Designing a Model for Vaccine Slot Tracker

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***Abstract*— In recent years, we have seen the outbreak of Covid. Vaccination has proved to be quite effective in this case. Vaccination of a large population in a country like India is a very difficult task. People wait for hours to get the vaccination slot, but still, they are not able to get the vaccination slot because the information about the place of vaccination and opening time is not available. We have proposed a Vaccination Tracker algorithm for this problem, which provides instant information to the users about the vaccination opening and location etc., which makes the registration of the vaccination very easy. The proposed model is based on the database, object-oriented, and networking techniques. It is a web-based application that clients can also access with a server.**

***Keywords*—** *Covid-19, Economy, Vaccination, Cowin, Application, healthcare, pandemic*

I. INTRODUCTION

The SARS-CoV-2, a new coronavirus that causes coronavirus illness (COVID-19), has caused an unparalleled healthcare catastrophe in recent times. It was declared a pandemic disease because of the significant spike in the number of cases.[1] Since the first case, more than 4 million cases of infections and even more than 300,000 death reports have been confirmed in various parts of the world, including the United States. COVID-19 has a high potential for progression. There is currently little knowledge about its behavior patterns, which all point to the urgent need to solve this public health emergency. Governments, corporations, and several public and private institutions worldwide are integrating their efforts to find a viable solution to reduce the risk of COVID-19 spreading worldwide. The use of digital technologies is critical in this scenario because they are vital tools for improvement regarding the health status of the population and the provision of essential services to them. The World Health Organization (WHO) recently released ten recommendations for improving healthcare quality and essential services through the use of digital technologies. If we talk about technology and digitalization, mobile phones are currently estimated to be used by more than 5 billion people worldwide; additionally, according to the "State of Mobile in 2019" report issued in 2018, 194 trillion dollars apps have been downloaded around the world in 2018. As a result, the great majority of the world's population can easily access and use apps, making them extremely popular. The historical context lacks understanding of the breadth and depth of coronavirus disease (COVID19)-related software. Furthermore, no comprehensive directory of all the apps developed to combat the COVID-19 pandemic has been established[2].For the vaccination drive, digitalization played a vital part in the scheduling and maintaining the necessary precautions to be taken possible. Now, there arises a question, what is vaccination, why is it mandatory, or how do vaccines protect? The simple answer to all these questions is that vaccination is the process by which a person is made robust or immune to a virus by administering a vaccine to them. It is the body's immunity that is stimulated by the vaccination, which keeps people protected against later illnesses or diseases. Now, coming to digitalization and app development, The Govt. Agencies developed over half of the apps used during the pandemic. In Fig 1, the graph depicts the total no. of vaccinations administered in various months from 2021 to 2022. In Jan 2021, the vaccination rate recorded was merely 191180 as compared to other months. The low response at the starting was due to a lack of awareness and technological advancements along with the vast population of the nation.

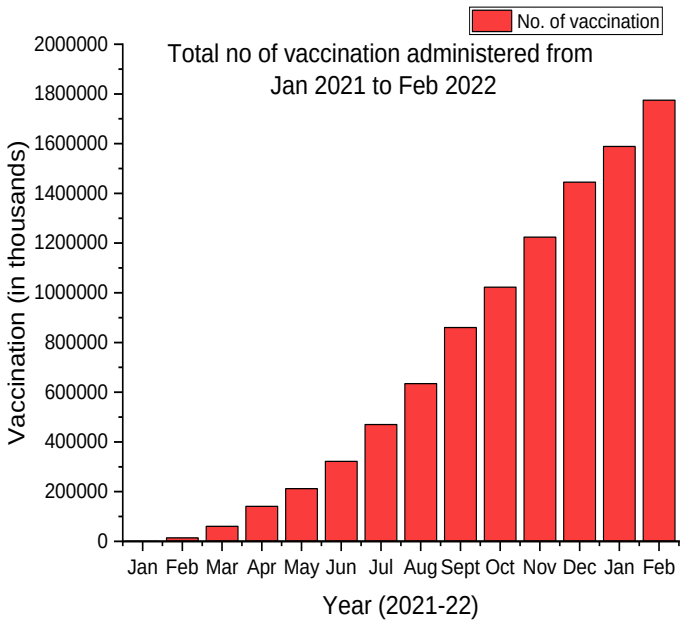

Fig. 1: Total number of vaccination from 2021 to 2022

The most common uses of the apps are to provide information on the number of infected, recovered, and deceased patients, record symptoms, and trace patients' contacts, the public's ease of access, and the use of artificial intelligence stance apps as tools capable of identifying new COVID-19 transmission foci, analyzing the proportion of propagation, tracking possible symptoms, and roughly characterizing positive cases at a distance. Managing and tracking vaccine stockpiles, logistics,

