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Review paper on improving COVID-19 vaccine distribution in India

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Abstract— *With the stark rise in the outbreak of COVID-19 in numerous countries, India, amongst other nations, too is considerably affected by it also it has shaken the global health system and economy by their roots. Virus is still spreading and there are no signs to decreasing the trend. Vaccination is the only effective and important means which could control this situation. Several research institutions and pharmaceutical companies have plunged into the race of vaccine development against COVID-19 and currently it is being distributed among the normal people. Logistics and supply chain for distribution of vaccine in the country like India where population is way too much is the challenge. The deployment of COVID-19 vaccines is kind of a challenge because of transportation and storage. Temperature data is an important source of knowledge that can be recorded from different data sources such as sensors. The study focuses on predictive maintenance to manage the vaccine distribution while transporting. Also, it focuses on post vaccine symptoms data which can be used for improving the vaccine.*

Keywords — Covid-19, Pandemic, Supply chain, Logistic, Big Data Technology, Forecasting

1. INTRODUCTION

The outbreak of corona virus in December 2019 in Wuhan, China, has put whole world on high alert. The World Health Organization (WHO) named it COVID-19 and declared it a global pandemic on January 30, 2020. The disease has spread to more than 200 countries with almost 128 million cases and more than 2.7 million deaths worldwide. These numbers are still increasing rapidly. Normal life has been disrupted because of mandatory lockdowns, isolations, and quarantines in response to the COVID-19 pandemic and has imposed a serious challenge to the global health system and economy. If it is observed properly then there is a pattern which says in every era of the 21st century there is a coronavirus epidemic, namely, severe acute respiratory syndrome (SARS) in 2002, Middle East respiratory syndrome (MERS) in 2012, and now COVID-19; and such epidemics are expected in future too.

Impact of globalization policy India has accepted; many foreign companies have started business in India as it is a global manufacturing hub. Growing demand in international
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markets are opening a new world of opportunities for the Indian Industry. India plays a major role in pharmaceutical industry at global level and improving supply chain management in pharmaceutical industry has been a challenging task for many companies. Pharmaceutical companies, worldwide, are facing challenges meeting global quality standards, observing to new healthcare reforms, and expanded service needs. The ultimate impact of COVID-19 from a healthcare and economical perspective is still very difficult to predict, but after the release of vaccine it seems that people will get back to their previous lifestyle soon. The process of COVID-19 vaccination on the scale is a challenging task. Vaccines require years of study and examination before reaching the citizens, but in 2020, scientists embarked on a race to create safe and efficient Covid-19 vaccines in very less time.

2. LITRETURE REVIEW

Many researchers from various countries are currently working on different processes which are included in vaccine distribution, these are some referred studies which are as follows:

In-depth analysis of cold chain, vaccine supply and logistics management for routine immunization in three Indian states by Central Coordinating Office, The INCLEN Trust International [1] described the detailed process of how vaccines get supply from source to destination and in between that process how they are managing temperature of the vaccine and trying to deliver it in a proper manner.

Protecting India: Public Private Partnership for vaccinating against COVID-19 [2] described COVID vaccination's strategy and planned administration roadmap of different countries like USA, UK, Australia etc. In this paper they have explained detailed information from start to end of vaccine distribution and registration.

3. METHODOLOGY

This research paper concentrates on the evaluation of various big data technologies to improve distribution of Covid-19 vaccine and to manage the after effect of vaccine if any.

A. Technology-Enabled Storage and Transport Solutions

Different levels comprising of Government Medical Supply Depots (GMSD), State/ Regional/ Divisional Vaccine stores, District and Community Health Centre (CHC) / Primary Health Centre (PHC) vaccine storage points created wide network of cold chain for Universal Immunization Program (UIP). Some states consist of municipalities as separate health administrative system at district level, which follows cold chain system like district level. The country's cold chain network has served as the backbone for ensuring vaccine storage at various locations and supply of vaccine between storage nodes and outreach sites at the recommended temperature for administration to the target population. There is pre- defined cold chain network which has been created for storing and transporting the vaccine. In India, the cold chain network is organized as per 6 levels as shown in the figure 1.

