Technological Interventions for COVID-19 Management: An Analysis

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Executive Summary

This assessment evaluates common technological intervention use-cases in response to COVID-19 through the framework of population penetration, privacy and effectiveness to arrive at a composite 'Viability Rating'.

We conclude that:

1. Recovery/stimulus package(s) should address the inequity of internet access.
2. A privacy preserving model should include clear stipulations on purpose limitation, data retention, data minimisation, and clear statements of liability on data collection, storage and retention.
3. Effective legislation including sunset clauses limiting the duration of the use of technological interventions must be laid down.
4. Limited scale proofs of concept should be conducted before a mass rollout until effectiveness of underlying technologies (BLE, Algorithmic Risk Determination etc) can be reasonably evaluated.
5. Technological interventions should not be deployed in a manner that may result in the denial of rights or benefits to any person(s).

The Need for Technological Interventions

Role of Technological Interventions

Technological interventions, which can be designed, developed and deployed relatively quickly have a critical role to play in supporting broader societal efforts to contain the spread of the pandemic.

Types of Interventions

Since the start of the COVID-19 outbreak, countries around the world have adopted a wide mix of policy measures to contain the pandemic. With concerns being raised about the risk of infections overwhelming healthcare infrastructure and the need to "flatten-the-curve", many technology-based interventions have taken shape to aid these efforts.

These have mainly been in the form of apps focused on the following use-cases:

1. Contact Tracing
2. Quarantine Management
3. Risk Determination
4. Providing COVID-19 and healthcare information (Informatory)
5. Issuing E-passes

Why we should assess them

With the ever-changing situation, it is essential to review them periodically to ensure critical resources are focused on inclusive goals that will benefit the largest number of people while simultaneously minimising costs imposed.

A Complex and Evolving Scenario

The combination of the impending relaxation of lockdowns, reverse-migration of migrant workers, rising case numbers, the evolving understanding of how the virus works and deluge of incorrect or out-of-context information presents a challenging set of circumstances for policy makers.

A number of scientists and researchers (Joint Statement, 2020) around the world have expressed reservations about the excessive reliance on contact tracing apps (Joint Statement on contact tracing, 2020) . Combined with the evolution of frameworks like DP-3T (DP-3T Github, 2020) and the Apple|Google (Apple, 2020) partnership, which has released its first version on 20th May, 2020, this space will continue to evolve.

Assessment of Representative Technological Interventions

Viability Rating

The Viability Rating of a technological intervention considers its capacity to complement pandemic management with due regard to its population penetration, privacy and effectiveness implications.

Technology interventions have been scored on the basis of (Takshashila, 2020):

1. Population Penetration: What portion of its serviceable audience[1] can the specific measure cater to.
2. Privacy: How well does the intervention fare against the principles of data protection.
3. Effectiveness: The ability to achieve the stated result.

A composite Viability Rating has been computed on the basis of the above factors and has been rated as:

- Cyan (high/good) if any two of Population Penetration, Privacy or Effectiveness are cyan and third is yellow.
- Yellow (medium/average) if any two of the three criteria are yellow, OR exactly one of the three criteria is magenta.
- Magenta (low/poor) if any two are magenta, OR any two are yellow and the third is magenta.

In the following pages, a representative set of interventions have been grouped by use-cases.

Contact Tracing [1/2]

Uncertain effectiveness, combined with low population penetration and inadequate privacy protections result in lower viability ratings for contact tracing apps.

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
Aarogya Setu (Pan-India)	Contact Tracing, Informatory, Risk Determination, E-pass				
PeduliLindung (Indonesia)	Contact Tracing, Informatory, Quarantine Management				
BeAwareBahrain (Bahrain)	Contact Tracing, Informatory, Quarantine Management				
WeTrace (Cebu - Philippines)	Contact Tracing, Quarantine Management				
nCOVID-19 Nagaland - Visitors App (Nagaland)	Contact Tracing, Quarantine Management, E-Pass,				
Coronawatch (Karnataka)	Contact Tracing, Informatory				
Corona 100m (South Korea)[2]	Contact Tracing, Informatory				