and fair distribution are all important aspects of vaccination. Immunization provides you with constant visibility and actionable data about vaccine distribution, monitoring vaccine distribution, and ensuring that it is fair and equal. Immunization allows you to schedule vaccination appointments and keep track of the vaccines that are being distributed.[3] Even during the current global epidemic, many governments have decided to implement apps to aid in the slowing of the rapid spread of the COVID-19 virus, which played a significant and appreciable role in the same.

The rest of the paper is divided as follows: section 2, related work, section 3, novelty of the proposed work, section 4, proposed model, section 5, simulation, and section 6, conclusion.

II. Related Work

In [2], the authors conducted a cross-sectional, descriptive observational study of all smartphone apps related to COVID-19. In the time period between Apr 27 and May 02, 2020, and searched for COVID-19 apps in the App Store (for iOS) and the Google Play Store (for Android). The terms coronavirus, COVID-19, and SARS-COV-2 were used in the search for information. It was decided to download and evaluate the apps. As a result of the investigation, they discovered 114 applications on the explored platforms. There were 62/114 (54.4 percent) Android devices and 52/114 (45.6 percent) iOS devices in the total. Three-quarters of the 114 apps were developed in Europe, while 28 percent were developed in Asia, and 26 percent were developed in North America. Foreign language usage was most prevalent in English (65/114, or 57.0 percent), Spanish (34/114, or 29.8 percent), and Chinese (14/114, or 12.3 percent). Apps for health and well-being/fitness (41/114, 41.2%) and medicine (43/114, 37.7%) were the most popular categories. There were 113 (99.1%) free apps among the 114 total. The average time between the analysis date and the most recent update was 11.1 days (SD 11.0). A total of 95 (83.3%), 99 (7.5%), and 3 (2.6%) of the 114 apps were designed for the general public, health professionals, or both. 64 of the 114 apps (56.1 percent) were created by governments, 42 by national governments (64.1 percent), and 23 by regional governments (35.3 percent). All but one app with more than 100,000 downloads (P=.13) was developed by a government, with the exception of the World Health Organization app, which had more than 500,000 downloads (P=.13). The most common uses were to get general COVID-19 information, COVID-19 news (53, 51.0%), record COVID-19 symptoms (53, 51.0%), and find people who have COVID-19 contacts (51, 47.7%).99 out of 107 apps were found to serve multiple purposes (92.5 percent). Their paper provides a comprehensive and one-of-a-kind review of all COVID-19 applications currently available.

In [4], the author mentions invaluable insights shared by the Chief Executive Officer of the National Health Authority (NHA), Ministry of Health and Family Welfare of the Government of India, Dr. R S Sharma, CEO of the National Health Authority (NHA), Ministry of Health and Family Welfare of the Government of India that the danger of such circumstances provides sufficient justification for the administration to depend on digital infrastructure despite the substantial concern about the digital divide that has been raised. There are two main principles that direct their work: the first is the goal of building the Cowin platform – the tech backbone that ultimately operates underneath the entire policy regulations of the government; and the second is the goal of ensuring that the Cowin framework – the technology backbone – is as secure as possible. Another is to focus on making the system more citizen-centric on a continuous basis. As a result, the framework has really been working with third-party requirements and ensuring that people have access to improved user interfaces while also ensuring that there is a single point of contact. The third solution was concerned with promoting the idea of One-Click Vaccination through the use of digital tools that were already in existence at the time. The fourth solution proposes the use of Cowin to allow corporations to organize health assessment and immunization campaigns, thereby incorporating the vaccination process into their corporate social responsibility efforts. The final recommendation made a case for the establishment of Vaccine Warriors through the use of financial incentives to encourage their participation.

In[5], the author explains the working and functionality of the Cowin App introduced by the Indian government. The COVID-19 virus was discovered in the marketplaces of Wuhan, China, and spread from there. Different countries have developed vaccine strains that are distinct from one another. 2 different monoclonal antibodies have been authorized by the Indian government for use in the country. One is CoviShield, manufactured by Oxford University, and the other is Covaxin, manufactured by the Indian pharmaceutical company Bharat Biotech. To supervise and regulate the immunization prescribed, the Indian government has developed an application entitled Cowin. The disadvantages and advantages of this application have yet to be determined. Their article can be concluded as an overview of the app's strengths and weaknesses, as well as its opportunities and threats, which can be determined by carrying out a SWOT analysis (Strengths, Weaknesses, Opportunities, Threat).

