



Requirements, Politics, or Individualism

What Drives the Success of COVID-19 Contact-Tracing Apps?

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From the Editor

Requirements engineers are attuned to the information that must be specified to define a product. Functional requirements, requirements for the quality and performance of the product, and technical or other constraints that bound the solution space are all considered. The sudden and unexpected demand for technical solutions to aid contact tracing during the COVID-19 pandemic highlighted the criticality of a nonfunctional requirement category that's perhaps the most elusive to define: trust. The degree to which users trust developers and their government sponsors' work truly has life or death consequences, with a very small allowable margin for error. Contact tracing apps appeared suddenly around the world in 2020. What have we learned about the requirements that matter to users? —Sarah Gregory

THE YEAR 2020 brought us the global pandemic of COVID-19, which is not just a health crisis but a disruption to the fabric of society around the world. With no vaccine yet approved, other measures have been taken all over the world related to lockdowns, social distancing, and contact tracing to quarantine the infected individuals and suppress community transmission. The numerous challenges presented by this

novel coronavirus, such as the incubation period, various symptoms, and asymptomatic superspreaders, have exacerbated the challenges of manual contact tracing.

The Rise and Fall of Contact-Tracing Apps

To complement manual contact-tracing methods, governments around the world started to look for alternative technological solutions to expedite the process, and a flood of coronavirus-related apps were launched in

the first half of 2020.¹ Contact-tracing apps make use of Bluetooth and GPS on mobile phones and provide a low-cost, low-energy solution by interacting with other mobile phones to record community interactions for a period of time tied to the period considered to represent the danger of infection transmission.

This digital solution promises great benefits in terms of the instant recording of interaction, mitigates the limitations and biases of patients' memories, and, in theory, has been

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considered a very effective solution for the large scale of the COVID-19 pandemic.² Singapore took the lead in developing a contact-tracing app called *TraceTogether* to defeat the spread of COVID-19, and many governments around the world jumped on the bandwagon. This turned out to be a real-time test for governments of how much their citizens would trust them with their location and contact data.

As we moved toward the end of a disastrous year, several countries endured a second wave of COVID-19; for other countries, the first wave never ended. Millions of dollars have

been poured into the development and advertisements of contact-tracing apps by governments around the world, with the promise that the contact-tracing-apps would be the “silver bullet” for battling the spread of COVID-19.

However, the true promised benefits of these contact-tracing apps have not been realized to their full potential anywhere in the world. Some countries, like the United Kingdom and Norway, had to pull their respective apps by mid-2020 after a significant number of issues regarding performance or privacy were reported. No

matter how technologically sound, these apps cannot provide successful outcomes without social factors that include, among others, the approval of the app users.³

Back to the “Users and Requirements”

Our previous research established that the dissatisfaction of users can result in software project failures even if delivered on time, on budget, and with high quality.⁴ This inspired us to explore the factors that limited the success of the contact-tracing apps.

App reviews have been recognized as a rich source of information for developers and researchers to analyze the concerns, requests, and issues of app users. To explore the (dis)satisfaction of users with COVID-19 contact-tracing apps, we downloaded and analyzed the app reviews from both the Apple and Google app stores for the duration of 1 January–30 July 2020 (see Table 1).

Sentiment scores usually are one of the indicators of the popularity, success, and adoption of an app. We observed that this was not the case for COVID-19 contact-tracing apps. For example, on the Google store, the Indian app *Aarogya Setu* had the highest volume of reviews as well as the most positive sentiments expressed by the users in these reviews through July 30 (see Figure 1); however, India never managed to get over the first wave of the pandemic and, as of 5 October 2020, was reporting around 90,000 cases per day recently (see Figure 2). On a closer look at the Indian app reviews, a significant number (around 25%) were politically motivated rather than focusing on the app, its functionality, or performance.

If the positive sentiments of users are not an indication of the success of a contact-tracing app, then how can we

Table 1. Selected countries and their apps, with the average ratings and review counts (on 30 July 2020).

App name	Country	Average rating		Review count	
		Google	iOS	Google	iOS
CovidSafe	Australia	3.1	3.1	3,659	7,591
Canada COVID-19	Canada	3.8	3.6	217	113
Corona-Warn-App	Germany	3.4	3.4	32,963	10,649
Aarogya Setu	India	4.4	3.1	413,026	3,870
COVA Punjab	India (Punjab)	4	2.5	8,399	159
המגן - אפליקציה למלחמה בקורונה	Israel	1.9	3.2	271	650
Immuni	Italy	3.3	3.3	12,541	3,316
AMAN	Jordan	4.3	4.1	795	29
NZ COVID Tracer	New Zealand	2.1	2.4	1,421	247
NOVID	United States	3.8	4.1	59	31
COVID-19 Gov PK	Pakistan	3.6	2.9	2,547	34
Tabaud (COVID-19 KSA)	Saudi Arabia	4.3	3.9	1,114	144
TraceTogeather	Singapore	3.1	2.3	2,682	1,013
SwissCOVID	Switzerland	3.1	3.2	1,157	585
Hayat Eve Sigar	Turkey	3	2.2	40,456	6,735
TraceCovid	United Arab Emirates	3	3.2	160	30

