Orchestrating the World’s Largest Covid-19 Vaccinations in India

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Abstract. We are seeing millions of people getting infected with Covid-19 virus and there is international cooperation to develop vaccines for immunization. Vaccines are to be expected soon may be within 6 months. The entire world is looking for vaccination for people of all ages in all countries. The manufacture of the vaccines is also on the focus. However, the next important issue is reaching people living in every nook and corner and ensure that they are vaccinated safely and monitor the pre and post vaccination condition of all the people. In this paper, the ecosystem framework for Covid-19 vaccination service chain using our results earlier developed for global supply chain network design is presented.

Keywords. Covid-19; vaccination; Service chain; Supply chain; Ecosystem; Governance, Risk; innovation.

1. Introduction

The development of vaccination platform ecosystem is needed for India and other nations as well for equitable and safe immunisation program. This work will help the health organizations to plan, coordinate and organize the vaccination in a highly transparent and efficient way. Our idea is that the central governments do the planning for the entire countries and entrust the responsibility to the state governments. The state governments identify vaccination centres. We first map the vaccination service chain at each vaccination centre with vaccines, medical staff for pre-testing, vaccination and monitoring for after effects. The operation of such service chain requires cooperation from logistics, cold storage, hospitals, private and public corporations, governments, etc. Using this ecosystem, following our work in [10], we developed the Governance, Risk, Innovation and Performance (GRIP) framework for the service chain. We developed the governance of the vaccination service chain for high performance, to identify the risks and innovations that are possible using digital technologies including Big data, artificial Intelligence (AI), Machine Learning (ML) and Application Programming Interfaces (API) to connect various stakeholders.

2. Vaccination Platform for the Country

Indian sub-continent has 1.38 Billion population in 28 States and 8 Union Territories. In India there are 640,867 villages (236,004 have less than 500 population) in 610 districts. About 833.1 million people in India live in villages and at least half of them are below 25 years of age. They speak in 14 languages. A lot of informal labour in India works as support staff as maids, drivers, security guards, and delivery staff, construction workers, etc. They migrate from villages to cities for jobs or livelihoods. Due to the pandemic and subsequent lockdown, the workers have lost their jobs and de-migrated to the villages. The contagion is hitting towns and villages where resources are scant, and people are sceptical of lockdown efforts. Advanced economies are trying to balance the impact on public health and the impact on the economy by adjusting policy responses like the degree of social distancing. Developing
countries are faced with much harder policy choices. Social distancing is hard to apply or enforce in the slums of many developing country cities, and the safety net is not sufficiently well developed to allow people to stay at home without working and still feed their families. It was lives vs livelihood and the entire world is under stress.

There was lot of cooperation among R & D labs and vaccine inventors and manufacturers across the world. The entire world is waiting for the vaccine. Once it arrives and is fit for use, the world’s population is ready for get vaccinated. In India, as mentioned above we have 1.38 billion people living in cities, villages, and towns. The vaccines are manufactured and shipped to airports or big warehouses. The vaccines need to be transported in cold chains following the temperature and other quality standards. It is unique logistics transport for the world both in size and distances. Digital Innovations are needed to transport the vaccines to all over the country. We must learn from earlier experiences are there any other instances which are close to the current situation.

2.1 Cross-Industry Innovation (CII)

In cross-industry innovation, already existing solutions from other industries are creatively imitated and retranslated to meet the needs of the company’s current market or products in terms of Technologies, Specific Knowledge, Capabilities, Business Processes, General Principles, Or Business Models. CII assists firms in cutting down uncertainty and risk in their innovation processes, because the solutions and technologies it introduces have already worked successfully in a different market. In the vaccination context, one can use the methods used in the context of Indian General Elections, Public Distribution System, Aadhar Card issuance as closer examples. Also, it is difficult to get assistance or buy equipment for one-time usages in terms of truck, refrigerators, cold chains, syringes and other accessories from other countries because of uncertainties and quality and quantities needed. One has to follow the effectuation principle and plan and organize the vaccination program for the entire country using available resources (Doctors, medical staff, trucks, cold chain, syringes, PPEs, etc.). This requires huge amount of effort in terms of logistics and supply chain and also coordinating the entire ecosystem. It requires scenario planning, simulations, developing AI and ML based algorithms, use of new technologies such as cloud, big data and blockchain. We develop a platform-based ecosystem model for vaccination in this paper as a contribution in this direction.