In [6], the author analyzed the drive's initial phase aimed to immunize past three crore healthcare workers. In March, the emphasis was on people over the age of 60 and those with co-morbidities who were between the ages of 45 and 60. Self-registration was made possible through the Aarogya Setu mobile application or the CoWIN website. As a result, the vaccination drive in April was restricted to people over the age of 45 years. Vaccination for those over the age of 18 is scheduled to begin in the month of May 2019. However, as with any technological advances, there are still some glitches that are being worked on a continuous basis. The portal can be unresponsive at times, resulting in a bottleneck that hinders the drive's progress. It is necessary to overcome the instability of web services and increase storage infrastructure in order for technological advancement to be efficiently streamlined. Additionally, the official site has, at points in time, cross-platform navigational issues that make it difficult to navigate. As a result, it is time-consuming to use the software application on a smartphone, which becomes even more difficult in vaccination sites due to the lack of access to desktop computers or laptops.

In [7], the authors explain their analysis as there have been numerous reports demonstrating how certain factors have an impact on the economy, as well as the reality that the economic system was significantly impacted during the Covid-19 crisis when there were lockdown drills and all commercial activity were halted. The situation was extremely critical, and everybody was in a state of complete panic. However, smart devices such as smartphones and tablet devices were extremely useful in raising awareness during this critical time period when people required accurate information. Data science was used to analyze the situation and determine whether the spike in Covid-19 was having either a positive or negative impact on the economy, with the majority of the results being negative. COWIN and Aarogya Setu, two smartphone applications that were extremely useful in managing the data from millions of vaccination drives, were particularly beneficial. We used Data Science to analyze the economic impact of Covid-19, but the technology has a wide range of applications. It can also be used to analyze the regional effects of Covid19, and Big Data can be used to determine which age category of the citizenry was the most adversely affected, allowing for the implementation of appropriate countermeasures to be implemented. To conclude, it should be noted that the economic system will take time to regain momentum; however, on the positive side, India, as a developing economy, served as a torchbearer during this pandemic and assisted many other countries in doing so as well.

In [8], As reputable evidence that an individual was vaccinated against COVID-19, tested negative for COVID-19, or healed from COVID-19, digital COVID-19 certificates aid in the facilitation of healthcare, occupational, educational, and travel-related activities during the pandemic. This paper contributes to our knowledge by providing the first state-of-the-art and thorough review of this ecological system. Their survey can be concluded in light of the ongoing global vaccination campaign; COVID-19 certificates are intended to relieve travelers of domestic & global travel restrictions, including entrance prohibitions, quarantine requirements, and testing. Similar proposals that have been authored in the relevant papers are included in the survey. In light of the fact that certain certification schemes are usually accompanied by mobile applications that make it easier for certificate holders to store, update, and verify their certificates, we also examine official Android apps for any element that might potentially put the user's privacy at risk. At least two different types of certificates are considered by approximately half of the existing schemes. The most widely accepted type of certificate is the immunity certificate, which is followed closely by the vaccination certificate. On the negative side, only a few schemes take into account scalability problems, which are critical considerations for real-world deployments. Also noteworthy is the fact that 54 nations have already established their own national official COVID-19 quality assurance system (7 from America, 15 from Asia, three from Europe, and three from Africa/Oceania), with 36 of them being endorsed by smartphone apps; some of these schemes work in conjunction with wider measures (as in the case of EUDCC), while others are stand-alone initiatives. There is a large number of mobile app-based schemes that are aimed at both the Android and iOS platforms, and they endorse all three types of proof, which are immunization, diagnostic procedures, and immunity. Only four of them, however, are available as open-source.

In [9], the author interprets the whole scenario as, so far, the COVID-19 global epidemic has been linked to 5.5 million reported deaths worldwide, with India accounting for 8.7 percent of all reported deaths. In the mentioned survey, the authors list and analyze the inequities that existed during India's vaccination strategy drive and also computed the impact of new policies that were implemented as a result of these inequities. In order to better understand these potential inequities, use data that has been made available through government portals to conduct not only qualitative but also quantitative analyses of the same.

