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Issues related to distribution of the COVID-19 Vaccine in sub-Saharan Africa

An Insight

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Abstract
Distributing the COVID-19 vaccine equitably on a global scale brings unprecedented challenges. This paper explores some of the challenges, focusing on Africa specifically, and mainly on land transport from point of arrival in Africa.

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Cover image: A community health volunteer cycling to provide emergency transport services to the community, Transaid/ Toby Madden

ACRONYMS

AMC	Advance Market Commitment
CEPI	Coalition for Epidemic Preparedness Innovations
CHW	Community Health Worker
COVID-19	Novel Coronavirus
Gavi	Global Allied Vaccine Alliance
iCCM	Integrated Community Case Management
LIC	Low-Income Countries
LMIC	Lower- and Middle-Income Countries
MoH	Ministry of Health
mRNA	Messenger RNA
ODA	Overseas Development Assistance
PPE	Personal Protective Equipment
SSA	Sub-Saharan Africa
UBP	Union Bancaire Privée
WHO	World Health Organisation

Background

Distributing the COVID-19 vaccine equitably on a global scale brings unprecedented challenges. This insight piece explores some of the challenges, focusing on Africa specifically, and mainly on land transport from point of arrival in Africa.

COVID-19 requires a global solution and Africa faces unique challenges when it comes to a vaccination programme on this scale. These challenges include procurement, storage and distribution of vaccines as well as creating trust and transparency in the system. Only a few countries in sub-Saharan Africa are likely to be able to purchase the vaccine themselves, directly with the vaccine manufacturers. Most countries will likely depend on receiving the vaccine through the COVAX initiative[1], led by the Global Allied Vaccine Initiative (Gavi), the World Health Organisation (WHO) and others who are working to ensure vaccines are available to low-income countries (LICs). Gavi aims to have two billion doses by the end of 2021 at "relatively low cost" via the COVAX commitment.

There are different ways for governments to invest in COVAX to secure vaccines. According to Gavi, all countries can apply for funding that covers 10 to 50% of their population. Initially countries will only be approved for a maximum of 20% of their population to ensure that all countries have access to a minimum volume of vaccines. Countries can agree to take part in COVAX until the 18th September 2021 and must make any partial upfront payments by the 9th October 2021. This COVAX facility aims to ensure equal access to COVID-19 vaccines and is available for all countries. At time of writing, 78 higher-income countries have applied.

An additional option for lower- and middle-income countries (LMICs) is the Gavi COVAX Advance Market Commitment (AMC), which aims to support equal access for (92) countries who are not able to self-finance the necessary quantity of vaccines. For LMICs there are estimates that the cost-share requirement will be in the region of US$1 to US$1.60 per dose. US$1.60 is said to be equal to approximately 15% of the full vaccine dose price (US$10.67).

Funding for LMICs is primarily made available by the Official Development Assistance (ODA), the private sector and the philanthropic sector. There are approximately 250 candidates for COVID-19 vaccines in various stages of development. There are several vaccines which are going through phase three clinical trials and are being considered for emergency approval by some governments. Table 1 lists the leading vaccines as of 11th January 2021. Pfizer-BioNTech has received emergency approval by the WHO and is currently being used in a number of countries. The Moderna, Gamaleya, Oxford-AstraZeneca, CanSino, Vector Institute, Sinopharm, Sinovac, SinoPharm-Wuhan and Bharat Biotech vaccines have also been distributed for emergency or limited use. Experts are suggesting that vaccines may not be readily available in Africa until the end of 2021[2].

Table 1: Leading vaccine candidates as of 11th January 2021[3]

Developer	Phase	Status
Pfizer-BioNTech	2 - 3	Approved in Saudi Arabia and other countries
		Emergency use in U.S., E.U., other countries
Moderna	3	Emergency use in U.S., E.U., other countries
Gamaleya	3	Early use in Russia
		Emergency use in Belarus, other countries

[1] COVAX is co-led by Gavi, the Coalition for Epidemic Preparedness Innovations (CEPI) and WHO. Its aim is to accelerate the development and manufacture of COVID-19 vaccines, and to guarantee fair and equitable access for every country in the world. WHO together with Gavi, the Vaccine Alliance, Coalition for Epidemic Preparedness Innovation and other partners is working to ensure equitable access to vaccines in Africa through the COVAX facility, the vaccines pillar of the WHO Access to COVID-19 Tools Accelerator

