Digital Solutions for COVID-19 Response

An assessment of digital tools for rapid scale-up for case management and contact tracing

JOHNS HOPKINS UNIVERSITY
Global mHealth Initiative
A Community of Excellence in mHealth Research, Innovation and Leadership

JOHNS HOPKINS
BLOOMBERG SCHOOL
of PUBLIC HEALTH

Suggested citation
Smisha Agarwal, Madhu Jalan, Shivani Pandya, Rennie Ferguson Rennie Ferguson, Donia Mustafa, Charles Ng, Alain Labrique. *Digital Solutions for COVID-19 Response: An assessment of digital tools for rapid scale-up for case management and contact tracing.* Johns Hopkins Global mHealth Initiative (JHU-GmI)- Johns Hopkins Bloomberg School of Public Health. Baltimore: Maryland; 2020.

Table of Contents

Acknowledgements:

We are grateful to the representatives from CommCare, Community Health Toolkit (CHT), DHIS2 Tracker, Go.Data, ODK, OpenSRP, RapidPro, SORMAS, and WelTel, who shared their time and insights with us to support the assessment of the platforms and the development of this report. This report was designed by Emmimade Design Agency. This report is supported by the Bill and Melinda Gates Foundation.

Glossary

Amazon Web Services (AWS) is a subsidiary of Amazon that provides on-demand cloud computing platforms and application programming interfaces (APIs) to organizations.

Application refers to a piece of software that is usually resident on a mobile device, packaged to respond to a particular need. Applications may be open-source or proprietary. Open-source code allows the source code to be viewed, revised, and adapted. However, for proprietary software, changes are dependent on the organization developing the software.

Digital health intervention refers to one or more digital technologies used to provide discrete functionality to achieve health sector objectives, e.g. text messaging to increase knowledge of services.

Digital Solution, sometimes used interchangeably with the term ***"application"***, usually encompasses software resident on the end-user's device, and includes the back-end server systems, processing engines, and the reporting and visualization software required to address the public health and clinical challenges.

Extract, Transform, and Load (ETL). is a standard mechanism used to describe the procedure of aggregating data from one or more sources into a different system for the purpose of analyzing the data.

Fast Healthcare Interoperability Resources (FHIR), is a standard describing data formats and an API for exchanging electronic health records. The standard was created by the Health Level Seven International (HL7) healthcare standards organization. HL7 is a precursor to FHIR.

Load balancing is the process of distributing network traffic across multiple servers to ensure application responsiveness. It also increases availability of applications and websites for users.

Platform refers to a digital application or a suite of applications that can be adapted to a number of use cases. A platform may have inherent functionality that can be leveraged to create a digital solution to address a problem.

Usage Metrics are related to the frequency, duration, and other measurements of how the user engages with the application. Examples of metrics include the amount of time spent by the user on the app on a daily basis, amount of time offline versus online, etc.

SARS-CoV-2 stands for severe acute respiratory syndrome coronavirus 2 and is the virus responsible for COVID-19.

Software as a Service (SAAS) is a software licensing and delivery model in which software is licensed on a subscription basis and is centrally hosted on the cloud.

Usage Metrics are related to the frequency, duration, and other measurements of how the user engages with the application. Examples of metrics include the amount of time spent by the user on the application on a daily basis, amount of time offline versus online, etc.

Executive Summary

Aims and Audience for the Report

Coronavirus disease (COVID-19) spread rapidly around the world in 2020, resulting in more than eight million cases and nearly half a million deaths in a matter of months. Healthcare systems in every country are now faced with an infectious disease whose risk and protective factors remain poorly understood, and without access to an identified treatment or vaccine in the near future. Healthcare systems anticipate being overwhelmed with managing critically ill patients in hospitals and remotely monitoring patients with less severe symptoms at home. Government officials are also planning for large-scale contact tracing programs to notify and track the contacts of suspected and confirmed cases to contain the onward transmission of the disease. Digital platforms can support case management and the process of listing, notifying, and monitoring contacts of confirmed cases. Digital tools must be designed to meet the needs of healthcare providers and public health officials in their critical roles on the frontlines of responding to and recovering from COVID-19 in communities around the world.

In an effort to fill this gap, the Bill & Melinda Gates Foundation requested the Johns Hopkins University Global mHealth Initiative (JHU-GmI) to conduct a rapid assessment of digital platforms that have an established presence in several low- and middle-income countries (LMIC), and either have or could be rapidly reconfigured to address COVID-19 related case management and contact tracing needs. Nine core digital platforms were identified for this assessment: CommCare, Community Health Toolkit (CHT), DHIS2 Tracker, Go.Data, ODK, OpenSRP, RapidPro, SORMAS, and WelTel.

The platforms were selected based on their existing deployment, flexibility, and adaptability for COVID-19 use cases, their ability to support multiple languages, and stakeholder interest in how these applications can be leveraged in response to COVID-19. The intended audience for this report is decision-makers in governments and healthcare systems who are charged with rapidly developing and implementing plans to prevent transmission of SARS-CoV-2 in their countries. Additionally, donors who are engaged in supporting these efforts would also benefit from the findings of the report.

While the assessment provides an overview of each of the platform specific to COVID-19, the following areas are covered in greater detail:

1. **Primary use case:** The use case illustrates the needs of a healthcare worker in managing a patient with symptoms of COVID-19 through the processes of patient triage, referral for testing, contact listing and notification, and contact follow-up; and of an administrator responsible for using information on transmission and treatment to make decisions about resource allocation.

2. Non-functional requirements: These address "quality attributes" of the platforms that can be used to judge the general operation of the system, such as system architecture, usability, security, extensibility, and scalability.

Summary Assessment

The framework for this assessment is not defined as a prescriptive list of criteria that platforms should have, rather they represent criteria that decision-makers may consider in determining the platform that suits their specific needs. Yet, for platforms that, on the surface, appear so similar, there are some guiding questions that decision-makers should answer to choose a solution that best aligns with their needs.

CommCare, CHT, DHIS2 Tracker, Go.Data, OpenSRP, SORMAS, and WelTel have the majority, but not all, of the functions identified for the primary use case. ODK is primarily optimized for data collection about cases and contacts, and is not optimal for a clinical setting where longitudinal follow-up of patients is expected. RapidPro is primarily optimized for remote communication with a client or between healthcare workers through messages.

Based on an assessment of non-functional requirements, the following distinctions between the platforms were identified:

Usability: From a usability perspective, the platforms are comparable. The user-interface for platforms such as DHIS2 Tracker, CommCare, RapidPro, and Go.Data are easily configurable with a multitude of options. CommCare has been translated into 50+ languages, and ODK is able to adapt to any language as long as there is a font-set to support that language. Go.Data and SORMAS have language packages that allow for easy translation into the language of choice.

Documentation and Software Productization: All the platforms have standard user and technical documentation available.

Open-Access and Developer Community: Open-source platforms publicly share their product roadmaps. Except for WelTel and Go.Data, all the platforms considered here have open-source code. Go.Data source code is intended to be open-source but is not currently available. Open-source code does not mean that deployment of the platform will be free of cost. For more details, please see the discussion on "Cost Considerations".

Comparatively, CommCare, DHIS2 Tracker, ODK, and RapidPro have very developed global communities with local expertise to customize and support the deployment of the tools without active involvement of the steward organization. CommCare, CHT, ODK, OpenSRP, and WelTel provide service-level agreements (SLAs) on a case-by-case basis based on client needs.

Reliability: Reliability is the ability of an application to run consistently without failure over time. System and data backups should be implemented regularly for use in case of failure. Besides this, disaster recovery plans should be in place.

If a digital solution is being developed for use in remote and disconnected settings, functionality that supports offline use should also be assessed in selection of the platform. All the platforms considered here were built with offline access in mind. However, offline capabilities can be difficult to assess, as platforms may advertise the product for offline use without existing success in the field.

All platforms can be deployed on the cloud. Cloud infrastructure provides backup and disaster recovery services. For CommCare, data is backed up on a daily basis. For CHT, automated failover and provisioning of new resources is performed every 12 hours for cloud-hosted instances. For ODK, the auto-send feature on the mobile devices helps prevent loss of information. For RapidPro, data is duplicated and backed up in multiple geographic locations.

Scalability: Scaling digital solutions that are data intensive require that the application maintain consistent performance without crashing or stalling as the number of users and data grows over time. CHT, DHIS2 Tracker, and ODK have been deployed to thousands of users. The largest instance of CommCare hosts over 600,000 users, ODK hosts 80,000 active users, and DHIS2 Tracker hosts 43,000 users. For platforms that are hosted on local servers, their ability to scale would depend on the infrastructure in place. RapidPro has had many installations supporting millions of users, including 4.4 million users in Nigeria.

Standards, Interoperability, and Data Accessibility: If it has been determined that COVID-19 case management data needs to be integrated with routine health information systems, or aggregate data sources for planning and resource allocation, decision-makers should consider methods of data integration that would work for their needs. CommCare, DHIS2 Tracker, OpenSRP, SORMAS, and WelTel comply with industry standards for healthcare data exchange.

Devices and Operating Systems: Most mature global offerings cater to the dominant Android operating system and leverage a wide range of hand-held devices. In addition to this: CHT, CommCare, DHIS2 Tracker, and WelTel have a restricted set of functions available on basic phones as well. RapidPro's messaging function is optimized for the simplest mobile device.

Messaging Capability: RapidPro has the most advanced capabilities for two-way communication, supporting interactive voice response (IVR) communications. CHT, CommCare, and OpenSRP have current instances of integration with RapidPro for the purpose of healthcare worker or client focused communication. CHT and WelTel have built-in mechanisms for two-way communication with cases. Programs which engage clients through SMS or phone calls may want to consider whether toll-free messaging or reversed-billed functionality may be available for purchase in-country. This may be achieved via two-way SMS APIs through Twilio or Africa's Talking. Use of toll-free lines may be critical to encourage system engagement by a population when airtime or data packages are expensive, and costs to the patient need to be avoided.

Security: While all platforms have out-of-the-box authentication, authorization, and data encryption, CHT, ODK, OpenSRP, and SORMAS have been audited by external entities.

Analytics: DHIS2 Tracker, ODK, and SORMAS provide an interface to R for further statistical analysis. CHT offers offline visualizations and the ability to connect to third party analytics platforms and data warehouses. OpenSRP can be integrated with various analytics and tracking tools as needed based on the use case. WelTel is working on integrating natural language processing (NLP) and predictive analytics into the platform.

Time to Deployment: CommCare, CHT, DHIS2 Tracker, Go.Data, ODK, SORMAS, and WelTel have a range of COVID-19 use cases developed that are turn-key ready for deployment. For simple message-based workflows for communication, RapidPro can be promptly adapted and deployed. OpenSRP is currently testing a COVID-19 application for case management and testing in Indonesia.

Cost Considerations: CommCare, CHT, ODK, SORMAS, and OpenSRP have open-source licensing. If needed, the steward organizations can provide end-to-end support in customization, hosting, and maintenance for a fee. SORMAS also provides open-source curation service of functionality programmed by third parties. For COVID-19 response, CommCare subscriptions are free. RapidPro and DHIS2 Tracker are both open-source, and the steward organization provides advanced troubleshooting support only. Local expertise must be found for customization, hosting, and maintaining the platform. WelTel follows a tiered subscription-based pricing model.

The table below summarizes the detailed assessments discussed above.

* Platforms may integrate with external analytics software.
** For the use case of COVID-19 patient triage, referral for testing, contact listing and notification, and follow-up.
*** Ability to order laboratory tests, follow progress of patient sample, and receive updates when results are available.
**** Please refer to platform overview pages for list of available use cases.

In summary, the platforms chosen for review are mature platforms that have been deployed all over the world. In the context of the COVID-19 use case involving patient triage, referral for testing, and contact listing and follow-up, **the two platforms that stand out for their maturity, flexibility, and large-scale deployment are DHIS2 Tracker and CommCare**. Both these platforms have turn-key ready applications for COVID-19 and a history of proven success with large scale deployments. Globally, there is much experience and capacity in adapting and deploying DHIS2 Tracker, with minimal involvement of the steward organization. With CommCare, adaptation and deployment support can be provided (at a cost) by the steward organization. If Ministries are interested in remote communication with healthcare workers or suspect cases regarding COVID-19 via a messaging platform, we would recommend the use of RapidPro, given its ease of adaptation and deployment.

COVID-19 and the Need for Digital Solutions

COVID-19 emerged as a global pandemic in 2020 with more than 300,000 deaths reported worldwide as of mid-May according to the World Health Organization (WHO).[1] It is estimated that 1 in 5 people with COVID-19 experience severe symptoms.[2,3] Countries and health systems are currently faced with a situation that is exposing critical vulnerabilities in public health infrastructure at the local, national, and international levels. Health systems in many countries are overwhelmed by the number of critically ill patients in their communities. Concern is growing about the potential impact that COVID-19 will have in low-resource settings, where there may be limited ability to support moderately ill patients at home and critically ill patients in healthcare facilities.[4,5] Interruptions in critical health services are also projected to result in increased indirect mortality among young children and expectant mothers.[6]

In the absence of a confirmed treatment or the likelihood of a near-term vaccine for COVID-19, mitigating the spread requires consolidated epidemiological efforts towards isolating cases, contact tracing, quarantine, and hygiene measures. Contact tracing, a cornerstone of epidemic control measures, requires public health staff to work with a confirmed case to recall everyone with whom they have had close contact over the time that they were infectious. Based on this listing of "contacts", public health staff must then reach out to each person to inform them of possible exposure to the virus and provide appropriate education and information. This is usually done anonymously, without revealing the identity of the case to the suspected contacts. Public health agencies may choose to monitor the contact to assess whether they develop any symptoms and encourage them to take necessary precautions to curtail further spread, such as through quarantine. This process of case confirmation and contact tracing, though critical to the containment of the virus, is resource- and personnel-intensive.

Mobile tools can facilitate and introduce efficiencies in monitoring, surveillance, detection, and prevention of COVID-19. Evidence from the 2014-2016 Ebola

Coronavirus disease (COVID-19) emerged as a global pandemic in 2020 with more than 300,000 deaths reported worldwide as of mid-May according to the World Health Organization (WHO).

Mobile tools can facilitate and introduce efficiencies in monitoring, surveillance, detection, and prevention of COVID-19. Evidence from the 2014-2016 Ebola epidemic highlighted the challenges of paper-based contact tracing, which resulted in delays in communication and response related to incomplete contact identification and loss of contact lists.

epidemic highlighted the challenges of paper-based contact tracing, which resulted in delays in communication and response related to incomplete contact identification and loss of contact lists.[7] Employing digital tools for case management and contact tracing can support a range of processes to facilitate effective identification, detection, reporting, and analysis of cases and contacts. Some more prevalent applications of use include the following:

- Where there are existing digital patient records, integrating a COVID-19 module with such records can help healthcare workers have access to critical parts of a patient's health history that may impact treatment decisions.
- Facilitating prompt communication between the laboratory, the provider, and the patient on case status so that appropriate treatments can be initiated and quarantine measures taken in settings where laboratories exist and can be digitized.
- Through real-time collection of data on confirmed cases, providing timely reporting to strengthen disease surveillance so that authorities can map out where the cases are occurring and allocate necessary resources.
- Digital records and list of contacts, to some extent, can be used to automate the process of notifying individuals, providing necessary precautions, and advice on tracking symptoms.

