COVID-19 Sāvdhān: Harnessing the Telecom Infrastructure for COVID-19 Management

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Abstract. The tremendous challenges brought on by the COVID-19 pandemic has brought to light the significance of inclusive and effective risk communication as a top priority for preparedness and response in health emergencies. A comprehensive emergency management strategy must include effective communication systems assisted with state-of-the-art Information and Communication Technologies (ICTs). For enabling communication, SMS messages utilizing the vast telecommunication sector have proven to be a very efficient tool. Messages should be precise, scientifically accurate, context-sensitive, entrusted, understandable, as well as relevant for the segment of society they are intended for. Geo-targeting helps in reducing over-alerting by minimizing the annoyance and the subsequent opt-out behavior caused by unnecessary alerts. This study provides an in-depth description of the established platform known as 'COVID-19 Sāvdhān', which allows for the SMS dissemination of pandemic-related messages to the geo-targeted population, including but not limited to information about vaccination, quarantine facilities, testing centers, hotspots, lockdown, essential supplies, and law and order situations. The platform has been widely used to disseminate more than 3.4 billion targeted SMS in 10 different languages across the length and breadth of India during COVID situation.

Keywords: Risk communication · Information dissemination · Pandemic management · COVID-19 · Common Alerting Protocol

1 Introduction

The new coronavirus (COVID-19) outbreak and dissemination have had disastrous effects on both the human population and the global economy. Over 228 countries and territories in the world have been affected by the Coronavirus pandemic. This included most urban clusters and even rural regions. According to the WHO COVID-19 Dashboard, there have been 572,239,451 confirmed cases of COVID-19 worldwide, with 6,390,401 deaths as of July 29, 2022 [1]. The fact is that while it took it took ninety-three days to reach the first million infections, it only took thirteen days to reach the second million [2].

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India has not been spared from the severe death toll and economic damage that COVID-19 has caused over the world. There have been 44,019,811 verified COVID-19 instances as of July 31, 2022, of which 143,676 are active cases, 43,349,778 have been treated or released from the hospital, and 526,357 are recorded fatalities [3]. The case fatality rate (CFR) is the ratio between confirmed deaths and confirmed cases. Compared to the stated global CFR of 5.64%, the fatality rate in India is relatively low at 3.30% on June 18, 2020, yet India still had the highest number of confirmed cases in Asia [4]. The world's worst-affected nations and regions' COVID-19 figures for CFR have been published in Fig. 1.

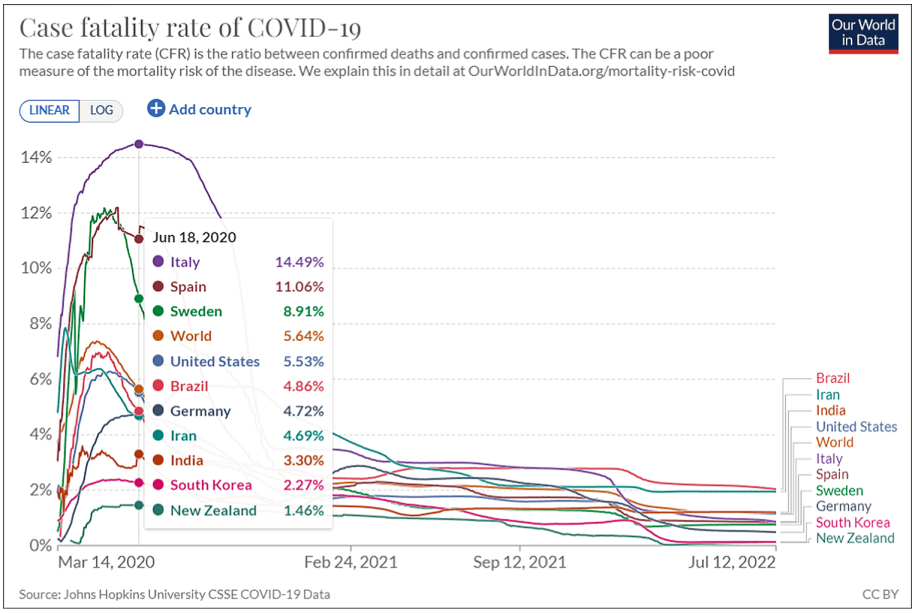

Fig. 1. Case Fatality Rate of COVID-19 across the globe [5].

Information and communications technology (ICT) has become increasingly important in these challenging circumstances for both addressing the pandemic's issues and adapting to daily life's new realities. The management of pandemics is intrinsically linked to mass communication. The decade's success depends on communication in all its forms. Almost every component of any hazard-mitigation approach is based on it. The capabilities of communications, data-gathering, and data-management technology have evolved in lockstep with our growing understanding of the causes, behavior, and mitigation of natural calamities. Indeed, one of the key factors in the realization that technology might significantly reduce the consequences of pandemic is advancements in the fields of telecommunications and computer sciences.

