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SUPPLY CHAIN GAPS OF COVID-19 VACCINE IN INDIA, TURKEY, POLAND, ITALY AND UKRAINE

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ABSTRACT

Vaccine production is complex, and the process of creating and packaging vaccines will take months. Vaccines must also pass through external quality management icons. People in some countries like India, Turkey, Poland, Italy, and Ukraine are concerned about the slow introduction of COVID-19 vaccines. The exact date when doses will be available is unknown. Due to a shortage of vaccines, appointment websites keep crashing. The appointment lines are very long. The supply chain management job is to ensure efficient vaccine storage, handling, and stock management, as well as strict cold-chain temperature control and the upkeep of appropriate logistics management information systems. The study aims to find gaps in the COVID-19 vaccine supply chain and distribution. One of the most difficult challenges is managing the COVID-19 vaccination program. Apart from the difficulties of supplying the vaccine during a pandemic, the race to vaccinate every citizen is a hard process due to a lack of supply chain, cold-storage procedures, and double-dose requirements.

Keywords: Coronavirus, Vaccine, Doses, Supply Chain Management, Logistics, Cold-chain.

1.Introduction:

There are 2.5 billion people who have been entirely excluded from the global vaccination campaign so far. Vaccines are in short supply in many of these low- and middle-income countries. However, since only a few pharmaceutical companies have succeeded in developing vaccines, doses are extremely scarce. One of the major problems is a lack of supply chain management. Despite this, many countries around the world need vaccines. For example, due to a lack of supply chain management, As of March 11, 2021, Honduras had only been able to vaccinate less than 0.1 percent of its population as seen in Figure 1.

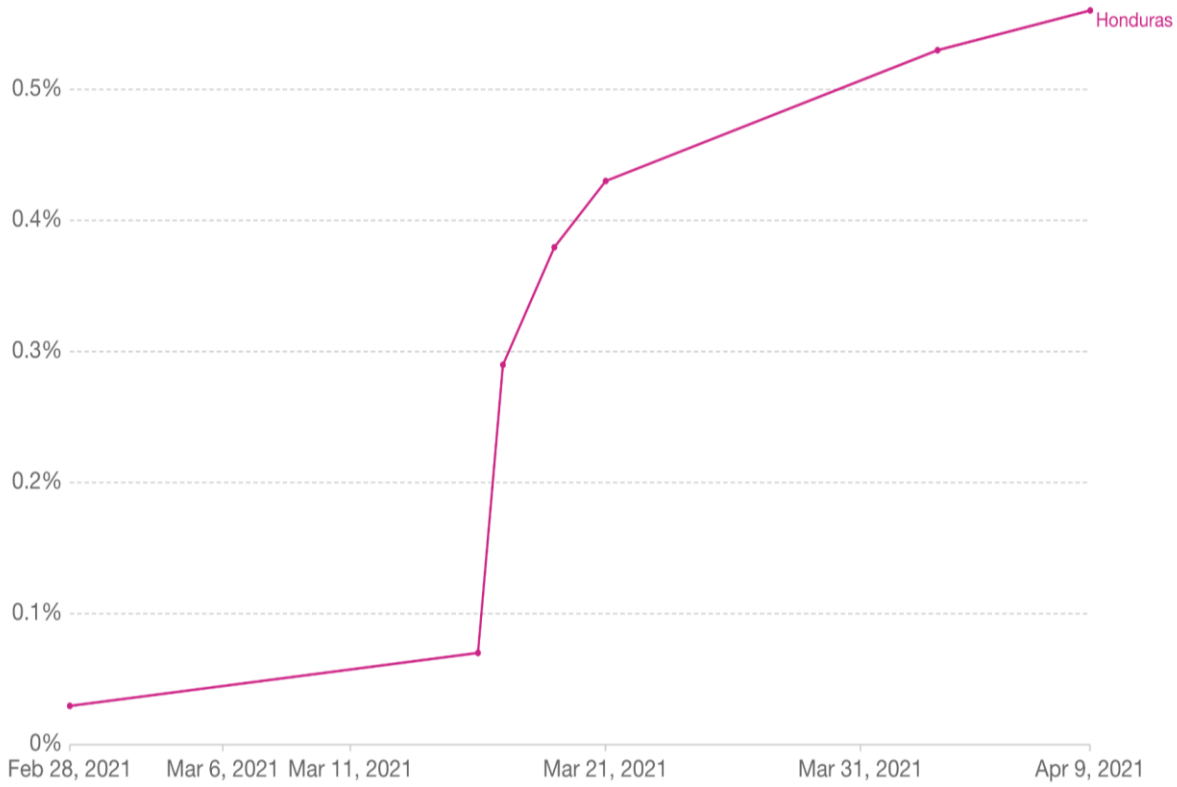

Figure 1. Percentage of people vaccinated in Honduras (Source: Coronavirus (COVID-19) vaccinations. (n.d.). Our World in Data.)

