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The Necessity and Insufficiency of Regional Vaccine Supply for Sustainable Health Outcomes?

BSMA Conference, Kigali, Oct 31-Nov 1, 2022

Nico Vandaele, Catherine Decouttere, Charlot Diepvens, Donovan Guttieres

Junior Ocira, Eki Ramnaps, Robin Kelchtermans, Carla Van Riet, Lise Boey

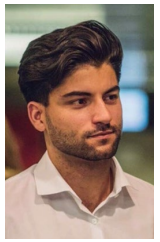
Access-To-Medicines Research Center

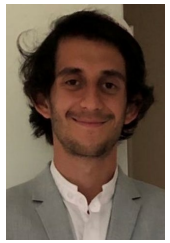
“Develop, disseminate and apply transdisciplinary, human-centered systems thinking to health system design and modeling in a global collaboration in the Access-To-Medicines field.”


Carla


Kim


Catherine


Laurent


Donovan


Grace


Nico


Robin


Stany


Charlot

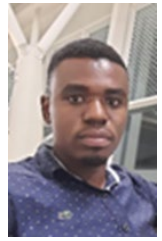

Paulina


Lise


Junior


Eki

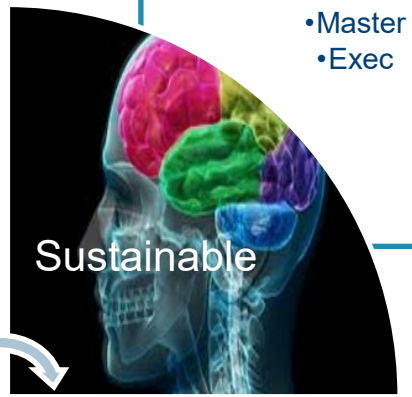

Tarun


David

- Research
- Courses
- Field work

- PhD
- Master
- Exec

A baby receives a dose of the rotavirus vaccine in Nicaragu
Credit: Gates Foundation

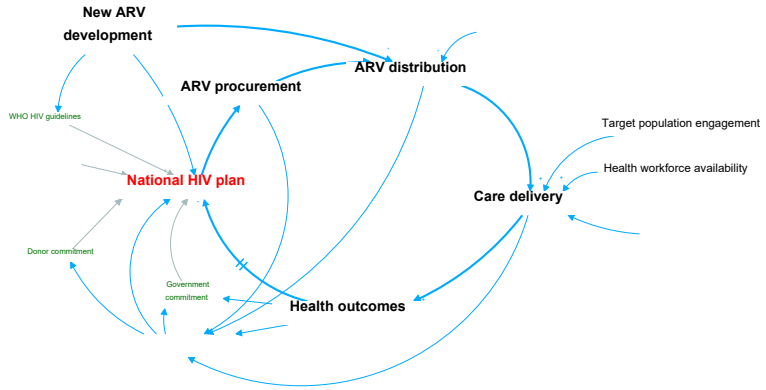


- Academic
- Public, NGOs
- Private
- EU countries
- Central Asia

- Rwanda
- South-Africa
- Kenya
- Tanzania
- Uganda

- Research
- Advocacy
- Field research
- Expert role
- Modeling

Health System (Re-)Design:
Human-Centered Systems Thinking & Design Thinking

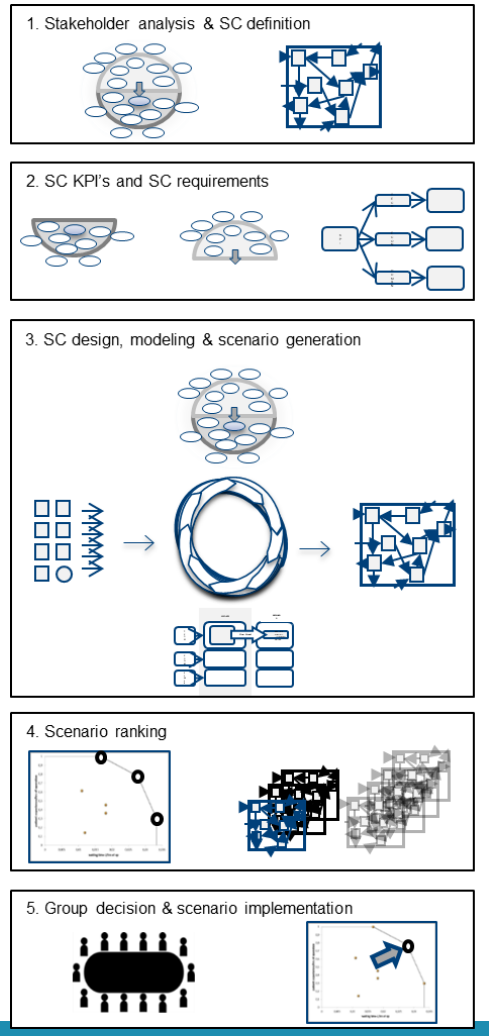


Systems Thinking

Human Centered

System Design

Design Thinking



C. Decouttere, N. Vandaele, S. Lemmens and M. Bernuzzi, '**The Vaccine Supply Chain Multathlon: the Reconciliation of Technology, Economy and Access to Medicines**', Advances in Humanitarian Operations, C. Zobel, N. Altay and M. Haselkorn, Springer (ISBN 978-3-319-24418-1), 205-227, 2016.