3. Covid-19 spread around the world

The world is seeing a tremendous amount of panic because of the spread of the Covid-19. As of today November 23rd, 2020, US, UK, France, Germany, and several other countries are facing the second wave of the corona virus. In India, several big cities like Delhi and Mumbai, and several states are imposing lockdown, night curfews, mandatory mask wearing restrictions, etc. However, due to the festive season and markets reopening people are crowding. Some of them not following the precautions of social distancing and mask wearing, etc. It is almost a year that Covid-19 has arrived at the world and people are probably tired of restrictions on social gathering. Countries have lockdown of cities, cancellation of travel inside and outside cities and countries. Factories, Construction, Shops, Restaurants, Hotels, Taxis, Autos, Schools, Colleges, Universities are all shut down except the essentials. Restrictions or ban have been imposed on travel or visiting tourist places, eating out in restaurants, socializing with friends and co-workers and several other normal
activities. Fortunately, services like IT, Internet, social media, online entertainment, power, water are made available. Online classes, zoom meetings, phone talks, working from home, TV entertainment services have made life easier.

Covid-19 is transmitted by infectious droplets (e.g., cough and sneeze droplets) and by nasal–oral route and hence through human to human contacts. There are two types of transmission: Symptomatic and asymptomatic. Thousands of people will get affected every day and need testing, medication, and hospitalization. Virus can probably survive for more than 3-14 days on a dry surface. Incubation period appears to be about 14 days after exposure.

Lockdown has created unimaginable difficulties for a large population in India that relies on the informal economy, part of which is labelled the gig economy. A lot of informal labour in India works as support staff as maids, drivers, security guards, and delivery staff, construction workers, etc. lost jobs. Doctors and Nurses are under pressure. Hospital staff and health workers doing their best. Economy is under pressure with no sales of any commodities other than food, masks and sanitizers.

More research on vaccines and international cooperation are visible involving various organisations/agencies. UNICEF, WHO are actively involved. In India, the central and state government work together in the implementation of lock down, social distancing norms, regulations and medical arrangements for Covid-19 infected patients. Pre-testing is being done and several government and private R & D laboratories are working together.

The development of the vaccine has led to people revisiting the importance of India’s cold chain like never before. Although there have been massive efforts to accelerate the entire process, it will take substantial amount of time to reach the corners of the country. Moving the goods across India will not be a problem, since we are well connected through road, rail, and air throughout the span of the country. But taking care of the cold temperatures, contamination and storage will be key issues. To ensure safe vaccination, it is important to map the vaccination service chain, and the logistics of the vaccine, how it reaches a village, reaches the pharmacy, how the doctors store the vaccine, before administering to the patient without compromising the safety.

Coordination between regulatory approvals and manufacturing has intensified in these months in developing an effective vaccine soon. While massive support is being lent to provide a strong backbone to clinical trials, many vaccine manufacturers are already planning and designing large-scale manufacturing upfront, even before completely knowing whether the vaccine will work. There is lot of literature on Covid-19 management particularly in relation to safety and the new normal for the supply chains. Most of them are from management companies such as Mckinsey [3], BCG[1] and several others. There are excellent WHO reports [16,17] on virus vaccination and precautions which are very informative. There are academic papers on Covid-19 predictions and how it is going to explode in various regions. These are very large in number and is very difficult to reference all them here. Only relevant literature pertaining to the topic is mentioned [1-17].

4. The vaccination supply chain

Vaccine distribution planning and its efficiency play a crucial role in prevention of infectious diseases from spreading. Efficient planning of vaccine delivery involves demand fulfillment,
cold chain constraints, number and size of the vehicles for distribution. Supply chain should supply vaccines to various customers in a well optimized way to reduce wastage and transportation cost. WHO reports that in some countries the wastage of vaccines is almost 50%? Also, the cost of new vaccines is increasing day by day. Vaccination needs to be done for each patient 2 times in the space of 20-26 days. This emphasizes for efficient and optimized distribution.

