion/articles/2020-04-22/taiwan-offers-the-best-model-for-coronavirus-data-tracking>; Nature. (2020 April 29). Show evidence that apps for COVID-19 are secure and effective. *Nature*. Retrieved from <https://www.nature.com/articles/d41586-020-01264-1>

⁵⁶ Ryan, M. (2020). In defence of digital contact-tracing: human rights, South Korea and Covid-19. *International Journal of Pervasive Computing and Communications*, 16(4), 383–407. <https://doi.org/10.1108/ijpcc-07-2020-0081>

⁵⁷ Chakravorti, B. (2020, July 6). Digital contact tracing's mixed record abroad spells trouble for US efforts to rein in COVID-19. *The Conversation*. Retrieved from <https://theconversation.com/digital-contact-tracings-mixed-record-abroad-spells-trouble-for-us-efforts-to-rein-in-covid-19-140414>

⁵⁸ Meizner, S. (2020, June 1). How many people have downloaded the COVIDSafe app and how central has it been to Australia's coronavirus response? ABC News. Retrieved from <https://www.abc.net.au/news/2020-06-02/coronavirus-covid19-covidsafe-app-how-many-downloads-greg-hunt/12295130>

⁵⁹ Künzi, M. (2020, October 29). How 80% of the Swiss population will download the COVID-App. Enigma. Retrieved from <https://enigma.swiss/en/blog/how-80-of-the-swiss-population-will-download-the-covid-app/>

⁶⁰ See for example <https://www.healthcareitnews.com/blog/emea/test-and-trace-three-point-plan-regain-public-trust>, <https://www.policingthepandemic.ca/>

The first theme connecting policy and governance with user-uptake is **level of compliance with existing privacy regulations**. Beyond national borders, four of the five countries (Ireland, Scotland, Iceland and Cyprus) are governed by, and adhere to, the European-wide General Data Protection Regulation (GDPR) on data protection and privacy in the European Union and the European Economic Area. This regulation also addresses the transfer of personal data outside the EU and EEA areas.⁶¹ These countries also are governed by the Directive on Privacy and Electronic Communications (ePrivacy Directive).⁶² Research suggests however, that Cyprus' *CovTracer* app may be at risk of breaching regional and international data protection laws, including the General Data Protection Regulation (GDPR). Extrapolating from the European Commission's "Common EU Toolbox for Member States," Cyprus may be a problematic jurisdiction as it is unclear what safeguards exist regarding the sharing of users' personal and location data. According to the Commission, collecting "location data is not necessary nor recommended for the purpose of contact tracing apps" and tracking users' "movements in the context of contact tracing apps would violate the principle of data minimization and create major security and privacy issues."⁶³ The European Data Protection Board acknowledges however, that collecting and storing location data "on the user's device" is permissible if "the user has given consent."⁶⁴ Since *CovTracer* stores all data on users' devices and requires consent before harvesting said data, the app may meet legal standards but not best practice principles. In addition, there is speculation that (1) *CovTracer* may be relying on algorithmic decision making (governed by Article 12 of the GDPR),⁶⁵ and (2) the app's security measures may be insufficient to comply with the European Data Protection Supervisor (EDPS) and other compliance bodies.⁶⁶ Finally, the Cyprus app has a data deletion period of one year which greatly exceeds the deletion period of many other D-CT apps (both within these case studies and more broadly). Even – and especially – in times of emergency like a global pandemic, international human rights law dictates⁶⁷ that any and all measures that limit people's rights and freedoms must be lawful, necessary, and proportionate. In contrast, in South Africa, Emma Sadleir, a social media law expert, has claimed that the app is compliant with South Africa's Disaster Management Act as well as its Protection of Personal Information Act.⁶⁸ The app has even gained the approval of Justice Catherine O'Regan, the COVID-19 designated judge.⁶⁹ Ultimately, D-CT apps are not immune to international legal standards and their compliance with these

⁶¹ Note, it remains to be seen how Scotland will be affected by the upcoming BREXIT regulations and their impacts on the applicability of the GDPR.

⁶² 4 Consolidated Version of the Directive on Privacy and Electronic Communications (ePrivacy Directive), 2002 O.J. (L 201) 37, <https://perma.cc/YHA5-EFXV>

⁶³ eHealth Network. (2020, April 15). *Mobile applications to support contact tracing in the EU's fight against COVID-19*. Retrieved from https://ec.europa.eu/health/sites/health/files/ehealth/docs/covid-19_apps_en.pdf

⁶⁴ European Data Protection Board. (2020, April 21). *Guidelines 04/2020 on the use of location data and contact tracing tools in the context of the COVID-19 outbreak*. Retrieved from https://edpb.europa.eu/sites/edpb/files/files/file1/edpb_guidelines_20200420_contact_tracing_covid_with_annex_en.pdf

⁶⁵ Ibid.