The COVID-19 epidemic has brought to light the vital role that the technology and telecommunications sectors play in ensuring that organizations, governments, and communities are linked and operating effectively. People all throughout the world are relying

on technology for information, social communication, and work from home because of the pandemic's socioeconomic devastation. Particularly during this unprecedented time, the telecom industry has demonstrated its importance for both enterprises and individuals, contributing to the flourishing of society. Telecom infrastructure can be used to help the needy, the administration, and coordinators to better handle the pandemic situation as created during COVID-19 in practically all crisis situations like that caused by coronavirus.

COVID-19 has led to a growth in the number of policy tools being employed at various levels of governments around the world to combat the pandemic. The Right to Information during a heath emergency must be a fundamental human right [6]. Despite widespread agreement on the crucial importance of timely disclosures of COVID-19 information, the transmission of epidemic information as a policy tool has gotten little attention in comparison to travel bans, lockdowns, social isolation, and economic stimulus package [7]. Looking into this, the importance of sending geo-targeted emergency messages which has been proven to be a promising communication tool to rapidly disseminate information and promote preventive behavior among the public during epidemic outbreaks is highlighted in this paper.

There is a widespread use of and access to smartphone and mobile devices in India, with mobile phone technology penetration at nearly 100% worldwide. Mobile telecom network today spans most of the country today. The overall tele-density of India stood at 85.91 as on December 31, 2021 [8]. Short Message service (SMS) is one of the most effective communication media as it is device independent and supports major Indian vernacular languages. Mobile technology especially Short Message Service (SMS) has huge impact in the communication system of modern civilization. The paper also mentions a usability analysis of SMS for pandemic management alert system.

For effective communication related to COVID-19, utilizing the potential of ICT infrastructure, Centre for Development of Telematics (C-DOT) has developed a system called **COVID-19 Sāvdhān** through which COVID messages are disseminated in the form of SMS to the population of the target area. SMS is also able to reach people who do not have smartphone or internet access. According to the International Telecommunication Union (ITU), almost half of the world's population (46.4%) is still not connected to the Internet, yet 97% of the world's population lives within reach of a mobile cellular signal and has 108 mobile-cellular subscriptions per 100 people worldwide [9]. SMS messaging can therefore be used to widely reach a section of the population of each country, in order to combat a disease from which no part of the population is protected. Location based messaging ensures end-to-end reach, thereby reducing the burden on such infrastructure in times of pandemic and also reducing network congestion. Through this COVID-19 Sāvdhān Platform, all the stakeholder agencies of the Central, State, and Local Governments are able to integrate at one place and automatically disseminate any important information related to their work to the population of the target area identified through postal zip codes or drawing customized polygon over map using geo-intelligent tools.

The paper is organized as follows: Sect. 2 provides background information along with similar works done in this field. Section 3 gives detailed description along with

implementation details of the established platform for enabling geo-targeted dissemination of SMS by authorities to the general population in local languages. Section 4 presents statistics on the platform's use in actual situations. Concluding remarks are provided in Sect. 5.

2 Background and Related Work

Effective pandemic management necessitates the timely and efficient exchange of pandemic-related information among various stakeholders before, during, and after any pandemic situation, for which telecommunications/ICTs play an important role. Technological advancements have opened new opportunities for supporting any kind of disaster resilience, the same applies to COVID-19.

The area of work includes leveraging technology for enabling effective communication and dissemination of targeted warnings to the vulnerable section of society supported by efficient ICT systems and building an ecosystem for pandemic management solutions to assist in better regulation of COVID-19. Sakurai and Murayama [10] have highlighted about the use of information technology in a wide range of disasters including natural, radiological, chemical, infectious disease outbreak, and human-caused crises [11] at different disaster management stages such as disaster response, recovery, preparedness and risk reduction. From local government's perspective, essential roles of information systems, i.e., information record, exchange and process, are critical in effective disaster management. Information record and exchange are initial functions of information systems prior to a disaster, while information process and exchange become core to disaster relief operations. Rattien [12] has mentioned the role of communication in hazard mitigation and disaster management. Mass communication plays a definitive role in the transition in thinking and action away from post-disaster relief and towards preparedness and hazard mitigation. Manalu, E. P. S., et al. [13] emphasized the crucial function of telecommunications in a crisis management scenario, that includes connecting, informing, and ultimately saving the lives of those affected by the disaster; and restoring connectivity to affected region so that government can connect with the citizens. The significance of emergency risk communication in public health emergency planning and response has been discussed by Seeger, Matthew W., et al. [14]. The effective management of emergencies during the COVID-19 pandemic crisis depends critically on communication. Any emergency preparation programme should aim to increase the country's capacity to recognize and respond to a variety of public health emergencies, such as emerging infectious diseases and natural disasters [15].