Conducting Preventive Mass Vaccination Campaigns need to execute high-quality preventive vaccination campaigns under safe conditions, without any harm to health of staff and community. Inventory or data records need to be maintained. Evaluation parameters are as follows:

1. Evaluate the capacity to implement a mass vaccination campaign safely and effectively by assessing: adequacy of human resources; cold chain capacity; logistical and transport.
2. Prioritize training of health workers and vaccinators to strictly adhere to infection prevention and control guidelines. Recommendations for the organization at vaccination sites and sessions.
3. Involve community and religious leaders in planning and health message dissemination.
4. Establish strong supervision and effective monitoring systems for any adverse events following immunization.

The vaccination supply chain has three phases. All the companies involved in all the phases should ensure the availability of hand sanitizer or hand washing station for use by recipients and companions at the entrance of vaccination sites and health facilities.

The health checkup is needed for the customers who must be vaccinated. The customers are to be tested for Covid-19, general health, blood pressure, sugar, fever, cough, cold, etc. If they are tested good, then they go through the vaccination. If they are tested Covid-19 positive or other ailments, then they are sent out for treatment. The health testing generally takes time particularly for Covid-19 tests and also blood tests.

Customers who are fit arrive at the vaccination center, which has doctors, medical staff, and security personal. Vaccination centers are supplied with vaccines, syringes, masks, PPEs, etc. by the medical suppliers. The vaccine cold chain maintains the vaccines at the appropriate temperatures. The staff are well trained on vaccinations and precautions they need to take. They are tested for any infection every day before entering the center and leaving the center. Vaccinators should perform hand hygiene after each recipient with hand sanitizer and use masks and PPEs. Also, the center should organize exclusive vaccination sessions for people with pre-existing medical conditions (such as high blood pressure, heart disease, respiratory disease, or diabetes). The center should arrange for waste disposal by consulting all the manufacturers.

After vaccination, the patient needs to be monitored for after effects. The customers need to get tested shortly as well as after 2-3 months. The pre and post vaccination testing for the health of the customer cannot be done at the same time. They can be either be done at other locations and the results are shared either digitally or through a medical dairy. This brings in the requirement for digital medical dairies and for storing and sharing the identity and health information in cloud.
5. Vaccine service chain Ecosystem

An ecosystem comprises of networks of companies, countries and their governments. Industrial, social and political organizations, logistics and Information Technology Services, infrastructure companies and the third party service providers that connect the companies and the countries to the external economic and social environment and resources including natural, financial and human resources with talent, connections and knowledge of the industrial environment, industry clusters, universities, etc.

The ecosystem approach is comprehensive and integrated and depicts all the stakeholders involved with the vertical on a single platform and involves analysis that looks at the location, planning, performance, risk, governance and innovation from a systemic viewpoint. The vaccine supply chain ecosystem has similar characteristics. The figure 2 shows the detailed ecosystem map of the vaccination service chain.

The service chain consists of the health testing centre, vaccinators, health monitoring centre, waste disposal and the governing organization. The map of the service chain is given in Figure 1. The resources arm includes clusters for collaboration and partnership, Universities and R & D labs for innovation, companies that provide Cloud data, AI, ML algorithms, Doctors, medical staff, security personnel, vaccine manufacturers, logistics and cold chain for transport, storage and at the vaccination centres.

The delivery service infrastructure is very important. The logistics and IT Infrastructure at vaccination centre, pre-testing and monitoring facilities, digital records and detection of the patient’s health, data banks form part of delivery service infrastructure. APIs should connect the stake holders and data need to be maintained and secured.

Institutions: The state and central governments, municipalities, social groups, NGOs all form the societal side of the institutions. The doctors, medical staff and their associations, vaccine
manufacturers, WHO, R&D labs, Serum Institute, Hospitals, etc. are the Institutions that need to be consulted and informed.