⁶⁶ Ibid.

⁶⁷ See for example analysis by Human Rights Watch of binding international instruments such as the International Covenant on Economic, Social, and Cultural Rights (ICESCR), the Syracuse Principles, and Others: https://www.hrw.org/news/2020/03/19/human-rights-dimensions-covid-19-response#_Toc35446577

⁶⁸ Nortier, C. (2020, October 13). COVID Alert SA app: The fine balance between public health, privacy and the power of the people. *Maverick Citizen*. Retrieved from <https://www.dailymaverick.co.za/article/2020-10-13-covid-alert-sa-app-the-fine-balance-between-public-health-privacy-and-the-power-of-the-people/>

⁶⁹ South African Government News Agency. (2020, September 2). Health launches COVID-19 contact tracing app. South African Government News Agency. Retrieved from <https://www.sanews.gov.za/south-africa/health-launches-covid-19-contact-tracing-app>

overarching frameworks of governance and accountability will likely only increase uptake by users who have the right to have their freedoms protected while also limiting the spread of COVID-19.

The second theme is at the intersection of **transparency of policies** and **lack of additional safeguards** surrounding the collection and management of D-CT app data. In Scotland for example, data can be shared “with police and other organizations that demonstrate an undefined ‘legitimate reason’ to access the data such as levying fines.”⁷⁰ Such vague framing and potentially overbroad data sharing with law enforcement without adequate safeguards in place is unlikely to withstand legal scrutiny. This type of data sharing is likely to impact public trust in government-initiated D-CT apps, as real concerns exist around the sharing of sensitive health data, location, and personal indicators with law enforcement. Marginalized communities are particularly vulnerable in this case, especially those that already face the brunt of over-policing and increased surveillance such as racialized communities, sex workers, LGBTQ2S+ persons, persons facing precarious housing situations, Indigenous groups, and persons with precarious immigration status, among others.⁷¹ Indeed, any limits on human rights must take into consideration disproportionate impacts on marginalized groups and specific vulnerable populations.⁷² Similarly, in Ireland, although individuals possess a high sense of trust in the government, O’Callaghan *et al*’s (2020) study on national attitudes of D-CT reflected deep rooted fear of D-CT apps acting as a conduit to more invasive, longer term surveillance measures.⁷³ Once again, this highlights the need for safeguards to protect people and their data. Meanwhile, the *Rakning C-19* (Iceland) privacy policy is easy-to-digest,⁷⁴ the country “transposed the GDPR into Icelandic law” to “promote that personal data be treated in accordance with fundamental principles and rules on the protection of personal data and respect for private life,”⁷⁵ and has an independent body – the Icelandic Data Protection Authority – enforcing data protection rules.⁷⁶ It seems as though the policy surrounding *Rakning C-19* is perceived as sufficient and appropriate to regulate D-CT. This context may not only explain higher uptake rates in Iceland, but also provide understanding as to why the country does not have legislation directly regarding D-CT, as will be briefly explored in the paragraphs following. This rights-respecting approach and clear messaging around the protection of people’s rights and liberties strengthens user trust in the interventions and reassures the public that their data will not be misused. This approach also ensures that users’ health status will not be used to discriminate now and in the future, and that false positives will be dealt with quickly and

⁷⁰ McLaughlin, M. (2020). Coronavirus: Police must be kept out of trace system, Sturgeon is warned. *The Sunday Times*. Retrieved from <https://www.thetimes.co.uk/edition/scotland/coronavirus-police-must-be-kept-out-of-trace-system-sturgeon-is-warned-09wzw5wdh>

⁷¹ See for example <https://www.policingthepandemic.ca/>

⁷² See also <https://www.hrw.org/news/2020/05/13/mobile-location-data-and-covid-19-ga>

⁷³ O’Callaghan, M. E., Buckley, J., Fitzgerald, B., Johnson, K., Laffey, J., McNicholas, B., ... Glynn, L. (2020). A national survey of attitudes to COVID-19 digital contact tracing in the Republic of Ireland. *Irish Journal of Medical Science*. <https://doi.org/10.1007/s11845-020-02389-y>

⁷⁴ Zhang, M., Chow, A., & Smith, H. (2020). COVID-19 Contact-Tracing Apps: Analysis of the Readability of Privacy Policies (Preprint). *Journal of Medical Internet Research*. <https://doi.org/10.2196/21572>

⁷⁵ Act on Data Protection and the Processing of Personal Data art. 1

⁷⁶ Library of Congress Law Library. (2020, June). *Regulating Electronic Means to Fight the Spread of COVID-19*. Retrieved from <https://www.loc.gov/law/help/coronavirus-apps/coronavirus-apps.pdf>

transparently with a recognition of their potential far reaching impacts, including on job loss in precarious employment situations, health insurance claims, and other potential far-reaching ramifications.⁷⁷