Despite of the availability of pandemic management systems, there is a gap between health authorities and administrators and the common public victims to be specific for which a lot of people get affected in the COVID-19 pandemic and that led to a greater loss to the development of the country. In the existing ecosystem, there is lack of co-ordination between different authorities, and limited utilization of communication media, resulting in less audience reach. The existing system does not cater to wide area coverage, because it lacks geo-fencing intelligence due to which the effectiveness of the alert messages decreases. Certain populations are more at-risk than others during a pandemic and health systems are required to have targeted risk messaging to ensure that

those populations have access to necessary protective materials and information [16]. Elazab, A., B. Shababa, and H. Hefny mentioned about the importance of Location Based Messaging Services in Risk Reduction Management [17], whether in natural disasters, or human made risks, and in many other areas that require informing numbers of people caught up in the scope of a particular area, to identify them in emergencies to help save their health and their life processes. Regardless the recipient's phone numbers or their segments (age, gender, the address in the contract with service provider, state, and if they use a post-paid or pre-paid line). The effectiveness of geo-targeted alerts is also mentioned in [18]. According to the study presented in [19], health authorities should take into account sending emergency alert text messages to the public in order to give them with correct and reliable information, which could lessen the impact of infodemics.

3 COVID-19 Sāvdhān: Enabling Targeted Messaging

3.1 Need and Importance of Targeted Messaging

The role of communication technology has been recognized as integral to disaster management for a long time. With rapid advances in Information and Communication Technology (ICT) in the last decades, the interoperability and integration of various communication systems including internet, mobile, landline, fax, e-mail, radio and television is increasingly becoming functional and has begun to transform the lives of people and communities.

The massive telecom infrastructure in India i.e., 1.15 billion wireless mobile subscribers, [20] is not being used to its potential. At the same time, the existing alerting system lacks geo-fencing intelligence, due to this, warning message is delivered to lots of people and is not relevant to most of them thus reducing the effectiveness of the alert messages. The existing system that was in place for alerting or notifying public through SMS, was mostly based on bulk messaging and also there was prior requirement of the subscriber's phone number. The COVID-19 pandemic outbreak in 2020, did not provide time to prepare and prevent it through awareness generation. Geo-fencing is defined as the mechanism that allows an administrator or operator to set up triggers or alerts so when a device enters (or exits) the boundaries defined by the administrator, an alert is issued. Geofencing is used by Retail stores to notify shoppers about deals only when they're at the boundary of their shop or mall.

The COVID-19 Sāvdhān system, having capability of targeted messaging provided a framework to authorities of Indian states and union territories to disseminate advisories, instructions directly to public without any pre-subscription through phone numbers in a location-based manner.

With the advancement of Mobile technologies, dissemination of geo-targeted SMS has become a reality. Figure 2 describes how geo-targeted messaging works. The persons connected to the mobile tower present in the geo-targeted area will only receive the SMS. With this mechanism, the seasonal population of tourists currently present in the affected area can also be warned.

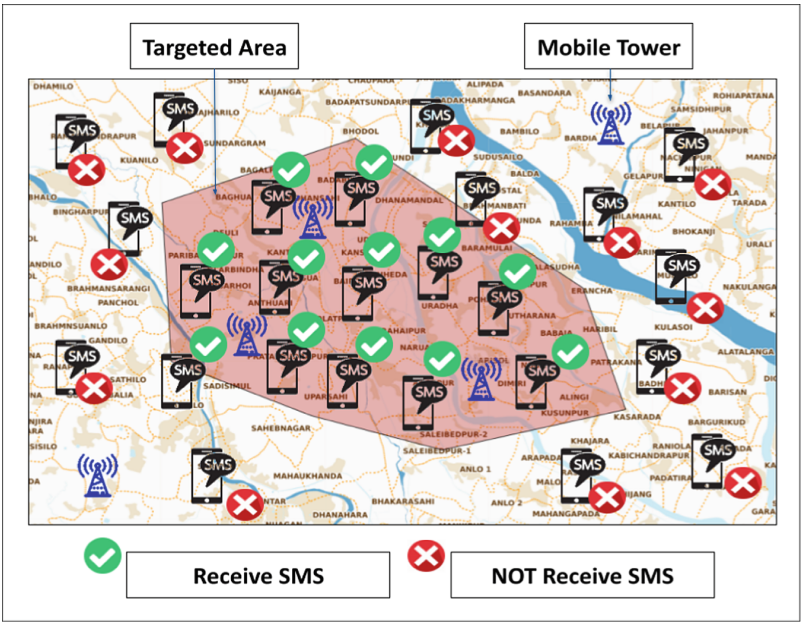

Fig. 2. Location Based Mobile Users Notification Mechanism using geo-fencing intelligence.

3.2 System Architecture and Information Flow

The COVID-19 Sāvdhān application enables officials to reach out to all mobile customers in any Containment Zone up to the level of individual mobile towers and deliver targeted messages regarding health, wellness, water supply etc. through SMS in local language.

COVID-19 Sāvdhān is an integrated platform facilitated by the Department of Telecommunications (DoT), Government of India through which Central and State Government Authorities are able to seamlessly integrate under one umbrella and disseminate any important information and advisories related to COVID-19 pandemic to a target area population (catering both local population and roamers) identified through zip codes and customized polygons. In coordination with DoT Field Offices in the States, the COVID-19 Sāvdhān platform enables dissemination of important information from government sources to the people of specific areas through SMS alerts in English and Indian vernacular languages, as easily understood by the local people, with the help of active Telecom Service Providers (TSPs) in the area. The targeted communication could include any COVID-19 mitigation measures including alerts on quarantine centers, supply of essential commodities, law and order issues, new COVID-19 hot zones etc. Various Government Authorities can directly reach to the people by harnessing the significant penetration of mobile phones in India through this platform. Internationally recognized Common Alerting Protocol (an ITU-T 1303.x recommendation) has been adopted in this platform for emergency Communication.