High/good
Medium/average
Low/poor

Contact Tracing [2/2]

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
HaMagen/ The Shield (Israel)	Contact Tracing				
Stopp Corona (Austria)	Contact Tracing				
CovTracer (Cyprus)	Contact Tracing				
Rakning C-19 (Iceland)	Contact Tracing				
StopKorona! (North Macedonia)	Contact Tracing				
eRouška (Czech Republic)	Contact Tracing				
Close Contact Detector (China)[3]	Contact Tracing				
TraceTogether (Singapore)	Contact Tracing				

High/good
Medium/average
Low/poor

Quarantine Management [1/2]

Poor privacy protections and inconclusive evidence of effectiveness were largely responsible for low viability ratings of quarantine management apps.

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
Quarantine watch (Karnataka)	Quarantine Management				
SMC COVID 19 Tracker (Surat, Gujrat)	Quarantine Management				
UP Self Quarantine App (Uttar Pradesh)	Quarantine Management				
COVID-19 Quarantine Monitor (Tamil Nadu)	Quarantine Management				
COBuddy – COVID19 tool (Tamil Nadu)	Quarantine Management, SOS for services				
nCOVID-19 Nagaland - Visitors App (Nagaland)	Contact Tracing, Quarantine Management, E-Pass				
WeTrace (Cebu - Philippines)	Contact Tracing, Quarantine Management				

High/good
Medium/average
Low/poor

Quarantine Management [2/2]

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
PeduliLindung (Indonesia)	Contact Tracing, Informatory, Quarantine Management				
BeAwareBahrain (Bahrain)	Contact Tracing, Informatory, Quarantine Management				
StayHomeSafe (Hong Kong)	Quarantine Management				

High/good
Medium/average
Low/poor

Risk Determination

Viability rating of risk determination use-cases were mainly impacted by the lack of reliable proof of effectiveness. In certain cases, low population penetration or poor privacy protections even resulted in a low rating.

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
Aarogya Setu (Pan-India)	Contact Tracing, Informatory, Risk Determination, E-pass				
Kavach (Chattisgarh)	Informatory, Risk Determination				
Test Yourself Goa (Goa)	Risk Determination				
Health Code (China)[4]	Risk Determination				

High/good
Medium/average
Low/poor

Informatory

Informatory apps can prove to be effective for dissemination of reliable information.

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness	**Viability Rating**
Aarogya Setu (Pan-India)	Contact Tracing, Informatory, Risk Determination, E-pass				
PeduliLindung (Indonesia)	Contact Tracing, Informatory, Quarantine Management				
BeAwareBahrain (Bahrain)	Contact Tracing, Informatory, Quarantine Management				
Corona 100m (South Korea)	Contact Tracing, Informatory				
Coronawatch (Karnataka)	Contact Tracing, Informatory				
Haryana Sahayak (Haryana)	E-pass, Informatory				
Kavach (Chattisgarh)	Informatory, Risk Determination				
RajCop Citizen (Rajasthan)	E-Pass, Informatory				
T COVID 19 (Telangana)	Informatory				

High/good
Medium/average
Low/poor

E-pass

E-pass apps can be effective provided they are accompanied by a simultaneous increase in the capacity to process requests.

App/Initiative Name	Use-case(s)	Population Penetration	Privacy	Effective-ness[5]	**Viability Rating**
Aarogya Setu* (Pan-India)	Contact Tracing, Informatory, Risk Determination, E-pass				
nCOVID-19 Nagaland - Visitors App (Nagaland)	Contact Tracing, Quarantine Management, E-Pass				
Haryana Sahayak (Haryana)	E-pass, Informatory				
RajCop Citizen (Rajasthan)	E-Pass, Informatory				
KSP Clear Pass (Karnataka)	E-Pass				
Grid (Jharkhand)	E-Pass				
CG COVID19 E-pass (Chattisgarh)	E-Pass				

*At the time of publication, Aarogya Setu only had the option of displaying an already-issued E-pass.