Beyond case studies, policy and governance has been a globally contentious issue linked to uptake. As more and more countries turn towards various innovative solutions to trace the spread of COVID-19, risks are beginning to emerge. Ultimately, if insufficient safeguards exist, these interventions may be co-opted and turned into mechanisms of surveillance. This is not only problematic for the general public, but it also disproportionately impacts marginalized groups.⁷⁸ Although these concerns are exacerbated in jurisdictions with weaker rights protecting mechanisms, they are by no means isolated. Groups like Amnesty International and Human Rights Watch have been tracing the far-reaching ramifications of D-CT apps across the globe – from Norway to Kuwait, from Israel to Australia, from Iran to England.⁷⁹ For instance, the voluntary D-CT app in Iran, *AC19*, was accused by residents as being a governmental surveillance tactic upon discovering the app was developed by Smart Land Strategy (a company that recently was accused of building spyware for the government).⁸⁰ While Iran has not “enacted comprehensive data protection legislation,” there are some provisions in existing laws and regulations.⁸¹ Furthermore, the country is in the process of drafting the Personal Data Protection and Safeguarding Act. Unfortunately, the Draft Act “is inconsistent with the international legal obligations of Iran to adequately protect the privacy rights of its citizens.”⁸² In this case, there does not seem to be the policies or governance in place to adequately protect residents if they were to engage with a D-CT app and share personal data nor stop the government from surveilling its residents. This factor may explain why the country had roughly 5% app-uptake prior to the app being taken down from Google Play.⁸³

Even in Canada, where the *COVID Alert* app has been approved by the Office of the Privacy Commissioner of Canada (OPC) and the Office of the Information and Privacy Commissioner of Ontario (IPC), their report stated that “it bears noting that an app, described worldwide as extremely privacy sensitive and the subject of reasoned concern for the future of democratic values, is defended by the Government of

⁷⁷ Canadian Civil Liberties Association. (2020, August 6). CANADA’S CONTACT TRACING APP: TO DOWNLOAD OR NOT. Retrieved from <https://ccla.org/contact-tracing-app/>

⁷⁸ Molnar, P., & Naranjo, D. (2020, April 15). Opinion | Surveillance Won’t Stop the Coronavirus. *The New York Times*. Retrieved from <https://www.nytimes.com/2020/04/15/opinion/coronavirus-surveillance-privacy-rights.html>

⁷⁹ Amnesty International. (2020, June 16). Bahrain, Kuwait and Norway contact tracing apps among most dangerous for privacy. Amnesty International. Retrieved from <https://www.amnesty.org/en/latest/news/2020/06/bahrain-kuwait-norway-contact-tracing-apps-danger-for-privacy/>; Human Rights Watch. (2020, May 13). Covid-19 Apps Pose Serious Human Rights Risks. Human Rights Watch. Retrieved from <https://www.hrw.org/news/2020/05/13/covid-19-apps-pose-serious-human-rights-risks>

⁸⁰ Gilbert, B. (2020, March 10). The Iranian government released an official coronavirus app for Iranians, but Google pulled it from its app store. *Business Insider*. Retrieved from <https://www.businessinsider.com/iran-coronavirus-app-pulled-by-google-2020-3?r=US&IR=T>

⁸¹ DLA Piper. (2019, May 23). Data Protection Laws of the World: Iran. Retrieved from <https://www.dlapiperdataprotection.com/index.html?t=law&c=IR#:~:text=Iran%20has%20not%20enacted%20comprehensive,regulations%20incorporate%20data%20protection%20provisions.&text=The%20Law%20Concerning%20Protection%20of,and%20Access%20to%20Data%202010>

⁸² Article 19. (2019, June 27). Iran: Personal Data Protection and Safeguarding Draft Act. Retrieved from <https://www.article19.org/resources/iran-data-protection-draft-act/>

⁸³ Udin, E. (2020, March 11). Coronavirus: Google Deletes Detection App after 4 million Downloads. *GizChina*. Retrieved from: <https://www.gizchina.com/2020/03/11/coronavirus-google-deletes-detection-app-after-4-million-downloads/>

Canada as not subject to its privacy laws"⁸⁴ Therefore, in Canada, it appears as though people are not protected by privacy laws when using the app. In fact, groups like the Canadian Civil Liberties Association (CCLA) have recognized the privacy-preserving, voluntary nature of the app in Canada's approach,⁸⁵ but also have called for greater transparency around data sharing, surveillance, and the recognition of differential impacts on various groups across the socio-political spectrum.⁸⁶

At the regional level, there has been some recognition of these risks. For example, the European Commission and the European Data Protection Board published guidance on the need to protect privacy and other fundamental rights as early as April 2020.⁸⁷ Similarly, Switzerland's parliament passed a legal amendment (prior to the implementation of the country's D-CT app) to govern the app and protect data collected by the app.⁸⁸ Meanwhile, Australia passed legislation (after the implementation of the country's D-CT app) to regulate how long data is retained, when data is deleted, how data could be used and by whom, as well as to prevent data from being moved offshore.⁸⁹ Beyond existing privacy regulations, these countries have implemented further legislation to safeguard personal data as it relates directly to D-CT apps which may explain the countries' respective 29%⁹⁰ and 24%⁹¹ app-uptake rates.