Currently India is providing two types of vaccines which needs to be stored in low temperature which is quite hard to maintain. While transporting or person. Here for monitoring such activity we will use predictive maintenance. Fault

detection and condition monitoring are critical components of predictive maintenance, and it can potentially eliminate disastrous equipment failures in equipment. Using sensors, unknown or abnormal patterns, events, or failures can be predicted using anomaly detection technology. If such activities or patterns are detected, an alarm is triggered as an early warning to authorized person so that they can make better decisions and arrange proactive rather than reactive maintenance.

An integrated architecture will be projected for fault detection for predictive maintenance. It contains four layers: big data consumption, management, analytics, and visualization, with capabilities ranging from data collection to real-time device status monitoring. It will combine big data technology like NoSQL databases with critical data protection strategies like encryption and access control. In this process, sensors will send the data in JSON format to particular data collection point through which system can process it for data warehouse. After that if any vaccines source to destination sensors and GPS trackers will be used to monitor the temperature.

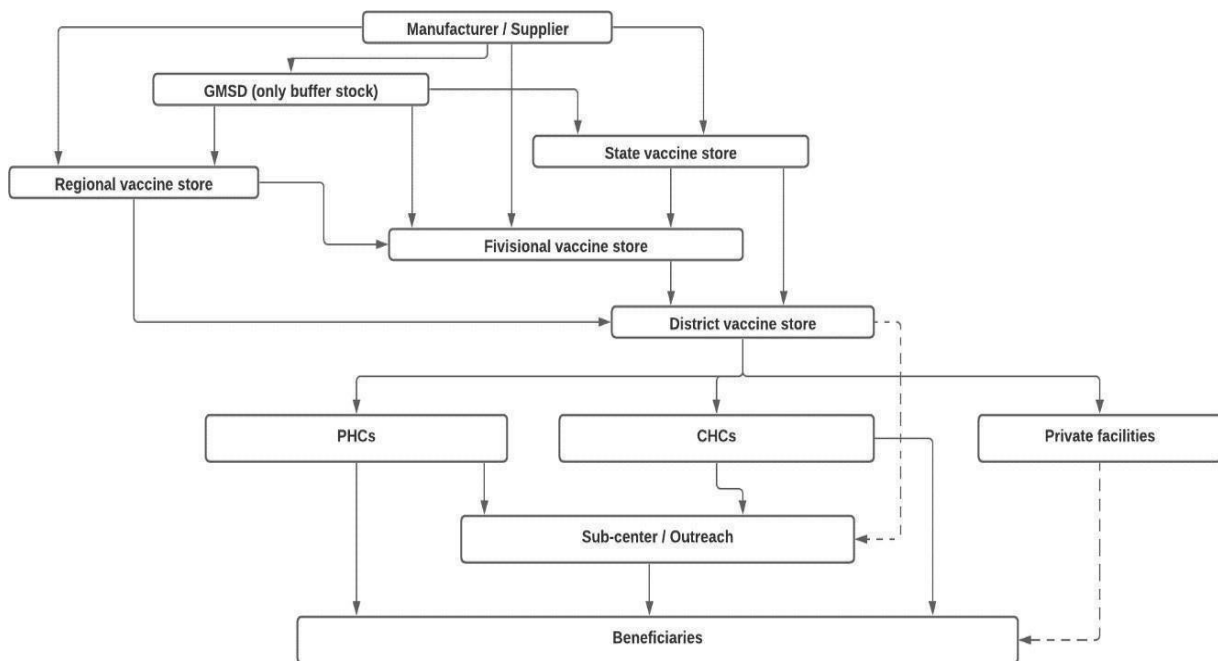


Figure 1: Vaccine Supply and Cold Chain Network in India

GPS trackers will be useful to track if there is some suspicious activity while transporting the vaccines. Barcode scanning system will be used in which barcode will collect supply chain data and when it is scanned it will send information to distributors and health workers. When a shipment is delivered, health workers scan barcodes and based on the vaccines' transport history they will receive an instruction message for preserving and safety of the vaccines. Sensors will be put on boxes or pallets which will collect and analyze the data related to temperature and location on hourly basis. If anything goes wrong, then it will send notification to respective authority preprocessing required, then it will be done and store it in NOSQL MongoDB database. Once health workers enter the details of patients to the system, it will get stored in database.