[2] https://www.gavi.org/vaccineswork/covax-explained

[3] https://www.nytimes.com/interactive/2020/science/coronavirus-vaccine-tracker.html COVID-19 Vaccine Tracker

Developer	Phase	Status
Oxford-AstraZeneca	2 - 3	Emergency use in Britain, India, other countries
CanSino	3	Limited use in China
Johnson & Johnson	3	
Vector Institute	3	Early use in Russia
Novavax	3	
Sinopharm	3	Approved in China, U.A.E., Bahrain
		Emergency use in Egypt
Sinovac	3	Limited use in China
Sinopharm-Wuhan	3	Limited use in China, U.A.E.
Bharat Biotech	3	Emergency use in India

Public trust and effective community engagement strategies

Public health experts advise that the majority of people need to be vaccinated for the vaccine to work effectively. People need to want to take the vaccine and understand the benefits it will bring to them, to their families and communities. Over the past few years, there has been a growing surge against vaccinations. Given the speed with which the COVID-19 vaccines have been developed, people are already raising concerns about the safety and efficacy of these vaccines. Engaging people to receive the vaccines also requires consideration for local context and has to be done in a sensitive and appropriate way, building trust and transparency and thereby increasing demand for the vaccine.

We have seen from the Ebola Virus outbreak that people can quickly lose trust in a vaccine[4]. Consideration must be given to a possible lower understanding or awareness of COVID-19 in some contexts. There is limited value in developing COVID-19 vaccines and distributing them globally, especially to rural and hard-to-reach locations, if there is no uptake of the vaccination. This will result in vaccine stock expiring in health facilities, district hubs and central warehouses.

Vaccine characteristics and considerations

The nature of the initial COVID-19 vaccines available create the biggest challenges both in terms of maintaining stability given their cold chain requirements and the need for multiple dosing. Both Pfizer and Moderna are based on messenger RNA (mRNA) and require storage and transport at cold temperatures and require two doses, several weeks/ months apart.

The Pfizer Vaccine requires ultra-cold chain where there would be a requirement for long-term storage at -70°C to -80°C. This requires specialised storage and distribution capability that many countries do not have. Other front runners like Moderna and others offer a significant improvement but still require a robust cold chain of +2°C to -8°C. The Oxford-AstraZeneca vaccine can be stored, transported, and handled between +2°C to +8°C for at least six months.

These vaccines will likely be imported into Africa via air, initially at least. Dry ice will be required to transport some of the vaccines which will limit the volume being transported. The airlines bringing the vaccines into the country will need this capability to transport at these temperatures. DHL and McKinsey have estimated that circa 15,000 flights will be required globally. Pfizer have recently advised that they would take responsibility for the transport of vaccines to the countries to ensure the cold chain is maintained. It would also be wise to

[4] https://www.thelancet.com/journals/laninf/article/PIIS1473-3099(19)30063-5/fulltext

start developing alternative logistics routes and equipment, considering ocean moves with in-land cold chain land transport.

National medical supplies agencies will need a skilled workforce to operate and manage specialised vehicles to transport the vaccine. Temperature-sensitive products can easily get damaged during transport. National agencies will also need to have access to local suppliers who can swiftly and effectively maintain specialised vehicles.

Adequate transportation and storage capacity in-country will also be required at a national level. A robust cold chain will be required which includes solutions at the last mile and an ability to store vaccines and maintain their temperature. In parts of sub-Saharan Africa only 28% of health facilities are estimated to have access to reliable electricity[5].

Key to an effective cold chain is robust temperature monitoring to provide security and confidence. The commonest failure of all is products falling out of safe storage temperatures for too long and rendering the vaccine ineffective. There are challenges that can be expected at the last mile and also with systems and training. The simplest way to monitor temperature control is through temperature record books and a thermometer. However, inexpensive probes can also be used to accompany products through the whole journey providing whole lifecycle traceability of the temperature journey of the product.

Companies around the world are looking at a range of solutions – dry ice cooled boxes with thermal sensors, investment in solar-panelled fridges etc. Some of these solutions are already in place and are used for routine immunisation programmes aimed at children. It is likely that these will need to be scaled if the vaccines arrive in-country on the scale that is currently being planned (note there is still a funding gap for the current scale planned).