The information to be disseminated by various stakeholder agencies involved may be about but not limited to:

- Vaccination centers, vaccine doses eligibility information.
- Opening of a COVID test centre in a specific residential area.
- About any existing/new Quarantine or Isolation facility in that area.
- Supply of Essential commodities by the Civil supplies Department in that area.
- Alert on new hot zone of COVID Positive cases in that area, Containment Zones/hotspots to warn the people to stay at home and be more watchful.
- Alert on law-and-order issues/lockdown information for people in specific areas.

The major stakeholders include the Central and State Authorities, Department of Telecommunications (DoT) Licensed Service Area (LSA) field units, and Telecom Service Providers. There are a total of 36 States/Union Territories with corresponding 22 DoT LSA units, and 4 major Telecom service providers (BSNL, Reliance Jio, Airtel, and Vodafone-Idea). The working model of the platform is shown in Fig. 3.

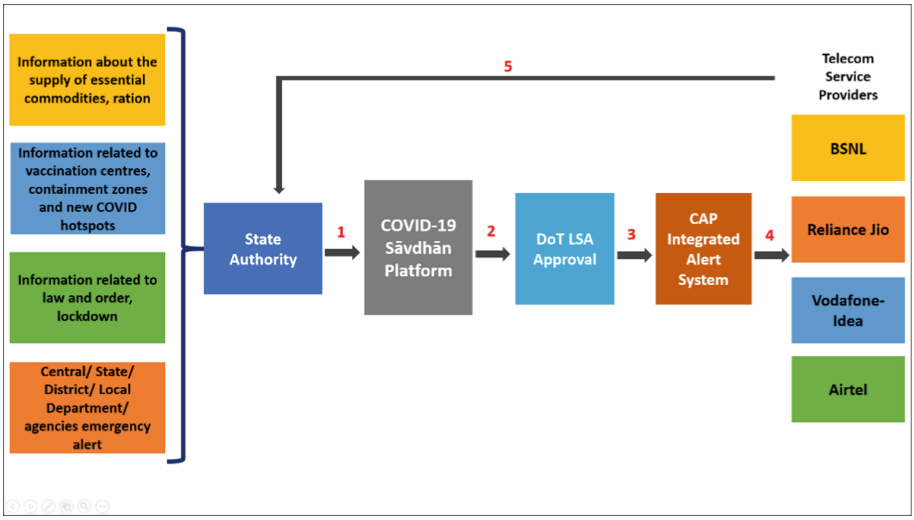

Fig. 3. COVID-19 Sāvdhān Flow Diagram.

- The COVID-19 Sāvdhān platform enables users of authorized agencies to access the service through a secure login via multi-factor authentication.
- The information to be disseminated by the different departments is fed into the platform by authorized State Authority officers.
- This information is due approved from the corresponding DoT LSA units' officers.
- The approved information passes through the developed CAP Integrated Alert System to give out a readable format of SMS. This SMS is disseminated to the target area residents (identified by their zip codes or customized polygons) through the active Telecom Service Providers like Airtel, Vodafone-Idea, Reliance Jio and BSNL.

– The targeted audience get the COVID-19 related required information through SMS on their mobile phones without the need to subscribe notifications or installation of the App on the phone.
– After successful completion of the dissemination of SMSs, dissemination statistics for the sent messages is available for records.
– The geo-targeted alert dissemination from platform consists of following steps as displayed in Fig. 4.

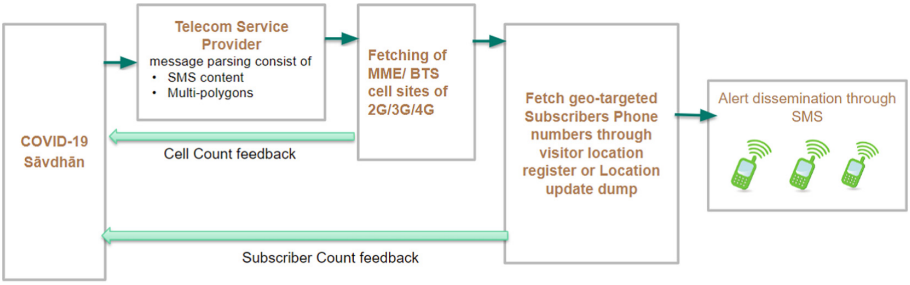

Fig. 4. Geo-targeted alert dissemination process through telecom service providers

3.3 Defining Message Structure

The adoption of Common Alerting Protocol (CAP), a standardized emergency messaging format, has been increasing in recent years. Common Alerting Protocol (CAP) is used as a standard format to exchange alerts or warning information among different alert generating agencies and TSP operators in the proposed solution. CAP is an international standard and adopted as ITU x.1303 recommendation. CAP provides geo-graphic targeting using geospatial representations, multilingual messaging, facility of inclusion of images, audio and video and standardized format for exchanging warning information over various types of networks [21], messaging. CAP is a lightweight XML-based data format that allows exchanging public warnings between the alerting technologies. Technologies. The use of CAP for alerting services has been used as part of many alerting systems, such as the Integrated Public Alert and Warning System (IPAWS) by the Federal Emergency Management Agency (FEMA) in the USA for warning dissemination through diverse media [22]. Other countries including Canada, Germany, Australia and Italy have also adopted CAP. The basic structure of the CAP message used is depicted in Fig. 5.