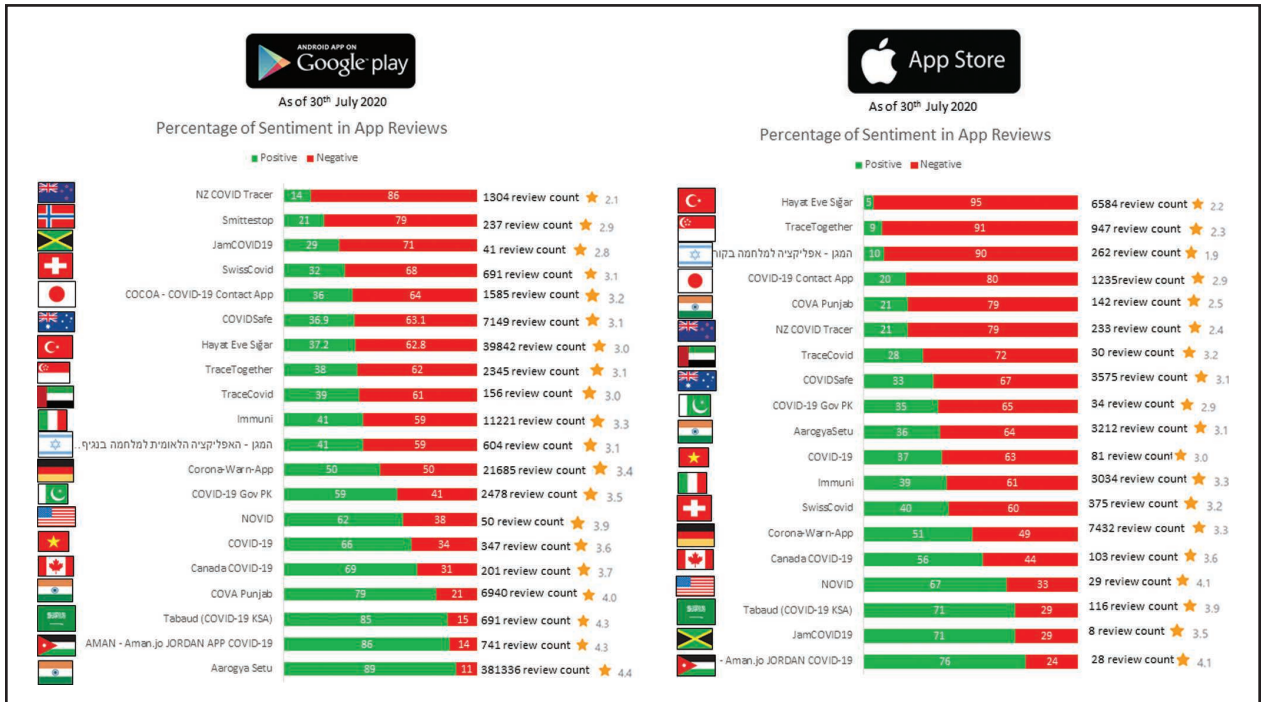


FIGURE 1. The overall sentiments of user reviews and star ratings for the selected apps.

measure the success of these apps? We started to dig deeper into the reviews to analyze the voices of users for the particular requirements of these apps.

- Bluetooth functionality:** A large number of these apps depend on the Bluetooth connection of the mobile device for “proximity tracking” of any other nearby mobile devices that have the same app installed on them. The dominant portion of the user reviews regarding the Bluetooth functionality was negative. Whether Bluetooth is the most suitable option for a contact-tracing app is another question, considering it comes with its own issues of range, proximity, signal strength, connectivity, inter-platform (Android and IOS) performance, and the consequences of inaccurate false positives and

false negatives are high during a pandemic. New Zealand’s app NZ COVID Tracer opted for an alternative to Bluetooth with QR code scanning, whereby people can create a digital diary of the places they have visited by scanning official QR codes. However, issues were reported by iPhone users that the app was not recording all of the scans, and, hence, the digital diaries of location history were inaccurate.

- Battery consumption:** These contact-tracing apps must run continuously on the mobile device while a person is in a setting of close proximity with other people, and this can impact the performance of the battery. The “low-battery mode” will not let the contact-tracing app run in the background. With Bluetooth, Internet, or GPS connection

requirements for the functioning of these apps, a significant number of users expressed their frustration on the issue of battery drainage. This is a work in progress for many apps, and, very recently, Singapore launched the latest version of TraceTogether to allow the app to operate with Bluetooth while running in the background to improve battery life.