High/good
Medium/average
Low/poor

Case Study: Contact Tracing [1/3]

This intervention benefitted from the high internet penetration in Austria, and satisfactorily addressed privacy concerns. Even though the effectiveness remains unproven globally, in the present context, the intervention has a high Viability Rating.

Stopp Corona (Austria) was classified as cyan for contact tracing based on:

- Population Penetration: Cyan, since more than 75% of its serviceable audience were expected to be able to access it based on internet penetration and expected feature-set compatibility.
- Privacy: Cyan, since it collects minimal data from the user, has a limited data retention duration of 30 days, and has a clear privacy policy and FAQs answering privacy concerns.
- Effectiveness: Yellow, as the ability to trace contacts using any technology remains unproven.

Therefore, a large proportion of the population could participate. While effectiveness concerns remain, guaranteeing anonymity, encouraging voluntary participation, and releasing the source-code help in building trust.

Case Study: Quarantine Management [2/3]

This intervention is targeted at a region with poor internet penetration and potentially significant proportion of incompatible hardware. The privacy protection measures are inadequate. Capacity concerns impacted effectiveness. Therefore , the intervention has a low Viability Rating.

UP quarantine was classified as magenta for quarantine management based on:

- Population Penetration: Magenta, since it could potentially be accessed by less than 35% of its serviceable audience based on internet penetration and expected feature-set compatibility.
- Privacy: Magenta, since the absence of a privacy policy to the App disallows determination of purpose limitation, with no clarity on data retention, and oversight accountability on the data collected, further increasing the possibility of breach and misuse.
- Effectiveness: Yellow, as the technological and human capacity to track and monitor accurately using GPS remains unproven.

Thus, a large proportion of the serviceable audience are excluded. The lack of a clear privacy policy and other data protection measures raise surveillance concerns.

Case Study: Multiple Use Cases [3/3]

This intervention targets a large territory with varying degrees of internet penetration and a higher proportion of rural population. Limited measures to address privacy concerns are being undertaken. Multiple use-cases resulted in Viability Scores ranging from low to medium.

Aarogya Setu covers multiple use-cases, it was therefore classified as -

1. magenta for contact tracing.
2. magenta for risk determination.
3. yellow for informatory.
4. yellow for e-pass.

These Viability Ratings were was based on:

- Population Penetration: Magenta, since it could potentially be accessed by only one-third of its serviceable audience based on internet penetration and expected feature-set compatibility.
- Privacy: Yellow, since purpose limitation, permission sought vis-a-vis the purpose and possibility of deanonymisation were judged to be moderately limited, moderately complied with and moderate respectively, in the presence of an ambiguously drafted privacy policy albeit with clear data retention stipulation.

Case Study: Multiple Use Cases [3/3]

- Effectiveness:

  Effectiveness scores varied by use-case.

  - Contact Tracing: Yellow, since the ability to accurately trace contacts using any technology remains unproven.
  - Risk Determination: Yellow, since both algorithmic and questionnaire based risk determination can lead to inaccurate results due to the algorithmic bias, evolving nature of the virus, and our incomplete understanding of its behaviour.
  - Informatory: Cyan, since it can provide up-to-date, official information through the App and IVRS.
  - E-pass: Cyan. At the time of publishing, this feature is limited to displaying an E-pass that has already been issued.

As the lockdowns are eased, participation in this intervention is being mandated based on its potential benefits. However, the high disparities in internet penetration across rural-urban areas, inadequate privacy protections, and inconclusive evidence of effectiveness in key use-cases should be considered. Therefore, its deployment should not be exclusionary and coercive.

Assessment Criteria

Population Penetration [1/2]

The population penetration should inform policy choices such as stringency of enforcement of intervention, trade-offs between expediency and equity, as well as technical considerations like choice of technology stack(s).