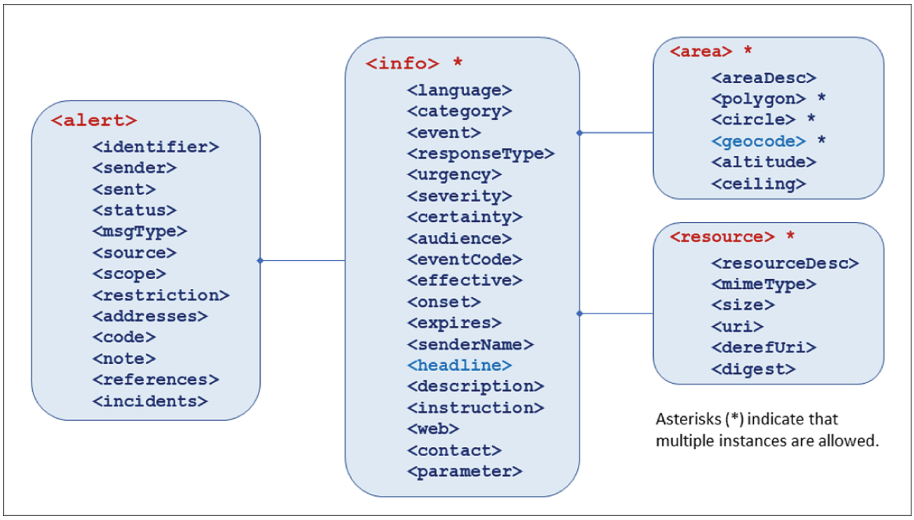

Fig. 5. Structure of CAP message.

The <alert> block provides the basic information regarding the COVID-19 related message which includes the purpose of the alert, its source, and an identifier that allows the alert to be uniquely identified among all other messages. The <info> block inside <alert> provides the details of the event, its severity defining the intensity, certainty that defines the confidence or probability, and urgency defining the available time to prepare for the concerned event. The effective and expiry date, description, and other additional information for the event may also be provided. The emergency message to be disseminated as SMS to mobile users is defined under <headline> tag in <info> block. The <area> block describes the targeted geographical area where the COVID-19 information is to be disseminated.

3.4 Features and Functionalities

CAP Message Generator, Validator, Aggregator, and Dispatcher. COVID related alerts and advisories are fed by multiple Central and State Government Authorities, which are generated and mapped to internationally adopted standardized CAP format. CAP Validator receives generated CAP alerts and validates it as per ITU CAP standard. Only the validated CAP file is processed and transferred to different interfaces. The CAP aggregator facilitates the aggregation of multiple generated similar alerts by different agencies for easing the dissemination process. The alert is finally dispatched to different interfaces of telecom service providers through CAP dispatcher for public dissemination.

Geo Intelligent Engine. Open Geospatial Consortium (OGC) compliant Geo-Location Management Module with Interactive User Interface allows users to demarcate one or more areas on a digital map. GUI allows operator to define CAP message and CAP polygons visually, and extraction and identification of cell sites in geo-fenced area.

This Geo-Intelligent server plus dedicated Web GIS infrastructure helps in creating, organizing and analyzing the disaster specific geographic information.

Alert-Docket Management and Notification Engine. Platform is enabled with Alert based Docket Management System that keeps track of status of issued alert (e.g., Forwarded to alert dissemination agency, received by alert dissemination agency, dissemination started, dissemination completed.) with time stamp throughout alert life cycle through notification and subsequent escalation mechanism to higher authorities, if needed. Email and SMS Notifications associated with various events are sent to different users based on their roles and organizations.

User Management, Multi-level Authorization & Role Based Access Control (RBAC). The platform enables users to create/modify/delete users with location- based restriction on its functionalities. Platform is enabled with user management to define and manage the role of each user with their responsibilities. Multilevel Authentication and Authorization and hierarchical message acceleration to different stakeholders is required to minimize the error before alert message dissemination.

Configuration and Log Management. Configuration management functionality of the platform enables the controlling authority (i.e., administrator) to establish the operating procedures (e.g., alert issuing procedure, alert specific authorization) and functionality (e.g., alert status notification, SMS dissemination report) based on defined Standard Operating Procedures. Also, record of all log messages is maintained through log management module, which helps to administer and facilitate the generation, transmission, analysis, storage, archiving and disposal of the log data created within the system. It is useful in identifying malicious activities (if any) to protect the platform from external vulnerabilities.

