# ICT Initiatives in India to Combat COVID-19

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## Abstract

The great loss of life and economic damage COVID-19 has wrought across the world has not left India untouched. In these tough times, Information and Communications Technology (ICT) has emerged as a key means of both resolving challenges caused by the pandemic and responding to the new reality of the everyday. Government at the central and state levels has actively engaged with the private sector to develop ICT solutions, particularly identification, isolation, contact tracing, and treatment, to deal with the evolving situation in the country. Of particular benefit have been the growing number of mobile applications and Artificial Intelligence (AI) based tools which have emerged during this time. However, the use of ICT involves its own set of challenges, especially concerning privacy safeguards. Governments must ensure the use of ICT is fair and proportional not only during the times of pandemic, but also in the post-COVID-19 era. Countries like South Korea and Hong Kong illustrate emergent best practices for the use of ICT in such crises.

## Introduction

COVID-19, originating in China, has not left any part of the world untouched. Globalization and increased travel around the world has facilitated the international spread of COVID-19. All over the world, COVID-19 is causing massive loss of life and economic damage. In India, the first case of COVID-19 was reported on 30th January 2020. As on 21st June 2020, there were 410,461 confirmed COVID-19 cases, out of which 169,451 were active cases, 227,755 were cured/ discharged, one migrated, and 13,254 were reported deaths.[1] Compared to the reported global fatality rate of 6.19%, the fatality rate in India is relatively low at 2.83%,[2] but India still has the highest number of confirmed cases across Asia. The worst hit states of India include Maharashtra, Delhi, Tamil Nadu, Gujarat and West Bengal.

Since the reporting of the first case in January, the Indian government was quick to take relevant necessary actions. This included screening passengers at all airports witihn the country, contact tracing to identify suspected COVID-19 carriers, entry restrictions for people travelling from mainland China and other affected countries, and the repatriation of Indian citizens working and traveling abroad. By 20th March India suspended all flights, both domestic and international. On 24th March 2020, when the number of confirmed COVID-19 cases touched 500, Government of India announced complete lockdown of 21 days across the country. During this initial 21 day national lockdown period, government focused on preparing for the upcoming COVID-19 crisis. Quarantine centers and laboratory facilities were established in large numbers across the country. Separate COVID-19 hospitals and isolation wards were created. Train coaches were turned into isolation wards to make mobile hospitals which can be

[1] https://www.who.int/docs/default-source/wrindia/situation-report/india-situation-report-21.pdf?sfvrsn=f96effa5_2

[2] https://economictimes.indiatimes.com/news/politics-and-nation/indias-covid-19-recovery-rate-improving-fatality-rate-declining-health-ministry/articleshow/76140228.cms?from=mdr

taken anywhere in the country if the need arises. Rapid Response Teams were formed. Various relief packages were announced by the government to deal with the financial crisis (Fair Wear Foundation 2020). The swift and stringent response by the Indian Government was praised all over the world and even recorded a score of "100" on the Oxford COVID-19 Government Response Tracker (OxCGRT).[3] Despite being the second most populous country in the world with a population of around 1.3 billion people, the COVID-19 infection rate was very low. Many possible explanations emerged for this. Many believed that the 21 day nation-wide lockdown successfully suppressed the pandemic. Others were of the opinion that numbers were low because not enough testing was done to identify the actual number of COVID-19 cases and associated deaths. Some even pointed to protective characteristics specific to India such as high temperatures and humidity and a hypothetical successful positive immune response of the Indian population. Many believed that demographics were playing a role because similar low fatality rates were being observed in other South Asian countries like Pakistan and Bangladesh. While on one hand India was broadly praised for its immediate action of imposing nationwide lockdown, there were others who believed that Indian government failed this pandemic test. This is because of the difficulties faced by workers in the informal sector during the period of nationwide lockdown[4] who suffered extreme physical, financial and mental hardship. Due to the shutdown of all modes of transport, many migrants were forced to walk thousands of miles to return to their homes, the largest mass migration in South Asia since Partition in 1947.

As an exit plan from the nationwide lockdown, districts across India were divided into three zones based on caseload: green, orange, and red.[5] After 20th April 2020, conditional relaxations were issued in green and orange zones. Within red and orange zones, two more zones – containment zones and buffer zones – were later added in the revised guidelines issued by the government of India.[6] [7] Since June 1 2020 to the present, the Ministry of Home Affairs (MHA) of the Government of India has issued Unlock 1 – phase guidelines for the re-opening of areas outside containment zones. Now, cases in India are continuously rising with each passing day.

[3] https://www.cnbctv18.com/healthcare/study-reveals-indias-response-to-coronavirus-most-stringent-5666531.htm

[4] https://www.nytimes.com/2020/05/27/opinion/india-modi-coronavirus.html

[5] Red Zone: Areas or the hotspots classified as those with the highest caseload; Orange Zone: Areas which have reported a limited number of cases in the past and no surge in positive cases recently; Green Zone: Areas with zero confirmed cases till date or no confirmed case in the last 21 days.

[6] Containment zone: The area of 3-kilometre radius around the epicentre (the residence of the positive case or where he has been isolated).

[7] Buffer zones: The adjoining blocks of the affected district or rural districts of the affected city.

## Role of ICT

Information and Communications Technology (ICT) has emerged as one of the key players in fighting the COVID-19 situation in India. The unprecedented crisis due to COVID-19 has accelerated the process of digitalization of many services and businesses including healthcare services, education, online delivery of goods and services, online payments, and work from home. Digital technologies are playing a key role in keeping our societies functional in this time of lockdowns and quarantines. The COVID-19 pandemic has compelled everyone to take a digital approach to being an employee, friend, or family member.

The latest ICT tools are offering a plethora of solutions to every aspect of the response to the pandemic, particularly identification, isolation, contact tracing, and treatment. Mobile and web technology is helpful for spreading awareness about COVID-19, facilitating contact tracing, notifying individuals who have come in close proximity to suspected carriers, tracking COVID-19 suspects in quarantine, real time tracking of crowds, remote monitoring of COVID-19 patients and much more. Drones are being used for enforcing strict quarantine and social distancing and for disinfection purposes. Robots are helping treat COVID-19 patients and sanitizing COVID-19 wards. Telemedicine is providing solutions for e-health checkups. Big data and Artificial Intelligence is being used for Research and Development (R&D) purposes.

### Mass awareness and support

The Government of India has taken various ICT initiatives for community awareness and support.

**COVID-19 Awareness Messages**

One of the unique methods adopted by the Department of Telecom of the Government of India for mass awareness is to put COVID-19 awareness messages as a caller tune instead of regular ringtone(Times of India 2020b). The messages, broadcast in Hindi, advise citizens to cover their mouths while coughing and sneezing, to clean their hands with soap thoroughly and regularly, to avoid touching their nose and face, and to contact the helpline number +91 11237978046 in case of any fever or discomfort.