- Security and privacy:** Since the launch of these apps, there have been serious concerns around the security and privacy of user data. Apple and Google together launched the Exposure Notification System⁶ in mid-May to address the privacy issues for contact-tracing apps by minimizing the collection of personal information. If governments violate the terms of the framework, then

the app can be removed from the app stores. In the case of Australia's CovidSafe app, which asks users for their name, phone number, postcode, and age range before they can register with the app, the Exposure Notification System will not be an option for the Australian government to use in their app. On the other hand, the Canadian app COVID Alert is open source and has used the Exposure Notification System; the app requires no identifiable information from users, and all data are to be deleted after 14 days. However, when a survey was conducted, a large number of Canadian citizens were hesitant to download the app.⁷

- **Trust and transparency:** Just like the virus, the pandemic brought

a new level to the spread of conspiracy theories and fake news on social media, decreasing the trust of a good portion of citizens regarding the government. In countries with a voluntary model and low trust index toward their governments, such as Australia, the United Kingdom, and Germany, citizens have shown more resistance to downloading and using the apps. Having said that, only in Germany, we observed that the government made sincere efforts to increase trust by increasing transparency during the Corona-Warn-App development by making it open source from the outset and by involving a number of reputable organizations. However, even as German officials refer to their

contact-tracing app as the “best app” in the world, Germany was struggling to contain the second wave of COVID-19 at the time of this writing.

- **Reliability and effectiveness:** Unlike the rigorous medical procedures for COVID-19 tests or vaccines, there are no rules for testing or approving the accuracy, reliability, and effectiveness of contact-tracing apps. There is no accountability, so far, for any governments to prove that their apps are reliable and effective in helping with contact tracing. The state of Victoria in Australia was hit by a second wave in July 2020, and the data collected from the CovidSafe app did not help in avoiding the second wave or contact tracing.

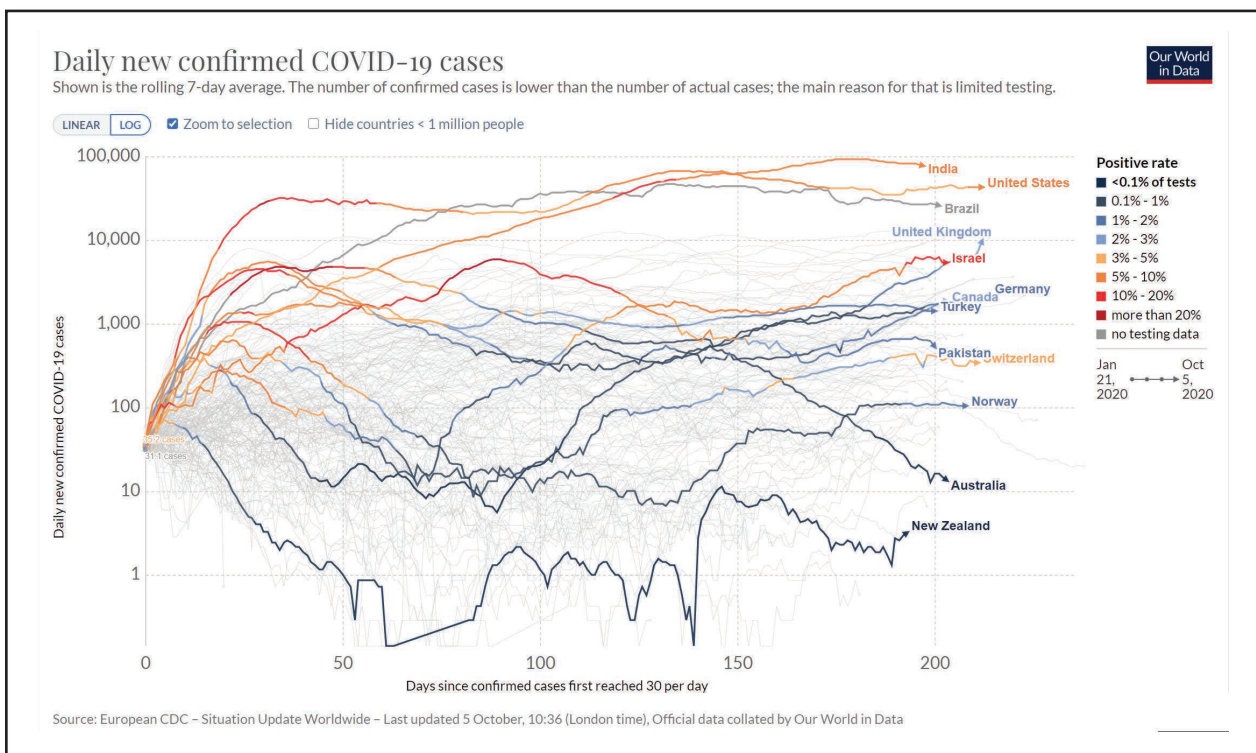


FIGURE 2. A comparison of COVID-19 case timelines for selected countries. CDC: Centers for Disease Control and Prevention. (Source: Our World in Data.⁵)

As noted, the German government has repeatedly called their Corona-Warn-App the best in the world, but they had around 5,000 cases of COVID-19 per day reported during October 2020.