Definitions:[8]

Suspect case:

- A patient with acute respiratory illness (fever and at least one symptom of respiratory disease, e.g. cough or shortness of breath), AND a history of travel to or residence in a location reporting community transmission of COVID-19 during the 14 day prior to symptom onset; OR
- A patient with any acute respiratory illness AND having been in contact with a confirmed or probable COVID-19 case in the last 14 days prior to symptom onset; OR
- A patient with severe acute respiratory illness (fever and at least one symptom of respiratory disease, e.g. cough or shortness of breath; AND requiring hospitalization) AND in the absence of an alternative diagnosis that fully explains the clinical presentation.

Probable case:

- A suspect case for whom testing for SARS-CoV-2 is inconclusive.
- A suspect case for whom testing could not be performed for any reason.

Confirmed Case:

- A person with laboratory confirmation of COVID-19 infection, irrespective of clinical signs and symptoms.

Contact:

A contact is an individual who has experienced exposure to a suspected or probable COVID-19 case recently. The contact is vulnerable to the virus in the two days prior to onset of symptoms and 14 days after the onset of symptoms:

- Face-to-face contact with a probable or confirmed case within one meter and for more than 15 minutes;
- Direct physical contact with a probable or confirmed case;
- Direct care for a patient with probable or confirmed COVID-19 disease without using proper personal protective equipment; OR
- Other situations as indicated by local risk assessments.

Questions remain about how well-adapted these technologies are to the current situation faced by countries globally, and whether existing platforms can be quickly repurposed and configured to address the critical technological needs that countries face to respond to COVID-19.

Based on Bill and Melinda Gates Foundation's request, JHU-GmI assessed digital platforms that have an established presence in LMICs. These platforms already have or could be rapidly reconfigured to address COVID-19 related case management and contact tracing needs.

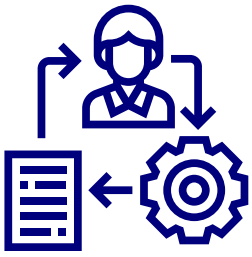
For the purpose of this report, we describe each of these platforms from the lens of capabilities needed to rapidly stand up a system for COVID-19 case management and contact tracing.

Valuable lessons have been learned about successfully using technologies for contact tracing from previous outbreaks.[7] Studies suggest that though the use of technological solutions might be helpful in facilitating data completeness, storage, and accuracy, there are many practical challenges to using technological solutions in the context of an epidemic in low-resource settings. Questions remain about how well-adapted these technologies are to the current situation faced by countries globally, and whether existing platforms can be quickly repurposed and configured to address the critical technological needs that countries face to respond to COVID-19.

Based on Bill and Melinda Gates Foundation's request, JHU-GmI assessed digital platforms that have an established presence in LMICs. These platforms already have or could be rapidly reconfigured to address COVID-19 related case management and contact tracing needs. Nine core digital platforms that were identified for this assessment: CommCare, CHT, DHIS2 Tracker, Go.Data, ODK, OpenSRP, RapidPro, SORMAS, and WelTel.

Those who are somewhat familiar with these platforms will recognize that they were developed to serve a range of functions in LMIC health systems. For example, over the last decade ODK has largely been used for the purpose of data collection for surveys in a number of sectors, including healthcare. In contrast, RapidPro has largely been used to send and receive data using SMS on basic mobile phones. Each platform is optimized for different functions, that can be repurposed to a range of use cases with varying levels of effort, including a response to challenges faced in a pandemic.

For the purpose of this report, we describe each of these platforms from the lens of capabilities needed to rapidly stand up a system for COVID-19 case management and contact tracing. This report should serve to guide technical decision-makers in Ministries of Health (MoHs) to select an appropriate tool (or group of tools) to effectively bolster COVID-19 preparedness and response in their community. Additionally, the "framework" (i.e. items used to describe each platform) provide decision-makers with a list of core capabilities that a system should have as they assess locally available or proprietary systems. This report should also provide a reference for the global donor communities who are making rapid decisions about supporting specific types of COVID-19 response work. Given the range of functionalities and origins of the different platforms being assessed, this report attempts to not place a value judgement on one platform against another. Rather, it is contingent upon the reader of this report to seek the "best fit" of the platform for their particular need within the specific context of where the solution is to be deployed.



Selection of Platforms and Process of Assessment

The nine digital platforms chosen for this assessment were selected based on a high number of global deployments, flexibility in adapting the platform for different use cases, multi-lingual support, and interest from global stakeholders in reconfiguring these platforms for COVID-19 response. While other open-source platforms as well as locally available proprietary products exist and might be valuable to a COVID-19 response, this effort to rapidly develop guidance prioritized the following platforms: CommCare, CHT, DHIS2 Tracker, Go.Data, ODK, OpenSRP, RapidPro, SORMAS, and WelTel.

This assessment entailed the following activities, with the objective of developing recommendations for use in COVID-19 response:

While other open-source platforms as well as locally available proprietary products exist and might be valuable to a COVID-19 response, this effort to rapidly develop guidance prioritized the following platforms: CommCare, CHT, DHIS2 Tracker, Go.Data, ODK, OpenSRP, RapidPro, SORMAS, and WelTel.

- Reviewed publicly available demo videos about the platform and its adaptation for COVID-19 specific use cases.
- Downloaded and used the platforms or their COVID-19 applications, where possible, to understand dependencies, usability, and possible barriers to use for each platform.
- Conducted a series of interviews with the platform developers and stewards to get clarity around functional and non-functional aspects that are of particular importance.
- Reviewed existing documentation and community engagement around the platforms on platforms.

The results of the assessment are presented in the following format:

A **Overview of the Platforms:**
The report starts with an overview about each of the nine platforms. Information specific to the availability of existing use cases for COVID-19 response, number, and scale of users are presented. This section presents information on COVID-19 specific use cases that are currently available on the platforms and can be deployed with minimal effort.

The following use cases are covered:

- **COVID-19 Case Management:** Broadly, the application may enroll suspected cases, capture demographics, risk factors and exposures, symptoms, create lab requests or support alternate ways of diagnostic testing, and monitor patient outcomes. The application may serve as a first step to linking confirmed cases with contacts, through contact listing.

- **Contact Registration and Follow-Up:** The application may strengthen active case detection through contact tracing activities, such as identification and follow-up of contacts of a suspected or confirmed COVID-19 case. This might be done through messaging (e.g. SMS or WhatsApp), phone calls, or other systems of communication.

- **Port of Entry Screening and Follow-Up:** The application may support the enrollment of travelers who have visited high-risk locations at ports of entry for monitoring and follow-up, as per local regulations.

- **Event-based Surveillance System:** The application may support reporting of aggregate data on individuals with COVID-19 symptoms, laboratory confirmation, etc. The application may specify a subset of minimum critical data points for reporting to facilitate rapid analysis and planning.

- **Lab Test Tracking:** The application may link the patient and the healthcare worker to the patient sample sent to the laboratory for testing. The application may provide guidance on the method to collect a sample and notify the provider when lab results are available. This feature may be integrated with the COVID-19 case management application.

- **Healthcare Worker Training:** The application may be adapted for country-specific content to train healthcare workers on appropriate symptom monitoring, use of personal protective equipment, safety protocols for facilities, and other personal and professional risk mitigation strategies.

- **Facility Readiness and Stock Tracking:** The application may support registration of healthcare facilities and help in collection and reporting of data on COVID-19 specific resources. This would allow decision-makers to see aggregate data on facility stock counts and readiness for planning and resource mobilization purposes.

For each platform, we specify a **"setting of delivery"**, based on the type of setting the application has been largely deployed in and, therefore, has been optimized for. This is classified as:

Community Health Setting

The platform has been used in a community-based setting by community health workers. This should signal to decision-makers that the platform may have features that might work well in settings with limited connectivity and offline use, and that the platform stewards have experience working with set up and transfer of data in a community-based setting.

Healthcare Facility Setting

The platform has been used in a facility-based setting. This should signal to decision-makers that the application is set up as a system for clinical case management, with possible linkages to systems for aggregate data reporting (e.g. DHIS2 Tracker), and to laboratory services.

Remote Communication

This platform is optimized for remote communication between providers and supervisors, as well as between providers and patients, using messaging channels such as SMS, WhatsApp, or in-app messaging. For example, it may be used so that healthcare workers in the community can report to the authorities about possible suspected cases, or healthcare workers in the facilities can communicate with cases and their contacts.

For the purpose of this report, we have defined a detailed COVID-19 case management use case that entails patient triage, referral for testing, contact listing and notification, and follow-up.

B **Requirements based on a COVID-19 Use Case for the Platforms:**

For the purpose of this report, we have defined a detailed COVID-19 case management use case that entails patient triage, referral for testing, contact listing and notification, and follow-up. Specific functions based on this use case have been defined upfront, and each of the platforms have been described based on those specific functions.

The specific functions are not intended to be prescriptive but are based on some of the more commonly used functionality that may be relevant to the COVID-19 response. This was done so decision-makers can determine which functionality is required for their context and choose a platform accordingly. Platforms may not be set up to work optimally for the entire use case, and different platforms may be combined if the entire use case is relevant.

To present platforms that are turn-key ready for immediate deployment for COVID-19 response, the report highlights functions that were available as of June 2020. If a function can be added with minimal effort, for example, through integration with another platform, it is indicated. If a function was under development at the time of the assessment, it is not included.

C **Non-functional requirements for the platforms:**

Non-functional requirements have been defined for each of the platforms. Non-functional requirements, or "quality attributes", are criteria that can be used to judge the general operation of the system, such as system architecture, usability, security, extensibility, and scalability. In cases where a lot of variability exists between the platforms, the criteria are described at length. In cases where differences between the platforms can be graded on a "maturity scale", they have been presented in comparative tables on a scale of 0-2. In most cases, '0' indicates that the functionality does not exist, '1' indicates that the functionality is partially developed, and '2' indicates a well-developed functionality. This facilitates a side-by-side comparison of the nine platforms to support decision-makers in prioritizing platforms with aspects that are suited to their specific contextual needs. Several indicators identified by the Global Goods Maturity Model were leveraged and adapted.[9] The areas of assessment are presented below:

Usability:
This describes features that make it intuitive for a user to interact with the system.

Documentation, Training, and Support:
The availability of support services and training.

Open Access and Developer Community:
The number of people who can customize the software, and provide training and operational support.

Standards, Interoperability, and Data Accessibility:
Adherence to global norms and standards to facilitate operations with other healthcare systems.

Reliability:
The system's potential to run consistently without failure.

Scalability:
The application's ability to maintain performance over time as the number of users increases.

Devices and Operating Systems:
Types of devices and operating systems supported by the system.

Messaging:
Support for messaging services such as SMS, WhatsApp, and Facebook Messenger.

Security:
Ways in which to safeguard the security and privacy of the data.

Analytics:
Capacity of platform to support extensive reporting and analytic capabilities.

Time to Deployment:
Factors that impact the amount of time taken to get the application ready for deployment in a country.

Cost Considerations:
Factors that impact cost such as licensing fees, customization, operational support, and technical support.

To present platforms that are turn-key ready for immediate deployment for COVID-19 response, the report highlights functions that were available as of June 2020. If a function can be added with minimal effort, for example, through integration with another platform, it is indicated. If a function was under development at the time of the assessment, it is not included.

Overview of Nine Prioritized Platforms

CommCare

Overview

CommCare is an offline-capable mobile data collection and service delivery platform designed for everything from simple surveys to comprehensive longitudinal data tracking. Their straightforward application builder allows for easy digitization of surveys and forms, as well as the integration of decision support, notifications, and SMS messaging.

COVID-19 Related Use Cases

- COVID-19 Case Management
- Contact Registration and Follow-Up
- Port of Entry Screening and Follow-Up
- Facility Readiness and Stock Tracking
- Healthcare Worker Training and Monitoring
- Lab Test Tracking

COVID-19 Application Deployment

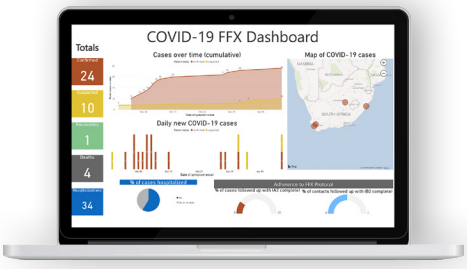
CommCare has been deployed for COVID-19 response in about 30 countries. For COVID-19, 20,000 users utilize CommCare applications globally.

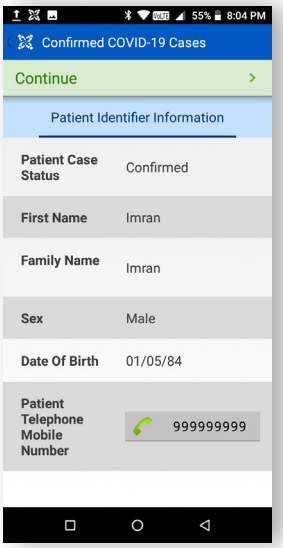
Setting of Delivery

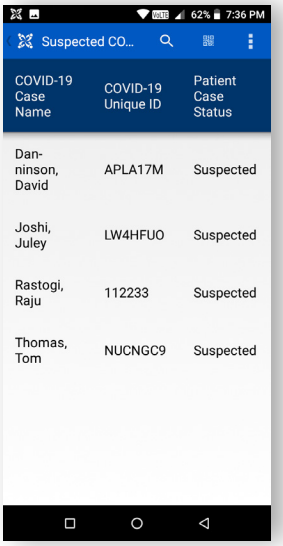
Community Health Setting; Healthcare Facility Setting; Remote Communication

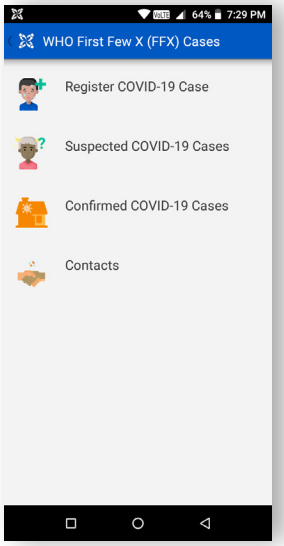
Notable Features

- Easily configurable with multitude of features
- Current instance of Bluetooth data transfer for low connectivity environments
- Several turn-key COVID-19 applications









Community Health Toolkit (CHT)

Overview

CHT is an open-source technology designed to support community health systems and frontline health teams delivering care in the hardest-to-reach communities. CHT is being co-created by the community as an open-source project. Medic Mobile, a US 501(c)(3) public charity incorporated in the United States, serves as the technical lead and initial steward for CHT; the organization contributes open-source code, design resources, documentation, and facilitates contributions from others.