The global initiative to create and distribute an effective vaccine for the COVID-19 coronavirus disease has already yielded some promising options a year after the pandemic began. The manufacture of multiple vaccines, at such a rapid pace, is unprecedented; usually, the process takes five to ten years. Notwithstanding, more inoculations were supported this time for COVID-19 vaccines, and the troublesome part is sorting out some way to oversee the immunization (Shipman, M. 2021, April 16)

Vaccinating a critical mass of the world's population, which is critical for keeping the pandemic under control, is currently facing a new range of challenges, including dangerous new virus strains, global competition for a limited supply of doses, and public skepticism about vaccines.

In countries such as China, Russia, the United Kingdom, and the United States, several vaccines have been licensed for general or emergency use. Over 200 million doses had been distributed worldwide as of February 2021. Several countries, including Israel and the United Arab Emirates, are making rapid strides in immunizing their people, although the vast majority have only vaccinated a small percentage of their populations or have yet to begin.

The majority of vaccines that have been licensed for restricted use were produced by companies and research groups in China, Russia, and the United States. The first clinical trial in the United States, with a vaccine developed by Moderna Inc., began in Seattle in March 2020. After huge scope preliminaries, the antibody has been supported for use in crisis circumstances in the United States, European Union nations, and numerous different nations. Administrative experts in various

nations have endorsed a vaccine created by Pfizer and BioNTech, in light of comparative promising outcomes. The vaccine developed by Johnson & Johnson was the next to enter the market in the United States, gaining emergency approval in late February 2021. However, these days the Johnson & Johnson vaccine has more major side effects like blood clots compared to others. Providers could temporarily avoid prescribing the Johnson & Johnson COVID-19 vaccine as federal health officials investigate a possible connection to extremely rare blood clots. Since receiving the Johnson & Johnson vaccine, six women aged 18 to 48 developed blood clots. Meanwhile, four of Beijing's candidates have been approved and are being used by other countries. Before large-scale trials, Russia licensed two vaccines, one of which is now available in hundreds of other countries. Furthermore, countries all over the world have supported a vaccine developed by the University of Oxford in the United Kingdom and the British-Swedish company AstraZeneca that is less expensive and easier to store and transport than others. As indicated above, several countries play a huge role in vaccination. The logistics and supply chain processes are analyzed in significant detail in this study to determine vaccine distribution gaps.

1.1 Supply Chain Management Process of COVID-19 Vaccination Distribution

Each country's Supply Chain Management Process (SCM) is unique. The basic SCM is as shown below Table 1:

Place order to the manufacturer
The manufacturer ships the products
Distribution should get approval in meantime from Customs and FDA-Food and Drug Administration
Shipment Release approval
Maintain inventory
Predict requirement from Usage
Place an order for at least double the first PO to maintain inventory.
Repeat the same

Table 1. Supply Chain Management Process

When it was revealed in November 2020, that three viable COVID-19 vaccine options would soon be available to the public, it was a source of tangible optimism and relief.

Pfizer, Moderna, and Oxford/AstraZeneca have all made significant progress, and while this is good news, the deployment and delivery of these vaccines present a whole new set of problems for logistics firms already dealing with a year unlike any other.

With a massive increase in e-commerce since the outbreak, logistics firms have been dealing with peak-like volumes for months, and the 2020 holiday season is expected to extend capacity even further. The deployment of COVID-19 vaccines will be difficult due to the large quantities needed

and the complexities of transportation and storage, putting global supply chains to the test (The Logistics Challenges, 2021).

1.2 Complexities of Vaccine Distribution

It's one thing to have enough capacity for e-commerce delivery, which logistics providers have managed to do through 2020, but delivering vaccines on the scale that will be needed is a completely different story. In a nutshell, it's the world's greatest logistical challenge. Back in December, it was 20 million doses. By April, the number is as high as 100 million or higher per month. A rise in distribution size also raises the risk of disruption. Key elements for this are cold chain capacity, storage requirements, and last-mile delivery.

Cold chain capability is one of the most critical factors in vaccine distribution, but in the case of the Pfizer vaccine, which must be stored at temperatures below -70°C, the supply chain is simply not prepared. Cold supply chain carriers used to carry medical supplies usually work at a temperature of two to eight degrees Celsius. This is fine for most vaccines, which are kept at about 4°C, and not too far off the requirements for Moderna's vaccine, which is stable for 30 days between two and eight degrees Celsius, although it falls far short of Pfizer's requirements. When it comes to distribution, the cold supply chain problem becomes much more complicated, particularly in parts of South America, Asia, and Africa.