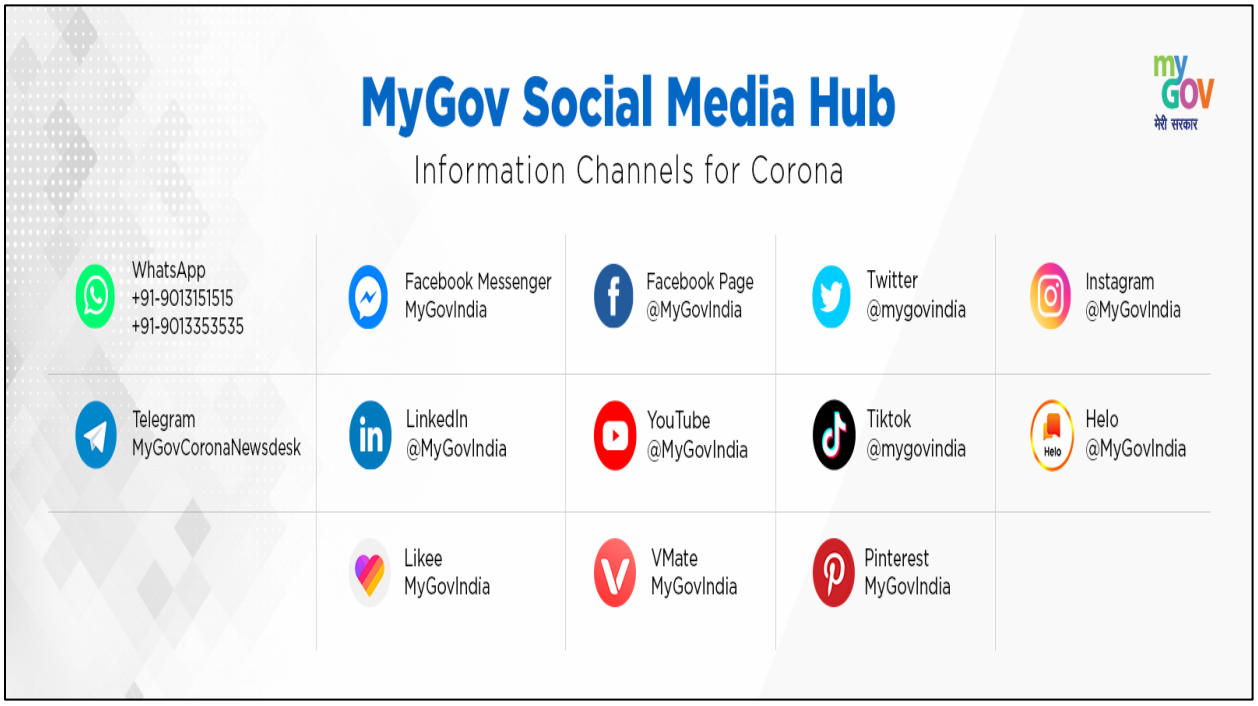
**Information Portals**

The Ministry of Health and Family Welfare website provides authentic information about India's COVID-19 situation.[8] MyGov Portal and National Health Portal of India also provide updates and authentic information related to COVID-19 in India (National Informatics Centre, Ministry of Electronics & Information Technology, Government of India 2020)(Ministry of Health & Family Welfare, Government of India 2020). The Government of India and WhatsApp has launched a WhatsApp bot called MyGov Helpdesk (WhatsApp Number: +919013151515) where citizens can send their queries related to COVID-19 and receive instant authoritative answers. MyGov Social Media Hub also provides a wide range of information channels concerning COVID-19(see

[8] https://www.mohfw.gov.in/

figure 1)(National Informatics Centre, Ministry of Electronics & Information Technology, Government of India 2020b).

**Figure 1 : MyGov Social Media Hub**




Source: National Informatics Centre, Ministry of Electronics & Information Technology, Government of India. 2020b. "#IndiaFightsCorona COVID-19." #IndiaFightsCorona COVID-19 in India, Corona Virus Tracker. May 12, 2020. https://www.mygov.in/covid-19/.

**Citizen Engagement Platforms**

**COVID 19 Feedback**

The COVID-19 feedback app has been developed by the Ministry of Electronics and Information Technology, Government of India(Geospatial World 2020). It is designed like a survey tool and helps gather information from the users about COVID-19 tests or treatment they may have undergone in the recent past. There is a separate section on user's feedback to improve the performance and experiences related to tests and treatment. This app helps government authorities in identifying areas which are worst hit by COVID-19 and to improve the COVID-19 testing facilities.

**MyGov App**

MyGov App is launched by Government of India(Geospatial World 2020; Ministry of Communications & Information Technology (Government of India) 2020). This app provides a platform to citizens to share their suggestions, ideas and comments to the Indian Government and thereby provides an opportunity for them to get involved in governance and the

formulation of policy. The app also provides users the latest information on the COVID-19 situation in India and relevant government advisories.

**Figure 2: MyGov App**


**Source:** Ministry of Communications & Information Technology (Government of India). 2020. "MyGov." 2020. https://play.google.com/store/apps/details?id=in.mygov.mobile.

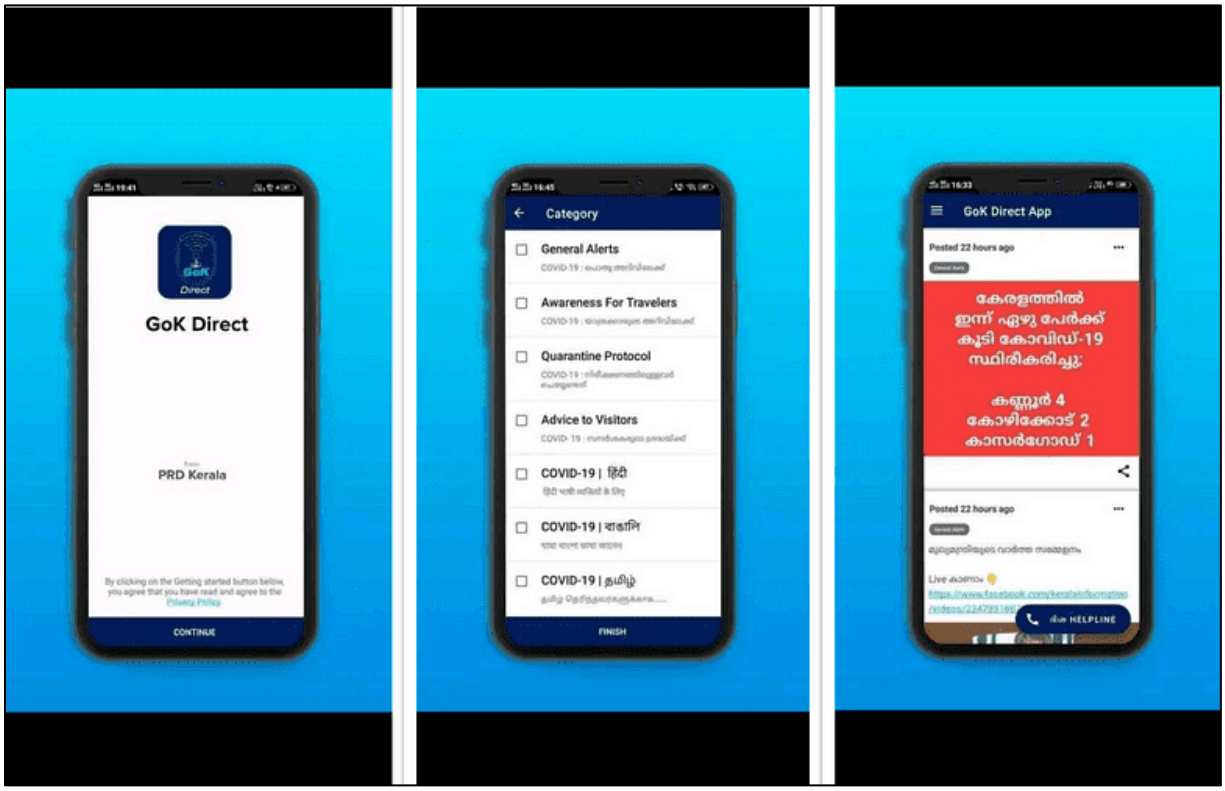
## State Initiatives

States in India have also taken initiatives for mass awareness and support. State Governments provide COVID-19 updates and authentic information on COVID-19 on their websites. The Kerala Government has launched a mobile application called "GoK Direct" for providing authentic information on COVID-19.

**GoK Direct - Kerala**

Gok Direct Kerala app is a joint initiative by the Government of Kerala and Qkopy (a local social communication platform). The app is available in multiple languages- English, Hindi, Malayalam, and Bengali. The app is designed to generate awareness and disseminate credible information related to COVID-19. It provides users access to useful information like quarantine protocols, guidelines related to travel and general tips on safety. The app settings provide users facility to enable WHO alerts as well.

**Figure 3: GoK Direct - Kerala**




Source: Mitter, Sohini. 2020. "Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India." Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

**Delhi Corona App**

The Government of Delhi has launched a mobile app named 'Delhi Corona' to fill the existing 'information gap' related to COVID-19(Anand 2020; Mohammad 2020). It provides real time information on the availability of beds and ventilators at both government and private hospitals designated for COVID-19 treatment in the national capital. The app also provides Information on COVID-19 cases and number of tests conducted, government orders, containment zones, COVID-19 Health Services, and lockdown services like finding a hunger relief centre or finding a shelter or to apply for ration etc. Further, it provides a platform to donate to the Chief Minister/ Lt. Governor relief Fund. The app is available in two languages – English and Hindi. It is currently available for Android users only. It provides access to Delhi government's Corona Helpline on WhatsApp. The app can also be used for redressal of complaints related to refusal by COVID-19 designated hospitals to admit COVID-19 patients by calling on 1031. The call is directed to the Special Secretary Health and a prompt action is taken. The information available on Delhi Corona app is also available on the web portal 'coronabeds.jantasamvad.org/'. The information can also be accessed via SMS on dialing the helpline number 1031. A WhatsApp number (8800007722) can also be used for this purpose.

**Figure 4: Delhi Corona App**


**Source:** Mohammad, Faisal. 2020. "We Tried Delhi Corona App; Here Are 10 Things You Need to Know." We Tried Delhi Corona App; Here Are 10 Things You Need to Know. June 2020. https://indianexpress.com/article/technology/social/we-tried-delhi-govts-delhi-corona-app-here-are-10-things-you-should-know-6439260/.

## Immediate relief and medical response

### Containment of COVID-19

Some of the innovative technologies to contain the virus are being pilot tested in many states in India.

- Milagrow HumanTech have launched 'Milagrow iMap 9.[9] Milagrow iMap 9 is a robot designed for floor disinfection purposes which can navigate and sanitize floors without any human involvement(Press Trust of India 2020d). Milagrow iMap 9 is being pilot tested at All India Institute of Medical Sciences (AIIMS) in New Delhi.
- Garuda Aerospace, a Chennai based start up, has developed an automated disinfecting Unmanned Aerial Vehicle (UAV) called "Corona-Killer 100" (a disinfectant spraying drone).[10] Garuda Aerospace has deployed 300 "Corona-Killer 100" drones for disinfection purposes across 26 cities in India.