COVID-19 Related Use Cases

Current:

- Port of Entry Screening and Follow-Up
- Event-based Surveillance System
- Contact Registration and Follow-Up

Planned:

- COVID-19 Case Management (Home-Based Care)
- Healthcare Worker Training

COVID-19 Application Deployment

CHT's COVID-19 package has been deployed for pandemic response in:

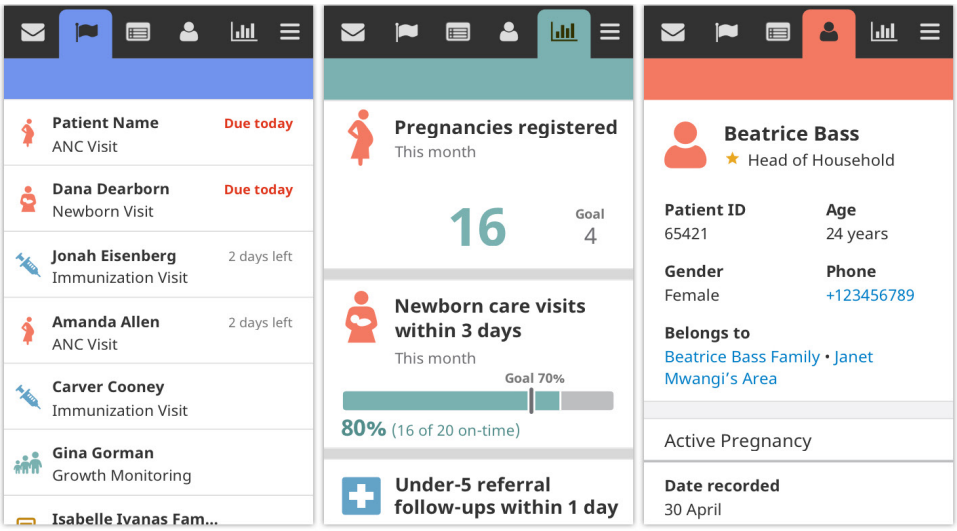
- **Nepal:** In Kathmandu Airport to register 10,000 travelers.
- **Kenya:** ~350 healthcare workers have been trained.
- **Niger:** 55 individuals have been trained in a modified contact tracing workflow.

Setting of Delivery

Community Health Setting; Remote SMS-based Communication with Patients

Notable Features

- Framework for building offline applications using task-based workflows
- Built-in mechanism for two-way communication via messaging
- Experience integrating with RapidPro for SMS communication



DHIS2 Tracker

Overview

District Health Information Software 2 Tracker (DHIS2 Tracker) is an open-source, web-based application that supports data collection, and analysis of transactional or disaggregated data. The core DHIS2 Tracker software development is managed by the Health Information Systems Program (HISP) at the University of Oslo.
DHIS2 Tracker is an extension of DHIS2 and should not be confused with DHIS2.
In practice, DHIS2 Tracker is used for tracking individual data and can be used in a community or facility setting; DHIS2 is used to track aggregate data, typically at a district-level. The DHIS2 Tracker has been built to work seamlessly with DHIS2. DHIS2 Capture is the mobile component of the DHIS2 platform.

COVID-19 Related Use Cases

- COVID-19 Case Management
- Contact Registration and Follow-Up
- Port of Entry Screening and Follow-Up
- Event-based Surveillance System

Notable Features

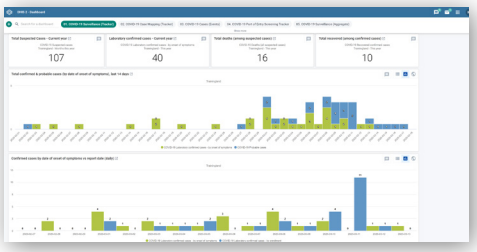
- Easily configurable with multitude of features
- Several turn-key COVID-19 applications
- Large active global community of implementers with local expertise in customization
- Interface with R for data analyses and presentation

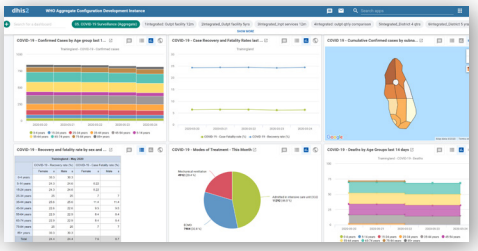
COVID-19 Application Deployment

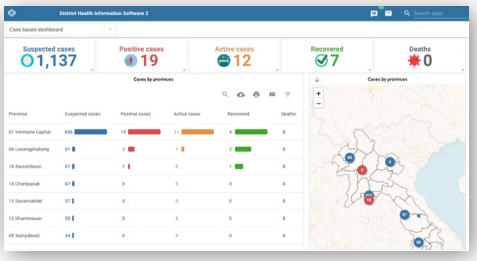
DHIS2 Tracker has been deployed in 52 countries and 17 Indian states. COVID-19 specific applications have been deployed in Angola, Bangladesh, Botswana, Burkina Faso, Cape Verde, Djibouti, Eritrea, Ethiopia, Gambia, Guinea Bissau, Indonesia, Ivory Coast, Laos, Madagascar, Malawi, Mali, Mozambique, Norway, Palestine, Rwanda, São Tomé and Príncipe, Senegal, Sierra Leone, Somalia, Somaliland, South Africa, Sri Lanka, and Uganda.

Setting of Delivery

Healthcare Facility Setting; Community Health Setting







Go.Data

Overview

Go.Data is an outbreak investigation tool for field data collection during public health emergencies. The tool includes functionality for case investigation, contact follow-up, visualization of chains of transmission including secure data exchange, and is designed for flexibility in the field - being able to adapt to the wide range of outbreak scenarios. Go.Data is a tool developed by the WHO, in collaboration with partners in the Global Outbreak Alert and Response Network (GOARN).

Notable Features

- Easily configurable with multitude of features
- Several turn-key COVID-19 applications
- Sophisticated built-in analytics with visual summaries of cases who need follow-up
- End-to-end support in customization, hosting, and deployment for COVID-19 free of cost

COVID-19 Related Use Cases

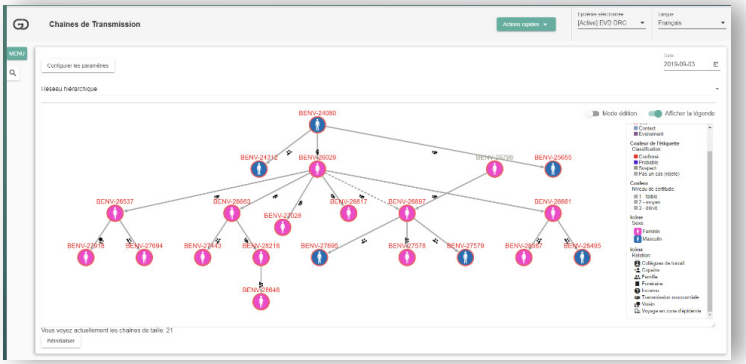
- COVID-19 Case Management
- Contact Registration and Follow-Up
- Lab Test Tracking

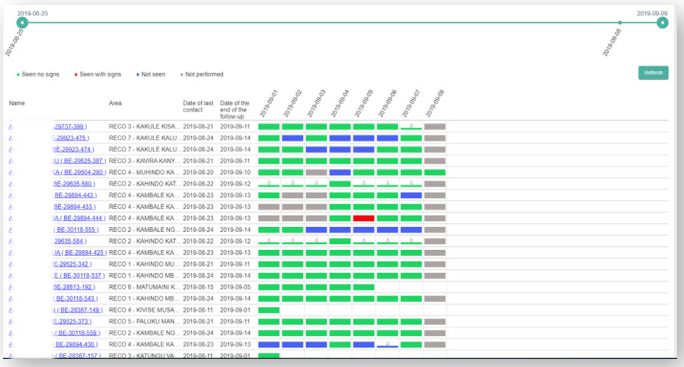
COVID-19 Application Deployment

The largest non-COVID-19 Go.Data deployment is done in the context of the Ebola virus disease outbreak in Nord Kivu, Democratic Republic of Congo. This Go.Data implementation started in August 2019 and has about 300 users. Go.Data has also been deployed for COVID-19 in many countries, including Malta and the Maldives.

Setting of Delivery

Healthcare Facility Setting; Community Health Setting

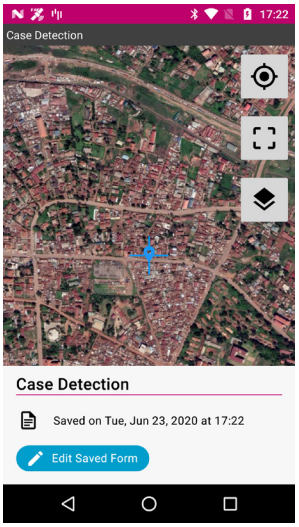


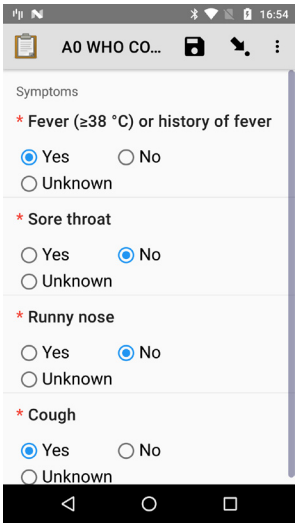


ODK

Notable Features

- Most active global community of developers and implementers with local expertise for customization
- Create forms on Microsoft Excel and Google Sheets which can be directly uploaded to the server





Overview

ODK is a free open-source suite of tools that allows data collection using Android mobile devices and data submission to an online server, without an internet connection or mobile carrier service at the time of data collection. ODK's strength lies in its global community of developers and ease of adaptation and installation. Though it is being used for longitudinal client follow-up, it is primarily optimized for use cases that involve cross-sectional point-in-time data collection. Nafundi is the primary steward for ODK and supports the ongoing development.

COVID-19 Related Use Cases

- Event-based Surveillance System
- Healthcare Worker Training and Monitoring

COVID-19 Application Deployment

Since this is a platform that organizations regularly self-deploy, not all deployments can be documented. There are documented deployments in Honduras, India, Kenya, Niger, Nigeria, Philippines, South Sudan, Spain, Zimbabwe, and Somalia. There is an average of 400,000 users monthly who are actively using the application. The largest active project is in Honduras with 80,000 healthcare workers; the second largest is in Nigeria with 70,000 healthcare workers. With respect to COVID-19 applications, the largest project is in Somalia where 4,000 healthcare workers are submitting contact tracing data.

Some key deployments are:

- **Global:** The London School of Hygiene and Tropical Medicine is running offline vaccine trials in LMICs with ODK.
- **India:** The MoH and partners have deployed ODK in key health facilities for case detection.
- **Somalia:** Contact tracing data from 4,000 healthcare workers trained by the WHO flows through ODK.
- **South Sudan:** The WHO and the MoH rely on ODK to get real-time data on contacts.
- **Kenya:** CORE Group's community health volunteers capture potential human and animal cases on ODK.
- **Philippines:** Quarantined and hospitalized cases in Region 12 are reported using ODK.
- **Pakistan:** Red Crescent Society conducts beneficiary registration for food distribution with ODK.

Setting of Delivery

Community Health Setting

OpenSRP

Overview

Open Smart Register Platform (OpenSRP) is an open-source mobile health platform that allows frontline healthcare workers to electronically register and track the health of their entire client population. It simultaneously provides program managers and policymakers with current data for decision-making.

COVID-19 Related Use Cases

Current

- COVID-19 Case Management
- Lab Test Tracking

Planned

- Contact Registration and Follow-Up
- Event-based Surveillance System (Geospatial Capacity)
- Facility Readiness and Stock Tracking

Notable Features

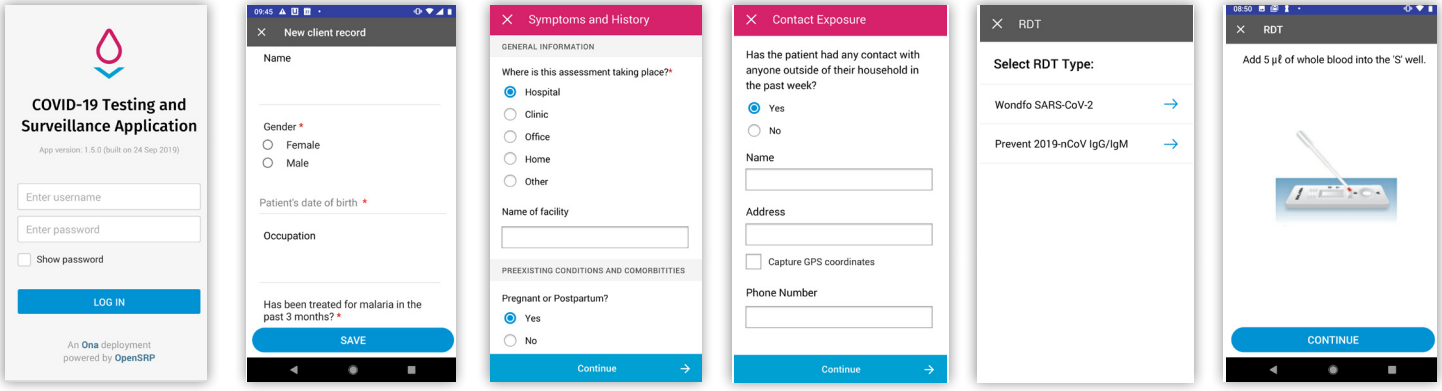
- Bluetooth data transfer for low connectivity environments
- Integration with RapidPro for two-way SMS communication

COVID-19 Application Deployment

The COVID-19 application is currently being tested and deployed in Indonesia with 200 healthcare workers.

Setting of Delivery

Healthcare Facility Setting; Community Health Setting



RapidPro

Overview

TextIt provides instant turn-key hosting of RapidPro by the original creators of the platform. TextIt runs the very latest version of RapidPro and provides hosting and support for hundreds of organizations across the world. One can visually build multi platform messaging and voice bots to engage internationally. At the core of TextIt lies our exclusive Flow engine. With Flows, anybody can create engaging SMS and voice applications without the need of a programmer or expensive consulting company.

Notable Features

- Advanced capabilities of SMS communication
- Large active global community of developers
- Very easy to customize and deploy with minimal expertise

COVID-19 Related Use Cases

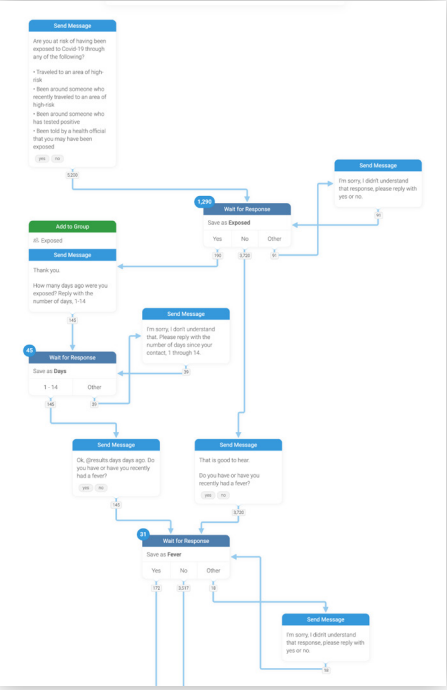
COVID-19 use cases can be quickly built fit-for-purpose and deployed.