Vaccines require cold storage, yet in some areas, the infrastructure to support such storage may be lacking. If refrigeration fails due to a power outage, for example, the vaccines are likely to be rendered worthless. Storage capacity would be further limited by the fact that these regions have a combined population of approximately six billion people.

Last-mile delivery is the most difficult obstacle, trucking companies shutting their doors, not because they're going out of business, but because they can't handle any more freight. Owing to a national driver shortage, there is currently insufficient staff to complete the last-mile delivery from the port to the final destination. When the vaccines arrive, delivery would be heavily reliant on local pharmacies, necessitating specialized training. Besides, as it was stated earlier, given the conditions needed by the vaccine, the last mile to rural healthcare centers presents a significant challenge. If the vaccine is delivered, there is the additional complication of varying interval times for a second dose and the process of prioritizing and monitoring those who will receive the vaccine first.

Some of the factors expected to aid in addressing gaps in the vaccine supply chain include adequate supply chain and logistics infrastructure, real-time visibility along the supply chain, micro-level planning to coordinate vaccine administration, effective planning and coordination among the agencies involved in vaccine administration, and so on. Vaccine production is expected to benefit from the financial support announced by the Quad nations to increase COVID-19 vaccine manufacturing by 1 billion doses. The stock of items such as syringes and gloves for the frontline healthcare workers is to be aligned with the expected increase in vaccine production in the next two years.

Cold chain infrastructure is currently located mostly in metropolitan cities around the world. Another region that needs to be addressed to solve vaccine delivery problems is the gap in the

distribution of cold-chain points between countries. Owing to an increase in COVID-19 cases in many countries as a result of the virus's second wave, a broader vaccination program is becoming essential for controlling its spread. As a result, the vaccine supply chain network is expected to undergo significant transformations, presenting opportunities for cold chain logistics service providers to meet the growing demand for vaccine sourcing, procurement, manufacturing, distribution, and last-mile delivery.

2. Research

With a production potential of over 11 billion doses, the United States, India, China, the United Kingdom, Germany, and South Korea are among the major vaccine-producing countries. Vaccine manufacturing has more than doubled compared to last year as shown in Figure 2 below. Since vaccine delivery necessitates a strong global supply chain network, GCC Cargo Services could quickly become one of the major logistics hubs by building vaccine distribution infrastructure at some of its main locations, seaports, and airports. Global supply chains are networks that cover several continents and countries in order to source and distribute products and services. The transfer of knowledge, processes, and services around the globe.