Report Management. Report Generator module is used to generate report for authorities providing status of all alerts in the specified timeframe in pdf or excel format along with information of statistics of alerts in the form of graphical representations for analysis and record purposes.

Regional Language Support. Platform also supports dissemination of alert message in English and different Indian vernacular languages including Assamese, Bengali, Gujarati, Kannada, Kashmiri, Malayalam, Marathi, Nepali, Odia, Punjabi, Sanskrit, Sindhi, Tamil, Telugu and Urdu. Platform facilitates users to type/input text content in supported languages.

Targeted Population and Subscriber Predictor. In case of SMS dissemination, number of mobile towers within the selected area and approximate mobile users in the targeted area in proportion with state wise mobile subscriber data periodically published by Telecom Regulatory Authority of India (TRAI) is displayed to authorities for aiding decision-making process. However, this figure can be used for rough estimation, actual number of mobile subscribers to whom SMS has been disseminated is notified by telecom service provider after completion of dissemination.

Area and Message Template Management. User can either use these area templates or create a new area based on its requirement. Pre-defined vulnerable areas (like-COVID

hotpots, containment zones, etc.) can be configured for dissemination in the system. It saves time for area selection during critical time. Users can also create different covid related specific messages templates and save as draft for future.

Task Scheduler. Task scheduler helps in scheduling the tasks like alert dissemination, without any manual intervention in an automated manner. It helps in generating periodic alerts or sending an alert in odd hours (Fig. 6).

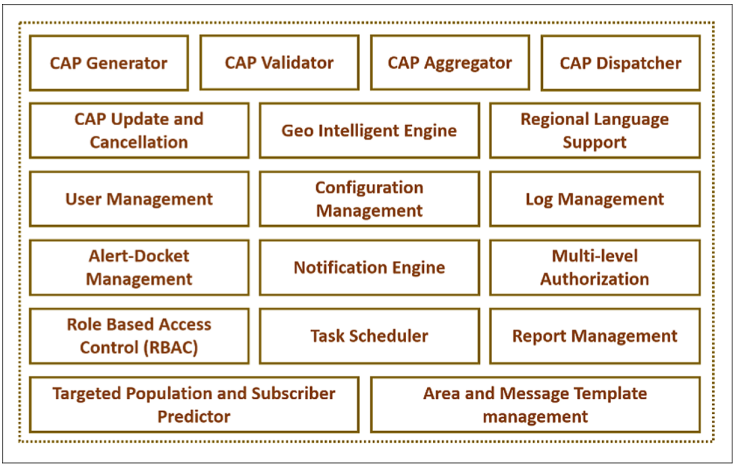

Fig. 6. Major Functionalities of COVID-19 Sāvdhān Platform.

4 Platform Usage and Statistics

4.1 Usage Scenarios and Message Content Analysis

The risk communication during health emergencies such as COVID-19 should address the information requirements for local, state, and central authorities, community, and the public at large in all phases i.e., before, during, and after emergency. The messages should be reliable, clear, simple, useful, scientifically accurate, context-sensitive, action oriented, and understandable for the common public. The developed platform is used for disseminating precautionary messages related to COVID-19 pandemic to the targeted population in their vernacular languages in different situations. The summary of different types of messages disseminated is provided in Table 1.

Table 1. Sample messages disseminated using COVID-19 Sāvdhān platform.

S. No.	Usage Scenario	SMS Disseminated
1	Lockdown, Law and Order and Containment zones information	IN VIEW OF THE COVID 19 PANDEMIC SITUATION, PAKYONG AND RONGLI SUB-DIVISION HAS BEEN PLACED UNDER COMPLETE LOCKDOWN. YOU ARE REQUESTED TO STAY AT HOME FOR YOUR OWN SAFETY. ISSUED BY GOVT. OF SIKKIM.
3	Lockdown, Law and Order and Containment zones information	ईटानगर-नहारलगुन में लॉकडाउन 3.0 शुरू हो गया है जो 3 अगस्त,सुबह 5 बजे तक रहेगा।कोरोना वायरस को रोकने के लिए ये बहुत ज़रूरी है,लेकिन यह आपके सहयोग के बिना निरर्थक होगा।घर रहें, सुरक्षित रहें। *(Original- Hindi)* Lockdown 3.0 has started in Itanagar Naharlagun which will continue till 5 a.m. on August 3. This is very important to stop coronavirus, but it will be meaningless without your cooperation. Stay home, stay safe. *(Translated)*
5	Lockdown, Law and Order and Containment zones information	चंद्रपुर जिल्ह्यात बाहेरुन येणाऱ्या सर्व नागरिकांना संस्थात्मक विलगीकरणात रहावे लागेल याची सर्वांनी नोंद घ्यावी. कोरोना नियंत्रण कक्ष, जिल्हाधिकारी कार्यालय, चंद्रपूर - 07172-261226, 253275 *(Original- Marathi)* It may be noted that all persons coming from outside in Chandrapur district will have to undergo institutional quarantine. Corona Control Room, Collectorate, Chandrapur *(Translated)*
6	Lockdown, Law and Order and Containment zones information	All religious and social gatherings are banned upto 14.4.20 by Govt. Legal action shall be taken under DM Act and 188 IPC against violators-Yamunanagar Police
7	Supply of essential commodities	Under PMGKAY, All AAY, PHH Ration Card holders will be provided 5KG FREE Rice per person for April to June 2020 in addition to their monthly quota. FCSD, SIKKIM
9	Supply of essential commodities	రేషన్ సమస్యకు 08612326776 కాల్ చేయండి. జిల్లా కలెక్టర్, నెల్లూరు. *(Original – Telugu)* Call 08612326776 for ration problem. District Collector, Nellore *(Translated)*
10	COVID-19 Testing	This is to inform all entering the state from Banderdewa Checkgate that antigen test is being carried out from 6AM-6PM everyday at the gate. As no one is allowed to enter the state without test, hence all are requested to strictly adhere and arrive within the period of 6AM-6PM.Issued by DIPR Locations for Rapid Antigen Tests in ICR: Banderdewa check