Vaccines go through lots of change in ownership, from national offices to regional offices to health centres. Vaccines are temperature sensitive and often get spoiled if they are not delivered on time. At the wholesaler or distributor level, if you pick up any vaccine or drug, the serial number in that product should be able to tell you the entire journey of the material. There are start-ups which uses Internet of Things (IoT) and blockchain to monitor every minute step of the products’ journey, providing complete transparency and preventing disruptions in large-scale deliveries. They record every change in ownership and one cannot repudiate the information. The UNICEF SMART CHILD initiative securely track and trace the vaccines from manufacturer to child by leveraging blockchain technology.

5.1 Service Chain Ecosystem (SCE) Framework

**Governance:** The vaccination service chain is fragmented; it is challenging for the diverse interest groups within the network to align themselves with the objectives of the service chain and the end-customer. Service chain governance and leadership are critical for achieving customer safety and virus transmission and achieving immunity.

**Risk:** The service chains are highly connected logistically and informationally. These connections can become sources of risk. Risk in global supply chains can emanate from several sources including the service chain partners.

**Innovation:** There are two types of innovations: new to the world or new to the market. In the vaccination service context, we need new-to-market innovations that can result in delivering vaccines at places accessible to the populations. Also use of digital technologies

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**Figure 2. Vaccination Ecosystem.**
such as cloud, big data, and AI to connect all organization to perform safe vaccination and monitor people’s health before and after vaccination.

**Performance:** The performance analysis of vaccination service chains depends on several factors beyond the elements of the service chain and the properties such as logistics delivery and vaccination centre lead times. The number of people vaccinated safely and the benefits to the cooperating organizations are the important measures.

Details of performance, innovation, risks and governance are elaborated below.

5.1a Performance:

The Ecosystem performance is an important measure. How do you measure the effectiveness of the vaccination supply chain as well as the supply chain?

![Figure 3. Performance of the Ecosystem.](image)

Figure 3 clearly shows that the performance measure is number of people cured and the number of transmissions due to the visit to the centres for testing. Some of the other measures include: the Covid-19 detection and the medical staff attendance, hospital staff care, medicines, protective gear like masks, availability of food and safety items to all people, food and accommodation for poor including migrant workers. Figure 3 also shows the contributions and importance of all the four pillars towards the performance and the rewards for the participant workers and organizations.

5.1b Innovations:

The Innovations can be new vaccine or new immunity procedures, or they can come from other pillars such as new regulations or new delivery mechanisms or from new resources. A few digital innovations that can improve the service chain efficiency and performance are identified.
- AI and ML algorithms for pretesting and post testing the customers and for testing the efficacy of the vaccines.
- Digital records for all the vaccine takers and ADPI to identify the customer’s health condition before and after vaccination. They can be advised without need to visit the vaccination centre.
- Control Tower to monitor and control the proceeds in the vaccination service chain.
- Telemedical centres for advising customers on the pre and post vaccination.
- Online skill training to the volunteers.

5.1c Risks:

The ecosystem has four parameters: the service chain, the resources, the institutions which are governments and social groups and finally the delivery mechanisms. The risks can come from any one of these elements like from network partners in the industry vertical or in the economic environment, etc. The virus such as Covid-19 or H1N1 will affect the entire industry. One must look at all the factors that will affect your supply chain and the changes they create. The effect of any risk can be a disruption, deviation, or a disaster. The risk can create mismatch between people waiting for vaccination and the resource shortage. If there is no supply of vaccines or masks due to supplier failure, then the vaccination centre need to be shut and people will be anxious and frustrated. Risk factors are tabulated.