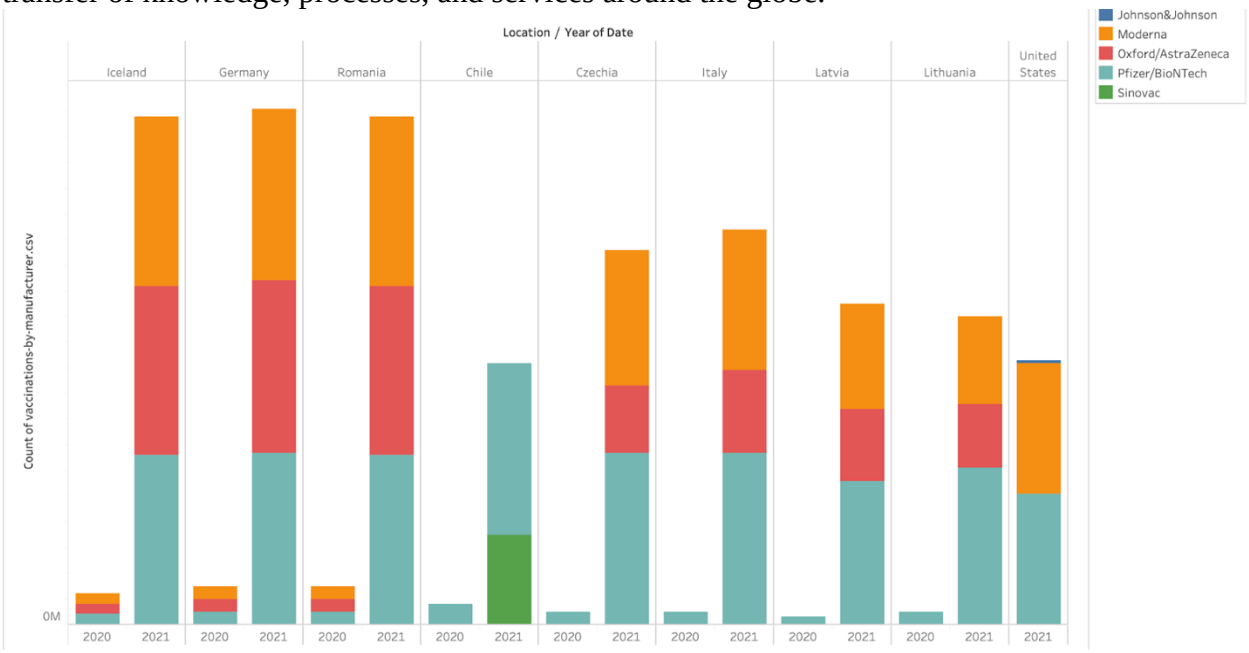

Figure 2. Increase in vaccine manufacturing from the year 2020-2021

Many countries around the world are implementing National Vaccine Programs to combat the spread of COVID-19 as in Figure 3. As of March 2021, the world average daily vaccine administered is estimated to be 1092 per million, with Israel, Chile, and the United States leading vaccination administration (Sivan, 2021).

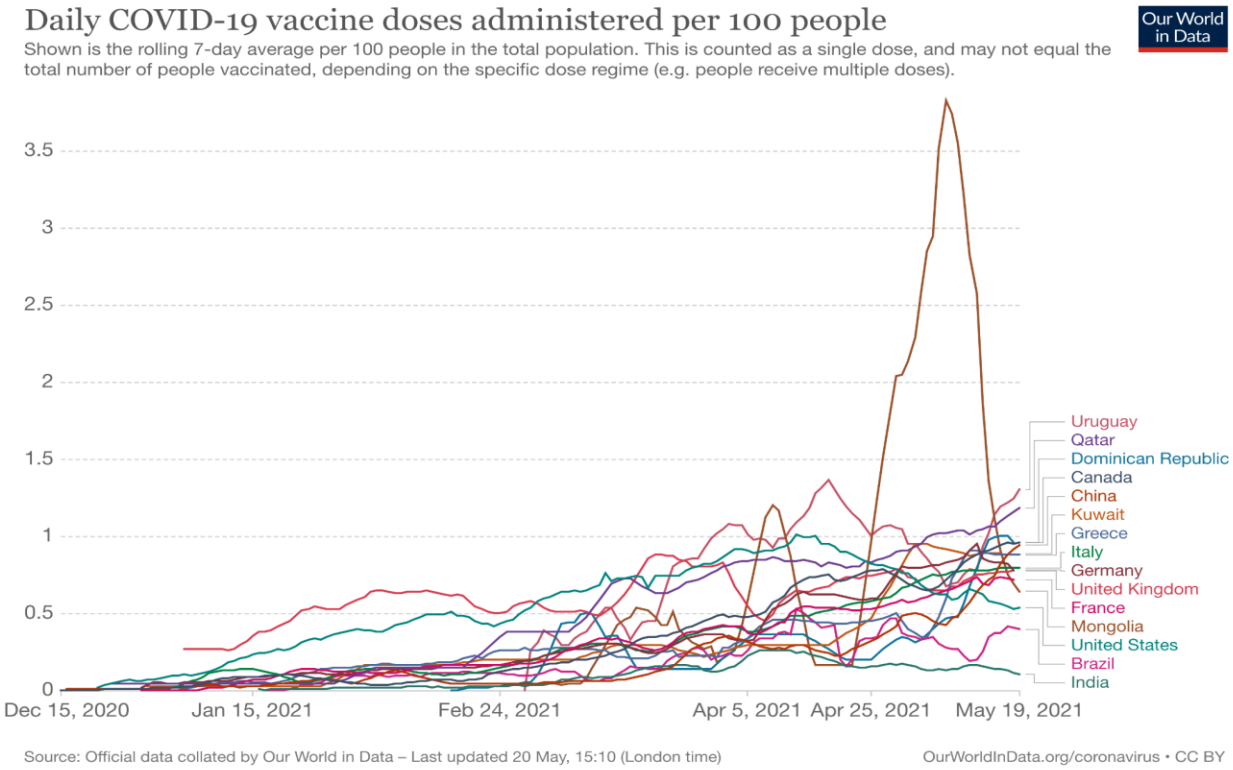

Figure 3. Vaccines Administered per Million Daily, March 2021 (Source: Daily COVID-19 vaccine doses administered per 100 people. (n.d.). Our World in Data).

However, many countries are not in the same situation and vaccine administrations are very slow. As per recent WHO statistics India, Turkey, Poland, Italy, and Ukraine are the top 5 countries where the percentage of COVID-19 deaths are increasing each day as shown in Figure 4 below. These countries are in the most need of vaccines. This research aims to understand the supply chain gaps in India, Turkey, Poland, Italy, and Ukraine.