8.4.4. Factor 7: Response Infrastructure

Another uptake factor is the state of a nation's response infrastructure, specifically as it relates to health and emergency management. This factor is especially important during COVID-19 as it impacts individual access to testing and treatment as well as broader management of the pandemic. This is a system (macro) level factor influencing individuals, considered to be the product of political and socio-economic spheres of influence.

⁸⁴ Office of the Privacy Commissioner of Canada. (2020, July 31). Federal and Ontario privacy commissioners support use of COVID Alert application subject to ongoing monitoring of its privacy protections and effectiveness [News Release]. Retrieved from https://www.priv.gc.ca/en/opc-news/news-and-announcements/2020/nr-c_200731/

⁸⁵ Office of the Premier. (2020, June 18). Ontario Enhancing COVID-19 Case and Contact Management [News Release]. Retrieved from <https://news.ontario.ca/en/release/57279/ontario-enhancing-covid-19-case-and-contact-management>

⁸⁶ Canadian Civil Liberties Association. (2020, August 6). CANADA'S CONTACT TRACING APP: TO DOWNLOAD OR NOT. Retrieved from <https://ccla.org/contact-tracing-app/>

⁸⁷ European Data Protection Board. (2020, April 21). Guidelines 04/2020 on the use of location data and contact tracing tools in the context of the COVID-19 outbreak. Retrieved from https://edpb.europa.eu/sites/edpb/files/files/file1/edpb_guidelines_20200420_contact_tracing_covid_with_annex_en.pdf

⁸⁸ Swissinfo.ch. (2020, June 25). Switzerland launches SwissCovid tracing application for residents. *Swissinfo.ch*. Retrieved from <https://www.swissinfo.ch/eng/switzerland-launches-swisscovid-contact-tracing-app-for-residents/45859778>

⁸⁹ Taylor, J. (2020, May 15). CoviSafe app: how Australia's coronavirus contact tracing app works, what it does, downloads and problems. *The Guardian*. Retrieved from <https://www.theguardian.com/australia-news/2020/may/15/covid-safe-app-australia-how-download-does-it-work-australian-government-covisafe-covid19-tracking-downloads>; Goldenfein, J. (2020, July 27). The Political Life of COVIDSafe Contact Tracing in Australia. *Blogdroiteuropeen*. Retrieved from <https://blogdroiteuropeen.com/2020/07/27/the-political-life-of-covisafe-contact-tracing-in-australia-by-jake-goldenfein/>

⁹⁰ Künzi, M. (2020, October 29). How 80% of the Swiss population will download the COVID-App. *Enigma*. Retrieved from <https://enigma.swiss/en/blog/how-80-of-the-swiss-population-will-download-the-covid-app/>

⁹¹ Meizner, S. (2020, June 1). How many people have downloaded the COVIDSafe app and how central has it been to Australia's coronavirus response? ABC News. Retrieved from <https://www.abc.net.au/news/2020-06-02/coronavirus-covid19-covisafe-app-how-many-downloads-greg-hunt/12295130>

Two main themes emerged in the research that suggest a link between the response infrastructure and uptake. The first theme relates to **response infrastructure experience and capability**. Comparing case studies, both Iceland (high uptake) and South Africa (low uptake) have extensive experience in managing crises yet the state of their health and emergency management infrastructure dramatically differs. From avalanches to volcanoes, Iceland labels itself as “...used to catastrophes.”⁹² They have legislation and public infrastructure in place for rapid response, which was apparent in their initial response to COVID-19. Preparation started early with free widespread testing available and contact tracing plans in place prior to the first positive case. Similarly, South Africa has widespread experience managing health epidemics like HIV and Tuberculosis (TB). Through efforts like redirecting HIV and TB clinics to assist with COVID-19 cases and ongoing door-to-door case finding, South Africa is leading the continent in testing per capita.⁹³ Yet, their health system has been unable to meet resource demands to effectively contain and control the virus. This is due to a lack of trained medical professionals, the inability to meet demands beyond managing the existing high prevalence of disease (HIV, TB, etc.), and reliance on imports for medical supplies.⁹⁴ Also, the health system is not equally accessible to the entire population. Black Africans typically live farther away from health facilities and do not necessarily have the resources to travel.⁹⁵ Furthermore, not everyone has health insurance and the poor have to go to public hospitals even though most ventilators are in private hospitals.⁹⁶