(*continued*)

Table 1. (*continued*)

12	COVID-19 Testing	gate, Lekhi CCC, TRIHMS, Ashoka hotel kiosk, Zoo road CCC, RKMH Itanagar, Heema Hospital, Niba Hospital Naharlagun. The rate for the RAT at the Govt facilities are Rs 250/- for APST/State/Central Govt employees and Rs 500/- for Non APST. Issued by DIPR
13	Scientifically Accurate Information	Did you know? COVID-19 infection occurs in two phases. Phase 1-Viral Phase ranges from start of 1st day of symptoms to 5th day. Phase2-Hyper inflammatory/Hypersensitivity phase ranges from Day 5-8. Early testing at the onset of symptoms on Day 1 is crucial to save lives. Call 14410 for information.
14	Scientifically Accurate Information	State Data reveals that from all age groups, the maximum number of fatalities due to COVID-19 belong to unvaccinated population group, indicating that severity of infection is higher, leading to lower chances of recovery and survival in non vaccinated people. Please get vaccinated on your turn.
15	Vaccination Information	As per GOI guidelines, COVID-19 vaccination has been deemed safe even for lactating women. Register now at cowin.gov.in and get vaccinated when your turn arrives.
16	Vaccination Information	Mild headaches, pain/swelling at injection site, fever, irritability are common side effects after COVID-19 vaccine and will subside in few days. Do not hesitate to vaccinate.
17	Advisories	A Corona affected person travelled in Haryana Roadways Bus HR58A-9541 which started at 8.30AM from Delhi to Yamunanagar on 11 March. Persons who travelled by this bus should inform on number 100. Yamunanagar Police.
18	Advisories	ହାତ ଧୋଇବା, ମାସ୍କ ପିନ୍ଧିବା, ସାମାଜିକ ଦୂରତା ନିୟମ ପାଳିବା, ଜନ ଗହଳିରୁ ଦୂରରେ ରହିବା, ତେବେ କରୋନାକୁ ଜିତିବା- ସୂଚନା ଓ ଲୋକ ସମ୍ପର୍କ ବିଭାଗ, ଓଡିଶା ସରକାର *(Original- Odia)* Washing hands, wearing masks, social distancing, staying away from public gatherings should be the only way to win over corona: Odisha govt *(Translated)*

4.2 Message Dissemination Statistics

During COVID-19 pandemic situation, the service of this system (known as 'COVID-19 Sāvdhān') has been rigorously used by 26 State & Union Territory authorities for sending nearly 3.4 billion of SMS in 10 different languages (Bengali, Gujarati, Hindi, Kannada, Malayalam, Marathi, Odia, Tamil, Telugu, and English) to the citizens of India related to COVID-19 mitigation measures including alerts on quarantine centers, supply of essential commodities, law and order issues, new COVID-19 hot zones etc. Figure 7 shows the usage of the platform by different authorities of States/UTs and total area targeted for dissemination of COVID related advisories and alerts is shown in Fig. 8. Figure 9 presents the screenshots of some messages received by the public.

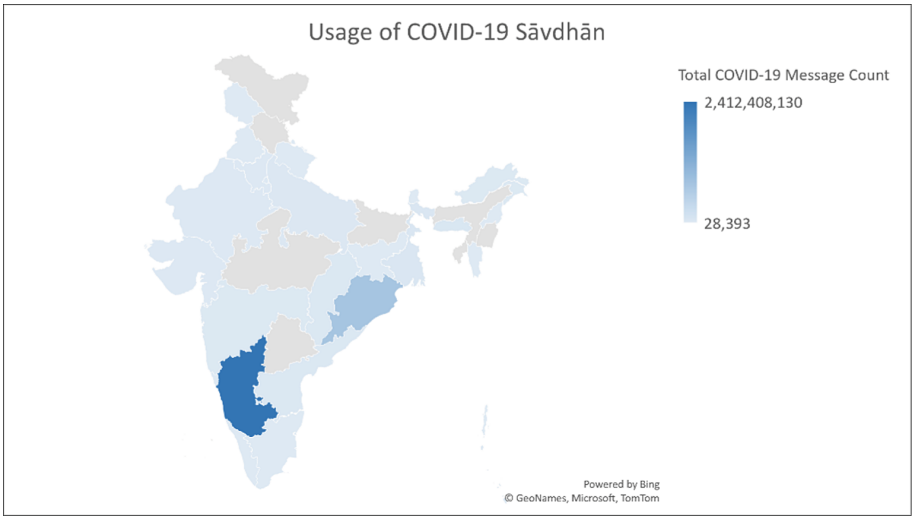

Fig. 7. Usage of COVID-19 Sāvdhān platform by different authorities of States/ UTs.