[9] Milagrow HumanTech is the No. 1 Domestic Robots company in India. https://milagrowhumantech.com/content/4-about-us

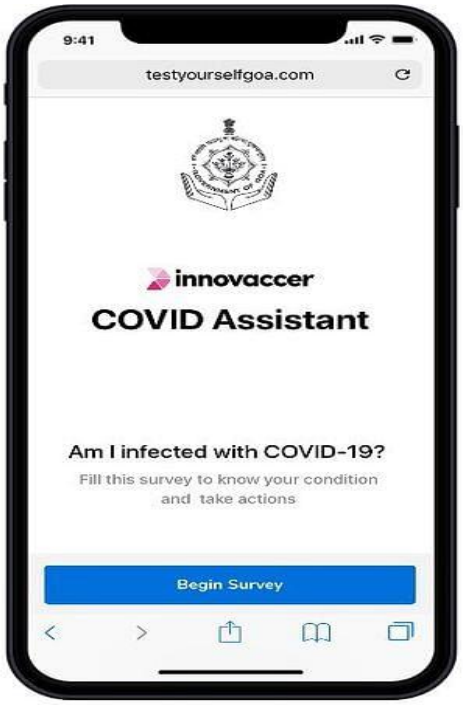
[10] Garuda Aerospace focuses on the design, build and customization of unmanned aerial vehicles (UAVs) or drones for various applications. https://www.garudaaerospace.com/about-us/

## Identification: Screening and Initial Assessment

**Test Yourself**

Test Yourself is built by Innovaccer,Inc., a healthcare technology company based in San Francisco. It is currently being used in two Indian states – Goa (**Test Yourself Goa**) and Karnataka (**Test Yourself Karnataka**)(Mitter 2020). The app assists citizens in carrying out a self assessment test for COVID-19. The app provides a platform for users to undertake a survey related to COVID-19 symptoms. Based on the results, the app guides users through appropriate next steps without having to physically visit the healthcare centre. The app also provides guidelines related to quarantine, use of face masks, list of nearby health centres, advisories related to social distancing and information on transportation to isolation wards. The app is available in four languages: English, Hindi, Konkani and Tamil.

**Figure 5 : Test Yourself**




Source: Source: Mitter, Sohini. 2020. “Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India.” Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

The Government of Maharashtra in collaboration with Apollo have launched an online COVID-19 self assessment tool. Various private institutes like Asian Institute of Medical Sciences and Neuberg Diagnostics have also launched an online COVID-19 self assessment tool.

**Sandhane**

The government of West Bengal has launched an app named 'Sandhane' (Search) to support community health workers like Accredited Social Health Activists (ASHA) in tracing COVID-19 suspects in rural and remote areas(Nag 2020). ASHA workers will visit each household and take note in case there are significant numbers of cases suffering from fever or other COVID-19 symptoms in a specific area. They will feed this data into the 'Sandhane' app which is regularly monitored by the state authorities. Rapid Response Team (RRT) would be sent to the area immediately for further action. This app aids in early detection and containment of COVID-19. It helps the government in identification and treatment of COVID-19 cases in rural and remote areas of the country.

**AI-powered tools for screening**

An AI based voice tool has been developed and designed by a professor and her students in Mumbai(Press Trust of India 2020b). This tool is able to detect COVID-19 through voice-based diagnosis using a smartphone app. The tool will detect COVID-19 based on the fact that the voice of COVID-19 patients is different from healthy people due to damage to the lungs and airways. Artificial Intelligence is able to detect these differences, which a normal ear cannot. When a person speaks to the microphone on the app, this voice tool breaks down the voice in multiple parameters like frequency, noise distortion etc. The values of these parameters are then compared to normal person's values which help detect COVID-19. This tool is being pilot tested by the University of Tor Vergata in Rome and has yielded 98% accurate results.

The Defence Institute of Advanced Technology (DIAT) in Pune, Maharashtra has also developed an AI based COVID-19 detection tool(Press Trust of India 2020h). The tool uses the chest x-rays of patients to identify COVID-19 infection. It will be particularly helpful for radiologists and also in telemedicine. An IIT-Roorkee Professor has also developed similar software which can detect COVID-19 and measure its severity using X-ray scan of the suspected patient(Press Trust of India 2020c).

The Government of Bihar has given approval to the Norway India Partnership Initiative (NIPI) to develop an artificial intelligence (AI)-powered tool which will enable identification of COVID-19 through cough sound analysis(Kumar 2020). The Norway India Partnership Initiative (NIPI) is working in collaboration with the Wadhwani Institute of Artificial Intelligence to develop this innovative tool. The tool will detect COVID-19 based on the fact that the cough of a COVID-19 patient is different from other coughs. Based on the reference coughing pattern, this AI powered tool will be able to detect COVID-19 as soon as the person coughs in front of the machine.

The above mentioned AI based tools acts as a first level of COVID-19 screening and those who test positive using these tools should go for laboratory based testing. These tools can help address the existing bottlenecks in the healthcare infrastructure and manpower. It provides one

of the best solutions to reach the remotest parts of the country by testing through a smartphone based app.

## Contact tracing and investigation

Contact tracing is one of the key pillars in the control of communicable diseases including COVID-19. It involves identification of the individuals who may have come in contact with the infected person (the "contact") and subsequent collection of relevant information from these contacts. In situations like the COVID-19 pandemic, manual contact identification becomes a challenging task. In such situations, ICTs can play a crucial role in contact tracing and further investigation.

**Aarogya Setu App**

The Aarogya Setu App has been developed by National Informatics Centre (NIC), Ministry of Electronics and Information Technology, Government of India(Wikipedia 2020; National Informatics Centre, Ministry of Electronics & Information Technology, Government of India 2020a; Mitter 2020). It is a contact tracing app available in 11 languages. The app uses Bluetooth and location data to track movement of the user. An alert is generated whenever a user has been within six feet of a COVID-19 patient by cross-referencing the pan-India government database of COVID-19 patients. The alert is accompanied by instructions from the Ministry of Health on self-isolation and the course of action to be taken in case the user develops COVID-19 symptoms. The app's user interface displays current status of user locality (the zone: red, orange, green), risk of the user getting infected with COVID-19 and updates on COVID-19. The app is somewhat similar to the community tracing app "Trace Together" used by Singapore.

**Aarogya Setu Wristbands**

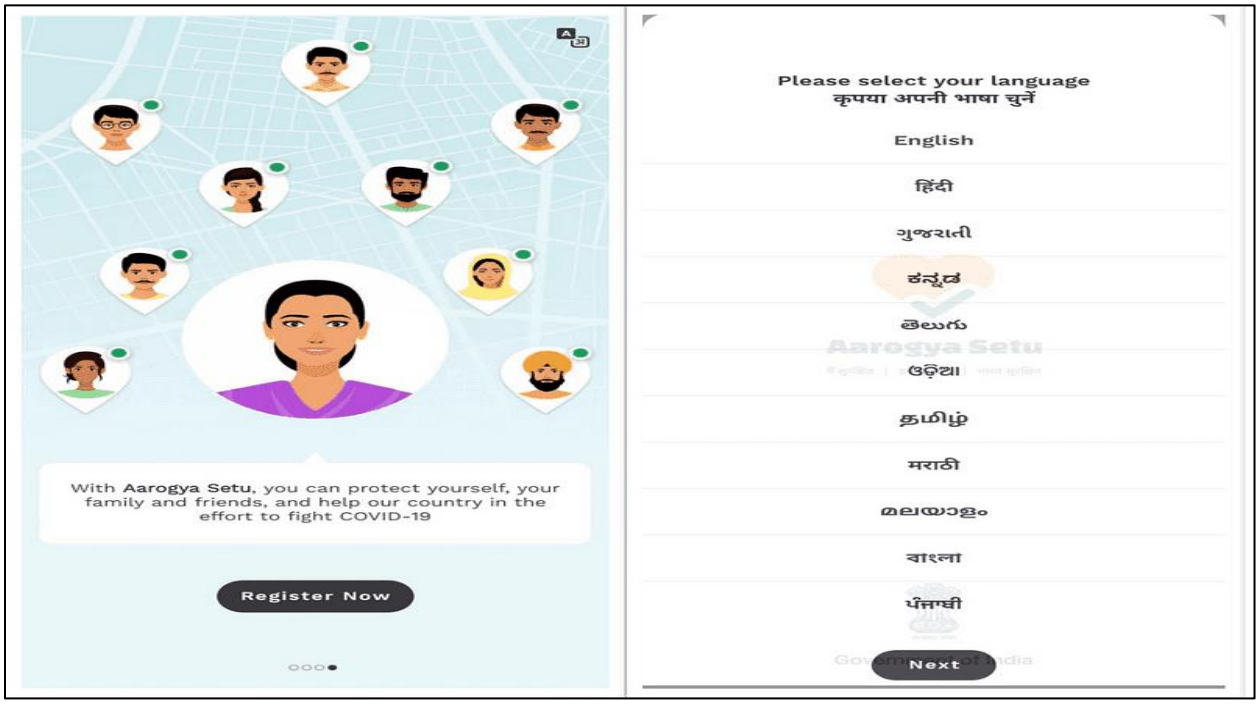
The Government of India is in the process of procuring large number of wristbands paired to the Aarogya Setu App for monitoring the movement of COVID-19 suspects in hospital or in home quarantine(Venugopal 2020). The wristband will aid in remote monitoring of suspect's temperature and symptoms related to COVID-19.