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Health System Re-Design: Access-To-Medicines' Projects

System thinking: prevention vs response

Childhood Immunization Sypply Systems Access	Multi-protection Yellow Fever/Rabies Climate, Zoonoses	HIV Long Acting Injectable, Vaccine, Resistance	Pathogen 'X' Lassa, Nipah, MERS, RVF, CHIKV	Covid-19 Antivirals, Vaccine, Allocation, Hesitancy	Pandemic Preparedness	Living Models & Tools Dynamics in Context, Data, Agents
EU, Rwanda, Kenya, Madagascar, Tanzania	Kenya	Kenya, South-Africa, Tanzania, Botswana	W-Africa, SE-Asia, M-East	Global, EU, Norway, Germany	Global, EU, Sub Saharan Africa	Overarching
Catherine, Kim, Stany, Carla, Leen, David	Catherine, Laurent	Paulina, Catherine, Lise	Carla, Junior, Eki, Catherine	Carla, Kim, Robin, Catherine, Lise, Grace	Catherine, Charlot, Donovan	Robin, Catherine

Human centered: behavior

System thinking: prevention vs treatment

➔ Up and Down to the Last Mile and far beyond

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Sections

Background & Lessons from COVID-19

Regional manufacturing in Africa

Manufacturing as part of a larger system

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Background & Lessons from COVID-19

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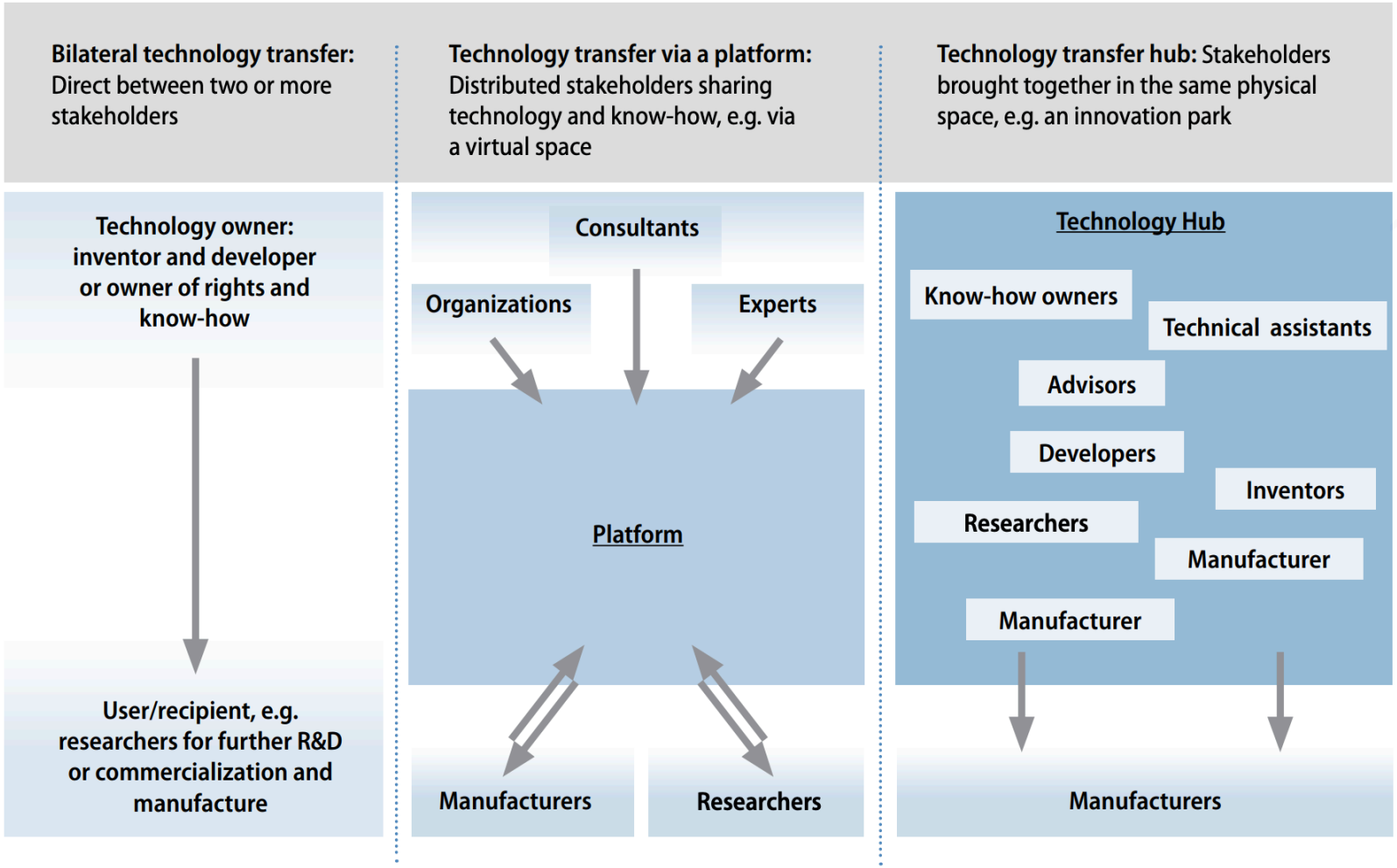
Overview

- Vaccine manufacturing is concentrated to a **few regions**
- **Dependency on imports** can lead to supply chain risks and undesirable prices, especially if there is competition due to demand volatility (e.g., pandemic)
  - Exemplified by COVID-19 vaccine inequity
- Political, regulatory, trade, and IP **restrictions** limit flow of raw materials and finished products, both for vaccines and other critical medical products
- Self-sufficiency through regional production could promote public health and socioeconomic outcomes
  - Potential for **innovation in related industries** and development of export capacity
  - Opportunity to design vaccines/therapeutics for **local needs and contexts** (e.g., variants, product presentation)