The **dynamics between manual and digital contract tracing** is the second theme that may influence uptake. Iceland established their manual contact tracing infrastructure well before COVID-19 cases started to increase and before *Rakning C-19* was implemented. Once the app was implemented, there were clear lines of interoperability between digital and manual methods. Manual contact tracers for example, have the ability to reach out to people through the app to request sharing their information to help track the virus. Similarly, in Ireland and Scotland (also quite high uptake), contact tracing team members will phone, text, or send an email to individuals that test positive (if they have it on record). Individuals also will be provided with a code which they then enter into the app so that other app users that may have contact with that person will receive an exposure notification. This approach is also seen in South Africa. Yet, while app-related communications highlight why the app is needed to supplement manual contact tracing (M-CT), it appears as though the D-CT and manual contract tracing methods are less integrated in South Africa in comparison to other countries.⁹⁷

⁹² Kolbert, E. (2020, June 1). How Iceland beat the Coronavirus. The New Yorker. Retrieved from <https://www.newyorker.com/magazine/2020/06/08/how-iceland-beat-the-coronavirus>

⁹³ Travaly, Y., Mare, A. (2020, July 8). Learning from the best: Evaluating Africa's COVID-1i responses. Brookings. Retrieved from <https://www.brookings.edu/blog/africa-in-focus/2020/07/08/learning-from-the-best-evaluating-africas-covid-19-responses/>

⁹⁴ Investec. (2020, June 8). Is SA's healthcare system prepared for Covid-19? Investec. Retrieved from https://www.investec.com/en_za/focus/beyond-wealth/is-south-africas-healthcare-system-prepared-for-covid-19.html; Anna, C. (2020, May 29). South Africa has virus testing backlog of nearly 100,000. CTV News. Retrieved from <https://www.ctvnews.ca/health/coronavirus/south-africa-has-virus-testing-backlog-of-nearly-100-000-1.4960080>;

⁹⁵ Devermont, J., & Mukulu, T. (2020, May 12). South Africa's Bold Response to the Covid-19 Pandemic. CSIS. Retrieved from <https://www.csis.org/analysis/south-africas-bold-response-covid-19-pandemic>

⁹⁶ Ibid

⁹⁷ Discovery. (2020, November 20). “Turn your smartphone into a life-saving device.” Discovery Insurance. Retrieved from <https://www.discovery.co.za/corporate/download-covid-alert-sa-app-today>

Beyond the case studies, study suggests that there must be a perceived benefit to app users regarding system capability to encourage uptake of D-CT apps. Specifically, the higher the perception of the response system capability, the more likely to have app-uptake. This implies access to testing and treatment is widely available and digital interventions are released in a timely and integrated manner (i.e. at the start of the pandemic and in complement to established systems and approaches like manual contact tracing initiatives). Without testing or treatment capability, there may be little incentive to download D-CT apps. As an example, Denmark has “carried out more tests per capita than any other country in Europe”⁹⁸ and research suggests that the country’s healthcare infrastructure is sufficient to manage the pandemic.⁹⁹ For instance, modelling two situations – one based on COVID-19 data from China and one based on data from Italy – Denmark will have “sufficient capacity of both ICU beds and ventilators.”¹⁰⁰ The perceived strong capability of Denmark’s healthcare infrastructure to manage the pandemic may have influenced user-uptake, which is currently around 24%.¹⁰¹ Meanwhile, in Canada, healthcare infrastructure capacity is certainly a concern, particularly for Indigenous communities where they had insufficient “physical infrastructure and supplies needed to manage an outbreak” prior to the pandemic.¹⁰² As a final example, France’s complex healthcare context further created challenges surrounding the capacity of the healthcare infrastructure. Many nurses and specialists were on strike in Nov-Dec 2019 demanding additional resources for hospitals.¹⁰³ Combined with insufficient PPE and diagnostic tests (a result of the “overreaction” of H1N1),¹⁰⁴ residents may perceive the healthcare system to be unable to test or treat positive cases, thereby creating a disincentive to download the TousAntiCovid app, of which 16% of the population has downloaded.¹⁰⁵

Revisiting an earlier discussion in Section 8.4.2 that apolitical/scientific-based management of pandemics may enhance uptake, in situations where a country’s emergency response strategies are intertwined with political priorities, individual perceptions of the health system’s capacity to respond will likely be impacted, thereby impacting uptake. The United States is a particularly poignant example as the action taken in response to COVID-19 at the federal level has been quite politicized and not driven by science. As a result, not only may residents perceive that the national health system’s capacity is unable to respond,¹⁰⁶ but the actuality is that the “explosive growth” in COVID-19 cases – arguably a direct result of the

⁹⁸ Kavacevic, T., Butcher, B. (2020, October 9). Covid in Europe: How much testing do other countries do? BBC. Retrieved from <https://www.bbc.com/news/54181291>

⁹⁹ COVID-19 Health System Response Monitor. (n.d.). Denmark. Retrieved from <https://www.covid19healthsystem.org/countries/denmark/livinghit.aspx?Section=2.1%20Physical%20infrastructure&Type=Section>

¹⁰⁰ Ibid.