Unfortunately, there is very little experience with mRNA vaccines to date. In addition, COVID-19 vaccines are being developed and approved in record time. Therefore, there are limited stability studies available. We currently know that Pfizer defines -70°C and 5 days at 2 to 8°C, Moderna defines -20°C and 30 days at 2 to 8°C and Oxford-AstraZeneca defines 2 to 8°C for six months. Although the required initial temperatures pose great challenges, the permitted storage time at 2 to 8°C sounds promising. However, storage outside of the freezer is problematic and can be difficult to manage. Regarding the freezers for the Ultra Cold Chain, freezers can only be open for a minute at a time and can take one hour to reset after opening.

The multiple dosing (taken several weeks apart) will add another layer of complexity, requiring two points of contact with people being vaccinated and increased data management. People need to come back, indicating a need for a recording and tracking system. Tracking who has been vaccinated will require due consideration, especially for migrant or highly mobile populations. This is likely to be more challenging in fragile and conflict affected states or in countries where issues of national identity are complex for a range of reasons. Some countries have taken the decision to delay the second dose and focus on administering the first dose to larger numbers of vulnerable people to provide a level of immunity.

Another challenge with the multiple doses (in conjunction with the storage considerations) is the distribution/ redistribution of vaccines, especially if there are not enough vaccines in the country allocations. There are also issues that once vials have been opened, they have to be used within a certain period of time. There may be opportunities to leverage emergency transport systems that are already in place to support these efforts.

It is the nature of viruses to mutate. At the end of 2020, COVID-19 variants were being identified. Variants were identified in the United Kingdom, South Africa, Japan and Brazil that were found to have much higher transmission rates, although they were not found to be more virulent. The vaccines under emergency approval are currently believed to work against these variants. However, it is likely that COVID-19 will keep mutating and multiple vaccinations may be required as they are developed in response to new variations. We are still to learn more on how the vaccine reduces the viral load in people and how it will help with reducing transmission to others. If new variations of the vaccine will be developed, the recall of ineffective or less-effective vaccines and the redistribution of new vaccines will be a significant logistical and supply chain challenge.

[5] https://poweringhc.org/about-us/

Last mile and reaching rural communities

Ensuring that essential medicines reach rural communities is already a significant challenge in many countries. Transport and distribution challenges from the central medical stores onwards are often cited reasons for stock-outs at health facility level. Transport availability from the district level to rural health facilities can often be limited and consideration needs to be given to areas that are not accessible by conventional 4-wheeled vehicles, or where access is not possible due to regular flooding etc. There is likely to be a need for investment in refrigerated vehicles, cold chain packaging and investment in tracking and visibility tools. Innovation will be required and consideration to the possible use of bicycles, motorcycles, boats and drones for hard-to-reach areas.

Reaching the last mile in the pharma supply chain is already a challenge in many parts of Africa. COVID-19 has made this situation increasingly challenging with efforts and funding being diverted. Transaid has found that 84% of health facilities surveyed in rural Zambia in July 2020 were experiencing stock related issues that they attributed to COVID-19[6].

Vaccination campaigns are often targeted to specific populations – for example taking place in child health week or involving mass vaccination programmes at schools and other such locations. Such programmes often require health workers to travel by bicycle or motorcycle with a cool box to re-stock at the health facility after each round. There are examples of where this has been done well for the routine immunisation of schoolchildren, but there is no precedent for adult immunisation on this scale.

Gavi points to some of these challenges, drawing on experiences from the donation and distribution of a new vaccine during the 2009 H1N1 influenza pandemic. Gavi reminds us that in many countries, immunisation systems were geared entirely toward vaccinating young children, which meant health workers had difficulty providing vaccines to the health care workers, pregnant women, elderly adults, and immune-compromised adults who were also considered at high risk from influenza[7]. COVID-19 will likely require an initial focus on vulnerable populations including the elderly and those with underlying health conditions[8].

The assembly of vulnerable groups raises concerns as it may put them at risk to other infections and their mobility may be a challenge. As a result, an increased number of door-to-door visits may be required or use of mobile clinics. Healthcare workers will also be a priority vaccination group, however even this priority target group for the COVID-19 vaccine is quite different to most current vaccinations that are targeted at children. Appropriate consideration to this factor is required.