But…

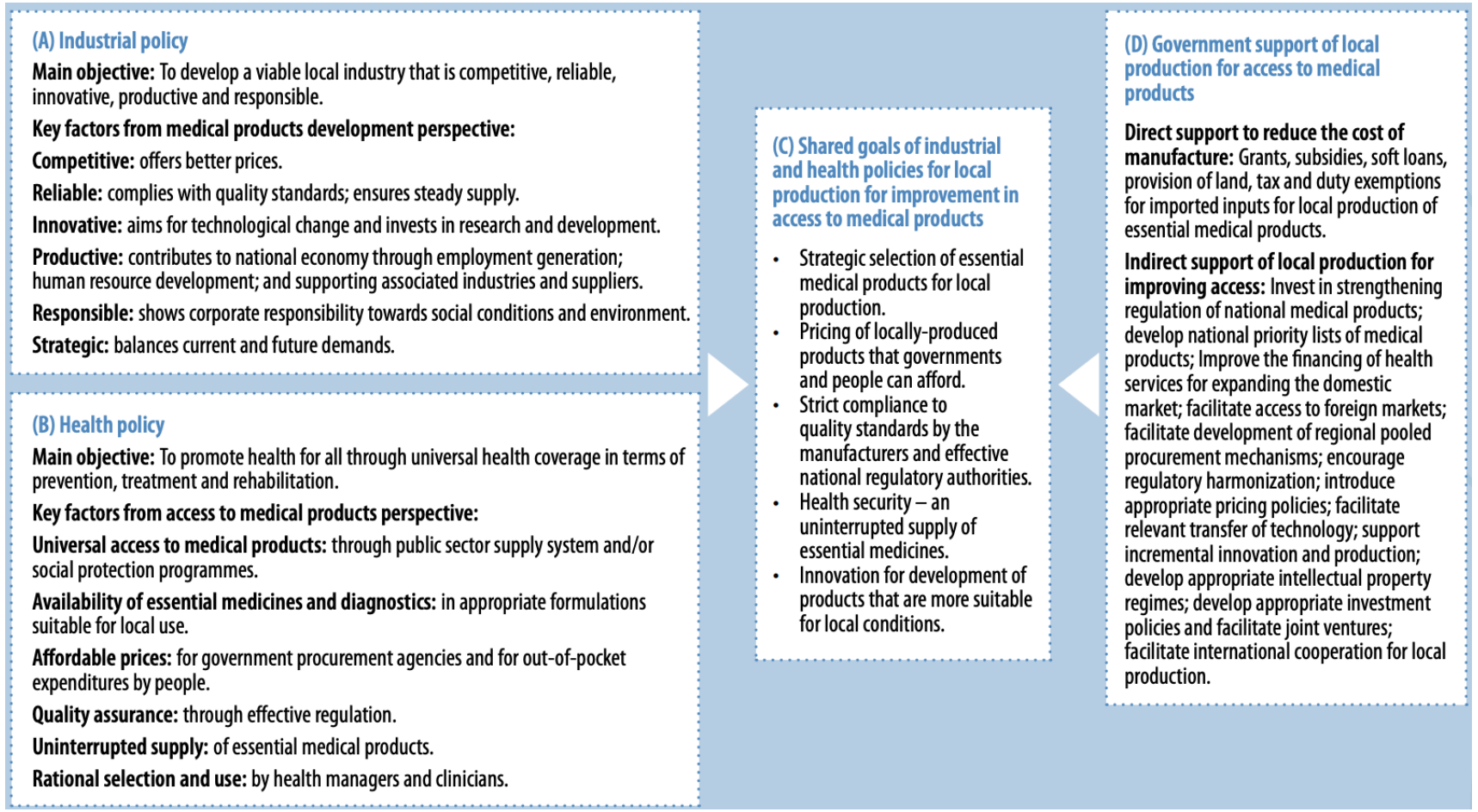
- Challenge generating demand and sustaining a regional **market**
- Need to put in place a **regional strategy** – investments, policies, technologies, business models, regulatory / procurement agreements, etc.
- As a minimum, important to consider **E2E** vaccine value chain: from R&D portfolio to last-mile delivery
- Tension between **costs** (economies of scale) and supply security, at least in short-term
- Unclear link between proximity of production and **access**

Three general pathways for the transfer of technology to support the local production of vaccines (WHO, 2011)



https://apps.who.int/iris/bitstream/handle/10665/77934/9789241502894_eng.pdf

Local production and access to essential medical products: A framework for improving public health (WHO, 2011)



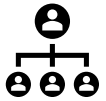
Private
Public
Academic

Partnerships
&
Collaboration

https://apps.who.int/iris/bitstream/handle/10665/77934/9789241502894_eng.pdf

Lessons from the COVID-19 Pandemic

- **Unprecedented speed** in the discovery and approval of vaccines



- Hoarding and vaccine nationalism led to **concentration of supply** in high-income countries

- **Delays** associated with the ramp-up of manufacturing and deliveries (e.g., restriction on import/export of raw materials & finished products)