¹⁰¹ The Local. (2020, September 24). What you need to know about technical error with Denmark’s Smittestop Covid-19 app. The Local dk. Retrieved from <https://www.thelocal.dk/20200924/what-you-need-to-know-about-technical-error-with-denmarks-smittestop-covid-19-app>

¹⁰² COVID-19 Health System Response Monitor. (n.d.). Canada. Retrieved from <https://www.covid19healthsystem.org/countries/canada/livinghit.aspx?Section=2.1%20Physical%20infrastructure&Type=Section>

¹⁰³ COVID-19 Health System Response Monitor. (n.d.). France. Retrieved from <https://www.covid19healthsystem.org/countries/france/livinghit.aspx?Section=2.1%20Physical%20infrastructure&Type=Section>

¹⁰⁴ Ibid.

¹⁰⁵ Fisher, T. (2021, January 15). TousAntiCovid is stalling and “is not possible to slow the spread of the epidemic”, says Cedric O. Inside Wales Sport. Retrieved from <https://www.insidewalesport.co.uk/tousanticovid-is-stalling-and-is-not-possible-to-slow-the-spread-of-the-epidemic-says-cedric-o/>

¹⁰⁶ Santhanam, L. (2020, September 1). COVID-19 has eroded confidence in the U.S. health care system. PBS News Hour. Retrieved from <https://www.pbs.org/newshour/health/covid-19-has-eroded-confidence-in-the-u-s-health-care-system>

unscientific nature of the response – is causing a significant strain on an already ill-prepared healthcare system.¹⁰⁷ Indeed, this context may negatively influence app-uptake. Finally, for systems that are not as prepared to respond to crises, e.g. much of the developed world, they may fare poorer than those that frequently face similar crises. As stated by Umar Ruhi, an associate professor of business analytics and information systems at the University of Ottawa: “these countries tend to have limited resources for enforcing containment measures and fragile health systems.”¹⁰⁸ In the case of Africa, as seen in South Africa amongst other countries, these countries are possibly very capable in terms of epidemic response capacity, but in many cases they have other challenges in responding to a pandemic that are more so linked to resources, politics, and broader socio-economic status.

8.4.5. Factor 8: Digital Capability (e.g. how effective the app can be, e.g. Bluetooth issues, modelling issues, etc.)

Perceptions of D-CT apps to act as a viable intervention to help contain and control the spread of COVID-19 emerged as another uptake factor in this study. We refer to this factor as digital capability, i.e. the level of effectiveness and efficiency of D-CT apps in achieving their intended purpose. This is considered a system (macro) level factor that is the product of the political, digital infrastructure, and socio-economic spheres of influence.

Across cases, five themes were identified regarding digital capability as an influencer of uptake. First, from Canada to the UK,¹⁰⁹ countries around the world have highlighted the need for **interoperability** to enhance D-CT capability. Specifically, apps need to be designed so that they can work across state and national borders, enabling a consistent exposure pathway for people moving between areas to not have to download a new app for each region. This functionality is, for example, fundamental for essential workers that must cross borders. Ireland, Scotland, and Northern Ireland have made great strides in building interoperability into their apps which may improve app-uptake. Many of the apps developed by Nearform (their shared app developer), and using the code developed for the Irish contact tracing app, are now interoperable.¹¹⁰ Therefore, for these countries where the developer and code are shared, the process to make an app interoperable is much easier. Yet, some countries have gone farther to interlink apps beyond a shared code or developer. In Ireland’s case, *CovidTracker Ireland* is now interoperable with the apps from Germany and Italy which are not developed by Nearform.¹¹¹ These apps are a part “of the first wave of national apps linked through the European interoperability gateway.”¹¹² While Scotland, Cyprus, and Iceland may be included in the European interoperability gateway in the future, only Scotland

¹⁰⁷ Unruh, L., Alexander, M., Koval, A., & Webb, E. (2020). North American COVID-19 Policy Response Monitor: United States. *Toronto, Canada: North American Observatory on Health Systems and Policies*. Retrieved from https://ihpme.utoronto.ca/wp-content/uploads/2021/01/US-COVID19-Response-Monitor_20201223.pdf

¹⁰⁸ Rocha, R. (2020, June 22). What countries did right and wrong in responding to the pandemic. *CBC News*. Retrieved from <https://www.cbc.ca/news/canada/covid-19-coronavirus-pandemic-countries-response-1.5617898>

¹⁰⁹ Government of Scotland. (2020). Protect Scotland app compatible with tracing apps in Northern Ireland and Jersey. Retrieved from <https://www.gov.scot/news/protect-scotland-app-compatible-with-tracing-apps-in-northern-ireland-and-jersey/>

¹¹⁰ Ibid.