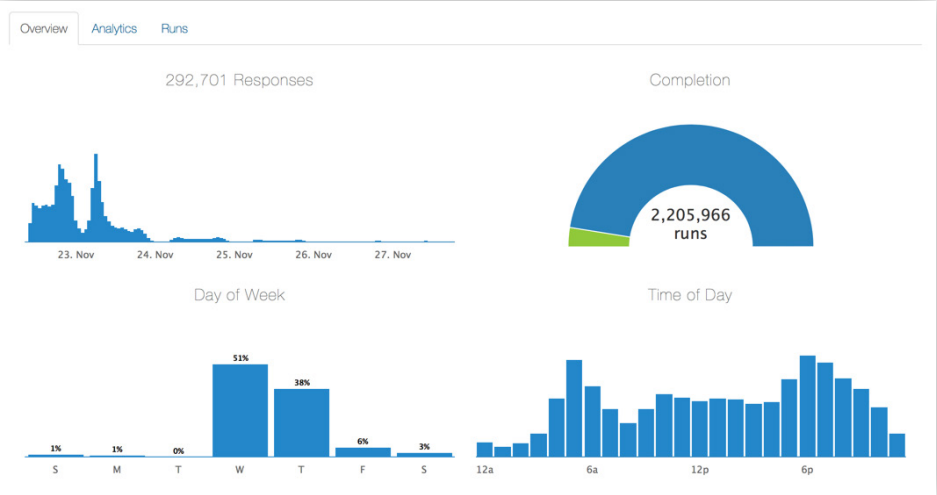
COVID-19 Application Deployment

No formal documentation of where Covid-19 apps are being deployed since the solution if easy to access, adapt and deploy without involvement of the steward organization.

Setting of Delivery

Remote SMS based communication with patients





SORMAS

Overview

SORMAS is an open-source Android and Web app, which was developed for case management, contact tracing, and surveillance, with a module for the management of laboratory samples and tests. SORMAS includes functionality for contact and event notification, clinical case management, task management, and outbreak detection algorithms.

COVID-19 Related Use Cases

Current

- COVID-19 Case Management
- Contact Registration and Follow-Up
- Port of Entry Screening and Follow-Up
- Lab Test Tracking
- Event-based Surveillance System

COVID-19 Application Deployment

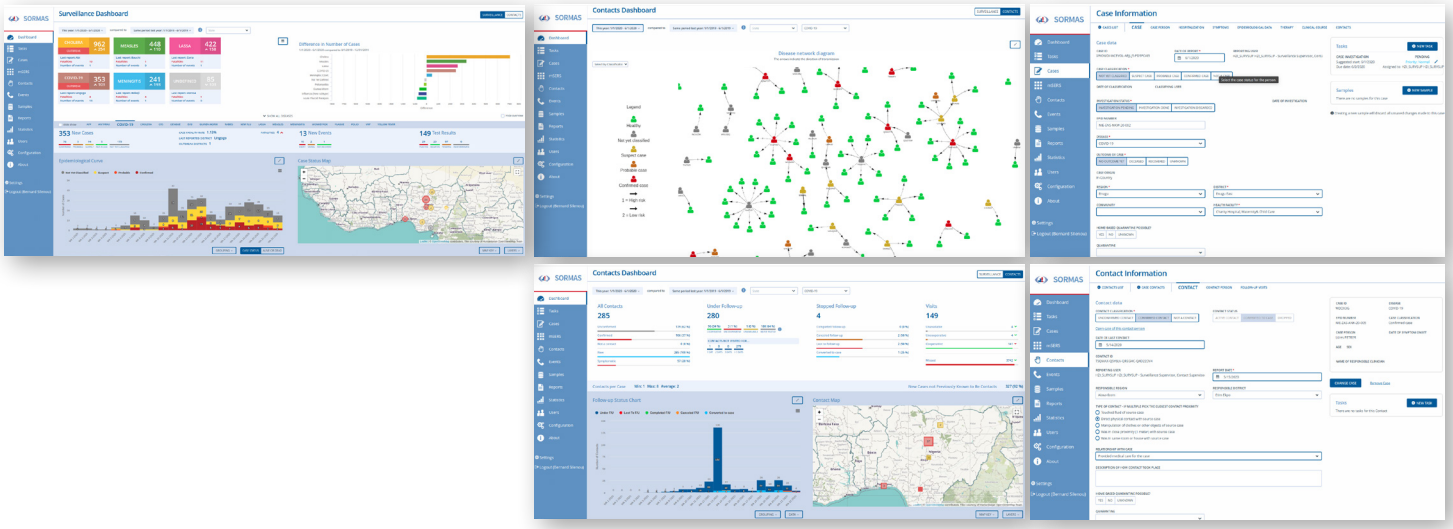
SORMAS has been deployed in Nigeria, Germany, Ghana, Fiji, France, and Switzerland.

Setting of Delivery

Healthcare Facility Setting

Notable Features

- The application supports appointment scheduling and healthcare worker task catalog with reminders
- Interface with R for data analyses and presentations
- Sophisticated in-built analytics with visualization of patterns of COVID-19 transmission



WelTel

Overview

WelTel integrates virtual care and patient engagement, connecting remote outpatients with the healthcare system via their mobile phones. Public health agencies are using it to monitor and support COVID-19 cases and contacts in home quarantine. The browser-based interface can work on a desktop or smartphone. Basic phones can also be used to connect with patients via SMS; patients do not need a smartphone or internet access. WelTel's system supports appointment scheduling and reminders, and broadcasts video or public health information on a secure patient portal.

Notable Features

- Current instance of Bluetooth data transfer for low connectivity environments
- Support for "open questions" when communicating with patients
- Triage using NLP algorithms is being integrated into the platform

COVID-19 Related Use Cases

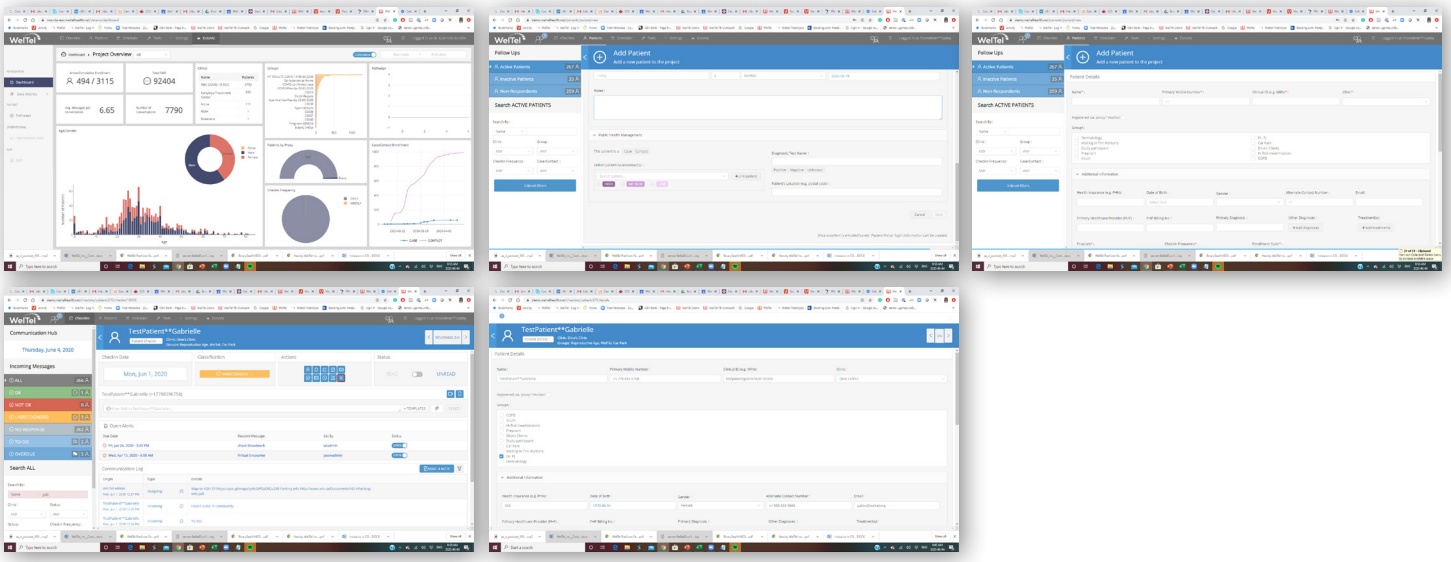
- COVID-19 Case Management
- Contact Registration and Follow-Up

COVID-19 Application Deployment

WelTel has been deployed in Rwanda, Uganda, Kenya, Canada, and the United Kingdom.

Setting of Delivery

Remote Communication



Requirements for COVID-19 Use Case: *Patient Triage, Referral for Testing, Contact Listing and Notification, and Follow-Up*

Illustrative User Story and Workflow

To contextualize the specific use case that has been defined for the assessment, consider the user story and workflow below.

USER PERSONAS

Facility-Based Provider:

Thomas is a 32-year-old doctor who has been working in the primary healthcare facility of Rutege for two years. As a newly trained doctor, Thomas is enthusiastic to learn more, polish his skills, and help his patients. During a routine day at work, he might see upwards of 80 patients, including pregnant women, children presenting with fevers, and older patients with chronic conditions such as diabetes and heart disease. The facility where he works has some basic laboratory services.

The new and varying information on COVID-19 has been difficult to follow and overwhelming. He has been hearing on the news about how doctors are at risk from COVID-19 and is nervous about how it will affect him and his family, including his aged mother who lives with them, and his three year old son. He is keen to continue to keep up his knowledge about COVID-19 and help his patients while keeping himself safe.

Clients/Caretaker:

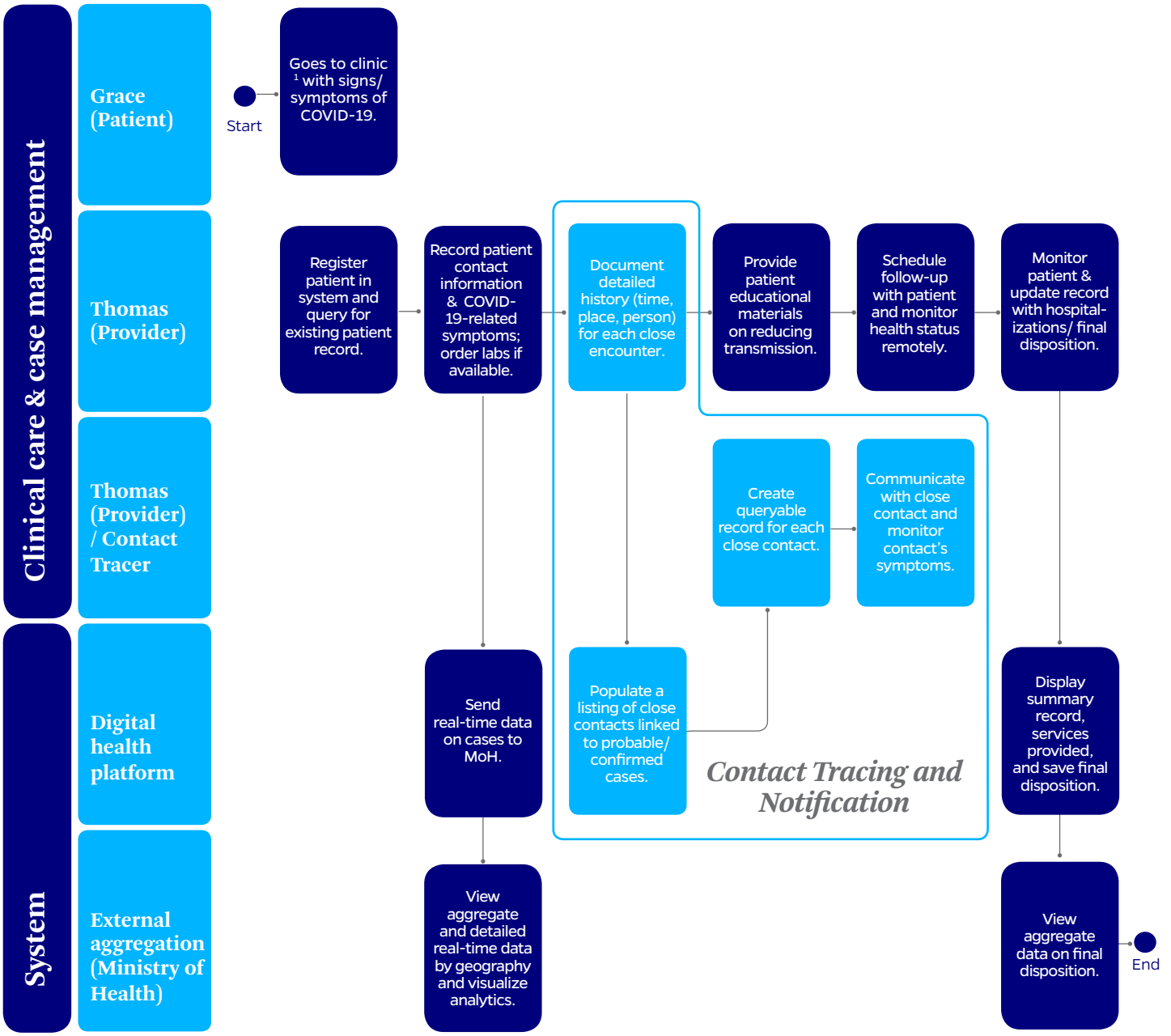
Grace lives in the village of Nosaki. She is 29 years old with an elementary-level education, and a mother of four young children under seven years old. Her husband is a truck driver who transports goods between some cities and their town. Sometimes, he might be travelling for up to one week at a time.

Sample User Story

- **Grace** has had a fever for the past four days, and this morning she noticed that she was very short of breath. **Grace** travels to the clinic where **Thomas**, a facility-based provider, works.
- When **Grace** arrives, she is ***registered*** in the system and she is asked to ***provide*** her contact information, including the address where she is currently staying, phone number(s), and an emergency contact, that **Thomas** or a medical secretary *enters* into the system.
- **Thomas** *creates* a new encounter form for **Grace** and ***inputs*** her demographics, vital signs, chief complaint(s), risk factors, exposure history, and symptoms related to COVID-19.
- **Grace** says she has been caring for an ill family member who recently traveled from a neighboring country with sustained local transmission for the past seven days.

  The system ***notifies*** the MoH of a new probable case. **Thomas** *orders* labs.
- **Thomas** *documents* a detailed contact history (time, place, person) for each close encounter that **Grace** had up to four days since before she became ill.
- **Thomas** *provides* educational materials to **Grace** about preventative steps to take to reduce transmission.
- **Thomas** *schedules* a time to follow-up with **Grace** and continually ***monitors*** her health status electronically and by phone call until the next in-person follow-up encounter.
- Based on a list of close contacts linked to probable and confirmed COVID-19 cases ***populated*** by the system, **Thomas** or another provider/contact tracer ***creates*** a queryable record to input demographics and risk factors of each close contact.
- **Thomas** or another provider or contact tracer will ***communicate*** with the close contact and remotely ***monitor*** the contact's symptoms and vitals and update the case file records as needed.
- **Thomas** continues ***monitoring*** **Grace's** symptoms and status remotely and ***updates*** Grace's record with any changes such as in-patient admission.
- **Thomas** *updates* **Grace's** record with the final disposition. The system *saves* the disposition information to **Grace's** record and the MoH is able to ***view*** aggregate data on her/the final disposition.

Workflow for patient triage, referral for testing, contact listing and notification, and follow-up



[1] Process will vary if patient is seen at home.

Comparative Assessment of Requirements for COVID-19 Use Case

Based on the user story and the sample workflow, the table below assesses the core requirements for the workflow involving patient triage, referral for testing, contact listing and notification, and follow-up, across the nine platforms. As stated before, these requirements present a menu of functions, rather than a prescriptive list, for the specific use case.