<table>
<thead>
<tr>
<th>Product &amp; Supply Chain risks</th>
<th>Institutional Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Clinical Trails risk</td>
<td>i. Regulatory risk: FE, IP, Customs delays, Taxes, Protectionism</td>
</tr>
<tr>
<td>ii. Outsourcing risk: Partner Risk, Breach of trust, IP theft</td>
<td>ii. Trade agreements,</td>
</tr>
<tr>
<td>iii. Design, manufacturing defects, Counterfeit, Inventory deficit</td>
<td>iii. Political: Govt. changes, Trade wars, Center state relations, Environmental issues, Corruption,</td>
</tr>
<tr>
<td>iv. Delays or Bankruptcies of suppliers</td>
<td>iv. Delays for clearances from several government departments</td>
</tr>
<tr>
<td>v. Sudden loss of demand due to vaccine failures, company bankruptcies,</td>
<td>v. Labor Unions, NGOs, Social interest groups</td>
</tr>
<tr>
<td>vi. Breakdown of Trucks, power or water, warehouses and Hospitals.</td>
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</tbody>
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<table>
<thead>
<tr>
<th>Resource related risks</th>
<th>Delivery Infrastructure Risks</th>
</tr>
</thead>
<tbody>
<tr>
<td>i. Infrastructure deficit, Industry Clusters quality, Talent shortage, Labor Unions</td>
<td>i. Failure of IT infrastructure due to network, or virus attacks, or natural disasters leading to the inability to coordinate operations</td>
</tr>
<tr>
<td>ii. Energy, Water shortage, Talent shortage</td>
<td>ii. SC Visibility Failure</td>
</tr>
<tr>
<td>iii. Social unrest, Natural calamities</td>
<td>iii. Inbound and outbound logistics failures due to carrier breakdown or weather problems</td>
</tr>
<tr>
<td>iv. Raw material: Price increase, Logistics costs, contamination, Virus in meat</td>
<td>iv. Lack of execution or governance mechanisms</td>
</tr>
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Counterfeits or fake medicine can be very dangerous and are a serious public health risk. The primary danger in taking a counterfeit medicine is that you are putting something into your
body that may not help your current condition and, more alarmingly, could result in harmful effects to your overall health. Experts at Pfizer have found harmful substances in counterfeit medicines including boric acid, leaded highway paint, floor polish, brick dust and heavy metals.

5.1d Governance:

**A Well-defined Network Governance Structure** identifies and manages relations with government, trade and social groups, labour, resources and delivery mechanisms. It also builds systems for effective communication, collaboration and coordination among the network partners, identifies and categorises risks from various ecosystem sources and puts in place risk mitigation strategies in operational readiness.

For every customer, the governance mechanism selects the medical staff, allocates the tasks and responsibilities and forms the vaccination chain. It ensures that safety precautions and health standards are followed. Further, it manages a control room for monitoring and execution of the planned activities in a timely manner under both normal and severe conditions. These tasks are done by an orchestrator appointed by the Governments.

5.1e Orchestration:

Orchestrators must be competent at recruiting the right providers, configuring the right chain of activities, and overseeing the performance of the network. Orchestrators should have deep domain knowledge, detailed understanding of practices and processes being coordinated including safety issues. Capabilities for Management of vaccine Procurement, vaccination centre and staff selection, Monitoring, Supervision and Visibility across the vaccination. Relationship Management: developing and maintaining trusted relationship with Customers, Suppliers, Service Providers, Government, Employees. Capabilities to Identify, Continually Redesign and Manage Processes to changing market needs. Recruiting the right Talent and Training, Mentoring them with the appropriate Performance evaluation tools.

![Figure 4. Orchestrating various participants in the vaccination chain.](image-url)
directions, and instructions from management are carried out systematically and effectively. Governance refers to how Orchestrator determines and coordinates the activities of the actors in the service chain. This includes selection of medical staff, pre and post testing sites and the vaccination timetable and security issues, etc. There are three separate functions involving selection of partners, coordination of the activities and finally execution and monitoring.

5.1 Partner Selection:

The central government assigns the responsibility to the states. Each state needs to select the places where the vaccination needs to be conducted in each of its cities and villages. Each vaccination site should have medical staff, vaccines, syringes, cold storage, masks, PPEs, etc. Selecting the places for vaccination and selection of medical teams involving the communities and volunteers are important. These can be based on the availability of resources and the distance the public need to travel for vaccination.

The value chain shows pre-testing equipment before vaccination and monitoring after the vaccination. Data collection include patients' profile, time of vaccination, aftereffects, etc. Algorithms can suggest if vaccination is advisable or not and what post care to be followed.

![Diagram](Figure%205.png)

**Figure 5.** The Governance mechanism.

5.1g Coordination:

Coordination is to bring different complex activities or organizations into a harmonious relationship. The coordination includes following points.