- **User acceptance:** The download of an app does not equal user acceptance or success of the app. India tops the world, with a combined 127.6 million downloads for Apple's App Store and the Google Play Store as of July 2020.⁸ However, as of September 2020, they also lead the world, at the moment, for the weekly average of highest number of reported infections (see Figure 2). In app reviews, we observed a significant number of comments in which users reported that they uninstalled the apps, as they cannot see any positive outcomes of the app during the pandemic. In August 2020, the Australian CovidSafe app reached a milestone of 7 million downloads,⁹ and the German Corona-Warn-App had 18.4 million downloads at the beginning of October 2020.¹⁰ Both countries are struggling with the second wave of COVID-19, as we write this article, with the respective contact-tracing apps still failing to deliver the promised benefits.

If it's not the requirements, downloads, or sentiments of reviews, then what has gone wrong with these contact-tracing apps?

When It's a Pandemic, Everyone Matters!

App developers are in a rush to provide solutions for governments to quickly demonstrate some action against the virus. Bringing technological solutions to address a problem will

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not help if there is little understanding of the bigger picture for humanity, where numerous complex, interconnected, large-scale social, political, and cultural factors play their roles.

Many countries around the world are now facing a second wave, and the contact-tracing apps seem to have not been much help in stopping or slowing it, even if designed using the best practices. Every country has its own unique struggle with COVID-19. The success of these apps depends heavily on the significant proportion of the population downloading and keeping the app active while in public spaces.

The COVID-19 pandemic is a social problem of interconnected humanity. Poor choices by just one person could be potentially enough

to impede the collective efforts of the whole society at large in its fight against the virus. Do these apps have the potential to understand that everyone matters during a pandemic? If no, they may not be very effective in this fight against a “wicked invisible enemy.”

References

1. P. H. O' Neill, T. Ryan-Mosley, and B. Johnson, “A flood of coronavirus apps are tracking us. Now it's time to keep track of them.” *Technol. Rev.* Accessed: Oct. 20, 2020. [Online]. Available: <https://www.technologyreview.com/2020/05/07/1000961/launching-mittr-covid-tracing-tracker/>
2. S. Altmann et al., “Acceptability of app-based contact tracing for

- COVID-19: Cross-country survey evidence,” SSRN 3590505, 2020.
3. M. Bano and D. Zowghi, “A systematic review on the relationship between user involvement and system success,” *Inf. Softw. Technol.*, vol. 58, pp. 148–169, 2015. doi: 10.1016/j.infsof.2014.06.011.
 4. M. Bano, D. Zowghi, and F. da Rimini, “User involvement in software development: The good, the bad, and the ugly,” *IEEE Softw.*, vol. 35, no. 6, pp. 8–11, 2018. doi: 10.1109/MS.2018.4321252.
 5. “Coronavirus Pandemic (COVID-19).” Our World in Data. Accessed: Oct. 20, 2020. [Online]. Available: <https://ourworldindata.org/coronavirus>
 6. “Exposure notifications: Using technology to help public health authorities fight COVID-19.” Google. Accessed: Oct. 20, 2020. [Online]. Available: <https://www.google.com/covid19/exposurenotifications/>
 7. “Aarogya Setu now world’s most downloaded Covid-19 tracking app.” India Today. Accessed: Oct. 20, 2020. [Online]. Available: <https://www.newswire.ca/news-releases/majority-of-canadians-would-sacrifice-personal-privacy-if-it-helped-stop-covid-19-finds-kpmg-in-canada-survey-891920008.html>
 8. “Scott Morrison.” LinkedIn. Accessed: Oct. 20, 2020. [Online]. Available: <https://www.indiatoday.in/technology/news/story/aarogya-setu-now-world-s-most-downloaded-covid-19-tracking-app-1701273-2020-07-16>
 9. A. Carter, “18 million downloads: Germany’s Corona-Warn-App hailed a success.” I am Expat. <https://www.iamexpat.de/expat-info/german-expat-news/18-million-downloads-germanys-corona-warn-app-hailed-success>
 10. “COVID-19 contact tracing.” Open Media. Accessed: Oct. 20, 2020. [Online]. Available: <https://www.iamexpat.de/expat-info/german-expat-news/18-million-downloads-germanys-corona-warn-app-hailed-success>



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