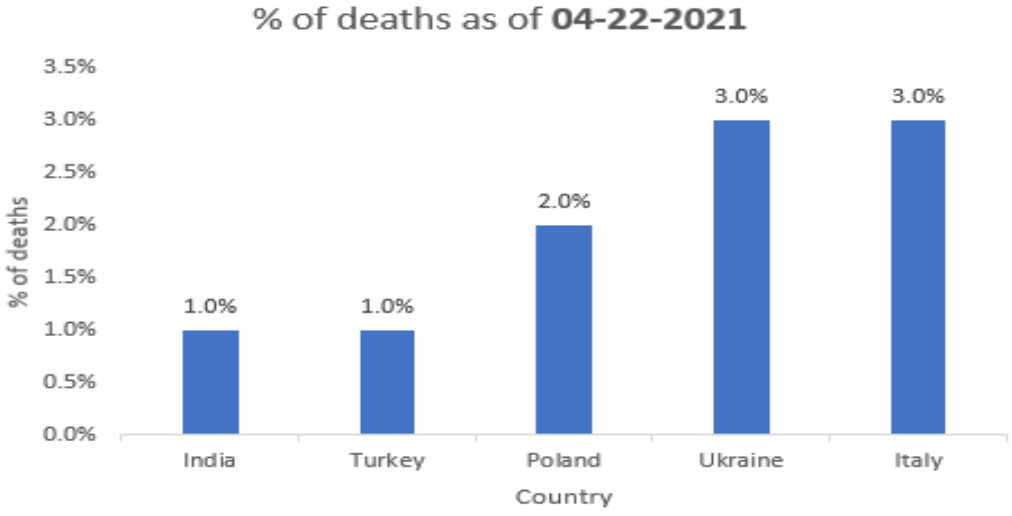

Figure 4. Percentage of deaths as of 04-22-2021 (Source: Coronavirus disease (COVID-19) – World Health Organization. (n.d.). WHO | World Health Organization**)**

Table 2 lists these top five countries with the highest number of COVID-19 related deaths. The COVID-19 vaccine is in higher demand in these countries, but supply is inadequate. Analyzing these countries will help determine the situation with the supply chain and distribution.

	Country	Vaccine	Effectiveness	Deaths
1	India	Moderna	94%	287,101
2	Turkey	J&J, Pfizer	95%	45,419
3	Poland	J&J, Pfizer	95%	72,250
4	Italy	Moderna	94%	124,646
5	Ukraine	Sinovac	70%	48,696

Table 2. Effectiveness of COVID-19 vaccine in top 5 affected countries (source: MNT News Team. (2021, May 10)).

According to the above table, in India & Italy, Moderna shows 94% effectiveness which is the most effective vaccine in both countries followed by J&J and Pfizer that have 94% effectiveness in Turkey and Poland. Ukraine shows 70% effectiveness using sinovac.
Based on COVID-19 deaths and vaccination effectiveness in these countries, cold storage management and supply chain analysis are done and detailed in the next sections.

2.1 India Analysis

In India, the Moderna vaccine has 94% effectiveness. According to a leading epidemiologist Shahid Jameel, the major problem for India will be managing the cold chain depending on the vaccine to be used. There is limited capacity in India to store, let alone transport vaccines to all parts of the country if they require minus 20 degrees Celsius or minus 70 degrees Celcius temperatures. India should go with vaccines that require storage and transport in liquid form (that is, between 4 degrees Celsius and 10 degrees Celsius) and not the ones that have to be kept frozen, India never needed to vaccinate the entire population at one go (Rao, V October 26, 2020).
The government should plan to administer vaccines to 300 million citizens in the first phase of the program or 600 million doses at two injections each. This will include 260 million people over the age of 50, an estimated 10 million people under 50 with severe comorbidities, and 30 million frontline staff who have been exposed to infections. According to ANI news international, India will use 29,000 cold chain points, 240 walk-in coolers, 70 walk-in freezers, 45,000 ice-lined refrigerators, 41,000 deep freezers, and 300 solar refrigerators for the storage of COVID-19 vaccine. It would be simple for the nation to stockpile 600 million doses, each with two injections. Based on this, India will issue a second PO (purchase order) and use supply chain management to maintain inventory, ensuring that everyone in the country is vaccinated within a week. However, this is only possible if India's supply chain gaps, such as cold chain management and IT-enabled supply chains, are fixed (A. 2021, May 20).

2.2 Turkey Analysis

In Turkey, J&J and Pfizer vaccines show 95% effectiveness. The Vaccine/Antiserum Logistics Unit of the Department of Vaccine and Preventable Diseases of the General Directorate of Public Health of the Republic of Turkey deals with the coordinations of antibodies or vaccines, antiserum, syringes, and carrying containers used in preventive health services in Turkey (Republic of Turkey Ministry of Health, 2020).