¹¹¹ Gorey, C. (2020, October 19). Irish Covid Tracker app now linked with apps from Germany and Italy. *Silicon Republic*. Retrieved from <https://www.siliconrepublic.com/enterprise/irish-covid-tracker-app-interlinked-germany-italy>

¹¹² Ibid.

currently is interoperable with other countries. Similarly, South Africa also seems to not be interoperable. Lack of interoperability may prove to be a disincentive for app-uptake. Any implementation of interoperability however, also must include a discussion of its risks both from an international as well as at the domestic app level. Interoperable data sharing between different jurisdictions may not be legally compliant, particularly if one jurisdiction does not have robust governance mechanisms in place. There also must be robust regulations and disincentivization against interoperability across various government entities, including law and border enforcement, as not only will such data sharing breach national and regional privacy-protecting legislation but user-uptake will likely be impacted if their data collected for the purpose of D-CT applications are widely shared, leading to profound potential human rights infringements.

Second, uptake challenges also have been associated with poor app functionality in **less connected environments**. In response, Scotland has designed their app to function in areas underground or on trains benefiting commuters.¹¹³ As described in Section 8.4.1, South Africa has developed their app so that it requires minimal space to download and mobile service providers have zero-rated the app so that people are not charged for the data used to download the app.¹¹⁴ In the above examples, improving app functionality in less connected environments may influence user-uptake. Whereas lack of action to address this issue, as seen in Ireland, Iceland, and Cyprus, may prove to be a disincentive.

Third, app implementers also appear to operate on the assumption that uptake challenges are associated with the **single-purpose functionality** of D-CT apps. As such, many of the apps studied also integrate additional functionality to help build their perceived usefulness. Some apps have additional chat features to connect with health officials (Iceland) to symptom checkers (Cyprus) to general statistics and optional health check-ins (Ireland). The extent these apps were useful and/or impacted uptake of these apps however, is inconclusive at this time as insufficient data currently exists on the benefits of added functionality. Therefore, whether Iceland, Cyprus, and Ireland's additional app features improve uptake in comparison to the single-purpose functionality as seen in Scotland and South Africa remains to be seen.

Fourth, perceptions of **app reliability** also appear to influence uptake. Glitches have been claimed across the case studies. In Cyprus, many app users claim the app does not work at all – claiming that glitches in the app force them to uninstall and reinstall and update the app regularly, which leads to a loss of all tracing data lost and created new every time.¹¹⁵ In Scotland, as highlighted in Module 7, Section 7.6.1: Factor 3, senior personnel in Police Scotland's health and safety group have allegedly labeled the app as

¹¹³ Fraser, G. (2020). In context: Protect Scotland app. Holyrood. Retrieved from <https://www.holyrood.com/inside-politics/view.in-context-protect-scotland>

¹¹⁴ COVID Alert SA App. (2020, September 1). Why are COVID Alert SA app users South Africa's new superheroes?. COVID-19 South African Online Portal. Retrieved from <https://sacoronavirus.co.za/2020/09/01/why-are-covid-alert-sa-app-users-south-africas-new-superheroes/>

¹¹⁵ Google Play. (n.d.). CovTracer - Apps on Google Play. Google Play. <https://play.google.com/store/apps/details?id=edu.rise.ihnilatis&hl=en&gl=US>

unreliable.¹¹⁶ In Ireland, the app was rapidly draining the battery of users' phones.¹¹⁷ These glitches and negative narratives may negatively influence app-uptake. Whether app updates fix these issues positively influence app-uptake will likely be determined over time as developers work out the issues and users start to experience a more consistent, reliable app.

The use of **centralized versus decentralized data collection** was identified as a fifth theme perceived to have strong uptake implications in terms of perceived digital capability. Ireland, for example, used a centralized approach in the initial stages of their digital contact tracing system.¹¹⁸ According to participant interviews, this form of data management was deemed to be more inline with traditional epidemiological approaches where one uses an index patient and their known contacts to develop a potential exposure chain. Bluetooth issues associated with their current app however, forced developers to reconsider their approach and weigh the many trade-offs between centralized and decentralized exposure notification systems associated with the scale of data collected and user metrics, data security risk, privacy concerns, and other technological barriers. These trade-offs are outlined in Table 8.2.0 below, which was developed by the DGHH Lab team and is based on the team's research and analysis. Ultimately, the Ireland team made the decision to switch to a decentralized approach that prioritized proximity tracking/exposure notification over centralized data collection for more streamlined tracking of the virus.