To be more specific, (a) look for inequities that may exist inside the policies, (b) evaluate the influences of new policies that have been implemented to increase vaccine uptake, and (c) identify data discrepancies that may exist across various sources of information. The number of cases, vaccine availability, apps and automation tools being developed, vaccine distribution, and the strategy and implementation of guidelines at the health Centre scale were all discovered to be published in a variety of sources, according to the research. Two major policies were evaluated for their effectiveness and illustrations of how the distribution of vaccination policies failed to achieve equitable distribution in certain states. To ensure that policies and decisions are based on reliable information, it is also critical that the vaccination records that are made available to the public are consistent and accurate. Several inconsistencies in the vaccination records made accessible on the COWIN Dashboard are brought to our attention. With the help of quantitative analysis, identification of vital disparities in the administering of vaccinations and endorsement of future policies be developed with equity and transparency as primary considerations. In the future, the Cowin platform will continue to evolve[10]. More functional requirements will be added, including those pertaining to kids and the assimilation of passports to make travel more convenient.

III. Novelty of the Proposed Work

Because India has the second largest population after China, keeping track of every citizen's vaccination is a nearly impossible task. While not a replacement for human oversight and management, the CoWIN App assists in gathering and storing all the required information for both current and future use. With 12 languages supported by the app, the developers have created a user-friendly interface that allows people from all over the globe to interact with the application with ease and comfort. This simplifies the process of working with the CoWIN application. Our greatest strength is our ability to experiment and develop an app in such a short period of time. The failure to raise awareness among people, particularly those living in rural areas, and the failure to find a solution to this problem are both significant drawbacks.

In Fig. 2, the graph portrays the different vaccination data from 2021 to 2022, i.e., the first dose, second dose, precautionary dose, and the total amount of citizens vaccinated yet.

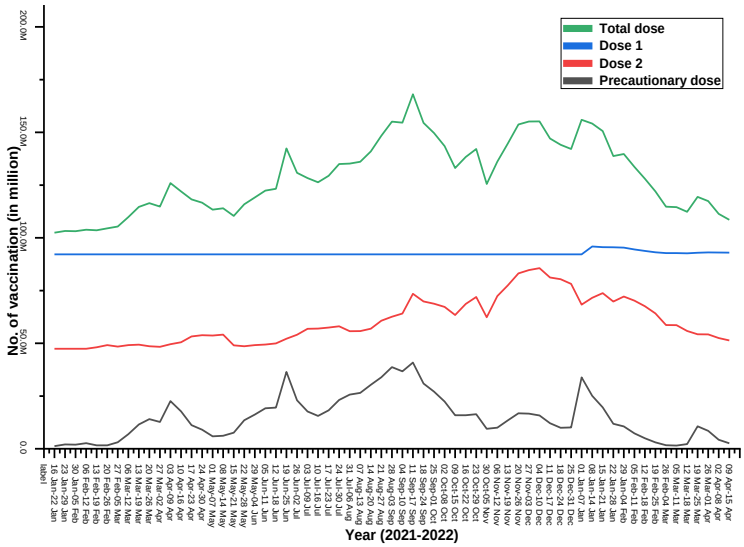

Fig. 2: Dose wise vaccination from Jan 2021 to April 2022

As shown in Fig. 2, there is a vast difference between the first and second doses of vaccination. There may be specific reasons for the same. The above-displayed data was extracted from the Cowin Dashboard [13]. As a part of the process, we did a small survey, in which we found out some points related to the decline in the graph of the second dose. Some people claimed that due to their busy schedules, they did not have enough time to look onto their next vaccination date and spent their time looking for an available timeslot in such a jam-packed situation where all the slots are already booked. We also found out that there are specific ways to increase the declining number of second dose vaccinations, which can be done through a reminder when the second vaccination period starts for an individual along with available slot information in the area, based on the stored data of dose one vaccination of the person. Once a reminder is sent, we can observe the rise in the second dose graph, resulting in the increment of fully vaccinated and responsible citizens of the country.