Use Case Key: 1 = Yes 0 = No	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
As a community healthcare worker, I may need to perform the following tasks:									
1. Risk assessment for suspecting and existing COVID-19 patients									
Register patients in the system with a unique ID	1	1	1	1	1	1	1	1	1
Query patient's past health from the system	1	1	1	1	1[E]	1	1	1	1
Record patient contact information (e.g. address, phone number, emergency contacts)	1	1	1	1	1[E]	1	1	N/A[H]	1
Input patient demographics, vital signs, risk factors, and symptoms related to COVID-19*	1	1	1	1	1	1	1	1	1
Provide educational materials for patients through audio, video, and images (regarding preventative measures like quarantine, handwashing, etc.)	1	1	0	0	1	1	1	1	1
Schedule a follow-up with patients	1	1	1	1	0[E]	1	1	1	1
Communicate with patient/contact via phone call	1	1	1	1	1[E]	1	1	1	1
Communicate with patient via one-way messaging (e.g. SMS, social media, in-app, WhatsApp)	1	1	1	1	1[E]	1[F]	1	1	1
Receive patient communication through messaging (e.g. SMS, social media, in-app, WhatsApp)	1	1	0	0	0[E]	1[F]	0	1	1
Record hospitalization events and the final disposition of patients	1	1	1	1	1[E]	1	1	N/A[H]	1
View a summary record and services provided for a client per encounter	1	1	1	1	1[E]	1	1	N/A[H]	1
Select/modify patient (cases/contacts) record in case of errors*	1	1	1	1	0[E]	1	1	N/A[H]	1[I]

Use Case Key: 1 = Yes 0 = No	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
As a community healthcare worker, I may need to perform the following tasks:									
2. Referral for testing									
Order laboratory investigations	1[A]	1	1	1	0[E]	1	1	N/A[H]	1
Receive updates when the results are available	1[A]	1	1	1	0[E]	1	1	N/A[H]	1
3. Contact listing of suspected and existing COVID-19 cases									
Document detailed contact history about the time, place, and person for each close encounter	1[A]	1	1	1	1	1	1	N/A[H]	1
Create a listing of close contacts linked to the suspected and existing COVID-19 cases	1	1	1	1	1	1	1	N/A[H]	1
Create record to input demographics and risk factors of the close contact	1	1[B]	1	1	1	0	1	N/A[H]	1
Select/modify contact record in case of errors*	1	1	1	1	0[E]	0	1	N/A[H]	1
Query the record of the close contacts from the system	1	1[B]	1	1	1	0	1	N/A[H]	1
4. Exposure Notification for 'close contacts' of suspecting/existing COVID-19 cases									
Communicate (two-way) via a messaging service with the close contact (SMS, Whatsapp, others)	1	1	0	0	N/A[E]	1[F]	0	1	1
5. Symptom Tracking of suspected/existing COVID-19 cases and contacts									
Communicate with the close contact to monitor their symptoms (call or messaging)	1	1[B]	1	1	1[E]	1	1	1	1
Update contact records with new changes/ symptoms	1	1	1	1	0	1	1	1	1
6. Reporting to Ministry of Health									
Submit patient-level/aggregate reports to my supervisor*	1	1	1	1	1	1	1	1	1

Use Case Key: 1 = Yes 0 = No	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
As the administration (Ministry of Health), I want to:									
7. Analyze the patient-level and aggregated data for trends									
View aggregate real-time data by geography*	0	0[B]	1	1	1	1	1	0	1
Visualize analytics that confers high level summaries*	1	1	1	1	1	1	1	1	1
View details on services delivered and patient status by healthcare worker/health facility*	1	1	1	1	1[E]	1	1	N/A[H]	1[I]

[A] CommCare: Files can be updated by users and notifications can be sent from user to user; however, one cannot receive updates or order directly to a lab.

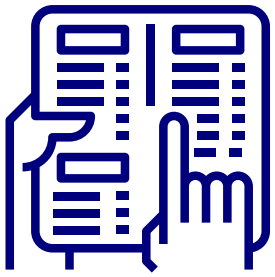
[E] ODK: The tool is not set up for patient management in a clinical setting. Data collected about a patient is submitted to a server; once submitted, that data can be used by another system for a variety of purposes. The submission cannot be retrieved to add additional information, but a new submission that augments the patient can be sent.

The mobile app can send an SMS or make a call as part of the form-filling process. New information for a patient may be added through a new patient record and would have to be manually merged once it is submitted. Functionality to view details on services delivered and patient status is not available today but can be added very easily.

[F] OpenSRP: No timestamp is associated with contact record at this point. Two-way messaging has been used in other applications but not in the COVID-19 modules; however, this is easy to add through RapidPro/TextIt.

[H] RapidPro/TextIt: This tool is not designed for the purpose of case management and longitudinal client follow-up. RapidPro supports communication via messaging. Integration with laboratory services may be feasible depending on the desired workflow.

[I] WelTel: Patient records can be edited. Notes cannot be added as a best practice for retention of records. Filters for data visualization by healthcare workers is currently only available in billing but can be added to reports with minimal effort.



Selecting an Appropriate Platform based on the Context

In each case, the country context, the enabling environment (e.g. availability of smartphones, human resources, network capacity, and reliability), and the operational challenges of introducing and scaling up a system must be considered

The framework for this assessment is not defined as a prescriptive list of criteria that platforms should have, rather they represent criteria that decision-makers may consider in determining what platform suits their specific needs.

In the previous sections, each platforms' inherent capabilities have been deconstructed into the major component parts required for COVID-19 response. Here, we deconstruct each of the platforms' non-functional aspects, such as ease of use and resource requirements, necessary to set up and launch the solution. Some of the platforms examined have common features and functions, and many of them are in widespread use globally. Several even have mature COVID-19 use cases thought through, with applications developed on their platform, ready for immediate deployment. In each case, the country context, the enabling environment (e.g. availability of smartphones, human resources, network capacity, and reliability), and the operational challenges of introducing and scaling up a system must be considered. Often neglected, but also worthy of consideration are the possible ethical and legal challenges presented with the introduction of a technology solution. For example, are there laws or standards which digital health systems must meet, or are there segments of the population who may be left out because of digital divides in the population at-risk?

As stated earlier, the framework for this assessment is not defined as a prescriptive list of criteria that platforms should have, rather they represent criteria that decision-makers may consider in determining what platform suits their specific needs. Yet, for platforms that, on the surface, appear so similar, there are some guiding questions that the decision-makers should answer to choose a solution that aligns with their needs.

From a usability perspective, the platforms are comparable. The user-interface for platforms such as DHIS2 Tracker, CommCare, and Go.Data are easily configurable with a multitude of options.

A. Usability

Usability is defined as the attribute of a mobile application or solution that captures how easy it is for a user to interact with the system. This contributes significantly to the utilization of the app, driven by simplicity to learn, efficiency of performing routine tasks, low error rates, and, the often overlooked, user satisfaction. Simply put, if an application is too hard to learn, users tend to abandon its use for simpler and possibly less efficient alternatives, such as paper forms. Global digital health solutions cater to a wide variety of healthcare workers (e.g. community health workers, doctors, nurses, administrators) working in a variety of healthcare settings. They usually speak different languages. There are a number of factors that go into determining the potential ease of use. Color, font, icons, help messages, and navigation ease are some factors to consider; however, each of these factors have a level of contextual and cultural variability. Although usability assessments typically involve multiple weeks of formative work engaging many test-users, we distilled these salient features in the tables below.

In general, most applications we reviewed had easy navigation with an intuitive user-interface, and filters and search functions to find information. Applications used checklists, radio buttons, and menus to make it easier to fill out forms. CommCare, DHIS2 Tracker, Go.Data, and ODK permit flexibility to allow colors and icons to be changed by the implementing organizations.

From a usability perspective, the platforms are comparable. The user-interface for platforms such as DHIS2 Tracker, CommCare, and Go.Data are easily configurable with a multitude of options. Go.Data and SORMAS have language packages that allow for easy translation into the language of choice.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ Textit[H]	WelTel[I]
Graphical User Interface											
There is no graphical user interface available with the system.	Some components have a graphical user interface while others do not.	A full-featured graphical user interface is available.	2	2	2	2	2[E]	2	2	2	2
Forms Available on Mobile and/or Computer											
The forms are built for mobile only and will require substantial effort to be made available on the computer for editing.	The forms can readily be used on mobile, but can also be made available on the computer for editing in a short period of time.	The forms are available for use on both mobile and computer.	2	2	2	2	2[E]	1[F]	2	1	2[I]
Search Interface											
There is no search interface available.	Basic search functionality is available.	Advanced search functionality is available.	2	2	2	1	1	2	2[G]	2	2
Real-Time Data Validation											
No real-time data entry validation and feedback is available.	Real-time data entry and validation is not available, but is provided when the data is synchronized to the server.	Yes, real-time data entry and validation is available during data entry.	2	2	2	2	2	2	2	2	2
Healthcare Worker Ease of Use											
The system is complicated, hard to use, and requires substantial training.	The system is somewhat easy to use, and would require some training.	The system is easy to use, and would require minimal training.	2	2	2	2	2	2	2	2	2

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Notification of Changes Made											
No, users are not kept informed of completed actions, changes made to the records, or errors.	Users are kept informed of some completed actions, changes made to the records, or errors.	Yes. Users are kept informed of completed actions, changes made to the records, or errors	2	2[B]	2	2	2[E]	2	2	2	2
Font Size											
No, the size of the font cannot be configured by the user	Zoom functionality can be used to view information.	The size of the font can be changed from the device.	1	2	2	2	2	0	0	N/A[H]	1[I]
Icons and Colors											
No, these cannot be changed easily.	Either icons or colors can be changed, but not both.	Yes, these can be changed easily.	2	1	2	2	2	0	0	0	0
Dropdowns, Radio Buttons, and Checkboxes											
No use of dropdowns, radio buttons, or checkboxes.	-	Yes, dropdowns, radio buttons, and checkboxes have been used to make data entry easier.	2	2	2	2	2	2	2	2	2
Tooltips											
No tooltips are used.	Tooltips are not used in the COVID-19 app but are available in the platform.	Yes, tooltips are used.	2	2	2	2	2[E]	1	2	2	2

Note: For Yes or No questions, we assess as 0 and 2.

[B] CHT: Incomplete tasks are marked. This tool currently uses JSON and Xforms.

[E] ODK: ODK on a browser is compatible with any device. ODK Build is a graphical tool, however creating forms through Microsoft Excel or Google Sheets is the preferred mode. Incomplete tasks are marked and informed to the user in a separate log. ODK uses tooltips on the server, but long and short hints on the mobile.

[F] OpenSRP: Forms can be completed on the mobile app. Forms can be viewed and configured for application updates on the computer. Analytics are available on the computer, and data forms are available on the mobile device.

[G] SORMAS: Filtering is available on fields.

[H] RapidPro/TextIt: There are some domain specific questions that are not applicable to TextIt and RapidPro/TextIt.

[I] WelTel: It is a browser-based interface, so it can run on both the computer and mobile. Zooming in on the browser enables better view of the information.

All the platforms have standard user and technical documentation available. Open-source platforms publicly share their product roadmaps.

B. Documentation and Software Productization

Documentation is one of the hallmarks of software maturity. Adequate, updated, and clear documentation facilitates not only the installation and customization of software, but also the training of users on the application and its uses. A clear software roadmap establishes current and future features which are planned and strategically ordered, based on feedback from users and identified needs or gaps. Gaps in documentation can make the process of software setup, launch, and training difficult, and can slow down the implementation.

All the platforms have standard user and technical documentation available. Open-source platforms publicly share their product roadmaps.

	Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ Textit[H]	WelTel[I]
Comprehensive User, Technical, Deployment, and Configuration Documentation	No user documentation exists.	Some user documentation exists (e.g. training manual and demo videos), but it only addresses a limited subset of common functionality.	A full suite of user documentation exists including training manuals, online courses, tutorials, and implementation guides addressing most of the common functionality.	2	1[B]	2	2	2	2	2	2	2
Formal Software Roadmap is Publicly Available	No software roadmap exists, or there is no publicly accessible and routinely maintained platform for new feature requests.	There is a publicly accessible and routinely maintained platform for new feature requests. A software roadmap exists describing the currently planned and resourced development activities.	New features and functionality are documented as part of a software roadmap, as part of a release cycle. There are forums for community members to discuss new feature requests. A clear prioritization process exists and is utilized for the development of new features and functionality as part of a product backlog.	2	2	2	0	2	2	2	2	1[I]

Note: For Yes or No questions, we assess as 0 and 2.

[B] CHT: A new website has been launched: http://docs.communityhealthtoolkit.org, with documentation and tutorials available.

[I] WelTel: Software Product Roadmap is available for all current customers.

Documentation and Software Productization

	Operational and Technical Support for the System	Support for Service Level Agreements (SLAs)
CommCare	Email support is available. Phone support is provided for paying customers only. Locations of operation are in Washington D.C.,Cambridge, MA. New Delhi, India, and Cape Town, South Africa.	SLAs are available for different subscription offerings. Technical support is available via email.
CHT	Email and phone lines for operational support are set up in San Francisco, CA, Nairobi, Kenya, and Lalitpur, Nepal. A team of 80 people are globally distributed in over 30 cities including Nairobi and Dakar. Technical support is provided based on the partnership model.	There is a standard SLA for systems that are on AWS* and supported by CHT. For locally hosted systems, best practices are provided but are available through local partners.
DHIS2 Tracker	University of Oslo supports the software and has a small implementation group. Country support is provided by regional experts.	This is usually provided by country level integrators.
Go.Data	Support is provided by WHO Team during regular weekday hours.	WHO hosted options are used as a temporary solution to support countries in the context of COVID-19. The aim is to move to country hosted options at the earliest convenience. No SLAs are supported.
ODK	Paid support is available from Nafundi and its local partners	SLAs are available from Nafundi and its local partners.
OpenSRP	Support services can be provided by either country level operators or Ona for a fee. Ona provides advanced technical troubleshooting for country level operators as and when required. Support contracts are flexible and are based on the country's requirements, including 24/7 support.	SLAs depend on the partner and country. It is flexible based on needs of the organization.
SORMAS	User hotline for questions is available weekdays 6 a.m. to 5 p.m. though email and phone. Country level partners may provide support as well.	Does not manage installations. This is managed by local partners.
RapidPro/TextIt	Support team is spread across the globe, however customers typically receive responses during US time-zone working hours.	RapidPro/TextIt does not offer any service-level agreements.
WelTel	This is based on the agreement. Email and phone support are provided 24 hours. Partnership arrangements exist with companies in Rwanda and Kenya for operational support. Advanced technical troubleshooting is provided by WelTel.	The SLAs are decided on a case-by-case basis.

*AWS: Amazon Web Services

C. Open-Access and Developer Community

Open-source software provides users the rights to use, change, and distribute the software freely. Open-source should not be interpreted as free-to-the-user. From an implementation perspective, it might be very challenging to adapt a software if there is inadequate documentation and no community around it. Depending on the maturity of the developer and user community around the platform, new use cases may place a heavy burden on the team undertaking the customization for the first time. Documentation, notification of bugs in the system, and a productized platform (covered in the previous section) are all important to ensure that there is complete information about the system. CommCare, CHT, DHIS2 Tracker, ODK, OpenSRP, SORMAS, and RapidPro are open-source. WelTel is a proprietary software. Go.Data is free-for-use, but the source code is not currently available.

To adapt and use open-source software, it is important to identify experienced individuals who can customize and provide ongoing operational support for the system. Most of the platforms assessed here offer fee-based support to customize and maintain the system. SLAs are a commitment between a service provider and a client on the expected services which accompany the use of the platform. It may include system performance guarantees, turnaround time for support questions, availability of backups, etc. This is usually based on discussions between implementing organizations and vendors customizing and supporting the implementing organization.