**Aarogya Setu Interactive Voice Response System (IVRS)**

Following the launch of Arogya Setu smartphone based mobile application; the Government of India launched the Aarogya Setu Interactive Voice Response System (IVRS) across the country in May 2020(Press Trust of India 2020f). This service has been introduced and implemented to include citizens having feature phones and landline connections within the Aarogya Setu ecosystem. Aarogya Setu IVRS is a toll-free service where citizens can give a missed call to the number 1921 using feature phone or landline and will receive a call back requesting for inputs related to their health. The questions asked on the call are aligned with the questions on Aarogya Setu mobile application and based on the responses the person will receive SMS about their current health status. The information provided will be added to the Aarogya Setu

database which will be processed to send future alerts related to their safety. Just like Aarogya Setu mobile application, this service is also available in 11 regional languages.

**Figure 6: Aarogya Setu App**




Source: Mitter, Sohini. 2020. "Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India." Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

## Enforcing quarantine and social distancing

### Geofencing Technology

Geofencing technology is being used for enforcing strict vigilance on COVID-19 suspects in quarantine. It uses location based service like GPS to set up a virtual boundary around the quarantine center. Mobile app is installed in the COVID-19 suspect's mobile device and this app uses GPS to trigger an alert whenever the suspect's mobile device enters or exits the virtual boundary.

**MahaKavach**

MahaKavach is a joint initiative by Maharashtra State Innovation Authority, National Health Authority, Nashik District Innovation Council, Nashik Municipal Corporation, Digital Impact Square (DISQ) and Kumbathon Foundation (Mitter 2020). It is basically a geofencing app and helps track the movement of COVID-19 suspects in and out of the quarantine facilities in

Maharashtra. The app helps in taking disciplinary actions against those who do not follow the quarantine instructions. MahaKavach app enables users to update their quarantine status, testing dates and other relevant health information.

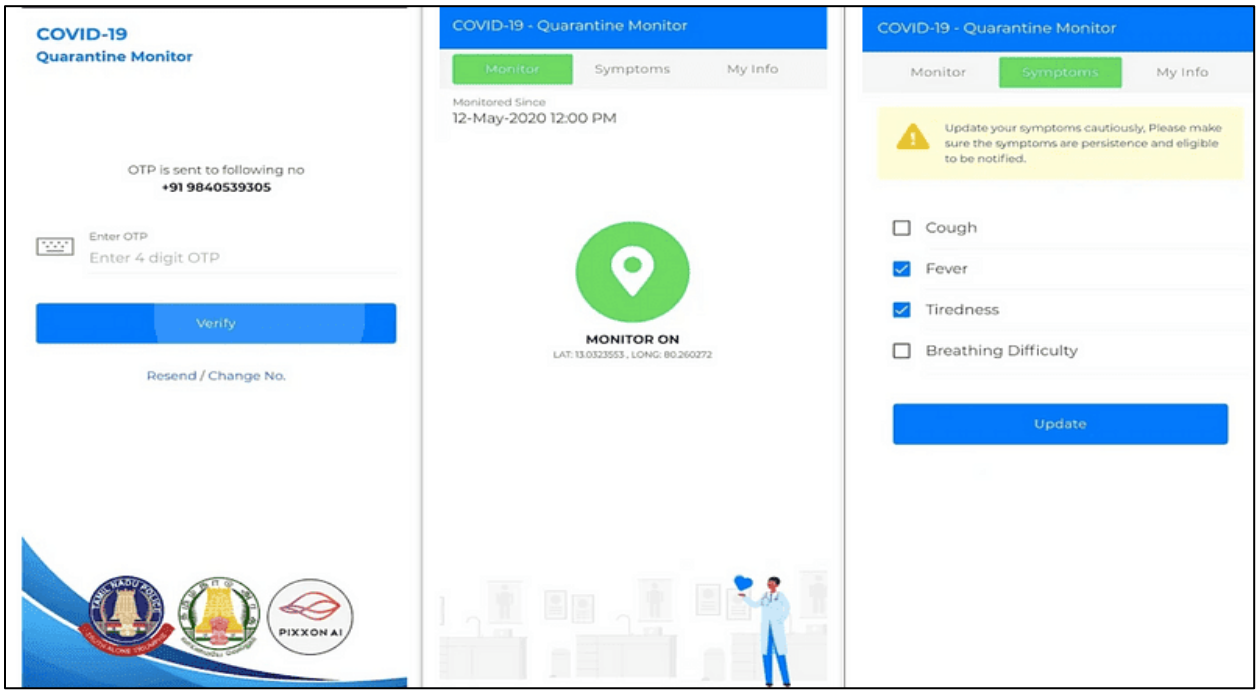
**Figure 7: MahaKavach App**


**Source:**
https://www.google.com/search?q=MahaKavach&rlz=1C1AVUA_enIN761GB764&source=lnms&tbm=isch&sa=X&ved=2ahUKEwiJw472_8vpAhX7yjgGHRXaAs0Q_AUoA3oECAsQBQ&biw=1299&bih=591#imgrc=kcucM6hMvBYYoM

**Quarantine Monitor**

Quarantine Monitor App is an initiative by Tamil Nadu state Government(Mitter 2020). It is built by the Tamil Nadu e-Governance Agency. The purpose of the mobile app is to track the movement of COVID-19 suspects under home quarantine. All the COVID-19 suspects under home quarantine will receive an SMS from the government authorities to download and install the app on their mobile by validating their number. The app will give an alert to the monitoring authorities in case the suspect moves 500 metres or one kilometer away from their home location. The app also helps in monitoring the symptoms of COVID-19 suspects in home quarantine.

**Figure 8 : COVID-19 Quarantine Monitor**




Source: Mitter, Sohini. 2020. "Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India." Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

**CoBuddy**

CoBuddy is an android based mobile application being used by Police authorities in Tiruvallur district of Tamil Nadu(Barik 2020). CoBuddy is a geofencing app and helps in monitoring the movement of COVID-19 suspects under home quarantine. The app uses face verification as an added layer of authentication. Random messages are sent to the user throughout the day to upload his/her photograph to verify their current location.