The circumstances of implementing a mass vaccine campaign during a pandemic also requires special consideration. There are significant risks when carrying out a vaccine campaign or sensitisation campaign that draws large crowds when considering the risk for infection. Safe techniques for conducting vaccine campaigns must be considered. In cases where mass vaccination campaigns are too risky, the resources required for an alternative approach such as door-to-door campaigns may need to be considered. This will require equipping health workers with the capacity to transport the vaccine at the necessary storage requirements. WHO has specific guidance on vaccination campaigns during a pandemic[9].

Skilled workforce to administer the vaccines on an unprecedented scale

In many countries in Africa, government protocols do not allow community health workers to administer vaccines, these must be done by a health worker with specialised training. Even with this specialised training, several of the COVID-19 vaccines present additional challenges. For example, those that have a requirement to be removed/ unpacked from ultra-cold chain refrigeration or those that require mixing it in-situ. Health workers should also be equipped with the necessary personal protective equipment (PPE) to prevent the spread of infections to health staff, who could further spread the infection during vaccination activities.

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[6] MAM@Scale, 2020, MAM@Scale Midline Survey Report, July 2020 compiled by Tendayi Kureya et al

[7] https://www.gavi.org/vaccineswork/why-delivering-covid-19-vaccines-might-be-just-hard-developing-them

[8] It is worth noting that some countries, e.g. Indonesia are taking a different approach and targeting younger working populations first in order to keep the economy going

[9] https://www.who.int/publications/i/item/WHO-2019-nCoV-Framework_Mass_Vaccination-2020.1

Identifying which vaccines are considered adequate for the sub-Saharan Africa (SSA) context is therefore crucial. Distribution and implementation programs must also consider the creation of additional training materials and sessions. The WHO has already designed and released several materials to support this including an open access "COVID-19 vaccination training for health workers".

New partnerships

Developing new partnerships with the private sector/ logistics service providers who can complement existing capabilities is likely to be required. Union Bancaire Privée (UBP) are already collaborating with Gavi and COVAX for example.

DHL has produced a useful white paper on Delivering Pandemic Resilience[10] which discusses the need for new partnerships. They identify inbound logistics and distribution as major supply chain pain points. They also suggest that looking ahead, governments will need to improve the medium- and long-term resilience of their supply chains in preparation for future crises.

Potential bottlenecks

During the COVID-19 induced PPE shortages, governments faced a range of different transport challenges. In the race to source PPE, a push-based sourcing approach predominated to ensure volume. This resulted in unpredictable supply in terms of volume, quality and delivery time. In the current pandemic, researchers are focusing on safety and efficacy but also seeking fast track approvals for their vaccines in order to ensure timely delivery and adequate need.

It will be important to map out the logistics requirements and identify potential bottlenecks along the whole supply chain – from intermediate transport, intercontinental shipment, warehousing, downstream distribution, and final short-term storage at the point of use. The challenges will be different along the supply chain and contextual factors will need to be considered.

Given the urgency of the pandemic, vaccines will likely be transported via air freight for longer distances. To ensure global coverage for the next two years, DHL estimates that some 200,000 movements by pallet shippers on 15,000 flights may be needed. In downstream distribution, accommodating the stringent temperature requirements will be even more challenging, though for a different reason. Downstream, the lot size decreases substantially. This poses three operational challenges.