Table 8.2.0: Overview of Centralized vs. Decentralized Trade-Offs

Centralized	Decentralized
+ More data for epidemiology and tracing	- Less epidemiological data
+ Metrics on app may be easier to collect or access	- Metrics may be harder to access
- Central data storage may present security risk	+ more secure
- Harder to scale	+ Easier to scale
- Potential user reluctance due to privacy concerns	+ More privacy centric may encourage greater use
- Technological barriers to function, no current fix	+ Google/Apple API was developing support this model

Meanwhile, Scotland, Iceland, and Cyprus used a decentralized approach from the beginning due to its perceived benefits, privacy-preserving components, and the negative connotations associated with a

¹¹⁶ Morrison, H. (2020). Officers urged to use NHS app-despite senior Police Scotland personnel calling it 'unreliable'. *Glasgow Times*. Retrieved from <https://www.glasgowtimes.co.uk/news/18784386.cops-urged-use-nhs-app---despite-top-cops-calling-unreliable/>

¹¹⁷ Irish Examiner. (2020, August 10). HSE says Covid app update will deal with glitch. Irish Examiner. Retrieved from <https://www.irishexaminer.com/news/arid-40030187.html>

¹¹⁸ Where data is stored and managed via a central location.

centralized approach. South Africa, on the other hand, started with a centralized approach of mobile phone data collection to track people before moving to *COVID Alert SA* which takes a decentralized approach.¹¹⁹ Ultimately, study suggests that due to the negative and positive perceptions of centralized and decentralized methods of data collection respectively, a decentralized approach will increase user-uptake whereas a centralized approach will hinder user-uptake.

Beyond the case studies, similar themes surrounding digital capability can be seen in the literature and in D-CT apps globally. Germany's app has had a multitude of glitches, from not working as reliably on buses, trains, and subways to error messages that require users to uninstall the app.¹²⁰ Up until a recent update, the UK's app was sending false alarms and phantom reports alongside not notifying people of exposure (amongst other issues).¹²¹ In terms of the decentralized versus centralized discussion, France has chosen, and defended, a centralized approach despite many countries within the EU abandoning that model due to privacy concerns. Yet, it may be a contributing factor as to why France has moderate app-uptake. In fact, Norway was forced to backtrack on its *SmitteStopp* app because the data collection posed "a disproportionate threat to user privacy – including by continuously tracking and uploading people's GPS location to a national database for half a year."¹²² The centralized component seems to be a key component in the ruling against Norway being able to continue using its D-CT app. Finally, returning to the interoperability discussion at the beginning of this section, Canada's *COVID Alert* app – which started in only a few provinces including Ontario – has started to expand and is now available for download and use in 9 of its 13 provinces and territories which may positively influence app-uptake.¹²³

8.5. Conclusion

Module 8 provided an overview of the system (macro) level factors identified in our research. The first factor was Accessibility & Inclusion. Digital constraints, app usability, and discrimination were the three themes explored in relation to the first factor. Trust in Public & Private Institutions was the second macro level factor identified. The main themes identified were the role of government in developing D-CT apps, role of politics in the country's COVID-19 response, and D-CT app development approach. The third factor was Policy & Governance where the level of compliance with existing privacy regulations alongside the intersection of transparency of policies and lack of additional safeguards surrounding the collection and management of D-CT app data were the two main themes identified. Response Infrastructure was the fourth factor identified. Response infrastructure experience and capability as well as the dynamics between manual and digital contact tracing were the two themes explored. The final factor was Digital

¹¹⁹ Young, N. (2020, April 7). South Africans are worried the government will use coronavirus phone tracking to spy on them. Quartz Africa. Retrieved from <https://qz.com/africa/1834409/coronavirus-south-africans-are-worried-about-cellphone-privacy/>

¹²⁰ Oltermann, P. (2020, September 23). Glitches dent German enthusiasm for Covid contact-tracing app. *The Guardian*. Retrieved from <https://www.theguardian.com/world/2020/sep/23/glitches-dent-german-enthusiasm-for-covid-contact-tracing-app>

¹²¹ Mageit, S. (2020, November 2). NHS COVID-19 contact tracing app fails to ask users to self-isolate. *Healthcare IT News*. Retrieved from <https://www.healthcareitnews.com/news/emea/nhs-covid-19-contact-tracing-app-fails-ask-users-self-isolate>

¹²² Hoeksma, J. (2020, June 18). Norway forced to backtrack on mass surveillance track and trace app. *Digital Health*. Retrieved from <https://www.digitalhealth.net/2020/06/norway-track-and-trace-app/>

¹²³ Government of Canada. (2020, October 30). Download COVID Alert today. Government of Canada. Retrieved from <https://www.canada.ca/en/public-health/services/diseases/coronavirus-disease-covid-19/covid-alert.html>

Capability where interoperability, less connected environments, single-purpose functionality, app reliability, and centralized versus decentralized data collection were the five themes discussed. For an overview of the individual (micro), community (meso), and community-system (meso-macro) level factors influencing user-uptake, see Module 7. For recommendations and future research, see Module 9.