**Corona Watch**

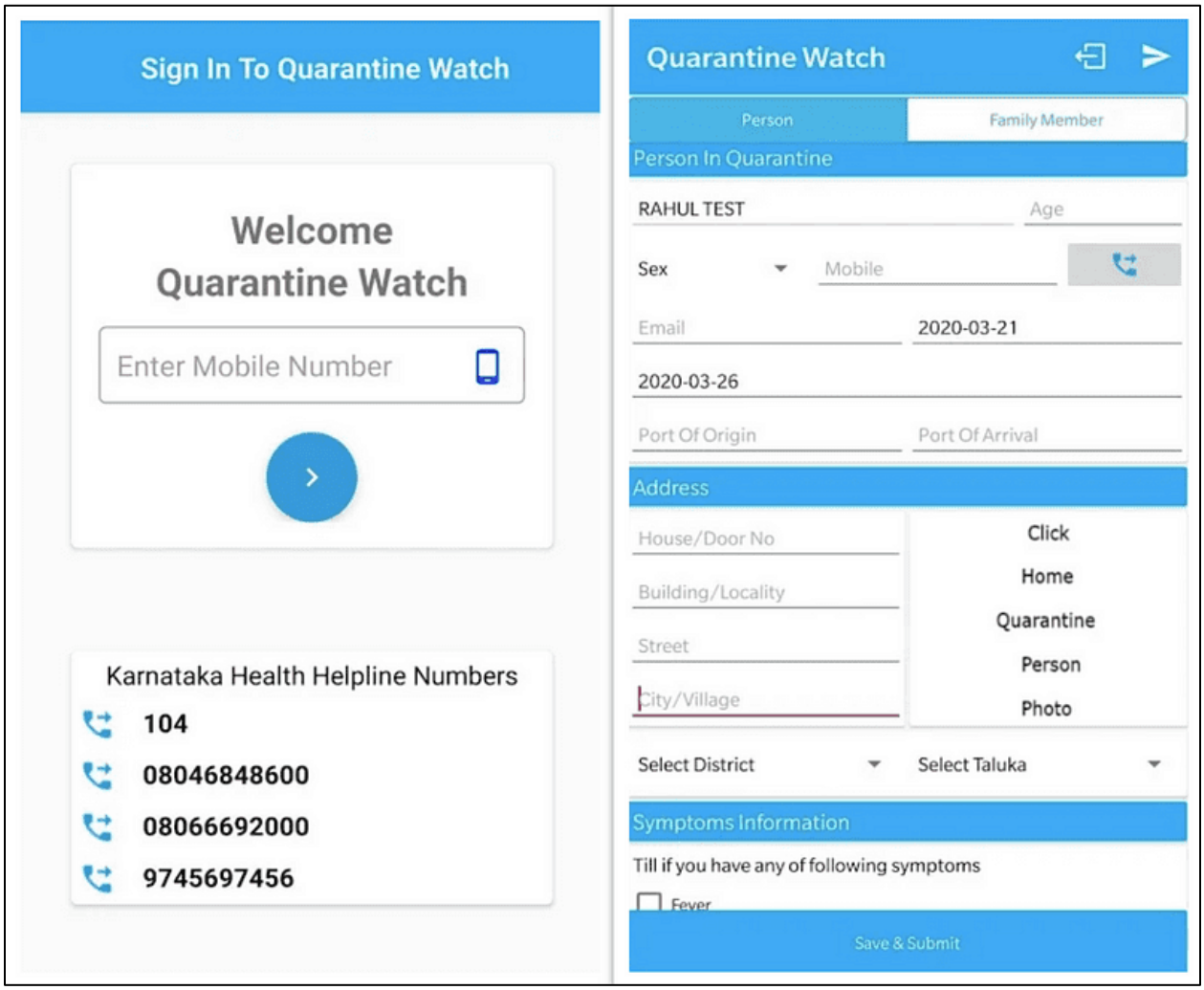
Corona Watch is an initiative by Karnataka Government(The Hindu 2020a). The app shows the current location of COVID-19 patients and their movement history in past 14 days. General public can make use of the app to avoid visiting these areas and if they have already been to such areas they can take necessary precautions and contact the helpline numbers- 104, 080-46848600, 080 66692000 if needed. The app also provides the facility to identify the nearest COVID-19 designated hospitals for availing further testing and treatment.

**Quarantine Watch**

It is developed by the Revenue Department, Government of Karnataka(Mitter 2020). The app is meant for self reporting by COVID-19 suspects who are under self-quarantine at home. Users

can be registered on the app by providing personal details like name, contact number, address details and travel history. The user is required to upload their selfie every hour (except between 10 pm and 7 am) during the 14 day isolation period and if there is any change in the GPS coordinates, the person will be moved to mass quarantine centers run by the Government.

**Figure 9: Quarantine Watch**

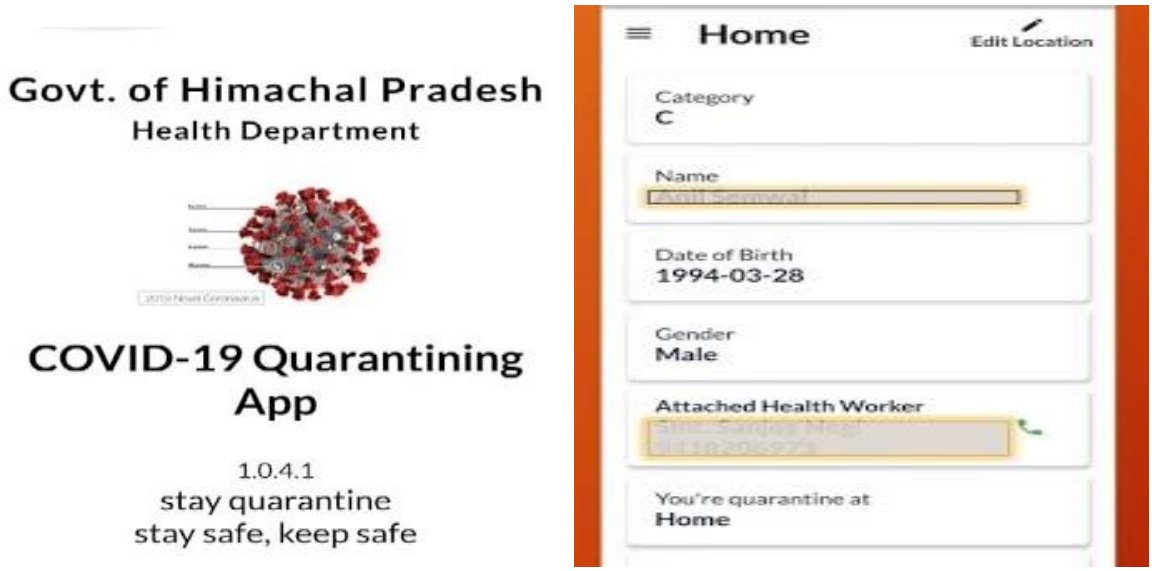



Source: Mitter, Sohini. 2020. "Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India." Coronavirus: 7 Contact Tracing and Patient Monitoring Apps Being Used by India. April 2020. https://yourstory.com/2020/04/coronavirus-contact-tracing-patient-monitoring-apps-india.

**Corona Mukt Himachal**

The Himachal Pradesh Government has developed a mobile application 'Corona Mukt Himachal' for tracking the movement of COVID-19 suspects under home quarantine (ETGovernment 2020a; Deptt. of Information Technology, Himachal Pradesh 2020).

**Figure 10: Corona Mukt Himachal**




Source: Deptt. of Information Technology, Himachal Pradesh. 2020. "Corona Mukt Himachal." 2020. https://play.google.com/store/apps/details?id=com.developmentlogics.patientgeotracker&hl=en_IN.

**SMC COVID-19 Tracker**

SMC COVID-19 Tracker App is an initiative by Gujarat state Government(Press Trust of India 2020a; 2020e). It helps in monitoring the movement of COVID-19 suspect in home quarantine. This app requires users to upload their selfie and press a button on the app every hour to update their location. If there is any change in the GPS coordinates, the person will be moved to mass quarantine centers run by the Government.

**Covicare and Coviguard**

Covicare and Coviguard apps are being used by three municipal corporations, namely, Navi Mumbai, Thane and Panvel in Maharashtra (ETGovernment 2020b). These apps are developed with the support of the Directorate of Industries. Covicare is helpful in conducting household surveys and getting the health statistics from the residents. It also provides access to area-wise information related to COVID-19. The Coviguard app is helpful in monitoring the people who are in home quarantine. The Coviguard app also has a built-in facility for personalized chats that helps the quarantined person to communicate with the authorities.

## Other Measures

- CCTV Footage of the quarantine center is also helpful in keeping an eye on the movement of COVID-19 suspects.

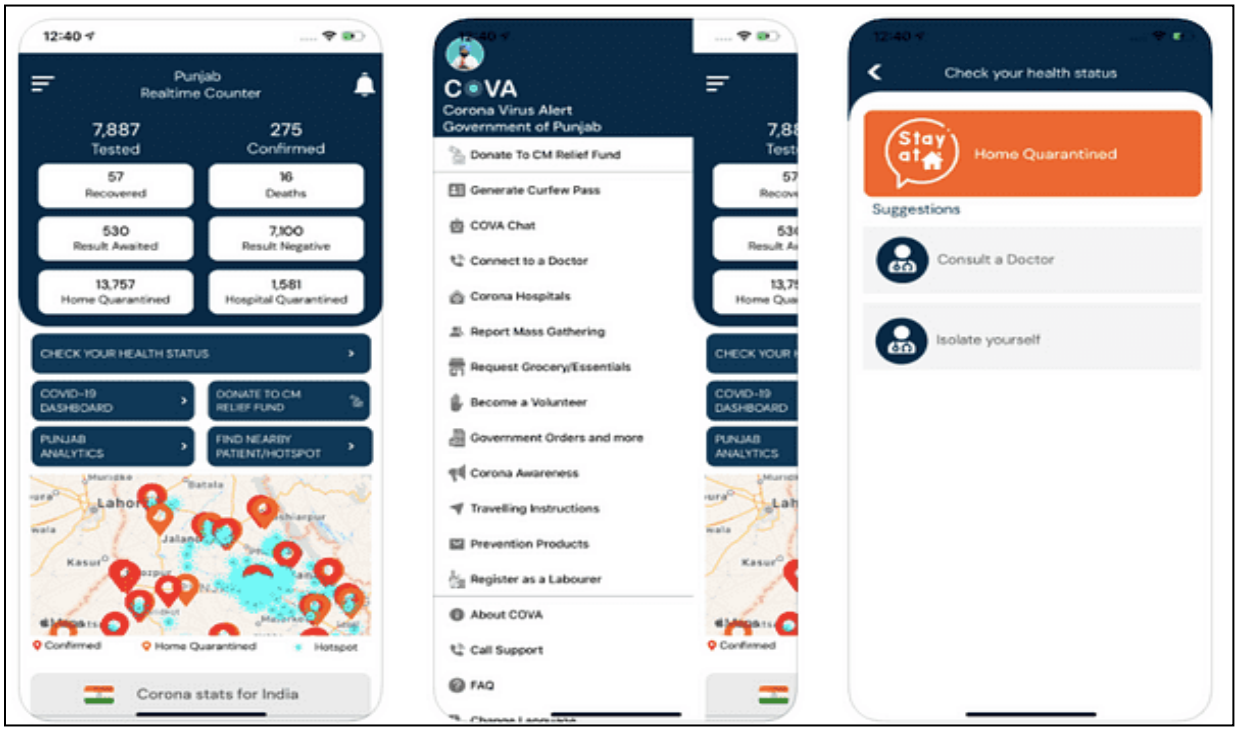
- Drones are being used to monitor the movement of COVID-19 suspects in quarantine centers. Drones are being leveraged for video surveillance and enforcing social distancing purposes. These are particularly helpful in the red alert and containment zones and in public places where people gather in large numbers like banks, ration shops etc.