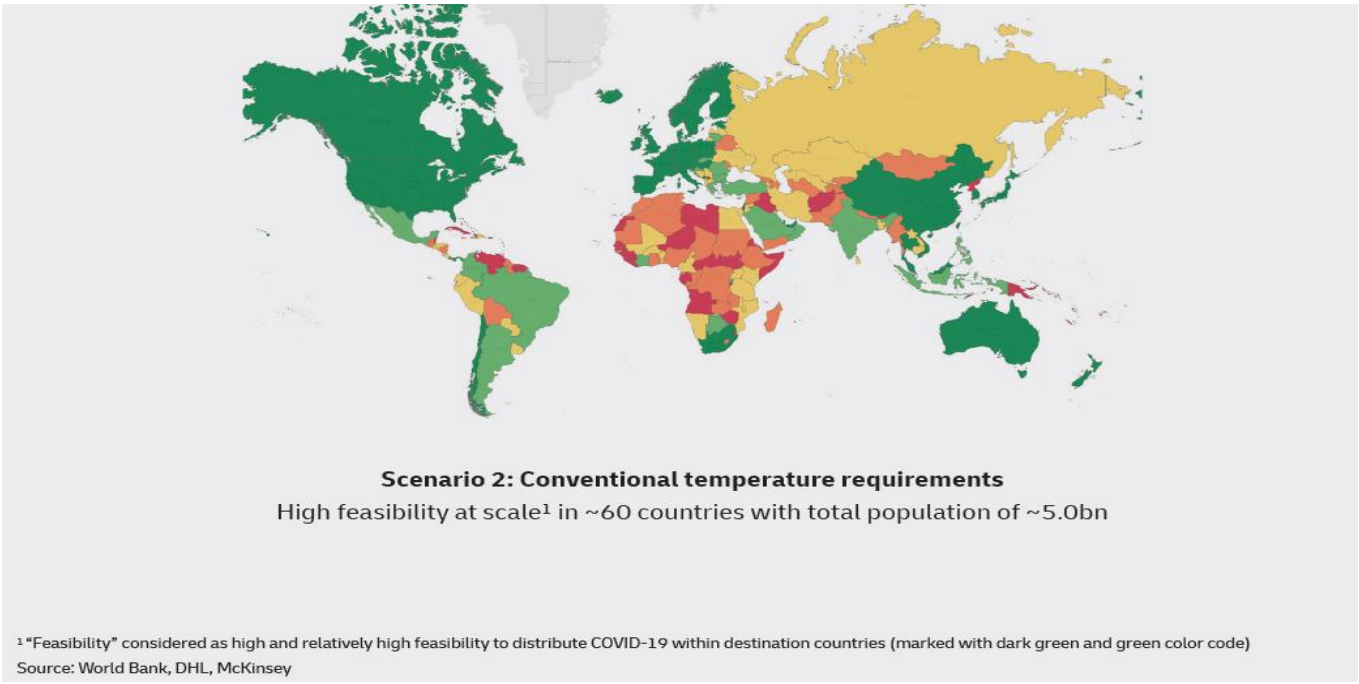
First, the **sheer number of shipments** – amounting to nearly 15 million cooling boxes – paired with the required volume of cooling bricks or dry ice is an overwhelming volume. Both the availability of suitable packaging as well as the maximum-allowed quantities of dry ice in air cargo transport could potentially limit shipment possibilities in certain cases if the preparations are not made in time.

Second, **ensuring consistent temperature management** (in a way that avoids damage to the vaccines throughout the last-mile network) is much more complex for ~50 boxes/ parcels than it is for one pallet shipper. Chain of custody is likely to be an issue with the potential for theft and hacking.

Third, the **physical handling of ultra-deep-frozen shipments** requires special equipment (such as gloves) and processes to avoid injury. This means that a large number of couriers and consignees need to be informed or even trained. This is unlikely to be a realistic option in SSA.

[10] https://www.dhl.com/content/dam/dhl/global/core/documents/pdf/glo-core-delivering-pandemic-resilience-2020.pdf

Figure 1: Global conventional temperature requirements



Delivering to the last mile in line with conventional transportation requirements (assuming sufficient shelf life at +2 to 8°C) is much more feasible; it allows for a more efficient distribution to end users globally since transport can rely on available capabilities and capacities, as well as prior experience and knowledge. However, even when leveraging existing infrastructures, the share of the world's population with good access to a vaccine only increases to ~70%, reaching a total population of ~5 billion in ~60 countries. Feasibility for supplying substantial parts of Africa remains low due to high outside temperatures and limited cold chain infrastructure. It is therefore important to consider innovative transportation modes to reach populations in less accessible regions.

Strengthening and building resilience in the cold chain

Whilst we recognise that COVID-19 will require swift and targeted responses, we must not waste the opportunity to build resilience in the supply chain and the cold chain for pharma grade products. This also includes building a strong network of partners from the Government, Not for Profit and private sector. Lessons learned from the start of COVID-19 crisis have demonstrated that effective partnerships with the private sector (manufacturing and supply chain) are important.