IV. Proposed Model

The proposed model contains some additional advanced features that can be included in the vaccination app to make it a more user-friendly and straightforward app. The model consists of a few steps to be followed by the user, such as after entering the homepage, the user needs to register itself by entering its basic details as per the section mentioned, an OTP will be sent to the user's mentioned contact number and email address for verification purpose, as soon as the user enters the OTP, the authentication process is completed. And if not, the user is asked to restart from the beginning. Once the user details are verified, the user can access the slot tracker feature. Depending on the vaccination status, i.e., if the user is not vaccinated yet, the slot tracker shows the slots available along with the location in the mentioned PIN. If the user is partially vaccinated (has taken the first vaccination dose), the system automatically sets up a reminder on the backend, which is sent to the user once the duration of the second dose starts. The algorithm of the proposed model is as follows:

Algorithm: Proposed Algorithm for Vaccine Slot Tracker

H: homepage; **R:** Registration; **R1, R2, R3…. Rn:** Registration serial numbers; **VS:** Vaccination Slot; **F1:**First dose vaccinated; **N1:** Not vaccinated; **r2: a** reminder for 2nd dose

Begin by Homepage (H)
Submit R
for each R(R1, R2, R3…. Rn):
OTP sent to provided email & contact number;
If (OTP==verified)
If (user==N1):
Display information regarding VS;
Store the data of R
Else
Redirect to H;
If (user==F1):
r2 starts for 48 days' time interval from the date of F1
Mail sent regarding slot availability to the registered email id of the user
Else
Redirect to H;
end if
end if
end if
End

The mechanism of the proposed model is shown in Fig.3.

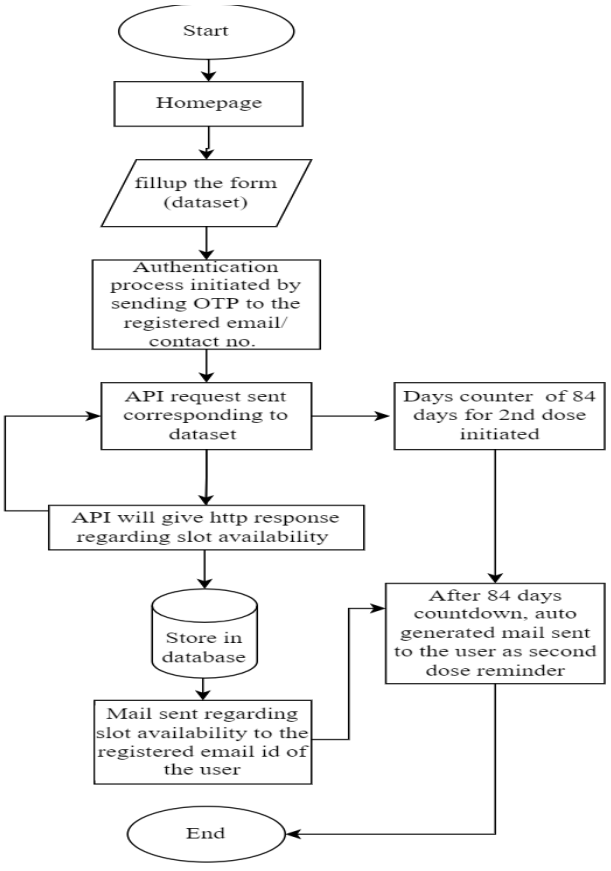

Fig. 3: Flowchart of the proposed vaccination tracker model

A. Role of the CoWIN App

According to our Honorable Prime Minister, the software will ensure that the people receive the second dose of the vaccine on schedule. Certificates will indeed be generated following the administration of the first and second vaccine doses, respectively. According to the platform's description, it serves as a "cloud-based information technology solution for the organizing, executing, tracking, and assessing Covid-19 vaccines in India [13]." In addition to assisting with administrative management (through the Orchestration Module), the platform can also monitor vaccine supply chains (via the Vaccine Cold Chain Module), onboard citizens as vaccine recipients (via the Citizen Module), update their vaccination status (via the Vaccinator Module), and issue certificates following vaccination (Certificate, Feedback, and AEFI Module).

B. Process for signing up for the CoWIN App

Registration requires the presentation of a government-issued photo identification card of any type. Once candidates have registered, they will be provided with a schedule detailing when and where to receive their vaccine shots. The Vaccination Unit will verify the beneficiary's information and update the beneficiary's vaccination status.[11]

The following are the steps in the overall process:

- **Step 1:** An SMS with the time and date is sent to the candidate registered on the CoWIN app.
- **Step 2:** The nominee must arrive at the vaccination venue and present the SMS to the vaccination officer.
- **Step 3:** The identification document is scanned by the vaccination officer.
- **Step 4:** The candidate's information on the CoWIN application is checked. The OTP (one-time password) received via SMS is used for verification.
- **Step 5:** The applicant is vaccinated, and the vaccination Officer reports the candidate's information in the CoWIN application.
- **Step 6:** The applicant receives another SMS with appointment information for the second dose, as well as an OTP.
- **Step 7:** The recipient must wait for approximately 30 minutes before being watched for any adverse reactions to the medication. If there are no allergic reactions, the candidate is free to leave.