## Multi-purpose Apps

**COVA Punjab**

The Government of Punjab has developed a multipurpose app called COVA Punjab (Corona Virus Alert)(Mitter 2020). It is available in three languages: English, Hindi and Punjabi. It provides citizens access to a real time dashboard for Punjab, India and World statistics, helpline numbers, prevention measures, government advisories, travel instructions and more. It helps citizens check their distance from the nearest COVID-19 patient. It provides a platform for self-screening for COVID-19 and locates the nearest COVID-19 hospital. The users can also request essential items, request a curfew pass through the app and report cases of mass gatherings. It is also a geofencing app and informs district authorities in case any suspect in quarantine moves beyond 100 meters from their location.

**Figure 11: COVA Punjab App**

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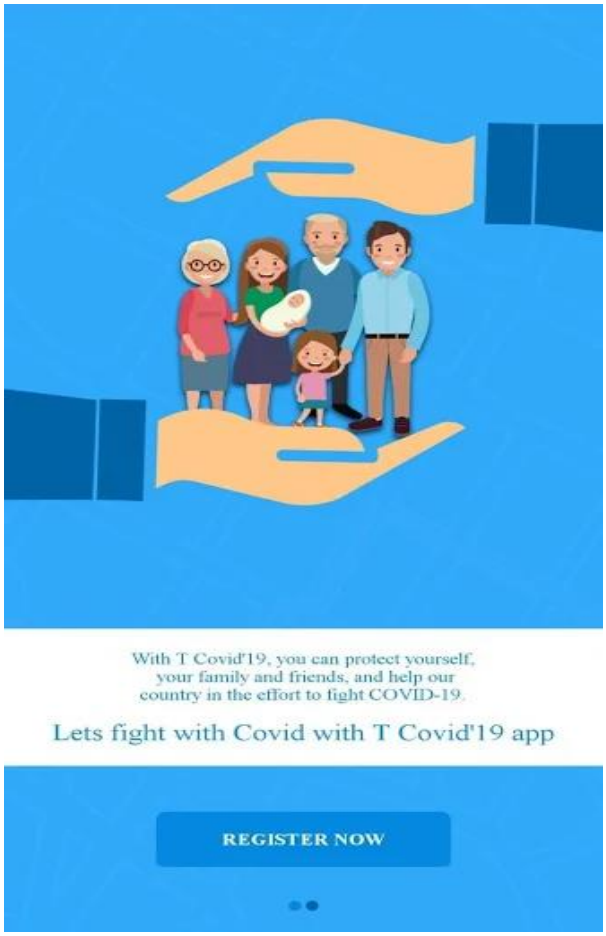
**T-COVID'19**

T-COVID'19 app is launched by Government of Telangana(ETGovernment 2020c; ET Wing, Govt of Telangana 2020). It is developed jointly by Cisco, AWS and Quantella. The app provides live updates on COVID-19 cases in the state. It provides access to government and WHO advisories related to COVID-19. Details related to government approved labs and test centers, isolation wards in government and private hospitals and quarantine centers in the state are also available on the app. The app aids the users in self assessment for COVID-19 and also provides a telemedicine platform to consult a doctor.

**Figure 12: T-COVID'19 app**





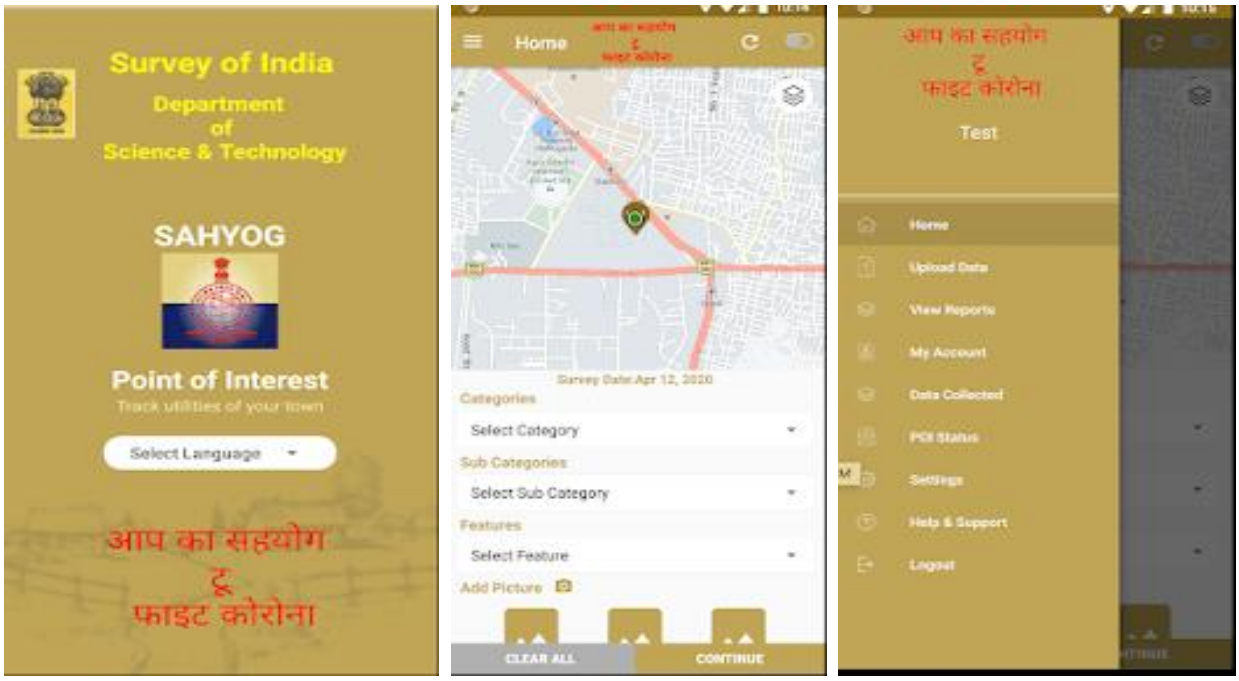
Source: ET Wing, Govt of Telangana. 2020. "T COVID'19." April 2020. https://play.google.com/store/apps/details?id=com.tsstate.citizen&hl=en.

**SAHYOG**

The SAHYOG app is developed by Survey of India (SOI), India's National Mapping Agency (NMA) under the Department of Science & Technology, Government of India(Geospatial World 2020; Survey Of India 2020). The main objective to launch the app is to help government improve its response system. It complements the Aarogya Setu app in the attainment of three objectives –

contact tracing, public awareness and self assessment. It helps community workers in carrying out door to door surveys, public awareness campaigns, contact tracing and delivery of essential items. Through this app users will contribute towards preparation of national database of the country. The app will collate data at the state level and geo-tag it for further analysis by Survey of India (SOI).