A recent WHO analysis[11] assessed Africa's "readiness" for what will be the continent's largest ever immunisation drive. All 47 countries in the WHO African Region received WHO's Vaccine Readiness Assessment Tool which was intended to be used by Ministries of Health (MoH), with support from WHO and UNICEF. It provides a roadmap for countries to plan for COVID-19 vaccine introduction and covers 10 key areas:

- Planning and coordination;
- Resources and funding;
- Vaccine regulations;
- Service delivery;
- Training and supervision;
- Monitoring and evaluation
- Vaccine logistics;

[11] https://www.afro.who.int/news/who-urges-african-countries-ramp-readiness-covid-19-vaccination-drive

- Vaccine safety; and
- Surveillance and communications and community engagement.

Forty countries have updated the tool and provided data to WHO. Analysis has found that based on the self-reports by the countries, the African region has an average score of 33% readiness for a COVID-19 vaccine roll-out, which is well below the desired benchmark of 80%.

WHO analysis of the country readiness data finds only 49% have identified the priority populations for vaccination and have plans in place to reach them, and 44% have co-ordination structures in place. Only 24% have adequate plans for resources and funding, 17% have data collection and monitoring tools ready, and just 12% have plans to communicate with communities to build trust and drive demand for immunisation.

Consideration must also be given to monitoring and evaluation activities. Whilst thorough reviews have been undertaken on the safety and efficacy of the vaccine, there have been no studies performed on potential long-term effects of the vaccine. Populations should therefore have a way to easily report side effects in a way that can be escalated to drug safety boards, especially as limited clinical trials in Africa have taken place.

Considerations going forward:

A locally led response will critical:

- What support does the Ministry of Health and central medical stores need and want?
- What support would national governments prioritise? – training/ capacity building for supply chain workforce? Training more Community Health Workers (CHWs) to administer vaccines (where protocols allow?) - CHWs and Integrated Community Case Management (iCCM) volunteers usually have strong relationships with their communities. Supply chain design support that also considers innovative models for last mile distribution. Track and trace and data management. Potential to partner with Humanitarian Procurement Centres (e.g CHMP in Kenya, endorsed by ECHO).
- How will people in fragile and conflict affected states be reached and how will this be managed for people who have no official national identity. Tracking who has been vaccinated will bring its own challenges (app-based solutions are being explored but are not likely to provide universal coverage).
- What lessons can be learned from previous successful health initiatives/ campaigns at national/ regional levels that have placed considerable focus on community engagement and capacity building at the district health management team level as well as looking at what building blocks are required for ensuring medicines/ vaccines reach people living in rural communities.
- Mapping of capacity in more detail (building on WHO's work) and working with national governments on identified gaps especially in the supply chain.
- Effective community engagement will be essential to create awareness of the vaccine, public trust and demand.

Anticipate and plan for bottlenecks and challenges:

- If the vaccines do arrive in large volumes in-country, there are likely to be bottlenecks at several points in the supply chain (for example allocations of vaccines, supply/ demand mismatch, allocations in-country, transportation into country, cold chain requirements, limited volumes on airplanes due to dry ice, storage facilities especially if ultra-cold-chain, dispensing the vaccine (both because of multi dose and because of viability of vaccines once vials have been opened).
- Cold chain capability usually becomes more challenging the further along the supply chain (towards the end-user).
- The last mile is likely to be most challenging and in rural areas will likely require thinking about a range of transport solutions to reach all communities.
- There may be a need for more household visits as the people most at risk from COVID-19 are often older people or those with pre-existing medical conditions and to avoid mass campaigns that may spread infection.

- Consideration needs to be given to who can administer the vaccine. Some countries are already looking at training up the people who can administer the COVID-19 vaccine. Different countries in Africa will have different policies around this.

Develop new partnerships to support the MoH:

- What will be the role of the private sector – what does the market capability look like and how can the COVID-19 immunisation catalyse new partnerships to strengthen the public health supply chains in Africa? How will the private sector be incentivised and paid?
- There will be a mix of different vaccines going to the LMICs based on availability and therefore there will be different storage and distribution models.
- Several organisations are looking at the use of drones for last mile delivery. Examples of drones that have moved vaccines previously include Wingcopter, Zipline, Swoopaero. This may make sense where time is of the essence.
- Support to governments and local markets to develop this capability and build resilience for future shocks.

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