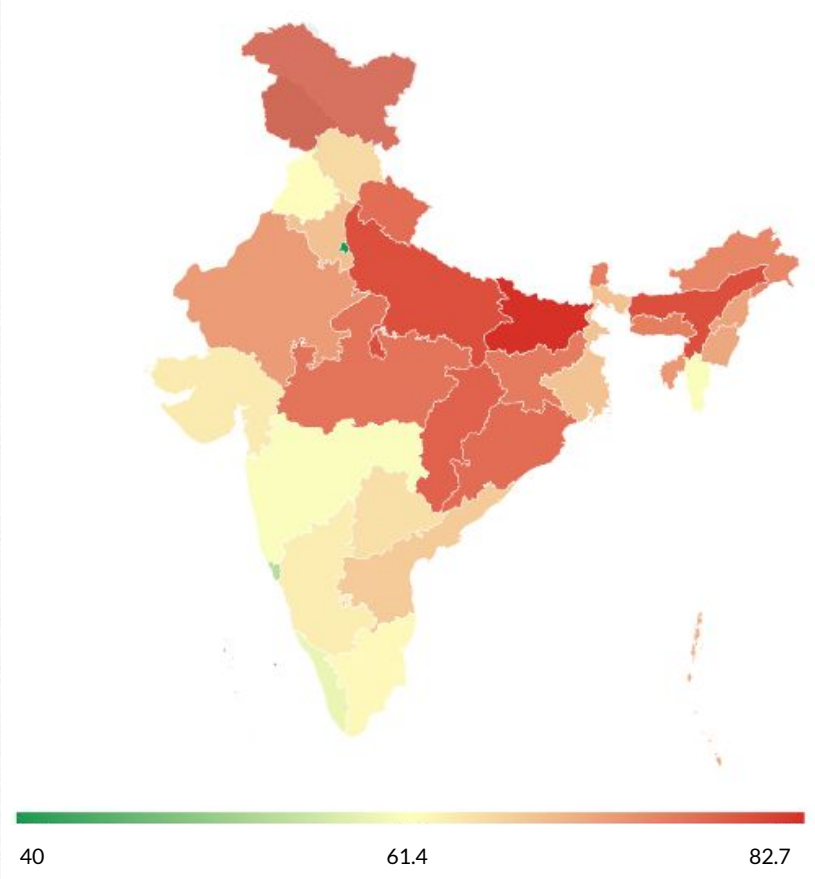
The population penetration of the underlying technology will serve as a baseline to determine how much of its serviceable audience will be able to take advantage of a given technological intervention.

- To assess this for the selected interventions, internet access is considered a primary factor.
- For interventions where the use of Bluetooth Low Energy is being proposed for contact tracing, an additional scaling factor is applied to account for a percentage of phones that may not support its use due to hardware limitations (Bradshaw, 2020) (Kelion, 2020).
- Of those who do have access, 30-40% do not use the internet on a daily basis (IAMAI, 2019).

These factors form a reasonable basis to estimate the distribution of costs and benefits of the interventions studied in this document. Further, exclusion from other public/private benefits based on these interventions will result in added costs being borne by those who lack uninterrupted access.

Population Penetration [2/2]

Estimated percentage of people by state/union territory who may not have access to a solution combining Internet access and Bluetooth Low Energy.



Source: Compiled by Takshashila Institution based on data from TRAI and Census 2011[6]

Privacy [1/2]

Pandemic management should utilise minimally intrusive technologies. Interventions should address concerns of mission creep and unauthorised use of data, through a clear legal framework with stipulations on liability.

Personally identifiable data forms the basis of all the technological interventions proposed across the globe. The consequential effects on the right to privacy of the individual and measures to preserve the data collected need to be scrutinised to ensure that immediate interests of the State would not lead to abysmal infringement of individual liberties.

- To assess the implications of a selected technological intervention on the privacy of the person from whom the data is generated (this applies to the person whose data is being collected as well as those they were in contact with), we have scrutinised the privacy policy of the App.
- Publicly available information, including media coverage has been factored in to comprehensively understand the implications on privacy.

Privacy [2/2]

The major factors considered,[7] upon the existence of a privacy policy is the method of addressing:

1. Purpose limitation: Whether the data collected has been explicitly demonstrated to be used for the limited purpose of managing the pandemic?
2. Permissions sought vis-à-vis intent: Whether the permissions sought by the App for data collection, limits itself to the stated intent of the App?
3. Possibility of deanonymisation: Whether the data points collected and the data security practices stated by the privacy policy indicate the ease of deanonymising data?
4. Data retention: Whether there exists a clear statement on data retention policy?
5. Oversight accountability on data collected: Whether clear indications on oversight accountability have been laid down on storage of collected data?