**Figure 13: SAHYOG App**



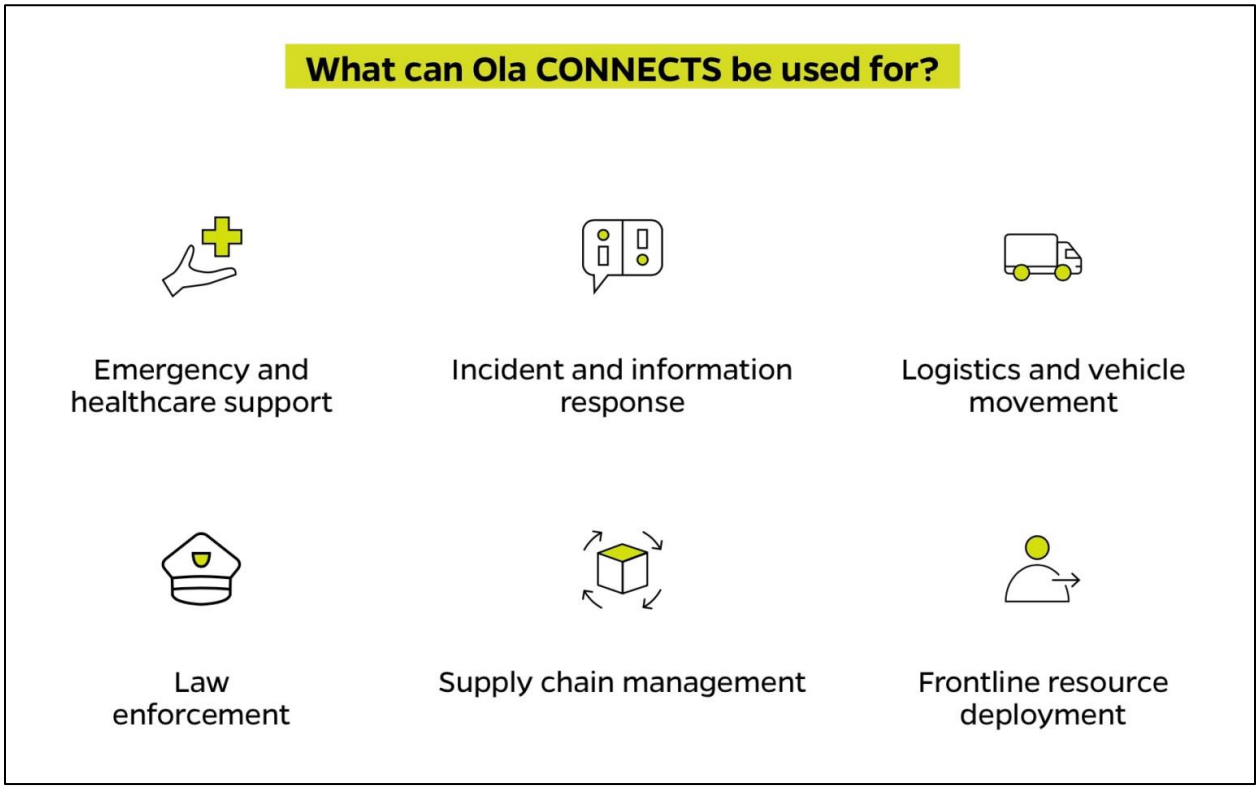

Source: Survey Of India. 2020. "Sahyog." 2020. https://play.google.com/store/apps/details?id=in.gov.surveyofindia.sahyog&hl=en

**Ola CONNECTS**

The Indian firm Ola has made available its technology platform "Ola CONNECTS" to the Indian Government to manage their on-ground operations during COVID-19 crisis(Singh 2020)[11]. Ola CONNECTS offers solutions to various problems in the real-time war against COVID-19. The platform can be used for real time tracking of crowds, goods and vehicles. The platform can be used as a geofencing app and helps with tracking the movement of suspects in mass quarantine centers or home quarantine. It has an inbuilt feature to verify via a selfie picture whether people are wearing masks. Ola CONNECTS can help in crowd control by enforcing social distancing with minimal disruptions to delivery operations and the supply chain. Ola CONNECTS is currently being used by Punjab Mandi Board for tracking and monitoring the movement of millions of farmers. Ola CONNECTS also helps farmers in the issuance of delivery passes based on real time crowd status and accessing real-time updates related to COVID-19.

[11] Ola is India's largest mobility platform and one of the world's largest ride-hailing companies, serving 250+ cities across India, Australia, New Zealand, and the UK. https://www.olacabs.com/about.html

**Figure 14: Ola CONNECTS**




**Source:** Singh, Manish. 2020. "Ola Opens Its Tech Platform to Indian Government to Combat Coronavirus Crisis." Ola Opens Its Tech Platform to Indian Government to Combat Coronavirus Crisis. April 17, 2020. https://techcrunch.com/2020/04/17/ola-connects-technology-platform-india-government/.

**mCOVID-19**

mCOVID-19 is an initiative by Government of Mizoram. It is a mobile based application for providing authentic information and updates related to COVID-19. The app provides local, national and international updates in Mizo language[12]. The app also aid in monitoring COVID-19 suspects in quarantine. It also provides access to government advisories, task force registration, volunteer registration, and mPASS (a pass to permit the movement of goods, vehicles and people).

**Unmaze**

The police authorities in Kasaragod district of Kerala have been using Unmaze, a mobile application developed by Innefu Labs (Mihindukulasuriya 2020; RP 2020). It is being used for contact tracing and quarantine monitoring purposes. The application is mapped with the user's mobile phone number. It picks up the user's geo-location along with the details of the devices

[12] https://mcovid19.mizoram.gov.in/

which have been in the vicinity of the device (5 – 10 meters). A notification is sent whenever the user has been within 5-10 meters of a COVID-19 infected person by cross-referencing the database of COVID-19 patients. The alert is accompanied by instructions for self quarantine. Subsequently, the device is regularly monitored to ensure that the user in not violating the quarantine guidelines. A separate notification is sent to the administrator to provide information related to the areas which need to be disinfected.

## Treatment

ICT is playing a key role in the efforts related to treatment of COVID-19 patients. The COVID-19 Pandemic has not only brought out concerns related to heavy work load for healthcare workers, but also concerns of medical teams getting infected with this deadly virus due to direct contact with patients. New innovative technologies like medical robots and remote monitoring systems are playing a crucial role in treating COVID-19 patients. These automation technologies not only mitigate the issue of increasing exposure of doctors and frontline healthcare workers to coronavirus from patients in treatment wards, but also help in reducing the demand for Personal Protective Equipment (PPE).

### Remote Health Monitoring Systems

The use of remote monitoring systems is seen as a breakthrough for medical and paramedical teams who gets exposed to the deadly coronavirus from repeated visits to monitor COVID-19 patients. It also helps in reducing the patient load at hospitals. Remote monitoring systems have been launched by various states in India.

**Indore 311 mobile app**

Indore, a city in Madhya Pradesh, is one of the worst hit cities in the nation. As per Madhya Pradesh government guidelines, asymptomatic COVID-19 patients are advised to stay in home isolation. To monitor and facilitate treatment of such patients, the state government has launched some new features in the already existing app called Indore 311 mobile app (ETGovernment 2020d; Press Trust of India 2020g). The new feature enables asymptomatic COVID-19 patients in home isolation to monitor their oxygen level and pulse rate by a pulse oximeter. The app also provides a pre-loaded questionnaire for uploading patients' health information on daily basis. The patients will be monitored by a team of doctors at the IMA (Indore Medical Association) control room. In case of emergency, patients can press the red button provided in the app to seek immediate medical care by the Rapid Response Team. Further, the app helps in tracking the movement of patients in and out of their home location.

**LiFi Technology**

Nav Wireless Technology Pvt Ltd has come up with a technology based communication solution called LiFi (Light Fidelity) for monitoring COVID-19 patients(Vora 2020). LiFi technology enables transmission of key parameters like temperature, ventilator reading etc. via wireless data transfer using LED lights. This technology uses light as a medium to transfer and receive information. This is being pilot tested in one of the hospital in Ahmedabad, an Indian city in the state of Gujarat.

**Milagrow Humanoid ELF**

Milagrow HumanTech has launched Milagrow Humanoid ELF. The Milagrow Humanoid ELF is designed to facilitate remote interaction with and monitoring of COVID-19 patients without any person-to-person contact, hence significantly reducing the risk of coronavirus transmission (Press Trust of India 2020d). The Milagrow Humanoid ELF is being pilot tested at All India Institute of Medical Sciences (AIIMS) in New Delhi.

**Monal 2020**

Monal 2020 is a remote health monitoring solution built by Electronics Corporation of India Limited (ECIL), under Department of Atomic Energy (DAE)(Express News Service 2020). It is launched in All India Institute of Medical Sciences (AIIMS), Rishikesh by the state of Uttarakhand. The term 'Monal' comes after the name of the state's National Bird. Monal 2020 consists of a wearable instrument for monitoring COVID-19 patient vital parameters like body temperature, blood oxygen level, respiration rate, heart rate etc. It also comprises of software that remotely displays these vital parameters on the mobile phone, laptop/desktop of the doctor in charge from any location. The system also uses Google maps or BHUVAN software (developed by Indian Space Research Organisation) for identification of patient location. Monal 2020 is built on Internet of Things (IoT) based technology.

**Figure 15: Monal 2020**


Source: Express News Service. 2020. "ECIL Develops Remote Monitoring System for Covid-19 Patients." ECIL Develops Remote Monitoring System for Covid-19 Patients. May 5, 2020. https://indianexpress.com/article/cities/hyderabad/ecil-develops-remote-monitoring-system-for-covid-19-patients/.

**Oxy 2 and AI-based biosensor**

Helyxon, a Chennai based start-up, in association with IIT Madras' Healthcare Technology Innovation Centre (HTIC) has launched two devices for remote patient monitoring(Babu 2020). One is the Oxy 2 for real time monitoring of temperature, oxygen saturation and heart rate. The other is the Artificial Intelligence (AI)-based biosensor device for monitoring of body temperature '98.6 Fever Watch'. The two devices keep track of spikes and aberrations in the parameters and whenever an anomaly is observed an automatic alert is sent to the health care provider. The devices also work as a geofencing tool for monitoring patients' movement from their home location. Both devices are in demand by healthcare providers in North America, West Asia and the Far East.