CommCare, CHT, ODK, OpenSRP, and WelTel provide SLAs on a case-by-case basis based on their client needs. SORMAS offers SLAs at an international level for adaptations, hotline, server hosting and remote server maintenance. This service is currently being used in Fiji, Switzerland, and Germany.

DHIS2 Tracker, Go.Data, and RapidPro do not provide SLAs as they are focused on advanced technical troubleshooting rather than day-to-day operational support. Operational support and SLAs, if provided, are available from country-level operators.

DHIS2 Tracker has one of the most mature local developer communities, with numerous training programs available free-of-cost or for a subsidized fee.

DHIS2 Tracker, ODK, and RapidPro have the most active global implementor communities with local expertise to customize and support the deployment of the tools without active involvement of the steward organization.

DHIS2 Tracker, ODK, and RapidPro have the most active global implementor communities with local expertise to customize and support the deployment of the tools without active involvement of the steward organization.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Standard Licensing											
The system is a mix of proprietary, commercial off-the-shelf, and open-source software. The licenses have to be determined on a module or a component basis.	The system is a mix of proprietary and open-source software, but licensing is very clearly documented.	The system has clear standard open-source licensing.	2	2	2	2	2	2	2	2	2
Open-Source Code											
Source code is not publicly available or is not released under an open-source license.	Source code exists on a publicly accessible repository and is licensed under an Open-Source Initiative approved license.	Source code exists on a publicly accessible repository and is licensed under an Open-Source Initiative approved license. Software is structured to allow local customizations, and new modules and functionality, without requiring forking of the main code.	2	2	2	0	2	2	2	2	0
Developer, Contributor, and Implementer Community											
No existing developer, contributor, or implementer community.	There is some existing community of developers, contributors, and implementers.	Well-developed community of developers, contributors, and implementers who are engaged on a communication platform. Community leadership includes representation from countries where the tool is deployed.	2	1	2	1[D]	2	1	1	2	N/A

[D] Go.Data: An online community forum has been created and launched recently.

CommCare and OpenSRP have one or more current instances where peer-to-peer Bluetooth data transfer has been used.

D. Reliability

Reliability is the ability of an application to run consistently without failure over time. In case of failure, there need to be regular back-ups of the data available to restore the system for normal functioning without loss of data. Comprehensive disaster recovery plans should be in place to ensure minimum disruption in case of large-scale problems. Providing highly reliable services in cloud computing is essential for maintaining customer confidence and satisfaction. Most cloud infrastructure providers offer this service to the application providers using their system. Hence this is an additional benefit that is passed on to the users of a system that is hosted on the cloud.

All platforms can be deployed on the cloud. Cloud infrastructure providers provide backup and disaster recovery services. CommCare data supports daily backups. For CHT, automated failover and provisioning of new resources is performed every 12 hours for cloud-hosted instances. For ODK, the auto-send feature on the mobile devices helps prevent loss of information. For TextIt, data is duplicated and backed up in multiple geographic locations. For locally hosted solutions, steward organizations provide guidelines on recommended backup strategies.

For digital health applications, reliability features allow for the application to deliver consistent results and address discrepancies in the information collected and stored. For example, errors such as multiple records for the same patient or the same identifier being assigned to patients should be minimized, and potential errors should be highlighted by the system. It is important for the applications to support offline work without an Internet connection. Testing for reliability should be performed for each version of the application before it is released.

If a digital solution is being developed for use in remote and disconnected settings, functionality that support offline use might guide the selection of the platform. Offline capabilities are difficult to assess, as platforms may advertise the product for offline use, but may not have successful deployments in the field. For a system to work seamlessly offline, the process of coordination for data collection and transfer is as critical as the technology itself. What system features are impaired without continuous connectivity? Will synchronization of schedules continue to work? Is there a risk of data duplication if the same patient is seen twice between updates?

RapidPro is distinctly different from the other platforms reviewed here, with a basic but well-developed functionality of two-way communication.

At minimum, for a system to work offline:

- Data collection should be possible in an offline environment without duplication of client IDs. There are two cases here that should be identified and resolved: the first is if the same client has been given multiple different client IDs; the other is when multiple different clients have been given the same client ID. For example, DHIS2 Tracker conducts a search of the local database and automatically suggests records for download if a duplicate exists. Unique identifiers can be reserved on the mobile device to continue adding client information, without risk of generating a duplicate client ID. Go.Data, SORMAS, and WelTel identify duplicates based on name, ID, and phone number, and allow the user to handle these on a case-by-case basis. ODK handles duplicates when data is synchronized with the server. All the applications can flag duplicates and allow the user to resolve the issue if present.

- Where connectivity may be a problem, the process of data transfer and system updates should be clearly articulated. If network connectivity is available within a short distance from end-users, most platforms assessed here can "upload" the data to a server based locally, on a secure 'cloud', or both. In the absence of constant, reliable connectivity alternative methods may be used to upload data to a local 'node' (e.g. a laptop in the hands of a supervisor) using a USB or Bluetooth connection, which is then synchronized with the Internet or system server by travelling to a connected area. CommCare and OpenSRP have one or more current instances where peer-to-peer Bluetooth data transfer has been used. All platforms allow data to be stored on the local device and uploaded when convenient or when a connection is available.

If 3G or 2G connectivity is extremely limited, decision-makers should consider platforms that have advanced text messaging capabilities, such as RapidPro. RapidPro is distinctly different from the other platforms reviewed here, with a limited but well-developed functionality of two-way communication.

Reliability

	Handling of Duplicate Accounts and Patient ID Numbers	Operations and Data Synchronization (Between Mobile Device and Server) in Low Connectivity Environments	Data Back-Up and Disaster Recovery Plans
CommCare	The application can be configured to prevent duplicates at registration by allowing cases that were previously registered to be on display at the point of registration, or by flagging if key fields entered are the same as another case which already exists within the users' local case database.	The application can run offline. Data are stored locally on mobile devices until the device has a connection to WiFi or cellular data.	Data is backed up securely every 24 hours. They have never incurred a data loss in their production environment.
CHT	The system creates a unique ID for each document on mobile. Synchronization is performed on the server which takes care of combining duplicates and creating unique identifiers for new patients.	The application has been designed to work offline. Data is stored locally on the device till connectivity is available.	An automated failover and provisioning of new resources is performed every 12 hours for cloud-hosted instances. Organizations manage their own disaster recovery and hosting when the server is hosted locally.
DHIS2 Tracker	Before being able to add a new tracked entity (i.e. registering a new case), the system conducts a search of the local database if the device is offline, and both online and local databases if the device is online to flag potential duplicates. It will automatically suggest records for download based on the user's organization unit assignment (i.e. a certain health entity). Also, system-generated unique identifiers can be reserved on the mobile device (i.e. a device 'checks out' a certain number of unique system-generated IDs to continue doing data entry offline, without risk of generating a duplicate ID).	The system can work offline, and can synchronize with the server when an internet connection is available.	Countries can host locally or on the cloud. University of Oslo does not directly provide hosting services for DHIS2 Tracker implementations, but provides technical assistance for server set up and maintenance for countries who host locally.
Go.Data	At present duplicates are based on names (first, last, and middle), identification (if any), and phone number. Fuzzy search is documented as an enhancement, which will be included in future releases to further develop duplicate identification.	The system can work offline, and can synchronize with the server when an internet connection is available.	The system is installed and maintained by the organization.

	Handling of Duplicate Accounts and Patient ID Numbers	Operations and Data Synchronization (Between Mobile Device and Server) in Low Connectivity Environments	Data Back-Up and Disaster Recovery Plans
ODK	A universal unique identifier is assigned to forms created on the device. This is synchronized with the server in the online mode to ensure there are no duplicates.	The system can work offline, and can synchronize with the server when an internet connection is available.	All submissions stay on the phone or mobile device, and are uploaded when connected to the server. There are also server side back-ups that are fully encrypted. Auto-send feature on the mobile devices helps prevent loss of information.
OpenSRP	A unique, system-generated ID is assigned to each client during registration, ensuring no two clients have the same ID. In addition, the user can record additional identifiers, as required by the program such as passport number, health insurance number, etc. Use of 2D barcodes that contain the ID number of the client is also supported.	The system can work offline, and can synchronize with the server when an internet connection is available.	This is provided by the cloud service that is being used.
SORMAS	An interface in the application flags duplicate cases, contacts, and events based on name, region, district, birth date, age, sex and other fields. The user can then choose on the best course of action, be it to merge records or change identifiers. The system also prevents the creation of duplicate user accounts and other data such as region, district, and health facility.	The system can work offline and data is synchronized with the server when an internet connection is available.	This is managed at the country level by partners and can vary based on their needs.
RapidPro/TextIt	N/A	The application works offline in addition to online.	TextIt creates a “master-master” configuration so that there is a duplicate of forms in all databases. All data is duplicated and backed up in multiple geographic locations.
WelTel	Once flagged by the system, information such as phone numbers and clinic names are used to sort out duplicates manually.	No current instances of case management in a low connectivity environment. For remote communication, system switches from browser-based messaging to SMS.	This is covered by AWS*.

*AWS: Amazon Web Services

CHT, DHIS2 Tracker, and ODK have been deployed to thousands of users. The largest instance of ODK hosts 80,000 active users, CommCare hosts over 600,000 active mobile application users, and DHIS2 Tracker hosts 43,000 users.

E. Scalability

Scalability is the ability of the application to maintain its performance over time, and under different conditions. Scaling digital solutions that are data intensive requires that the application maintains consistent performance without crashing or stalling as the number of users and data grows over time.

Cloud providers offer auto-scaling which can help in the management of resources and load balancing. Solutions hosted on local servers have to be managed more actively by the system administrators to ensure load balancing.

Even though it is hard to predict conditions in the field, testing for scalability should be performed for each release of the application. CHT, DHIS2 Tracker, and ODK have been deployed to thousands of users. The largest instance of ODK hosts 80,000 active users, CommCare hosts over 600,000 active mobile application users, and DHIS2 Tracker hosts 43,000 users.

	Largest Deployment of the Application (Not Specific to COVID-19)	Cloud-Based Platform	Performance and Scalability Testing
CommCare	The largest non-COVID-19 instance has over 630,000 active users. For COVID-19, 20,000 users globally utilize CommCare applications.	The system is cloud-based. CommCare is hosted in an ISO 27001 certified infrastructure, with GDPR* and HIPAA** compliance. There are two public locations for data storage: AWS*** in the United States, and Softlayer (an IBM company) in India.	Every release is tested for scale, load, and performance. The network operations are optimized for minimal bandwidth and high-latency environments. CommCare has rate limits on the number of form submissions allowed per project space in a given period of time. When rate limiting occurs, all form submissions from CommCare mobile and web apps are saved locally until rate limiting expires, at which time those forms will be auto-synced.
CHT	28,000 community health workers are supported globally. The largest deployments include close to 9,000 healthcare workers in Uganda, 9,000 healthcare workers in Nepal, and nearly 4,000 healthcare workers in Kenya.	Both local hosting and cloud hosting are supported. Deployments are usually on AWS*** in the United Kingdom, but can be hosted on other cloud systems as well.	For every release performance, profiling is conducted.

	Largest Deployment of the Application (Not Specific to COVID-19)	Cloud-Based Platform	Performance and Scalability Testing
DHIS2 Tracker	The largest non-COVID-19 deployments of DHIS2 Tracker is in Bangladesh with 16,000 users for healthcare, and 43,000 users for immunization tracking.	The system can be hosted locally or on the cloud.	This depends on the configuration of the user. The system is configured to offload the 100 most updated cases from the mobile device. Stress-testing has been performed with 200 synchronous users.
Go.Data	Numbers are not available.	Go.Data can be set-up to run as a standalone installation or a server installation. Installation on a cloud-based environment is possible.	Regular tests with 10,000 cases, 200,000 contacts, and 180,000 follow-ups have been performed. In addition, a stress-test with 300,000 cases and one million contacts was performed.
ODK	There is an average of 400,000 users monthly who are actively using the application. The largest active project is in Honduras with 80,000 healthcare workers. The second largest is in Nigeria with 70,000 healthcare workers. With respect to COVID-19 applications, the largest project is in Somalia where 4,000 healthcare workers are submitting contact tracing data.	The system can be hosted locally or on the cloud.	The system has been load-tested. The system must be configured based on the size of the deployments. There are often projects with 1,000 or more enumerators
OpenSRP	OpenSRP has approximately 21,000 healthcare workers across 13 countries that are using various iterations and modules of the open source tool. A BRAC and UNICEF project in Bangladesh currently supports 3,000 community health workers and 12.6 million clients. For the OpenSRP-based COVID-19 Testing and Screening Application, currently being deployed in Indonesia, is used by 200 doctors and nurses. It is used to support approximately 5,000 patients per day.	Both local hosting and AWS*** cloud hosting is available. The system is deployed on Alibaba in Indonesia.	Load testing is done for each deployment. Bandwidth is simulated on different versions of smart phones to test for performance. Integration testing is conducted on the mobile application, the server software, and the connections between the system components.

	Largest Deployment of the Application (Not Specific to COVID-19)	Cloud-Based Platform	Performance and Scalability Testing
SORMAS	The application has been deployed for 500 healthcare workers in Nigeria, 200 in Fiji, and 150 in Germany. The largest deployment was in Nigeria with over 170,000 cases, 113,000 samples, 31,000 contacts, and 800 Events.	Both local hosting and cloud hosting is available.	Load testing is done with each deployment. The system has been deployed in Nigeria for a number of year for all notifiable diseases on a single instance. Performance and load testing is a part of all releases, and results are publicly available. Penetration testing is done externally once a year.
RapidPro/TextIt	There is no limit to the number of contacts that can be supported by the system. Multiple deployments exist supporting global scale interactions with millions of users daily.	All data are stored on RapidPro/ TextIt servers that are hosted on AWS***.	All load base is unit tested with 100% coverage. Multiple performance tests are run on each commit to prevent regressions.
WelTel	Currently 60 healthcare workers use it in Canada, several hundred in Rwanda, and over 5,000 patients use it in Kenya.	The system is using AWS*** cloud service. It does not allow local deployment.	The system has been load tested for over a 100,000 users. WelTel has been rolled out in places with 2G network where its SMS interface is used.

*GDPR: General Data Protection Regulation

**HIPAA: Health Insurance Portability and Accountability Act

***AWS: Amazon Web Services

Among the platforms: CommCare, DHIS2 Tracker, ODK, OpenSRP, SORMAS, and WelTel comply with industry standards for healthcare data exchange.

F. Standards, Interoperability, and Data Accessibility

In addition to documentation, mature systems increasingly adhere to global norms and standards around the way in which data are captured, stored, and exchanged with other systems that are in use. Over the past decade, a number of digital health architectural standards have emerged (e.g. HL7 and FHIR), which helps data to not only be stored with optimal efficiency, but also to be exchanged seamlessly across an ecosystem of tools and solutions using the same standard. This is especially useful for patient continuity, as they move across providers and levels of facilities, but also for the aggregation of data at the national or regional level.

In several countries, a dominant system for data aggregation and reporting might be in use. If it has been determined that COVID-19 case management data needs to be integrated with routine health information systems (if they exist), or aggregate data sources for planning and resource allocation purposes, decision-makers should consider methods of data integration that would work best for their needs.