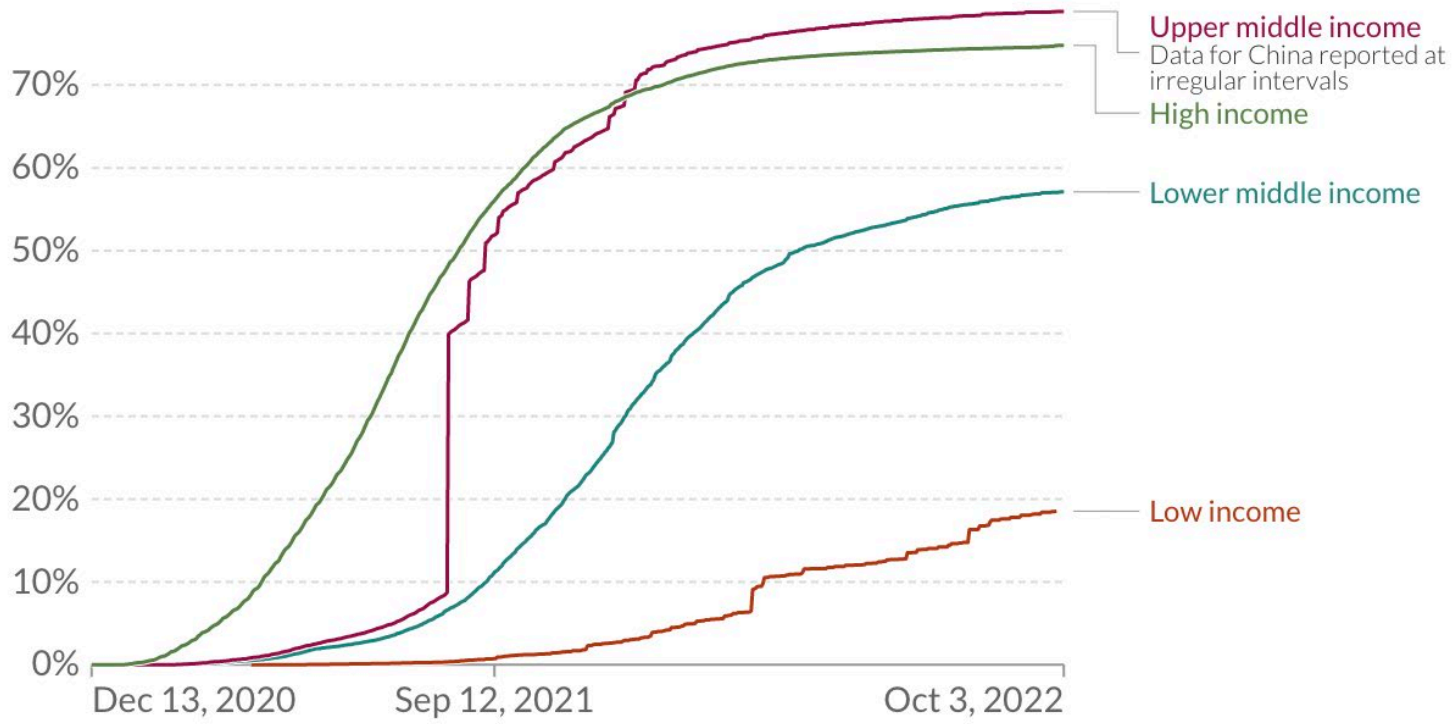
- Multilateral mechanisms such as COVAX (designed to guarantee equitable access through pooled procurement) received **little support** in early stages of the pandemic

- **Donations** of vaccines, often close to expiry, had an impact on demand, vaccine hesitancy and waste

Pandemic value chain's unique features: preparedness & response

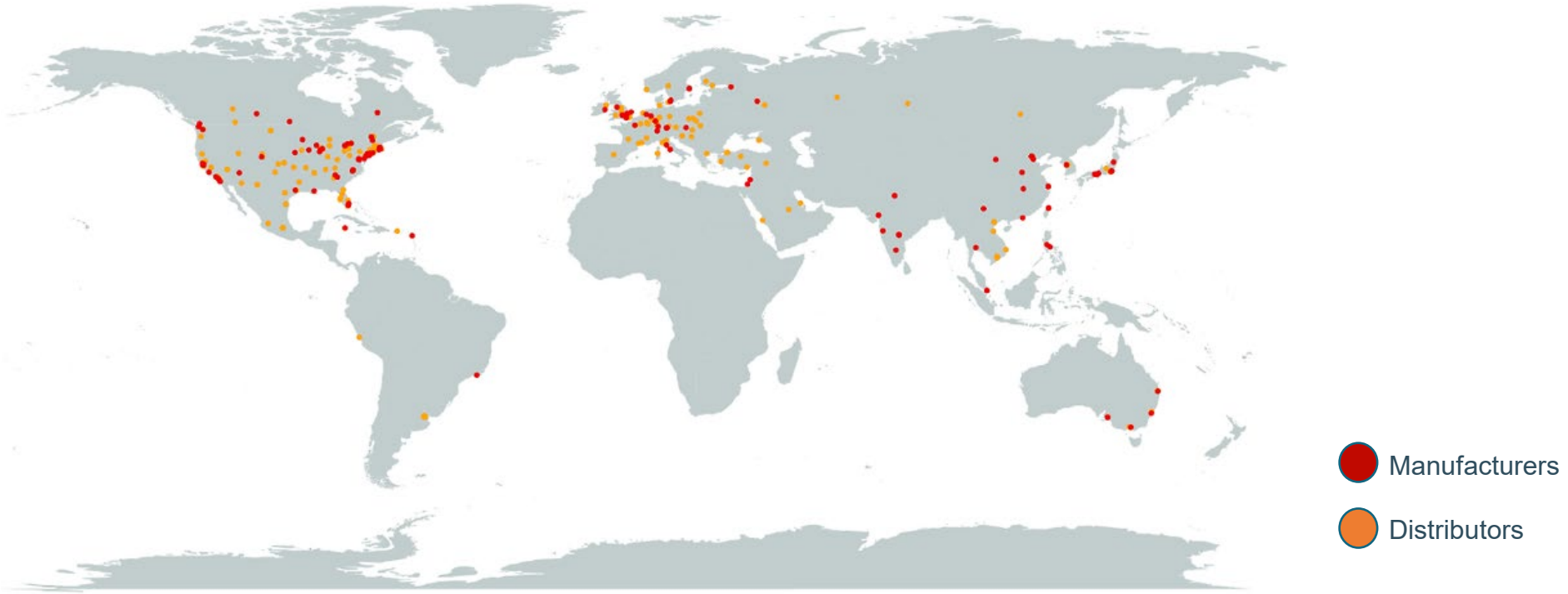
		Peace Times	Pandemic Times
Research & Development	DESIGN	• **Safety & efficacy a priority** → Low iteration on product	• **Safety & efficacy a priority** → Need for next-gen products
	TIME	• **Long, lower risk** → Steps in sequence	• **Rapid, higher risk** → Steps in parallel
	FUNDING	• **Mostly private funded**	• **Public-private funded**
Manufacturing & Supply	DEMAND	• **Predictable** → Safety stock available	• **Unanticipated spike** → Initial supply scarcity
	RAW MATERIALS	• **Redundancy in suppliers** → Free flow of materials	• **Competition and hoarding** → Supply disruptions (bullwhip)
	PRODUCTION	• **Available capacity** → Routine, lean operations	• **Constrained capacity** → Rapid scale-up / scale-out

COVID-19 vaccine coverage gap: Percent of population who completed the initial COVID-19 vaccination protocol



Source: Official data collated by Our World in Data – Last updated 4 October 2022
Note: Alternative definitions of a full vaccination, e.g., having been infected with SARS-CoV-2 and having 1 dose of a 2-dose protocol, are ignored to maximize comparability between countries.