1) For every place, selection of staff; assigning functions to them, number of vaccinations per day, pre-post care to be taken (e.g., product tolerances and process standards for vaccines), the start and delivery schedules both in time and dates, etc.

2) Identifying and collecting key parameters patient data, time of vaccination, pre and post effects is needed.

3) Ensuring to follow all partners set by the Governmental and international organizational regulations on vaccination for consumer safety, including children and women.
5.1h Execution:

Online Supervisory Control Coordinates all the services needed for the vaccination. The following points are given below.

Patients queuing and vaccination and exit; Warehousing at vaccination site; Arranging for the vehicles to staff and also supplies; Managing the health clearance at vaccination site; contacting Hospitals in case of post vaccination emergency; Managing all exceptions through a control room.

How do you select the rules for planning coordination and control? The service chain involves people coming for vaccination, medical staff, organizations such as hospitals, vaccination sites, etc. We follow Thompson (1967. Selection of partners for vaccination service chain is creating pooled interdependencies between a large number of loosely coupled agents, where standardization of connection and transacting procedures is the key coordination mechanism. Such interdependencies are well managed by standardized rules and shared mechanisms to orchestrate transactions. Under standardization, there are established rules or routines for how people should coordinate their activity as with traffic rules. The rules such as wearing masks, social distancing, sanitization, pre-testing information, etc. Similarly during the vaccination and after rules need to be followed.

Sequential interdependence refers to serially structured tasks, one agent’s input is another agent’s output precisely as in the service chain. In the flow of patients from the pretesting to vaccination and finally post testing, involving Covid testing, staff, vaccines, cold chain transport, vaccination, and monitoring; the output of one stage is clearly the input of another stage. The complexity of information transmitted between firms can be reduced through the adoption of technical standards that codify information and allow clean hand-offs between trading partners.

Reciprocal interdependence involves simultaneous, ongoing relationship between parties in which each agent’s input is dependent on the others’ output and vice-versa. Reciprocal interdependencies require the transmission of information through mutual feedback processes. Instead of a central planner, mutual adjustment implies joint problem solving and decision making between the vaccinator, testing sites and medical staff, etc.

5.2 Control Tower

Among the best practices in this area is the establishment of a “control tower” with end-to-end visibility on different scenarios, vaccine inventory movements, patient deployment, and associated logistics. This tower can be used to identify and track strategic indicators related to inventories (coverage rate, availability of vaccines). Above all, this will enable a company to test the robustness of its ecosystem, assessing the long-term strength of its main components (suppliers, partners, and distributors) and the need to act with them (using a risk heatmap, identifying alternatives, accelerated vendor qualification process, or targeted support in some cases).

6. The Vaccination Process and Delivery Mechanism to All

The central govt assigns the responsibility to the states. Each state need to select the places where the vaccination need to be conducted in each of its cities and villages. Each vaccination site should have medical staff, vaccines, syringes, cold storage, masks, PPEs, etc. The value
chain shows pre-testing equipment before vaccination and monitoring after the vaccination. Selecting the places for vaccination and selection of medical teams involving the communities and volunteers is important. Data collection: Patients profile, time of vaccination, aftereffects, etc. Algorithms can suggest if vaccination is advisable or not and what post care to be followed.

6.1 Platform Ecosystem development

Identify potential participants and articulates roles, responsibilities, contributions, and interactions upfront. Focus on partners with the greatest value potential and/or strategic importance. Build effective communication, collaboration and coordination among partners. Setting and tracking the performance metrics related to vaccinations, safety, and service levels for each partner—and for the ecosystem. Focusing on national value creation is also paramount. Delivering services that generate safety, improved health, use of tools such as data pooling, or data sharing to ensure that all partners are healthy and safe. Establish mechanisms for protecting intellectual property (IP), and set-up contractual commitments regarding data-sharing agreements and IP. Identify and categorize risks from various sources and put in place risk mitigation strategies in operational readiness. Set-up agile partnership arrangements so that the ecosystem can respond quickly to changes in the business landscape.