All platforms allow for data to be manually downloaded as a *.csv (text) file. This can be shared and uploaded in the appropriate system to integrate data sources. However, doing this requires there to be a process for data download, transfer, and upload, as well as accountability mechanisms to ensure that all individuals in this chain can do so in a timely and regular manner.

Alternately, data might be seamlessly integrated with an existing system if appropriate APIs exist. This can be a more time-consuming and costly process; however, one that might be worth the investment if setting up a system to operate over a longer period. Automating these functions can free up human resources in the long-run, while also reducing error rates attributable to manual data transfers. Among the platforms: CommCare, DHIS2 Tracker, ODK, OpenSRP, SORMAS, and WelTel comply with industry standards for healthcare data exchange. In several countries, DHIS2 Tracker is a commonly used data aggregating and reporting system. Most platforms have at least one instance of integrating their systems with DHIS2 Tracker or a comparable backend system.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Compliance with Industry Standards											
The toolkit does not support either FHIR or HL7, and it would take substantial effort to add.	The toolkit does not support either FHIR or HL7, but this can be added with minimal effort.	The toolkit supports either FHIR, HL7, or both.	2	1	2	0	2	2	2	N/A[H]	2
Integration with Standard Back-End Systems (e.g. DHIS2)											
No integrations exist.	Integration is either being planned or in development.	Integration has been established with at least one system.	2	2	2	0	1	2	2	2	2
Support for Healthcare Coding Standards (e.g. ICD-9, ICD-10, LOINC, SNOMED)											
No healthcare coding standards are supported.	Support for healthcare coding standards can be added with some simple changes.	At least one of the healthcare standards are supported.	0	1	2	2	2	0	0	N/A[H]	0

[H] RapidPro/TextIt: There are some domain specific questions which are not applicable to TextIt and RapidPro/TextIt.

Most mature global offerings cater to the dominant Android operating system and leverage a wide range of user-held devices.

G. Devices and Operating Systems

The availability and selection of mobile devices and operating systems is among the most important considerations to reflect upon when selecting a software platform. Most mature global offerings cater to the dominant Android operating system and leverage a wide range of user-held devices. A few of the platforms reviewed here perform optimally when end-users can access the sophisticated computing capacity of smartphones, others rely on the lowest common denominator technology: SMS. This does not make one type of solution better or worse than another, but instead allows the planner to identify technology that fits the problem being addressed in a way that "best-fits" the local environment for most people.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Support for Smartphones											
No, smartphones are not supported.	-	Yes, smartphones are supported.	2	2	2	2	2	2	2	2	2
Support for Feature phone											
No, feature phones are not supported.	-	Yes, feature phones are supported.	2	2	2	0	0	0	0	2	2
Support for Basic Phones											
No, basic phones are not supported.	-	Yes, basic phones are supported.	2	2	2	0	0	0	0	2	2
Support for Android											
No, Android is not supported.	-	Yes, Android is supported.	2	2	2	2	2	2[F]	2	2	2[I]
Support for iOS											
No, iOS is not supported.	-	Yes, iOS is supported.	0	1[B]	0	2	2[E]	0	0	2	2[I]

Note: For Yes or No questions, we assess as 0 and 2.

[B] CHT: Apple iOS is supported on browsers other than Safari.

[E] ODK: ODK has been migrated to support iOS.

[F] OpenSRP: This does not display reports on Android for the COVID-19 application.

[I] WelTel: This has a browser-based interface.

RapidPro has the most advanced capabilities for SMS-based communication. CHT, CommCare, and OpenSRP have current instances of integration with RapidPro for the purpose of communication. CHT and WelTel have built-in mechanisms for two-way communication with cases.

H. Messaging Capability

Text messaging is an important form of communication between healthcare workers, the healthcare system, and clients. Especially in the context of COVID-19, text messaging could be used by healthcare workers to report to supervisors and the healthcare system about suspected cases, and to follow up on cases and contacts to assess whether there has been an onset or change of symptoms. This is of particular importance when communicating with patients who may not have access to the application being used by healthcare workers. SMS uses standardized communication protocols to enable mobile devices to exchange short text messages. It is important to understand if a platform supports one-way messaging, from the healthcare worker to the patient, or two-way messaging, where the patient is able to respond using the same channel. In-app messaging, WhatsApp, and social media messaging systems such as Facebook Messenger are also becoming popular modes of communication with patients who have access to smartphones.

Programs which engage clients through SMS or phone calls may want to consider whether reversed billed or toll-free messaging that are available to purchase or can be obtained through mobile network operator (MNO) negotiated agreements. The implementation of toll-free messaging would be similar to the integration with two-way SMS APIs and through aggregators such as Twilio or Africa's Talking. The use of zero-rated or reversed billed services may be critical to encourage engagement by a population when airtime or data packages are expensive, and costs to the patient need to be avoided.

CHT, CommCare, OpenSRP, RapidPro, and WelTel support two-way SMS messaging through integration with RapidPro. DHIS2 Tracker and SORMAS support one-way SMS messaging. Most platforms that have two-way messaging functionality use integration with RapidPro for that function. RapidPro has the most advanced capabilities for SMS-based communication. CHT, CommCare, and OpenSRP have current instances of integration with RapidPro for the purpose of communication. CHT and WelTel have built-in mechanisms for two-way communication with cases.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Messages Sent to Patients through SMS											
No, this functionality is not available.	-	Yes. This functionality is available.	2	2	2	0	2[E]	2[F]	2	2	2
Patients Can Send SMS back to Healthcare Worker and/or Facility											
No, this functionality is not available.	-	Yes. This functionality is available.	2	2	0[C]	0	N/A[E]	2[F]	0	2	2
WhatsApp Messaging Support											
No, this functionality is not available.	-	Yes. This functionality is available.	2	0[B]	0	0	N/A[E]	2[F]	0	2	0[I]
Social Media Messaging Support (e.g. Facebook Messenger)											
No, this functionality is not available.	-	Yes. This functionality is available.	0	0[B]	0	0	N/A[E]	2[F]	0	2	0
Toll-Free Messaging Available											
No, this functionality has not been made available for any deployment.	Toll free functionality is not currently available, but can be added with minimal effort.	At least one instance of toll-free messaging is being used currently.	2	2[B]	0	0	N/A[E]	0	0	2	2[I]
Notifications Can Be Sent Out to a Larger Group											
No, this functionality is not available.	This can be built into the system	This is built into the system.	2	2	2	0	N/A[E]	2	0	2	2

Note: For Yes or No questions, we assess as 0 and 2.

[B] CHT: CHT has an integration with RapidPro/TextIt which can be used to support WhatsApp and Facebook Messenger. CHT has established reverse billing in Siaya county, Kenya.

[C] DHIS2 Tracker: It is possible for users to send a SMS back to the DHIS2 Tracker to submit data, but this requires a DHIS2 Tracker user account. There are cases where implementers are adding other layers of technology (e.g. RapidPro/TextIt) to support communication with patients, and only submit relevant data to DHIS2 Tracker for storage.

[E] ODK: The mobile app can send an SMS or make a call as part of the form filling process.

[F] OpenSRP: The SMS functionality is being used in other applications, but not in the COVID-19 modules. SMS, WhatsApp, and Facebook Messenger functionality can be made available through OpenSRP's RapidPro/TextIt integration.

[I] WelTel: Short codes are incorporated into the system, but pricing would have to be adjusted for this additional functionality. WhatsApp integration is in development.

I. Security

While all platforms have out-of-the-box authentication, authorization, and data encryption. CHT, ODK, OpenSRP, and SORMAS have been audited by external entities.

Security is a critical consideration for healthcare systems as they store sensitive patient information. The most basic factors to consider are authentication, authorization, and encryption of data. Authentication deals with confirmation of the identity of the person accessing the system. Authorization deals with the ability to limit access to information for users based on their needs. Encryption is the process of ensuring that data is coded when it is transferred over the network to the server (and vice-versa) to prevent unauthorized access. While all platforms have out-of-the-box authentication, authorization, and data encryption. CHT, ODK, OpenSRP, and SORMAS have been audited by external entities. These companies specialize in testing the systems for potential security breaches.

Another aspect of security is to ensure all access and changes to the system are logged, which would be available, accessible, and editable by administrators. Most platforms can log information at the database or application level. Go.Data and ODK both provide an admin interface to be able to access this information.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
System Provides Tracing and Logging of Changes Made by the User											
Tracing and logging is available at the database level only.	Tracing and logging is provided at the application level but has no easy to use interface.	The tracing and logging is made available to system administrators through an easy to use interface.	2	2	1[C]	2[E]	2	1[F]	2	2	1
Security Controls and Implementation Guidance is Comprehensive											
No security controls or implementation guidance are in place.	Role-based authorization and authentication exists, if appropriate. Guidance on encrypting all remote access (e.g. web interface or APIs) is available to implementers.	Role-based authorization and authentication exists, if appropriate. All remote access (e.g. web interface or APIs) are encrypted by default using current best practices. An independent security audit of the software has taken place within the last twelve months.	2	2[B]	2	2	2	2[F]	2	2	2

[B] CHT: Security audits have been performed on the software, though not in the last twelve months.

[C] DHIS2 Tracker: Limited audit logs are exposed through DHIS2 Capture application.

[E] ODK: Incomplete tasks are marked and informed to the user in a separate log.

[F] OpenSRP: Tracing and logging changes is a manual process. Security audit is being performed on the system.

DHIS2 Tracker, ODK, Go.Data, and SORMAS provide an interface to R for further statistical analysis. Go.Data has a sophisticated set of built-in analytics, including visual summaries of cases who need active follow-up. Go.Data and SORMAS allow visualization of patterns of COVID-19 transmission.

J. Analytics

The application of analytics in the tracking and managing of COVID-19 is extremely important in order to understand the prevalence and transmission of the virus. At minimum, the applications should provide reports on the number of suspected, probable, and confirmed cases based on geographical areas, healthcare centers, and patient demographics. This capability may be built into the platform or achievable through integration with an external analytics software package. All the platforms provide dashboards, mapping, graphs, and tables, all with multi-level filtering to varying levels of sophistication. They all provide the ability to extract data into a *.csv file for analysis in other analytics tools.

DHIS2 Tracker, ODK, Go.Data, and SORMAS provide an interface to R for further statistical analysis. Go.Data has a sophisticated set of built-in analytics, including visual summaries of cases who need active follow-up. Go.Data and SORMAS allow visualization of patterns of COVID-19 transmission. OpenSRP can be connected to third-party analytics platforms and electronic data warehouses using existing ETL (extract, transform, load) tools. OpenSRP uses Canopy Analytics to provide usage metrics. WelTel is working on integrating NLP and predictive analytics into the platform.

In addition to analytics, it is also important to see data on usage metrics which describe how the application is being used by the healthcare worker. For example, we might want to know if a community healthcare worker has not used the application in several days. The platforms provide usage metrics to varying degrees of granularity.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Data Export to CSV Files											
The users have no access to data from the system.	The users have to request access to data from the company.	Users can automatically download the data they want through an easy to use interface.	2	2	2	2	2	2	2	2	2
Usage Metrics											
The system does not provide any usage metrics.	The system tracks usage metrics but does not provide a graphical user interface to view them.	The system has an easy to use interface to allow analysis of usage metrics.	2	2	1[C]	2	2	2[F]	2	2	1
Analytics and Reporting Capabilities Built into the Platform											
There are no analytics and reporting capabilities built into the platform.	There are basic analytic and reporting capabilities.	There is extensive reporting and analytics capabilities available in the platform.	2	1	2	2	2	2[F]	2	2	2

[C] DHIS2 Tracker: DHIS2 as a platform has usage metrics with a graphical user interface through an application called “Usage Analytics”; this is made available through the platforms’ web interface.

[F] OpenSRP: OpenSRP uses Canopy Analytics. The analytics are not available on phone.

Analytics

	Analytics Provided by the System, and Integration with Other Systems (e.g. R, Tableau, and Excel)
CommCare	Data can be imported into the analytical tool of choice including Tableau, PowerBI, and Excel. CommCare allows for the development of basic web-based reports based on the data collected. No real-time analytics are provided by the system.
CHT	The data can be exported in Excel or CSV format to external analytics systems. No real-time analytics is provided by the system.
DHIS2 Tracker	Real-time analytics is provided by the system. Dashboards, mapping, and multi-level filtering are included. DHIS2 Tracker also provides an interface to conduct further statistical analysis using R Shiny. An external partner has also created a relationship tracing application to visualize the possible spread of disease across a cohort of cases and their contacts.
Go.Data	The system has extensive built-in analytics. Visualizations include chains of transmission using timelines, integrated data bars, and network graphs. Other reports include epidemiological charts, visual color-coded summaries, and reports of patient data and contact follow-ups. Go.Data also has a set of APIs that can be used for data exchange with other systems, and for data transfer to external analytic tools.
ODK	Data can be exported in a *csv file format. The server has an extensive REST API and supports direct connections with PowerBI, R, and Tableau for dashboarding.
OpenSRP	Analytics are provided on the computer using SuperSet and a Custom Web Interface. ETL* tools can be used to export data into third party analytics platforms.
SORMAS	Has a configurable API for data access. Internal analytics include dashboards for cases and contacts. Chains of transmissions graphs show the spread of the disease. Ad hoc queries are supported by the system. A secondary application provides access to statistical analysis through R Shiny.
RapidPro/TextIt	Data can be exported in CSV or JSON format. A configurable API facilitates data transfer to an external analytics tool such as Tableau, PowerBI, or Excel.
WelTel	Real-time reports and dashboards can be available for patient information. Predictive analytics and NLP will be available soon.

*ETL: Stands for “extract, transform, load”. Used to copy data from one or more sources into a destination system.

CommCare, DHIS2 Tracker, Go.Data, ODK, SORMAS, and WelTel have a range of COVID-19 use cases developed that are turn-key ready for deployment. For simple message-based workflows for communications, RapidPro can be promptly adapted and deployed.

K. Time to Deployment

Deployment of an application consists of several activities that are required to make the application ready for use in a country or an organization. Many factors go into time to deployment. The availability of pre-existing COVID-19 modules that are already being used elsewhere is one factor that can reduce the time to deployment. The section on "Use Case" identifies common functionalities for COVID-19 response and helps the reader assess functions that are configurable versus those that require new development. Multilingual support, documentation, and the availability of resources to customize and support the implementation can hasten deployment.

Most of the applications here have been built with global deployment in mind and hence support multiple languages. They also provide good documentation and training materials. DHIS2 Tracker is highly configurable to the needs of the organization in terms of the wide range of functionality they offer. CHT, CommCare, DHIS2 Tracker, ODK, OpenSRP, RapidPro, and SORMAS have active communities that support and use the applications. Go.Data is a relatively new application that is supported by the WHO; they have just started a community forum. CommCare, DHIS2 Tracker, Go.Data, ODK, SORMAS, and WelTel have a range of COVID-19 use cases developed that are turn-key ready for deployment. For simple message-based workflows for communications, RapidPro can be promptly adapted and deployed. CHT and OpenSRP are in the process of developing and deploying COVID-19-specific applications as well by June 2020. The relative ease of use and local ownership of RapidPro has resulted in fit-for-use development of numerous COVID-19 specific deployments; however, there is no comprehensive listing and description available.