All vaccines purchased for safety are carefully analyzed and evaluated by the Turkish Medicines and Medical Devices Agency TTCK (Türkiye Ilaç ve Tibbi Cihaz Kurumu) of the Ministry of Health. Only vaccines that pass the TTCK safety tests are approved for use by the general public. COVID-19 vaccines are also subjected to this rigorous testing. Ankara, in Turkey, has a sophisticated, technologically advanced system in place to distribute coronavirus vaccines to millions of people, complete with specialized equipment, tracking numbers, and dedicated infrastructure. Beginning January 12, 2021, Turkey plans to deliver vaccines throughout the country using special storage chambers with air conditioning and temperature controls varying from 20 to minus 20 degrees Celsius (68 to -4 F). The first shipment of the Sinovac vaccine from the Chinese Sinovac company arrived in Turkey on December 30, 2020, containing 3 million doses, and is now being stored in a separate storage facility at the Turkish Ministry of Health in Ankara. Since the immunization showed up, wellbeing authorities have been checking arbitrary examples in labs; if no anomalies are found and the vaccine is supported for crisis use, it will be appropriated by unique service vehicles. At the ministry's central storage in Ankara, more than ten special cold-chamber machines provide ideal distribution environments for the vaccines; these vehicles are environmentally friendly and emit low sound. Since the start of the COVID-19 outbreak last year, the vehicles have been used to transport testing materials, drugs, and samples, and they can be monitored in real-time. As part of the ministry's program, the Ministry of Health will prescribe vaccines to everybody.

Once the vaccines have been distributed to local authorities, they will be stored in cold-chamber vehicles with capacities of up to 13 cubic meters (460 cubic feet) and then transported to vaccination points designated by the authorities. If proper supply chain control is maintained, the entire country can be vaccinated in less than 45 days, according to data from Turkey's cold-chain capacity and initial batches. However, due to an increase in COVID-19 cases, cold storage requirements are posing significant concerns about who will be eligible for the Pfizer vaccine and when it will be available. The fact, according to experts (Ducharme, J. 2020, November 13), is that the Pfizer vaccine will most likely not be available to all in Turkey, at least not right away. The services required for ultra-cold storage are most likely to be found in large medical centers and urban areas. People living in rural areas, nursing homes, and developing countries who do not have access to these facilities may have to wait for other vaccines to progress into the production pipeline. The Pfizer vaccine can be stored for up to six months at -70° C. However, due to their high energy consumption, many hospitals, as well as neighborhood medical offices and pharmacies, lack ultra-cold freezers, which cost about $10,000 to buy and run. This is a major issue in Turkey.

2.3 Poland Analysis

Polish company will develop a vaccine distribution platform with Microsoft (Business Insider Polska, 2021). According to the government's vaccination program commissioner, Poland has received a total of 1,051,000 doses of the COVID-19 vaccine, with 456,000 doses arriving at

hospitals that are part of the distribution network. Michal Dworczyk also mentioned that 50% of the vaccines have been deposited with the Material Reserves Agency to ensure that patients who receive the first dose receive a second dose. “We achieve maximum tolerance only after the second dose, and we don't want patients to be subjected to any logistical problems on the producer's side”, according to Dworczyk (The First News, 11 Jan. 2021). To date, 9,006,539 people have been vaccinated in Poland, which has a population of 37,970,000 people. To get the whole country vaccinated, Poland will require another 28,963,461 vaccinations. As a result, they'll need to keep the supply chain running for the next 28,963,461 vaccines. Poland has a massive vaccine requirement. The Polish government should keep track of the vaccines injected and when to schedule the next shipment's purchasing order. Poland should also concentrate on local distribution in areas where there is no cold chain management, in order to reduce vaccine waste. Poland should re-impose a series of restrictions to combat the wave of infections, including shutting schools, shopping malls, and theatres. Boosting its vaccination drive, less than a tenth of the 38 million population has been inoculated so far Doses should currently be allocated to states proportionally by population. (Huaxia, 2021). Due to a delay in vaccine supply by the European Commission, Poland could only vaccinate seniors aged 60 and up, teachers, military personnel, and first responders after first distributing vaccines to the most exposed people, such as physicians and nursing home employees.