6.2 Actor’s network

Network of organizations include R &D labs, Vaccine manufacturers, Clinical trial labs, Distributors, complementors such as third party service providers, cold chain logistics, hospitals, boundary resource developers, distributors, customers, competitors, government agencies, etc., involved in the production and delivery of products or services through both

Figure 6. Vaccination Logistics Ecosystem.
competition and cooperation. The third-party developer, on behalf of the platform owner, develops applications, services or systems for satisfying end-users of the platform.

Platform owner connects the customers (Govts.) and vaccine producers, through various international agencies and coordinate and execute the interaction and delivery. Platform acts as an intermediary between the Countries buying the vaccine and the Vaccine producers or service providers. For each vaccine transfer, the Platform need to map and manage the chain of activities identifying the firms involved till delivery to the customer.

6.3 Institutional and Societal Constraints

The vaccine and services need to follow the WHO and government regulations on privacy, safety, health protection and welfare. In the Indian context, ICMR and SERAM should approve the vaccine. Cooperation of the International organizations such as WHO, UNICEF and ICMR, Pharma Industry associations and conforming to the societal and Government norms are important. The platform management is responsible for the safety and integrity of the vaccine customers and medical staff.

6.4 Resources

Resources include Human (Research and medical staff), Financial (Banks, VCs, etc.) and Industrial (cold storage logistics, transport Infrastructure), Relationship capital (partner network with manufacturers and Govts) and Digital (Cloud, Blockchain, Analytics, Mobile apps) resources required to deliver the value proposition to the vaccine providers and customers. The technology-driven resources such as Internet, Cloud, Mobile, Big data and analytics, Blockchain make high impact. Ordinary resources such as medical staff, security; websites; mobile internet, APIs, etc.

User-friendly web-site, 24/7 customer care services, APIs allows partners to ensure safety and health.

6.5 Delivery Mechanisms

Management should ensure delivery of right product at the right place, in right quantities and right condition, to the right customers at right time and right cost. This needs integration and synchronization of vaccines, Medical staff information across all partner organizations including the customer segments. Delivery of products can be made efficient through use of IOT, sensor networks and augmented reality. Coordinating and monitoring the delivery process is an important issue and is often done using an execution dashboard. Vaccine Returns are common and have to be dealt with.

7. Conclusion

The vaccines are still in the developmental stage and most of them are in final stages. The whole world is waiting for their arrival after necessary approval. Everyone needs to be vaccinated and this is uniquely different from other diseases. There are uncertainties regarding the final approval, effectiveness, after effects and their distribution to countries. Fair allocation of the vaccines to countries, from countries to states, states to cities and villages is an issue that is more political than mathematical monitoring using digital records, Big data analytics as vaccination goes on is a must to take care of any ill effects.
The service chain of the vaccination in India has been presented. This is applicable to other countries as well. Vaccination was done for other viruses earlier in several countries. But the fundamental difference is that now every person of all ages across the world need to be vaccinated. Given the fact that the vaccines are still under clinical trails and only a few of them are in trial 3 and the manufacturing capacity and cold transport limitations, the vaccination process need to proceed in stages. The following problems need to be addressed:

1. How to allocate the vaccinations or more precisely? What is the order in which the vaccination process need to be done? As India is large both geographically and population wise and also reaching some of the villages need to be planned carefully. Which places do you choose first and who in these places: Places with high infections, in slums areas where people live closer and cannot follow social distancing, allocate to all states based on population figures, medical staff, police, military, sanitization workers first, age based allocation children, old agers, etc.

2. How do you choose the places for vaccinations, pre and post testing and the medical and security Staff assignment? How do you propagate the rules and regulations to be followed by all the people? Should they be issued tokens based on Aadhar so that their identity is stored?

3. Given the fact that the primary purpose is prevention of disease, there should not be transmission during the vaccination gatherings across all sections of people. The precautions to be followed such as social distancing, wearing the masks, sanitization, etc. should be the priority. Very few vaccines can actually prevent transmission.

4. Big data identification and collection for Covid-19 testing, vaccine effectiveness, prediction using NLP, AI, ML algorithms from contact tracing, speech, CT scan, genes, disease history, relationship with Covid-19 patients, people getting vaccinated, etc. are important.

5. Control tower to monitor the progress and problems for various factors need to be built in, to create the best vaccination program.

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