Functionality does not exist (0)	Functionality somewhat exists (1)	Functionality is well developed (2)	CommCare[A]	CHT[B]	DHIS2 Tracker[C]	Go.Data[D]	ODK[E]	OpenSRP[F]	SORMAS[G]	RapidPro/ TextIt[H]	WelTel[I]
Availability of Public Documentation of Issues or Bugs											
The issues and bugs are not documented, or they are documented but not publicly available.	The issues and bugs are documented but are made available on a case-by-case basis through email or other informal channels.	The issues and bugs are documented and made publicly available to all developers.	2	1[B]	2	0	2	2	2	2	1[I]
Pre-Built Modules for COVID-19											
No pre-built modules for COVID-19. New code will have to be written to create these modules.	Some pre-built modules for COVID-19 and/ or some existing modules that would need to be re-configured to work for COVID-19 applications.	Pre-built modules for COVID-19 that can be deployed out-of-the box with minimal changes.	2	2	2	2	2	2	2	0	2
Interfaces for Importing Data into the Platform											
There is no formal system for importing data.	There are basic importing capabilities.	Some APIs are available for importing data. At minimum a *.csv file can be imported easily by the system administrator.	2	2	2	2	2	2	2	2	0[I]

[B] CHT: A website (http://docs.communityhealthtoolkit.org) has been launched with documentation and training materials.

[I] WelTel: Issues and bugs are shared with customers. An API for CSV upload is currently under development.

Multilingual Support

CommCare	As CommCare has been deployed in over 130 countries, most languages are supported. Languages supported include French, English, Spanish, German, Arabic, Bahasa (Indonesia), Chinese, Japanese, Norwegian, Swahili, Bambara, Kinyarwanda (Rwanda), Burmese, as well as several Indian languages and dialects (e.g. Kannada, Hindi, Marathi, Tamil, Telugu, Malayalam, Gujarati, Punjabi, Bengali, and Assamese).
CHT	Languages supported include English, French, Spanish, Hindi, Swahili, Bahasa (Indonesia), and Bamanankan (Bambara).
DHIS2 Tracker	University of Oslo HISP supports a translation server for DHIS2 Tracker. An active Community of Practice contributes to translation. The COVID-19 metadata package for DHIS2 Tracker is currently translated into English, French, Portuguese, Spanish, Norwegian, Russian, and Arabic.
Go.Data	Languages supported include Portuguese, Spanish, English, and French. Mongolian has been self-translated by the organization.
ODK	ODK is multilingual and translations are provided by the community and by the developers. The mobile app supports 50 languages that include French, Burmese, English, Japanese, Spanish, Swahili, Hindi, and German. Forms support whatever language the form designer includes. The server defaults to English, but Spanish and French translations are coming soon.
OpenSRP	Languages supported include Bahasa, English, French, Arabic, and Portuguese.
SORMAS	SORMAS has multilingual support for English, French, German, Italian, Finnish, and Spanish on its platform. An interface is provided for users to generate any additional language interface themselves.
RapidPro/TextIt	Language of flow can be chosen during flow creation. There are thousands of languages and dialects to choose from globally, with representation from every continent. Any language that has been assigned an ISO 639-3 code is supported.
WelTel	Languages supported include English, French, Kinyarwanda (Rwanda), and Swahili.

CommCare, CHT, ODK, Go.Data, OpenSRP, and SORMAS have open-source licensing. If needed, the steward organizations can provide end-to-end support in customization, hosting, and maintenance for a fee. RapidPro and DHIS2 Tracker are open-source and the steward organizations provide advanced troubleshooting support. Local expertise must be found for customization, hosting, and maintenance of the platform. WelTel follows a tiered subscription-based pricing model.

L. Cost Considerations

It is important to take cost considerations into account when buying a technology solution. The direct and indirect costs of deploying a technology solution includes the initial startup cost and operational costs. For digital health tools there are usually two models of pricing: Software as a Subscription (SAAS) and the technology licensing model.

For SAAS models, the software is licensed on a subscription basis and is hosted on the cloud. SAAS solutions are usually priced on a per-user model, and the number of users can be increased over time based on the needs of the implementing organization. There may be initial costs for customization, deployment, and training; after which, the annual cost includes operational support and standard enhancements. The advantage of SAAS-based models is that there are no hardware costs, and back-up, replication, and other maintenance is taken care of by the company hosting the solution.

Under the technology licensing model, the implementing organization buys a license to the software. There are initial costs of buying hardware, customization, deployment, and training. The implementing organization also buys an annual support contract that includes upgrade, and technical and operational support. Here, there are additional costs that need to be considered for backup, replication, disaster recovery, etc.

Most of the applications, other than WelTel and Go.Data, have free open-source licensing; essentially, they can be deployed independently by the implementing organization if local consultants are available and have the necessary expertise to adapt them fit-for-purpose. If local expertise is not available, some steward organizations can also provide this support for a fee. Specific to COVID-19, these services may be available free of cost or at a highly discounted price.
CommCare, CHT, ODK, Go.Data, OpenSRP, and SORMAS have open-source licensing. If needed, the steward organizations can provide end-to-end support in customization, hosting, and maintenance for a fee. RapidPro and DHIS2 Tracker are open-source and the steward organizations provide advanced troubleshooting support. Local expertise must be found for customization, hosting, and maintenance of the platform. WelTel follows a tiered subscription-based pricing model.

Cost Considerations

CommCare	Users can download an Excel file from the website to understand projected costs. This is based on the scale of operations, monthly and annual operating costs, capital expenses, hosting fees, etc. CommCare subscription fees are waived for organizations using it to respond to COVID-19. Interested parties are able to apply for a pro bono subscription by filling out a basic form. The cost of the app is as follows: **Standard:** $250 monthly: for programs with one-time data collection. Two-way messaging is not offered. Limited support (takes 3 business days for response). **Pro:** $500 monthly: For field staff. Two-way messaging not offered. **Advanced:** $1000 monthly: for distributed field staff, advanced security, and two-way messaging. **Custom:** Amount to be decided, and paying annually: Company asks for path to scale mobile data collection, and two-way messaging. Onboarding is: $1500: 6 hours of training. Access to customer support team is provided. $5000: 20 hours of training and regular customer support. $7500: 20 hours of training and deployment of multiple apps in one or more countries.
CHT	CHT is open-source and hence there are no licensing fees. Costs are based on the customization, installation, and operational support services provided by CHT.
DHIS2 Tracker	The software is open-source and there are no licensing fees. University of Oslo provides open technical assistance through the Community of Practice. Customization, configuration, and operational support has to be sourced at the country level. This is provided by either an in-country health information system staff or external technical assistance.
Go.Data	Countries can download the software and deploy it themselves.
ODK	Free and public open-source software. Costs are based on the customization, installation and operational support services provided by ODK or by local partners. The company offers pro-bono help with using ODK for COVID-19 response. They have helped organizations with premium support, form design, server hosting, feature development, training, custom analytics, and scaling guidance.
OpenSRP	The platform is open-source and hence there are no licensing fees. Costs are based on customizations and operational support.

SORMAS	SORMAS is open-source and free for any country to download and use. Initial support at set-up as well as service level agreement for installation, hosting, customization, and hotline is available in some countries.
RapidPro/TextIt	RapidPro/TextIt is an open-source and free software. TextIt offers free hosting for all COVID-19 related projects. All costs are encompassed in “credits”. One credit is equal to one message sent or received via the TextIt platform (e-mails from a flow do not use credits). Accounts come with 1,000 free credits. If connected to a channel like a social media platform, (e.g. Facebook, Twitter, Telegram), there is no additional charge for messages. If an SMS aggregator, gateway, or carrier is chosen, there are additional charges per message from the service chosen.
WelTel	The software is based on a SAAS* model of $10 per user per year for up to 10,000 users. This includes the costs of outgoing SMS from healthcare workers. WelTel has a tiered pricing model, so the prices decrease with the number of users. There are professional services charges for customization and data integration. Local hosting can be provided for a cost based on request.

*SAAS: Software as a service

Conclusion

In the previous sections, we describe the functionality of each of the platforms based on testing the platforms and discussions with the platform stewards about availability of specific functionality. To summarize the readiness of the platforms for COVID-19 response, we present below a table with 12 high-level features on a comparative scale: “not available”, “some functionality available”, “most functionality available”, and “advanced functionality available”. Unlike prior sections, where the results are based on a more objective and binary assessment of whether a specific function is available, the summary below brings in a subjective dimension based on the authors’ engagement with the platforms. We classify the platform as having “advanced functionality available” if the platform is notable for a particular feature.

* Platforms may integrate with external analytics software.
** For the use case of COVID-19 patient triage, referral for testing, contact listing and notification, and follow-up.
*** Ability to order laboratory tests, follow progress of patient sample, and receive updates when results are available.
**** Please refer to platform overview pages for list of available use cases.

The platforms chosen for review are mature platforms that have been deployed all over the world. They are flexible, work reliably in low resource environments and can be translated into multiple languages. In the context of the COVID-19 use case involving patient triage, referral for testing, contact listing and follow-up, the two platforms that stand out for their maturity, flexibility and large-scale deployment are **DHIS2 Tracker and CommCare**. Both these platforms have turn-key ready applications for COVID-19 and a history of proven success with large scale deployments. Globally, there is much experience and capacity in adapting and deploying DHIS2 Tracker, with minimal involvement of the steward organization. With CommCare, adaptation and deployment support can be provided (at a cost) by the steward organization.

If Ministries are interested in remote communication with healthcare workers or suspect cases regarding COVID-19 via a messaging platform, we would recommend the use of **RapidPro**, given its ease of adaptation and deployment.

Resources for All Platforms

Platform	Resources
CommCare	Product Summary Page: https://dimagi.com/commcare/ Product Login Page: https://www.commcarehq.org/ Quick Start Guides: https://dimagi.com/quick-start/ Product Support Pages: https://confluence.dimagi.com/display/commcarepublic Evidence Base: https://www.dimagi.com/toolkits/commcare- evidence-base/ Case Studies; https://www.dimagi.com/case-studies/ CommCare Key Features Series: https://www.youtube.com/watch?v=wpQ-Xm2liKs CommCare for COVID-19: https://confluence.dimagi.com/display/commcarepublic/CommCare+for+COVID-19 Dimagi COVID-19 Overview Page: https://dimagi.com/covid-19/ Dimagi YouTube Page (e.g. webinars and demos): https://www.youtube.com/channel/UCt8JcRhWywkVJRR_YWv4OhA **Contact Information** info@dimagi.com Source Code: https://github.com/dimagi/commcare-hq
CHT	Community Health Toolkit Project Site: https://communityhealthtoolkit.org/ Community Health Toolkit FAQs: https://communityhealthtoolkit.org/faqs/ Features and Demo Access: https://communityhealthtoolkit.org/features/ Community Health Toolkit YouTube Channel: https://www.youtube.com/channel/UC181IppaxJy9MhnIGkcUpKg CHT Introduction Video: https://www.youtube.com/watch?v=7_2hL7VxuRA Demo Video: https://www.youtube.com/watch?v=fKvgWEaaAGA Community Health Application Framework GitHub: https://github.com/medic/medic-webapp Medic Mobile Blog: https://medicmobile.org/blog **Contact Information** Josh Nesbit, CEO of Medic Mobile, josh@medicmobile.org Jacqueline Edwards, COO of Medic Mobile, jacqueline@medicmobile.org CHT Information Desk: cht-info@medicmobile.org

DHIS2 Tracker	Website: https://www.dhis2.org/ DHIS2 YouTube Playlists: https://www.youtube.com/channel/UC7lT6wGX_IXkfguh2DvcrSA/playlists Experts Academy Videos: https://www.dhis2.org/oslo2018-videos#overlaycontext=academy Contact Information: post@dhis2.org Source Code: https://github.com/dhis2/
Go.Data	Website: https://www.who.int/godata Contact Page: https://www.who.int/godata/go.data-contact-us Email: godata@who.int
ODK	Website: https://getodk.org Documentation: https://docs.getodk.org Forum: https://forum.getodk.org Code: https://github.com/getodk Contact: email@getodk.org
OpenSRP	Website: https://smartregister.org Contact Information Matt Berg, info@smartregister.org Source Code: https://github.com/OpenSRP
RapidPro/TextIt	Rapid Pro: http://rapidpro.github.io/rapidpro/ TextIt: https://textit.in/ Forum: https://community.rapidpro.io/marketplace/textit/ Contacts: support@textit.in
SORMAS	SORMAS Website:https://sormas.org/ SORMAS Demo Page: https://sormasorg.helmholtz-hzi.de/sormas-demo.html SORMAS Configuration Guide: https://github.com/hzi-braunschweig/SORMASProject/blob/development/README.md
WelTel	Website: https://www.weltelhealth.com/ Email: info@weltel.org

References:

[1] WHO Coronavirus Disease (COVID-19) Dashboard. Accessed May 17, 2020. https://covid19.who.int/?gclid=CjwKCAjwwYP2BRBGEiwAkoBpAg0odm6QSqD8bosMkXaYI4BL05CXaRLeX5vqxsxp-V1bzC_daQrnJxoCHZkQAvD_BwE

[2] Q&A on coronaviruses (COVID-19). Accessed May 16, 2020. https://www.who.int/news-room/q-a-detail/q-a-coronaviruses

[3] Wu Z, McGoogan JM. Characteristics of and Important Lessons From the Coronavirus Disease 2019 (COVID-19) Outbreak in China: Summary of a Report of 72 314 Cases From the Chinese Center for Disease Control and Prevention. JAMA. 2020;323(13):1239-1242. doi:10.1001/jama.2020.2648

[4] Apr 24 SOP, 2020. Preparing for COVID-19 in Low- and Middle-Income Countries: Leveraging U.S. Global Health Assets. The Henry J. Kaiser Family Foundation. Published April 24, 2020. Accessed May 17, 2020. https://www.kff.org/coronaviruscovid-19/issue-brief/preparing-for-covid-19-in-low-and-middle-income-countries-leveraging-u-s-global-health-assets/

[5] COVID-19 Case Management in Humanitarian and Low-Income Settings: Dilemmas and Decisions. Accessed May 17, 2020. https://www.youtube.com/watch?v=QdtdHjmcIXQ&feature=youtu.be

[6] Roberton T, Carter ED, Chou VB, et al. Early estimates of the indirect effects of the COVID-19 pandemic on maternal and child mortality in low-income and middle-income countries: a modelling study. Lancet Glob Health. 2020;0(0). doi:10.1016/S2214-109X(20)30229-1

[7] Danquah LO, Hasham N, MacFarlane M, Conteh FE, Momoh F, Tedesco AA, Jambai A, Ross DA, Weiss HA. Use of a mobile application for Ebola contact tracing and monitoring in northern Sierra Leone: a proof-of-concept study. BMC infectious diseases. 2019 Dec 1;19(1):810.

[8] WHO, Global surveillance for COVID-19 caused by human infection with COVID-19 virus. Interim guidance. 20th March 2020. Accessed 25th May 2020.

[9] What are Global Goods? Accessed June 27th, 2020. https://wiki.digitalsquare.io/index.php/What_are_Global_Goods#:~:text=To%20help%20identify%20areas%20of,Model%20for%20digital%20health%20tools.&text=Currently%2C%20the%20maturity%20model%20is,Forum%20in%20December%20of%202017.

Icons made by Freepik, geotatah, Good Ware, itim2101, phatplus, Pixel Perfect, Smashicons, and Those Icons from www.flaticon.com