2.4 Italy analysis

The mayor of Cremona, one of the northern Italian towns first hammered by the coronavirus during the pandemic’s initial explosion in Europe, received a call over the weekend that the local vaccination center was empty. The region’s booking system had failed to set up appointments with older residents, leaving more than 500 doses of vaccine at risk of going to waste. Italy's mass vaccination plans are inherently complicated and would almost certainly need to be adjusted. As a result, they are vulnerable to confusion, disinformation, and misunderstanding, all of which may endanger their credibility. Clear and reliable contact from trusted health and medical officials is critical to resolving these challenges and ensuring the vaccination program's success in reducing vaccine waste. The vaccination campaign in Italy started on December 27, 2020, with the distribution of 9,750 doses of the Pfizer–BioNTech COVID-19 vaccine. The COVID-19 vaccination program in Italy is still far from achieving the government's goals, and it slowed even more over Easter. In recent weeks, an average of 240,000 doses per day have been administered in Italy, more than double the amount reported a month ago. However, this is still well short of the stated target of 300,000 a day, and the goal of half a million seems increasingly improbable. Over the Easter weekend, the vaccine program slowed to a halt, with less than 500,000 doses distributed throughout the country in three days. The national government's regional health authorities, on the other hand, should have between 2.3 and 2.9 million doses in stock and ready to go. Italy has administered at least 27,416,033 doses of COVID vaccines so far. Assuming every person needs 2 doses, that’s enough to have vaccinated about 22.7% of the country’s population. More of Italy's regional health authorities have begun allowing people in their 50s to book their first dose of the Covid-19 vaccine (Speak, 2021).

The EU signed a contract in December for 300 million doses of the Pfizer-BioNTech vaccine, which includes a vaccine for Italy as well, but production issues have arisen.

Due to a temporary reduction in deliveries, the vaccine's distribution in Italy has been postponed. Later, the EU increased its order to 600 million vaccines so that countries like Italy would get them

quickly, and the French company Sanofi agreed to help in their production. The Moderna vaccine distribution also ran into issues, with Italy receiving fewer vaccines than anticipated.

2.5 Ukraine Analysis

According to Ukraine's Health Minister Maksym Stepanov, there are sufficient facilities to maintain a cold chain for coronavirus vaccine storage. Ukraine is all set. Ukraine also has refrigeration facilities capable of storing the vaccine at -70°C. Ukraine began its vaccination campaign with 500,000 doses of India's CoviShield vaccine on February 24, 2021, nearly two months after the official launch of the vaccination campaign in EU countries on "V-day," December 27, 2020. On March 9, 2021. 1.9 million doses of China's CoronaVax arrived in Ukraine on March 25. Ukraine is also willing to work with other vaccine manufacturers. Ukraine will receive between 2.2 and 3.7 million Oxford/AstraZeneca vaccine doses as part of the international COVAX program by June 2021, according to the Ministry of Health. The vaccination program in Ukraine is currently moving at a snail's pace. The Ukrainian vaccination campaign must deal with 47 percent of Ukrainians who are not ready to be vaccinated, according to research conducted by the Kharkiv Institute for Social Research, in addition to an inadequate number of doses required, as estimated by a Ministry of Health that was behind the times. Ukrainians cite fear of side effects, the dubious safety of “hurriedly” manufactured vaccines, the expense which 51 percent of Ukrainians are unwilling to pay, and, last but not least, the country of origin as reasons for delaying or refusing to get the shot. In the battle to stop the spread of the coronavirus, the country has faced various obstacles. The Ukrainian government has also done little to introduce a comprehensive contact monitoring and tracing program, the lockdowns were introduced too late and with insufficient vigilance, and new, more infectious strains of the virus are now spreading throughout the world. Moreover, immunization has as of late become accessible to Ukrainians however, many seem skeptical of antibodies and decline to take them in any event, when they become accessible. Ukraine should begin working with federal, tribal, territorial, and local partners, as well as other stakeholders and the general public, to share public health knowledge about the vaccine, both before and after it is distributed, to boost vaccine trust and uptake. The government should prepare to carry out vaccines using an information technology (IT) system capable of supporting and tracking distribution, administration, and other necessary data, but due to a shortage of Covid-19 vaccine, the Ukrainian government is unable to vaccinate the entire population (Holt, 2021).

3. Findings

According to the analysis done above for the countries, five main key elements are listed below to fulfill the gaps in the supply chain to make the vaccine available to every citizen of the country.

Cold Chain Management

Building Network

IT Enabled Supply Chain

Vaccine Data Recording using Tiberius, VTS, or The Teach group

Third-Party storage and shipments

These five key elements are evaluated according to the research done and categorized in two levels :

Needs Improvement - key element does not meet vaccine expectations or requirements but can be rectified with specifically identifiable and reasonable interventions.

Fair - The key elements meet vaccine expectations or requirements in accordance with the rules or standards.

		India	Turkey	Poland	Italy	Ukraine
1	**Cold Chain Management**	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement	Fair
2	**Building Network**	Needs Improvement	Fair	Fair	Needs Improvement	Fair
3	**IT Enabled Supply Chain**	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement
4	**Vaccine data recording using VTS, or Teach Group**	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement
5	**Third-Party Storage % Shipments**	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement	Needs Improvement

Table 3. Gaps in the supply chain of vaccines in India, Turkey, Poland, Italy, and Ukraine.