Overall, India's peak is expected to be the result of the central government's strict implementation of measures such as mandatory face masks, social distancing, frequent hand washing, halting public transportation entirely during lockdown periods, and restricting internal and international movements to only essential travels, and so on.[11]

V. SIMULATION

The database, object-oriented, and networking approaches are all used in the development of the suggested model. Because we have a large number of locations where we need to maintain entries in the database, we are utilizing SQLite software, which is among the best and most user-friendly programs available for storing information. As the front-end software, this project makes use of PHP, which is an object-oriented programming language, and it has a connection to the MySQL database. It is a web-based service that customers may access via a server as well as through a browser. The minimum required hardware and software specifications are listed in table 1.

Table1:Hardware and Software requirements

HARDWARE		
Processor	**:**	Pentium 2.4 GHz or above
Memory	**:**	256 MB RAM or above
Cache Memory	**:**	128 KB or above
Hard Disk	**:**	3 GB or above [at least 3MB free space required]
PENDRIVE	**:**	5GB
SOFTWARE		
Operating System	**:**	Windows 10
Font-End Tool	**:**	JSP, Servlets, JavaScript, Html Css bootstraps
Backend	**:**	SQLite, Django, Python

The simulation of the proposed model is performed using Django as the basic backend, and the database is managed through SQLite. At first, when the user visits the webpage, the user is asked to fill up the basic details such as name, email, pin code of the area, and age of the user. Before proceeding further, there is an authentication interface in which the authentication is done by sending an OTP to the registered mail id of the user. Once the user is authenticated, it is directed to another webpage which is the service provider page, i.e., all the information and features can be accessed from this page. At first, the user is asked for the date range, i.e., how many days from the current date the user wants the information. For example, if the date is Jan 03’ 2022, and the user enters range: 3, then the slot availability will be displayed on the result will be from Jan 03' 2022 to Jan 05' 2022. The features include information regarding the availability of slots at various locations on the basis of the selection of states and their districts and their respective PIN codes. The portal also seeks the minimum age regarding which the user wants to access the information. There is the option of the vaccine you prefer and whether the user wants a free or a paid vaccination and its availability. Once the user enters this information, the result is displayed on the screen

in a tabular format. If the user has already taken the first dose, then a reminder of the second dose is automatically set up at the interval of 48 days from the date of the first dose vaccination. Once the interval is completed, the user is sent a mail on the registered email id regarding the availability of the slots on the basis of its first dose vaccination details consisting of the date range, State, District, Pin code, Free/ paid vaccination and preferred vaccine. Fig.4 shows the actual implementation of the vaccine slot tracker for the proposed model.

Fig. 4: Proposed Vaccine slot tracker

Despite the fact that wealthy countries are administering mass immunizations at record rates, developing countries continue to be affected by a number of complicating factors, including the spread of COVID-19, testing hurdles, mass vaccination challenges, and medical supply constraints.[12]

VI. Conclusion

The COVID-19 outbreak has had a disproportionately negative impact on certain persons compared to others; hence, vaccination of the general public is essential in order to prevent the pandemic's impacts. Equitable vaccine distribution is critical to the success of any vaccination program. Throughout the epidemic, technology, data, and policymaking appeared to have had a significant impact, particularly in the case of India. We discovered a variety of sources of information being released on the number of cases, the availability of vaccines, the development of phone applications and bots, the dispensing of vaccines, and the planning process. Because of the obstacles faced by vaccine delivery, tracking, and registration, the conventional COVID-19 vaccine strategy is deemed fragile. In the proposed model, the main emphasis is mainly on the features that are yet not introduced in the models of the existing vaccination drive platforms. The first is to set a reminder for the second dose of vaccination on the basis of the date of the first dose. It would entail granting citizens the reminder amidst their busy schedules. The second goal is to create contents that will be used for widespread awareness campaigns. But it is immunization, not vaccinations, that will put an end to the epidemic. We must ensure that vaccines are distributed fairly and equally and that every nation receives them and is able to use them to safeguard its citizens, beginning with the most susceptible.

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