COVID-19 vaccine manufacturing and distributing firms are geographically concentrated



Note: OECD; Based on ADB's M*apping on Supply Chains for Pandemic-fighting Products* (2020), **data extracted 1 December 2020**; the ADB continues to update the database. Includes distributors and manufacturers of COVID-19 vaccines at all levels of relevance (1, 2 and 3); excludes observations for which location information was not available at the city-level. Red dots overwrite orange dots.

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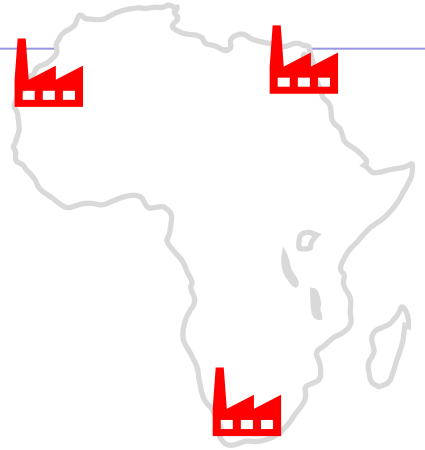
Assessing the gap in manufacturing: Focus on Africa

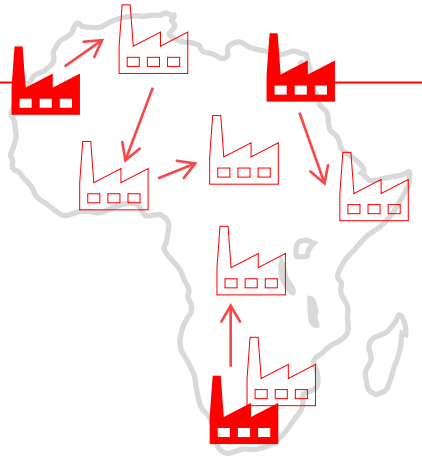
Current state map

Existing supply chain for vaccine manufacturing and related industries.



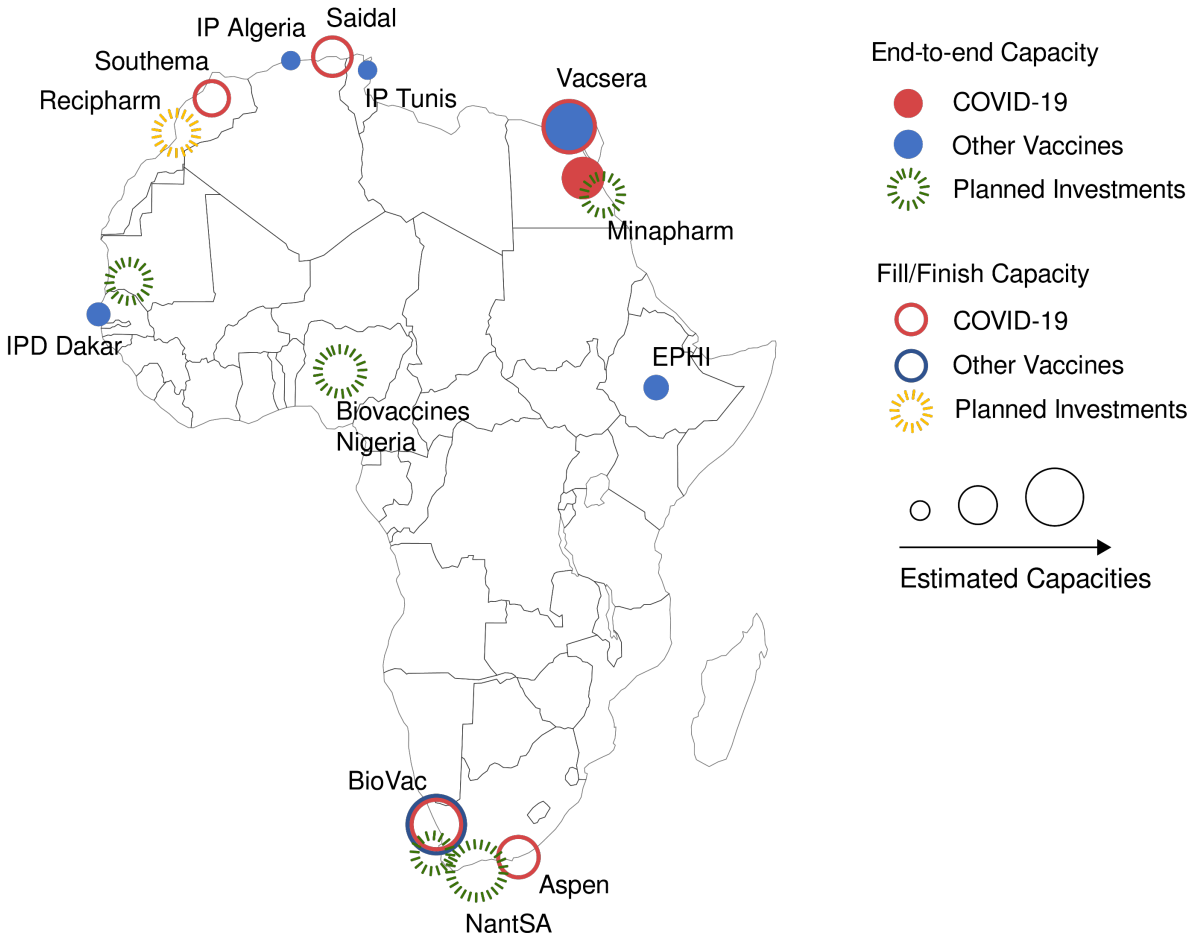
Future state model

Manufacturing capabilities required to meet regional objectives (e.g., 60% by 2040)