### Robots for treatment

The use of robots is also being explored in various states in India to minimize the contact of healthcare teams with COVID-19 patients in hospitals and to address the shortage of Personal Protective Equipment (PPE).

**Nightingale-19 Robot**

The Nightingale-19 Robot is being used in hospitals in Kannur and Thalassery districts in Kerala (Thomas 2020; Zachariah 2020). Nightingale-19 can deliver food, medicines and other essential items. It also provides video conferencing facility to interact with the patient.

**Figure 16: Nightingale-19 Robot**


Source: Zachariah, Serene Sarah. 2020. "Kerala's 'Nightingale-19' Robot Serves Meals, Helps Doctors Treat COVID-19 Patients." Kerala's 'Nightingale-19' Robot Serves Meals, Helps Doctors Treat COVID-19 Patients. April 2020. https://www.thebetterindia.com/224546/covid-19-kerala-robot-nightingale-19-innovation-protect-health-workers-india-ser106/

**KARMI-Bot**

The Kerala Government has initiated the use of robot KARMI-Bot in one of the hospitals in Ernakulum district for the purpose of serving food and medicines to COVID-19 patients, collecting the trash produced by patients, enabling video call between patients and doctors or relatives and performing disinfection of the isolation ward(Bhatia 2020; The Hindu 2020b). KARMI-Bot is developed by Kochi-based startup Asimov Robotics.

**Figure 17: The KARMI-Bot**


Source: The Hindu. 2020. "Kerala Government Hospital Deploys Robot to Serve COVID-19 Patients." Kerala Government Hospital Deploys Robot to Serve COVID-19 Patients. April 2020. https://www.thehindu.com/news/national/kerala/kerala-government-hospital-deploys-robot-to-serve-covid-19-patients/article31432663.ece.

Robots are also being pilot tested in other hospitals across India(Nainar 2020). These include Jaipur's Sawai Man Singh Hospital and Mahatma Gandhi Memorial Government Hospital in Tamil Nadu(Times of India 2020a).

### Telemedicine and e-consultation

Telemedicine, the use of telecommunications technology to evaluate, diagnose and treat patients from a distance, is increasingly becoming an important part of healthcare Infrastructure. In fact virtual care has been in India for years, COVID-19 has only accelerated its acceptance and use on a wide scale. In this time of lockdown and quarantines, telemedicine has emerged as a frontline weapon for seeking medical care. Telemedicine considerably reduces

the burden on hospitals and helps in reducing the spread of coronavirus among doctors, healthcare teams, patients and families. Telemedicine provides a platform to virtually examine COVID-19 suspects in mass quarantine centers or at home quarantine. It spares manpower at hospitals for treating critically ill patients. It also saves time and scarce resources like Personal Protective Equipment (PPE). It provides access to healthcare services that may not be available otherwise. Telemedicine is acting as a boon to the COVID-19 response.

On 25th March 2020, Telemedicine Practice Guidelines were released by the Ministry of Health and Family Welfare, Government of India. As per the guidelines any registered medical practitioner in India can make use of telemedicine tools for providing healthcare services in the country. These guidelines were notified and gazetted by the Government of India on 14th May 2020(Shroff 2020). These guidelines which were proposed around ten years back finally saw the limelight during the national COVID-19 crisis. This law could not have come at a better and more appropriate time. The public will now get the benefit not only for COVID-19 relief but for other diseases as well(Press Information Bureau, Government of India 2020). It is now legally possible to use telemedicine to deliver healthcare to the masses and work towards achievement of universal healthcare. Many hospitals in India are using telemedicine for consultation purposes. For Instance, Medanta Hospital is using a comprehensive telemedicine platform 'Medanta eCLINIC' for virtual consultation(Raval 2020). Apollo Hospitals are also providing e-consultation facility to enable patients to seek medical care while being at home. All India Institute of Medical Sciences in New Delhi has also initiated tele-consultation for non-COVID patients. Amidst the coronavirus outbreak, telemedicine has emerged as a critical technology for providing essential care to patients not only in India but worldwide. Though telemedicine has emerged as one of the obligatory option for many to seek medical care during COVID-19, soon it will become a new normal.

## Challenges and Pitfalls

ICT enables new ways of dealing with the COVID-19 crisis and should not be considered as a sovereign remedy to a pandemic. ICT acts as a catalyst to facilitate the processes involved in combating COVID-19. The central and state governments in India have launched various new mobile apps to deal with the COVID-19 situation in the country. However, the most vulnerable sections of society, the poor and elderly, are less likely to benefit from these interventions. Most of these mobile apps are designed for smartphones and poor are less likely to afford them while elderly are less likely to use them. Therefore, efforts should be directed towards scaling up those ICT interventions which enables inclusion of these vulnerable groups. Misinformation on social media platforms is another challenge in the age of COVID-19. For instance, false claims about curing COVID-19 by breathing hot air from a hairdryer or injecting Vitamin C into the bloodstream have circulated widely online. Such false claims are dangerous and efforts should be made to flag and remove such information from social media platforms.

There are many concerns around the Government of India mobile app 'Aarogya Setu' being used for contact tracing purposes(George 2020). First, the app collects a lot of personal information about the user but there is less information on how online privacy of the users is protected. Clear legislation on how the personal information of the user will be used can help resolve this issue. Second, the unique digital identity number in the app assigned to the user is a static number which again creates user privacy issues. A constantly changing digital identification number could be a better approach. Third, there is no clear documentation available publicly on the inner workings of the app. If the government intends to make this app permanent then there are concerns that it can be used for iniquitous and nefarious means. Not only 'Aarogya Setu' but all other apps that track real-time movement of people raise privacy concerns.

## Best practices from other countries

Technology has always been the top priority of the South Korean government, and South Korea has also proven to be the global leader in using ICT to fight against COVID-19. With the help of Artificial Intelligence (AI), South Korea was able to develop a COVID-19 testing kit in just three weeks time which normally would have taken around 2-3 months to develop(ITU News 2020). South Korea has had a 'Smart quarantine Information System' in place since the MERS outbreak in 2015(ITU News 2020). All in-bound travelers are required to download a smartphone based mobile app and submit their health conditions using the app during the 14 days quarantine period. This helps health authorities to examine a full record of the patient's movement and to quickly identify, isolate and treat the suspected COVID-19 patient in a timely manner. The authorities are also using CCTV footage, GPS location data from mobile phones, and credit card records to trace people who might have come in contact with a COVID-19 infected person. South Korea has leveraged Artificial Intelligence (AI) for the development of various tools to aid in quick diagnosis and classification of case severity(ITU News 2020). The AI based Chest X-Ray Image Support Decision Tool developed by VUNO helps in identifying abnormal findings on chest x-rays within few seconds and is able to classify if the patient needs intensive care. AiHub is a medical platform which utilizes AI to examine lung diseases within few seconds. AI based Hand-held chest X-ray camera can scan the chest in just three seconds and gives a heatmap visualization of abnormal lesion. For sharing information related to COVID-19, South Korea has developed AI based public chat robots. For instance, voice robots based on AI automatically calls people who seek information or need attention. Besides, South Korea has also developed a number of mobile applications to deal with the COVID-19 situation in the country. One of the most widely used apps among them is the 'Corona 100m (Co100)' app for contact tracing purposes.

Hong Kong has showcased the best example in the world of caseload mapping. It has published building-by-building map which illustrates the number of COVID-19 cases at every single address in the whole city without any additional identifiable information[13]. Further, early in March, Hong Kong started putting electronic wristbands on all in-bound travelers to monitor

[13] Map available at https://chp-dashboard.geodata.gov.hk/covid-19/en.html

their movement during the 14 day quarantine period(Agarwal 2020). Thailand took the initiative of providing free SIM Cards to monitor the movement of all the passengers (including Thai) travelling from high-risk countries(Agarwal 2020). The travelers are supposed to download AOT (Airports of Thailand) app which helps in tracking their location for 14 days. The travelers are not allowed to enter the country in case they refuse to take the SIM Card and download the AOT app. Countries like Germany and Italy are strict in terms of data protection laws and are using anonymised location data to identify public places where people are defying lockdowns by gathering in groups. Robots are manning quarantine centers and isolation wards in countries like China and Singapore(Seetharaman 2020). China has implemented 'Hangzhou Health Code' system which automatically assigns the users different colors- red, yellow and green, based on their proximity with the corona infected person(Agarwal 2020). This system helps police authorities enforce a flexible quarantine within the country. Early in the course of the pandemic, Singapore rolled out 'TraceTogether' app for contact tracing purposes setting a standard which only few countries have been able to meet(Agarwal 2020). Aarogya Setu contact tracing app ,launched by Government of India, and Israel's "HaMagen"(or "TheShield") app are few such examples.

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