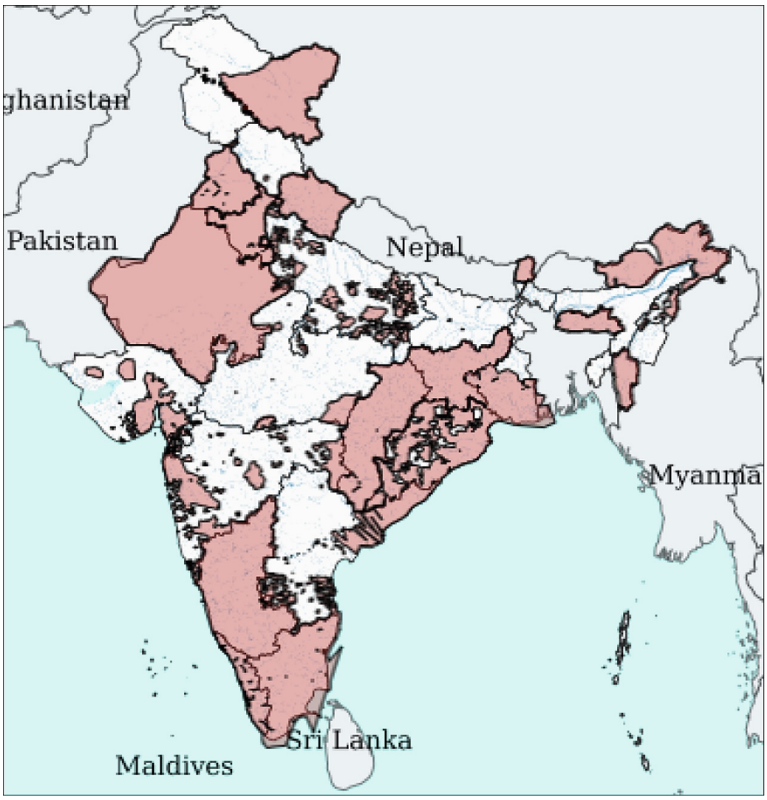

Fig. 8. Targeted Area for dissemination of COVID-related advisories and alerts

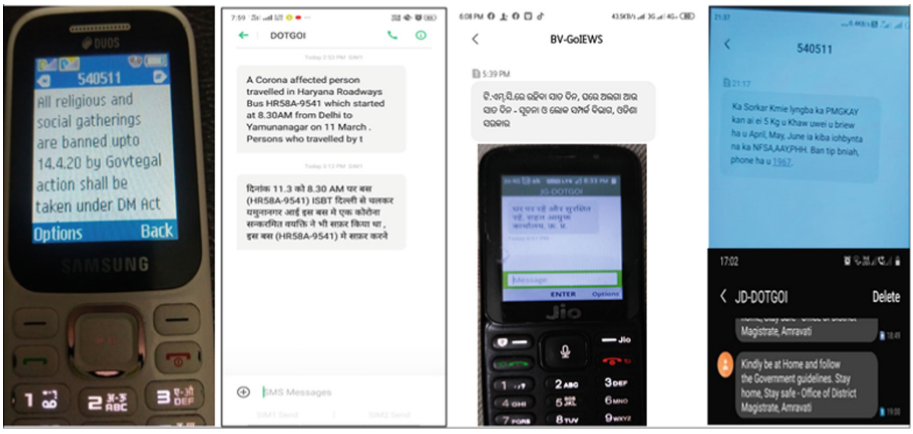

Fig. 9. Screenshots of actual received messages

5 Conclusion

In this paper, implementation of a platform for enabling targeted risk information communication for COVID-19 management has been discussed. This brings all the responsible authorities to a common platform for better coordination and effective communication and disseminating location specific alerts and advisories in vernacular languages. Providing accurate, precise, and actionable information regarding any hazard or pandemic is very important. The immense penetration of mobile phones makes SMS an effective communication channel for alerting. Targeted messaging, avoiding over-alerting is necessary. The same platform can be extended for dissemination of alerts related to other disasters or emergency situations. To enable last mile reachability, use of other communication media channels including satellite, broadcasting, and internet technologies will further extend the outreach. Providing information in regional languages in linguistically diverse country like India is very important. Multi-technology, multi-variant interfaces, and presence of legacy infrastructures pose big challenges, which are being addressed to enable effective communication.

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