Thanks to collaboration with PATH & CEPI

Existing vaccine manufacturing in Africa is limited and highly clustered in Northern and Southern Africa



End-to-end Capacity

- COVID-19
- Other Vaccines
- Planned Investments

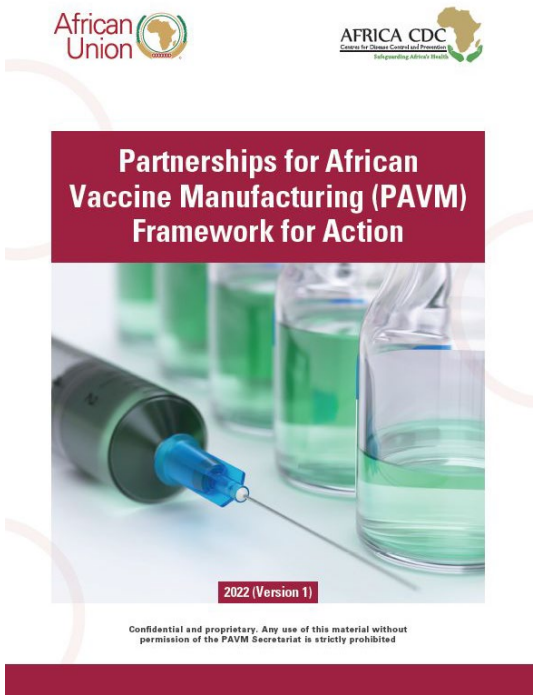
Fill/Finish Capacity

- COVID-19
- Other Vaccines
- Planned Investments

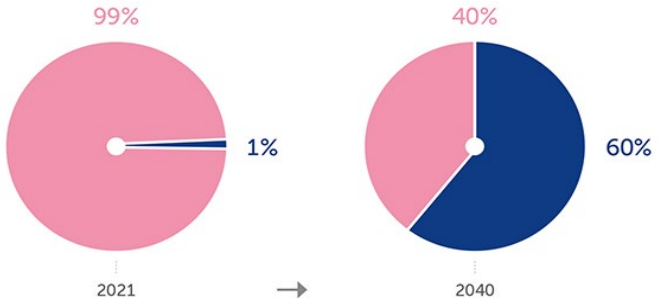
Estimated Capacities

- Conclusions based on publicly available information; a survey conducted by CEPI in 2H-2021 to map vaccine manufacturing capacity and capabilities in Africa, Southeast Asia and the Western Pacific, the Middle East, and Latin America and the Caribbean; and interviews with African manufacturers.
- Few manufacturers for legacy vaccines
- Growing number of fill-finish facilities for COVID-19 vaccines
- For planned investments, only high-maturity commitments are included in the analysis

PAVM: 60% local production of vaccines administered by 2040



Regional Objective



Priority vaccines and expected demand by 2040

Archetype	Disease	Does a vaccine exist?	African doses volume by 2040 (Mn)
Legacy	Hepatitis B, Diphtheria, Tetanus, Whooping Cough	✓	~370
	Tuberculosis	✓	~140
	Measles	✓	~240
	Yellow Fever	✓	~50
	Cholera	✓	~30
	Typhoid	✓	~20
	Meningococcus[1]	✓	~60
Expanding	Human papillomavirus	✓	~30
	Pneumococcus	✓	~140
	Rotavirus	✓	~120
	COVID-19	✓	~710
	Malaria	✓	~120
	HIV	✗	~110
Outbreak	Ebola	✓	~1
	Influenza[2]	✓	~10
	Chikungunya	✗	~1
	Rift Valley fever	✗	~1
	Lassa fever	✗	~1
	Disease X	✗	N/A
	Total		~2,200

1. Including key serogroups found in Africa (A, C, W and X)
2. Considering here outbreak Influenza

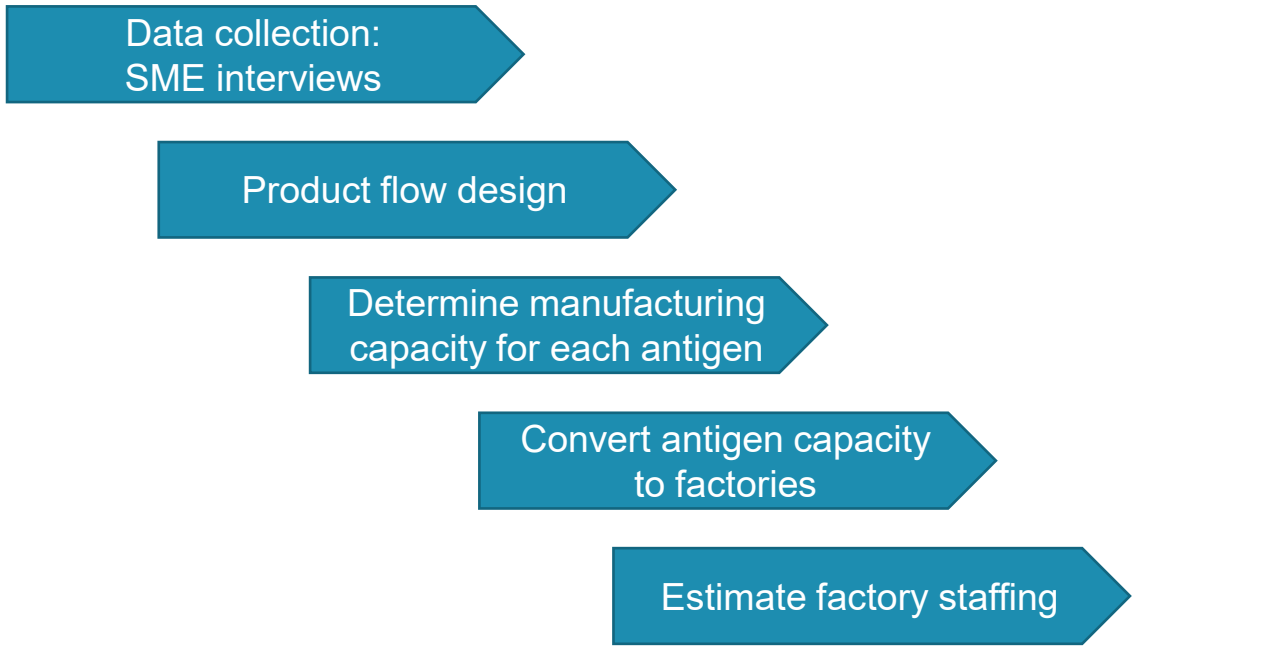
https://africacdc.org/download/partnerships-for-african-vaccine-manufacturing-pavm-framework-for-action/