According to Table 3, India, Turkey, Poland, Italy, and Ukraine must improve their IT-enabled supply chains, vaccine data recording, and third-party storage shipments. In contrast to India and Italy, Turkey, Poland, and Ukraine are doing a fair job of developing networks. A Polish corporation, for example, is in talks with Microsoft about developing a vaccine distribution platform. According to Ukraine's Health Minister Maksym Stepanov, Ukraine also has the best cold chain management of any region (UNICE 2021, February 22).

Cold chain management is the most challenging task in vaccine distribution. Countries such as India, Turkey, Poland, Italy, and Ukraine should get prepared with the capacity to store and transport vaccines to their all parts and be mindful to maintain required temperatures between minus 20 degrees Celsius and minus 70 degrees Celsius.

Building a network perspective is evaluated by county. India and Italy should build a network of public-private and public-public partnerships, identifying and securing access to required physical logistics infrastructure, establishing IT-enabled supply chain transparency, and establishing organizational structures and allocating resources to institutionalize and coordinate the entire response management, including plan, partners, infrastructure, and IT are all tasks that must be accomplished.

From the time they are bottled until they are ready to be injected into patients' arms, a number of the leading COVID-19 vaccines under production will need to be held. Temperatures as low as minus 80 degrees Celsius have been reported. That isn't going to be fast. Vaccines can be produced in one continent and transported to another. They'll travel from one logistics hub to the next before arriving at the hospitals and other facilities where they'll be administered.

IT-enabled Supply Chain meaning the monitoring, storage, and distribution of millions of doses of the COVID-19 vaccine is a massive task that necessitates a variety of IT resources to coordinate and sustain fluid supply chains.

India, Turkey, Poland, Italy, and Ukraine Governments should use barcodes to help healthcare providers cope with the unprecedented rapid development, distribution, and administration of COVID-19 vaccines. The data should be fed into the government's Vaccine Operations Center in each country using software such as Tiberius, designed to register vaccine orders and track vaccinations. Tiberius goes so far as to crunch the numbers on population prioritization, such as recipient age, to figure out which states in a nation need how many vaccines at each point of the implementation.

End-to-end resource control is critical since all formulations of the vaccines so far require two doses separated by at least three weeks. Providers must be able to determine how many doses are available and monitor vaccine effectiveness and potential patient side effects after vaccination.

Vaccination data recording is another element to fulfill gaps. Countries can also start using the Vaccine tracking System (VTS) and The Teach group. VTS is a system that codes each dose and tracks real-time dose stock levels and temperatures accordingly. The VTS is in charge of the vaccines that are delivered to each healthcare facility after they have been approved. As a result, VTS avoids vaccine delays, monitors and records the vaccine, and quantifies which vaccine is administered to which person by which healthcare provider. This method eliminates the use of expired vaccines and allows for the detection and treatment of any potential side effects. VTS keeps track of the temperature and stock levels of each dose of vaccine and antiserum in real-time (24/7 live) in all logistical stations, from warehouses to delivery vehicles and refrigerator cabinets to healthcare professionals prescribing to specified individuals. It's a user-friendly cold chain quality system that alerts and directs them.

Teach groups to help to maintain a record of vaccines, pharmaceutical distribution to government healthcare administration, healthcare workers, and patients would be able to communicate easily and accurately. If a new shipment of vaccine arrives in transit, for example, the pharmaceutical company would notify the government, which would then notify each state. States would then notify hospitals of the shipment's details, and hospital administrators would inform staff of the shipment's arrival date. Finally, healthcare workers would inform the next prioritized group of patients about when they should come in for the vaccine.

Third-Party Storage Shipments needs improvement for all five countries. India, Turkey, Poland, Italy, and Ukraine should use third-party storage shipment as they are the most common and efficient means of transporting goods between continents, but vaccine standards are simply impossible to meet in such an environment. The only other choice is to fly, which is very expensive. In the next two years, up to 200,000 pallet shipments, 15 million cooling box deliveries, and 15,000 flights will be needed through various supply chain setups to provide global coverage for COVID-19 vaccines. Intermediate transportation, intercontinental shipment, warehousing, downstream delivery, and final short-term storage at the point of use are all possible bottlenecks in the main supply chain.

4.Discussion

Further research could be done on how to collaborate and cooperate with domestic and international public health partners to develop and enforce a mechanism for the ethical and equitable global distribution of COVID-19 vaccines in order to reach every person. Regardless of discrepancies in foreign, federal, state, and local health strategies, regulatory systems, and practice models, a concerted effort to ensure universal global vaccination is required to contain COVID-19 and limit the continued destruction of public health, economies, and geopolitical ties. To synchronize lines of action and ensure a successful mass immunization program, effective communication, cooperation, and coordination with government agencies, public health groups, regulatory agencies, and health departments are crucial.

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