Effectiveness [1/3]

Since effectiveness of interventions has not been conclusively established, limited scale proofs of concept should precede mass rollouts. Deployment should not lead to denial of rights and benefits.

Effectiveness refers to the ability to achieve the stated result. Eg. A contact tracing App is effective if it can trace accurately and precisely.

Most mobile-based interventions are using applications that utilise Bluetooth low energy or global positioning system (GPS) or a combination of these two technologies.

Contact Tracing

- GPS locations, in isolation, would not clearly identify people who would have come in close contact. It would only be able to recognise a set of people who might have been in, approximately, the same vicinity.
- Relying solely on GPS, could trigger a high number of false positives/false negatives. However, locally stored GPS locations could aid memory for manual contact tracing or in identifying infection hotspots.
- Bluetooth can potentially identify which sets of people might have come into close contact with each other based on the attenuation of bluetooth signals due to physical obstructions.

Effectiveness [2/3]

- A few reservations around the precision, range, interference of bluetooth and inability to detect surface transmission have been raised (Wired, 2020) (BBC, 2020). (Johns Hopkins University Hub, 2020)

Although, incontrovertible evidence to establish the effectiveness of these two technologies is not available, bluetooth seems better equipped for contact tracing.

Quarantine Management

Some interventions are using GPS to determine location and image recognition to verify selfies of quarantined people.

Accuracy of algorithmic image recognition systems is still maturing and can result in false positives/false negatives. GPS based location data and Image Metadata are both susceptible to spoofing/manipulation.

The capacity to manually scrutinise images also remains uncertain.

Effectiveness [3/3]

Risk Determination

Coronavirus is novel and the nature of the virus is changing rapidly.

- Fixed questionnaires about symptoms, travel history and exposure to the virus may not result in an accurate risk assessment.
- Algorithms lacking transparency about the input variables resulting in uninterpretable outputs, could lead to propagation of unknown bias in risk assessments.

Informatory

Interventions disseminating/broadcasting reliable,up-to-date official information through apps can increase awareness and dispel panic

E-Pass

Online E-pass apps could facilitate faster processing of applications. Capacity to process requests would have to be simultaneously upgraded.

Conclusion

Conclusion [1/2]

Based on this assessment, we conclude:

1. Available data regarding internet penetration and usage patterns suggest that significant proportion of people have unreliable connectivity and limited access to technological feature-sets. This inequity of internet access should be addressed in recovery/stimulus packages.

2. The analysis of impacts on privacy indicate that data protection has not been adequately weighed in the technical design of most App-based interventions. A privacy preserving model should include clear stipulations on purpose limitation, data retention, data minimisation, and clear statement of liability on data storage, collection and retention.

Conclusion [2/2]

3. Presently, these interventions function in the absence of a sound legal framework. It must be addressed by effective legislation covering liability of the State for its actions. A mandate for sunset clauses for the duration of the temporary use of such technological interventions must be clearly laid down.

4. The effectiveness questions surrounding bluetooth or GPS based interventions and algorithmic based risk/immunity are unresolved and are likely to remain so in the medium term. Limited scale proofs of concept should be conducted before a mass rollout.

5. Considering the Viability Rating of the technological interventions studied, they should not be deployed in a manner that may result in the denial of rights or benefits to any person(s). Participation should not be mandatory or coerced.