Shifting momentum toward regional production

- **Growing vaccine market** due to 1) rapid population growth (25% of globe by 2050), 2) need to close coverage gaps, and 3) introduction of new vaccines (e.g., malaria).
- **Nascent vaccine industry**: Today, Africa locally *produces only 1% of the vaccines it administers*; the remaining 99% are largely imported through international procurement mechanisms (e.g., GAVI, UNICEF).
- **Health disparities**: Heavy reliance on vaccine imports contributes to significant barriers to vaccine.
- **Institutional transformations** spurred by the COVID-19 pandemic: pooled procurement mechanisms, technology transfer efforts, regulatory harmonization.

Future state model: Project milestones

Technical assessment of minimum manufacturing requirements to meet **PAVM's 2040 target demand** across **15+ priority vaccines**



Collect data on main manufacturing components (e.g., bioreactor size, yield, process times)

Building blocks of vaccine manufacturing process for a "typical" manufacturing facility per pathogen & platform

Estimate number of batches and lines needed to reach the 2040 PAVM target vaccine demand

Number of facilities (exploration of synergies)

Number and type of staff required

Validated capacity, doses produced over time, scenarios (e.g., delay, resources blocked, change in resources, utilization etc)

Project partners:

PATH KU LEUVEN ACCESS-TO-MEDICINES CEPI

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Learnings from technical assessment

- A **continental strategy** is needed to promote sustainable manufacturing of routine and pandemic vaccines
  - Despite numerous ongoing efforts, no shared map of investment and intervention needs in Africa currently exists. Consequently, capacity-expanding efforts risk misalignment.
  - **Significant investments** are needed to expand manufacturing capacity and the needed workforce
- Just like vaccine manufacturing in real-life, **simulations** are sensitive to data (both process and demand assumptions) and subject to stochastic events
  - Emphasis on **quality data collection and validation**
- **Networks can be combined in multiple ways**
  - If sites or facilities are deemed too large, smaller facilities could be created
  - A reorganization of sites could also be done based on on technology and capacity
- Proposed future work
  - Expand scope of **scenarios** and perform **extensive sensitivity analysis** of process parameters to understand which have the largest impact on various KPIs
  - Run **simulations beyond 2040**, with **phasing in of capacity** over time relative to demand
  - **Validating with manufacturers** and **on-the-ground assessment** of resource requirements