B. Feedback System for Tracing Post Vaccination Symptoms

When it comes to registration of vaccine India follows some guidelines. First citizen who is willing to take vaccine need to visit "CoWin" website and mobile application, where he/she will enter their basic details and select nearest Centre from where they can take the vaccine. Basic information consists of

their authorized ID proofs like Aadhar card, PAN card, Driving License or Passport etc. Once they have registered themselves, they will receive an automated text message where government will provide them information about their vaccination timing and Centre. On the day of vaccination, person need to show the same ID proof which they have provided at the time registration, so medical officer can check the identity of person. Once they will receive first dose of vaccine government provide certificate of vaccination and a text message for second dose. One day before the second dose person will receive a reminder text message for their vaccine.

As per current system, there is no system which collects the post vaccination data, so there is no data or information related to the people who are facing any post vaccine symptoms like fever or body pain etc. In some cases, it is observed that after taking vaccine also people are getting affected by Covid-19. Vaccine starts working on human body after almost 4 weeks from second dose. So, post vaccine symptoms data will help to pharmaceutical companies to improve the vaccine in future.

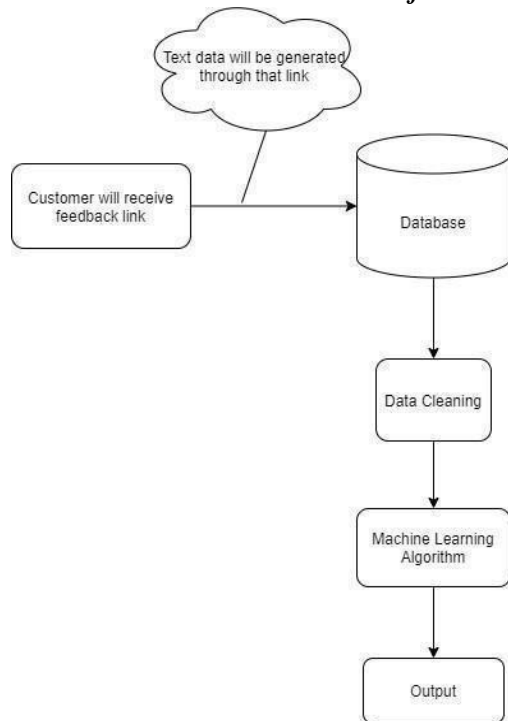


Figure 2: Feedback System for Post Covid Vaccination Symptoms

Information of all individual patient will get stored and once the patient will get 2nd dose of vaccine, after that patient will get one link on his/her registered mobile number. Through that link they can provide their current medical condition. Through this process government will get to know about post vaccine symptoms. The main challenging task is to process this kind of data. So before applying any machine learning algorithm data cleaning is required. After data cleaning, there are various

machine learning algorithms can apply like;

1. Multinomial Naïve Bayes
2. Stochastic Gradient Descent Classifier
3. Random Forest Classifier
4. K-Nearest Neighbors Classifier

Also based on the historical data of vaccine distribution, we will use forecasting method which forecasts number of vaccines required for next phase. Using this forecasting method, we can try to avoid the situation like wastage of vaccines. Also, we can predict demand and supply of vaccines and using that we can export those vaccines to other countries.

4. CONCLUSION

Unprecedented level of preparation and implementation is required while rolling out Covid-19 vaccines. Vaccination is process is defined in several phases where maintaining also this data is quite important task from start to end of the process. So, through the concept of collecting the data from sensors and after that using predictive maintenance it will help government of India to manage the data of vaccine distribution. Also, by applying different machine learning algorithm on data which is being collected by feedback system after final vaccination would help pharmaceutical companies to improve their vaccines in future.

5. REFERENCES

- [1] Research Paper - In-depth Analysis of Cold Chain, Vaccine Supply and Logistics Management for Routine Immunization in Three Indian States: An INCLIN Program Evaluation Network Study
- [2] Research Paper - Protecting India: Public Private Partnership for vaccinating against Covid-19.