Notes

[1]*Serviceable Audience is defined based on the location an Intervention will cater to. Eg. For a pan-India App, all of India is considered to be its serviceable audience. For an App by the Government of Karnataka, the population of the state of Karnataka will be considered as the serviceable audience.*

[2] *Corona 100m was no longer available in the Google Playstore at the time of publication of this document.*

[3] *Close Contact Detector uses government surveillance data and uses App interfaces for exposure notification.*

[4] *Minimal information is available to determine the data protection practices as well as effectiveness of the Health Code.*

[5] *While, in theory the intervention would improve efficiency, capacity would have to be increased to smoothen the process.*

[6] *Projection is based on 60% of internet subscribers having devices supporting Bluetooth Low Energy. This is higher than the Counterpoint Research and CCI Insight of 50% and 30-40% respectively. TRAI data is broken down by Service Areas combine Andhra Pradesh and Telangana; Bihar and Jharkhand; Maharashtra and Goa; Jammu & Kashmir and Ladakh; West Bengal and Sikkim; Uttarakhand and Uttar Pradesh; and Arunachal Pradesh, Manipur, Meghalaya, Mizoram, Nagaland and Tripura. Union Territories (in existence before 2019) are combined with neighbouring states.*

[7]*The metrics have been chosen on the basis of the principles laid down in the Draft Personal Data Protection Bill, 2019.*

References

Hale, T., Webster, S., Petherick, A., Phillips, T., & Kira, B. (2020). *Oxford COVID-19 Government Response Tracker. Blavatnik School of Government. Retrieved from Oxford COVID-19 Government Response Tracker:* https://covidtracker.bsg.ox.ac.uk/

Privacy International (2020). Tracking the Global Response to COVID-19. Retrieved from Privacy International: https://privacyinternational.org/examples/tracking-global-response-covid-19

(2020, April 19) Joint Statement on Contact Tracing. Retrieved from : https://drive.google.com/file/d/1OQg2dxPu-x-RZzETlpV3lFa259Nrpk1J/view

(2020, April 29). Joint Statement. Retrieved from: https://drive.google.com/file/d/1uB4LcQHMVP-oLzIIHA9SjKj1uMd3erGu/view

(2020, April) Decentralized Privacy-Preserving Proximity Tracing documents. Retrieved from: https://github.com/DP-3T/documents

Apple Inc. (2020,April) Privacy Preserving Contact Tracing https://www.apple.com/covid19/contacttracing

The Takshashila Institution (2020, May). Viability Rating Framework. Retrieved from: https://takshashila.org.in/viability-rating-framework

Bradshaw, T. (2020, April 20). 2bn phones cannot use Google and Apple contact-tracing tech. Retrieved from the Financial Times https://www.ft.com/content/271c7739-af14-4e77-a2a1-0842cf61a90f?shareType=nongift

Kelion, L. (2020, April 20). Coronavirus: Why are there doubts over contact-tracing apps?. Retrieved from BBC News: https://www.bbc.com/news/technology-52353720

References

IAMAI & Neilsen, (2019, September). *India Internet 2019. Retrieved from:* https://cms.iamai.in/Content/ResearchPapers/d3654bcc-002f-4fc7-ab39-e1fbeb00005d.pdf

O' Neill, P. H., (2020, April 22). *Bluetooth contact tracing needs bigger, better data. Retrieved from MIT Technology Review:* https://www.technologyreview.com/2020/04/22/1000353/bluetooth-contact-tracing-needs-bigger-better-data/

Vaijanti, K. (2018, August 8). *Smart phones as educational tools: A reality check from rural India. Retrieved from Centre for Communication & Development Studies:* https://digitalequality.in/smart-phones-as-educational-tools-a-reality-check-from-rural-india/

Lee, A. (2020, April 17). *If Bluetooth doesn't work for contact-tracing apps, what will?. Retrieved from* WIRED: https://www.wired.co.uk/article/bluetooth-contact-tracing-apps

Volkin, S. (2020, March 20). *How Long Can The Virus That Causes Covid-19 Live On Surfaces? The Hub, Johns Hopkins University. Retrieved from:* https://hub.jhu.edu/2020/03/20/sars-cov-2-survive-on-surfaces/

Vi Hart, *et al.* (2020, April 3). *COVID-19 Rapid Response Impact Initiative | White Paper 5 Outpacing the Virus: Digital Response to Containing the Spread of COVID-19 while Mitigating Privacy Risks. Edmond J. Safra Center for Ethics, Harvard University. Retrieved from:* https://ethics.harvard.edu/files/center-for-ethics/files/white_paper_5_outpacing_the_virus_final.pdf

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