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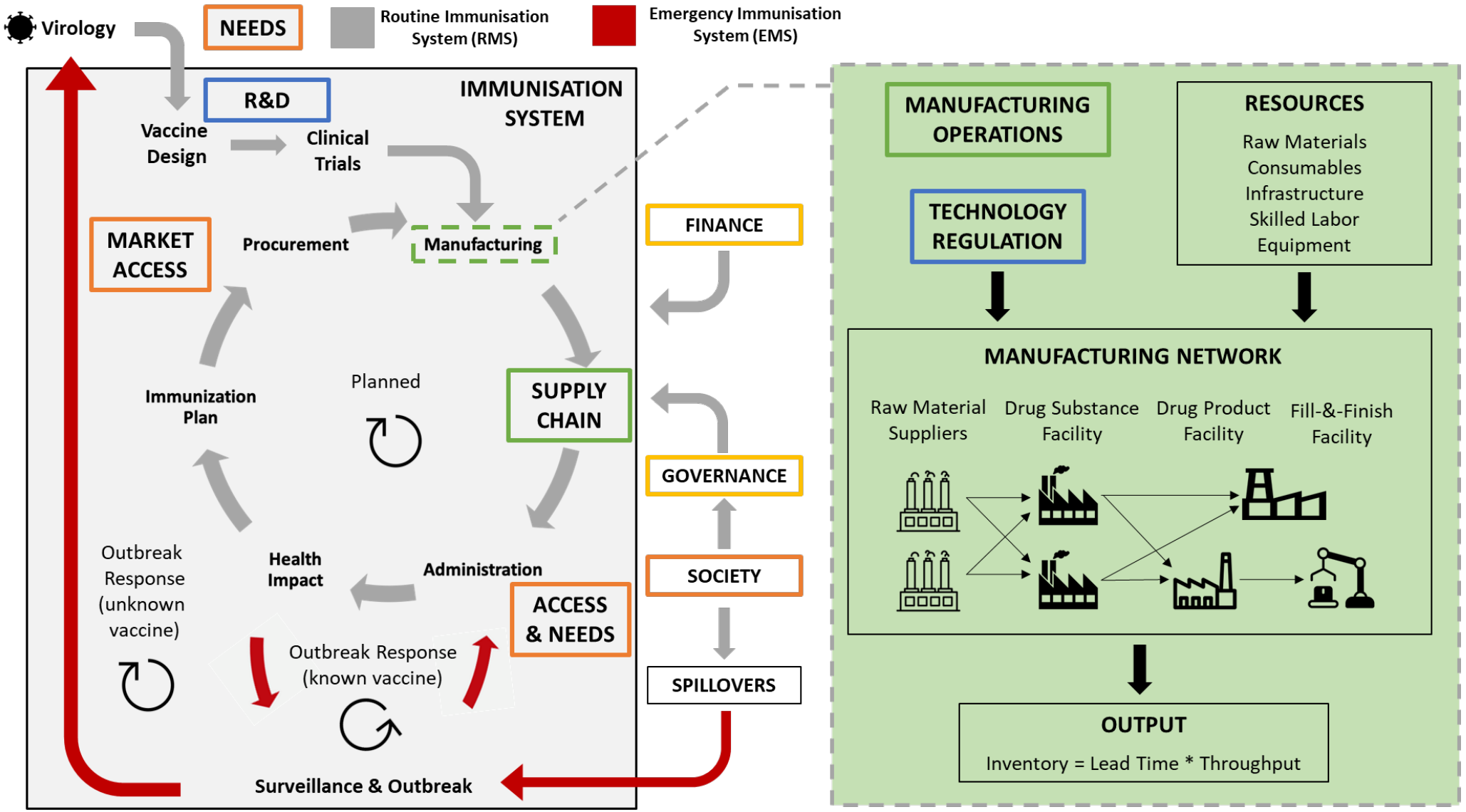
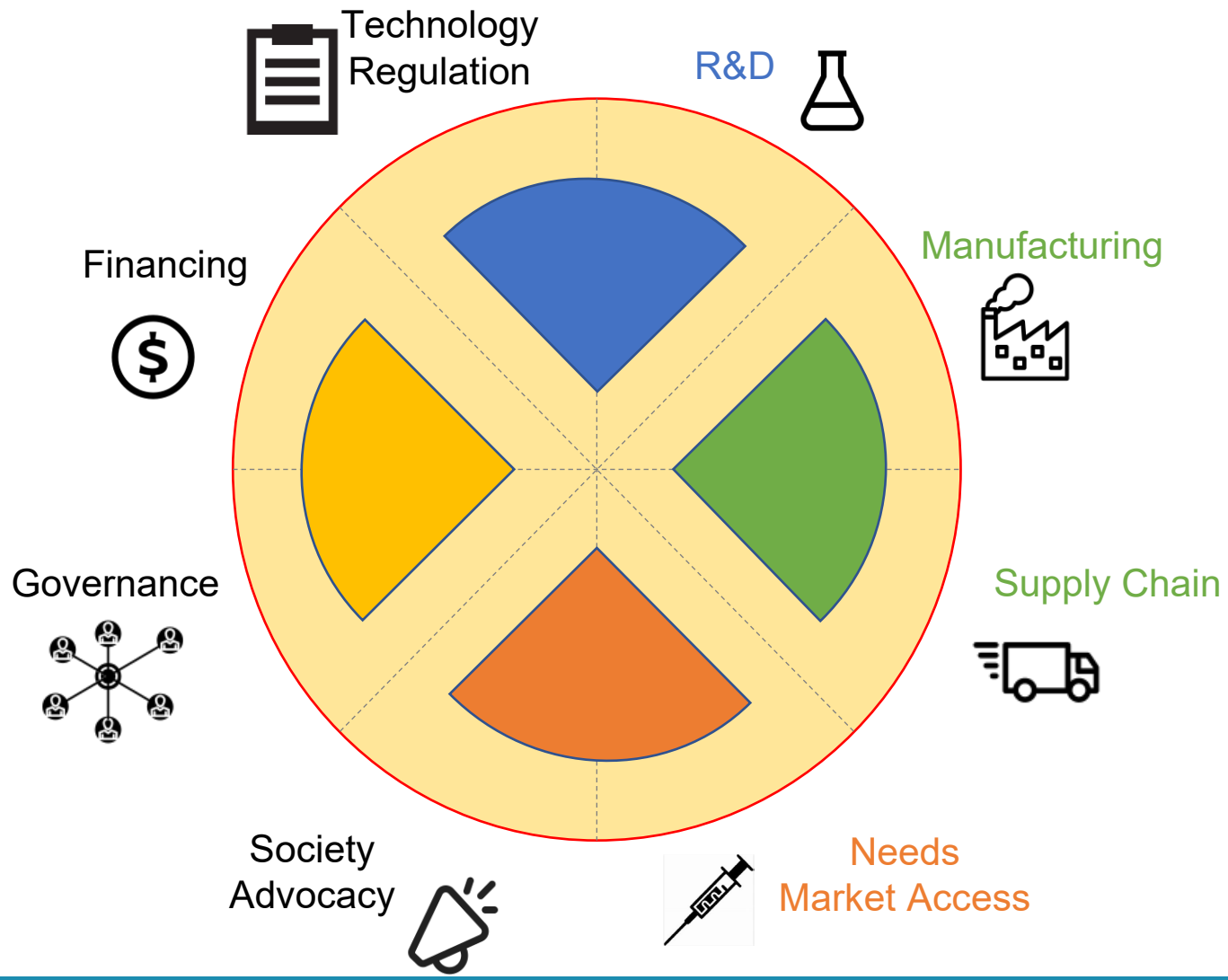
Positioning manufacturing within the broader immunization system



A systems approach is critical to ensure sustained vaccine access

Factors to consider

- Goals
- Opportunities
- Challenges
- Context



Examples of networks supporting regional production

dcvmn

Developing Countries Vaccine Manufacturers Network

AVMI

AFRICAN VACCINE MANUFACTURING INITIATIVE

ebpmn

Emerging Biopharmaceutical Manufacturers Network

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Thank You!

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