Allocation logic and algorithm to support allocation of vaccines secured through the COVAX Facility

Explainer based on commonly asked questions

15 February 2021

Purpose of this document

This document aims to explain the logic of how COVAX Facility secured vaccines will be allocated among participants during Phase 1 using the Allocation Algorithm. A previous explainer covers the overall Allocation Framework and the different Phases (link)

It is:

- A simple explanation of the allocation algorithm and its logic.
- A current description which may be subject to future changes as adaptations are made to the allocation operationalization due to shifts in supply, demand, or policy.
- A focused view on the allocation algorithm for vaccines.

It is not:

- An exhaustive description of how the allocation of vaccines will be carried out.
- A static view of exactly how the allocation mechanism will operate for the entire life-span of the COVAX Facility
- A full explainer covering all aspects of COVAX Facility and Allocation Framework and other key process (e.g., Allocation governance, procurement, country delivery, actual allocation results, etc.)

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The need for an Allocation Algorithm

1) How will the Allocation of COVAX vaccine be structured?

Phase 1: Proportional allocation up to 20% of total population

Participants receive doses proportionally to their total population given the ubiquity of the threat:

Participants progressively receive doses until all participants reach 20% of their total population (or less if they so requested).

The rate at which participants receive vaccines depends on country readiness and the availability of doses (not on threat and vulnerability).

The allocation moves on to phase 2 once all participants have reached 20% coverage (or less if they so requested).

Phase 2 may start ahead of this if available doses are unable to be allocated to some participants due to lack of readiness, funding, or territory issues. However, these participants would be prioritised to get to their requested coverage as soon as possible.

Based on supply projection it is as of now expected that phase 1 will unfold throughout most of 2021.

Phase 2: Weighted allocation beyond 20% (if supply severely constrained[1])

Participants receive doses at variable rates, based on consideration of vulnerability and COVID-19 threat:

In the case of a severely constrained supply, the timing of participant shipments would be based on a risk assessment based on Threat and Vulnerability.

Participants with a higher risk would receive the doses they need faster than others, although all participants will receive some doses in each allocation round.

Threats and Vulnerabilities will be based on metrics defined closer to the end of phase 1 by the COVAX Facility, potentially related to the participant's vulnerability to severe disease and its healthcare system.

All participants will receive the total doses they have requested as rapidly as possible in phase 2.

The current algorithm does not reflect approaches that are specific to phase 2 allocations. The algorithm will be updated at a later date to accommodate final Phase 2 specific parameters.

2) What are the objectives of Phase 1 of vaccines allocation?

In Phase 1, where participants receive doses proportionally to their total population given the ubiquity of the threat, up to 20% coverage[2] has the following seven objectives:

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[1] The definition of severe constraints and related threshold are still being determined.

[2] Or until their requested coverage, individual participant exceptions can apply e.g. due to logistics constraints

1. **No doses should remain idle** – doses should not be 'stockpiled' before allocation
2. The **allocation serves all participants able and willing to receive doses** (excluding any limitations based on deals).
3. Only products that have **Emergency Use Listing (EUL), Pre-Qualification (PQ)** or in some cases **Stringent Regulatory Approval (SRA)**[3] can be allocated[4]
4. **Time gap between first and last participant** receiving COVAX doses within a round should be **minimised**
5. Participants should receive doses to progress at the same rate and cover the **same proportion of population** over time[5]
6. Participants should **receive a single product** throughout where possible[6,7]
7. Participants receive products **in line with their vaccine characteristic preferences** where possible[7]

While all objectives apply to Phase 1, the last three are the objectives that the algorithm optimizes for, and other upstream or downstream processes address the first four objectives

3) Why is an Algorithm needed to allocate vaccines in Phase 1?

The Allocation Framework (and resulting Mechanisms, including the Algorithm) are a key component of an overall approach centred on equitable access to COVAX vaccines, adapted to be pragmatic so participants can have access to vaccines as soon as possible.

To support the implementation of the allocation framework and keep in line with the principles set forth in this document, it was important to develop an objective and transparent tool to support the allocation process.

Furthermore, the allocation is relying on rapid computations of various data streams which necessitate an IT solution. Phase 1 will aim for participants to receive doses covering the same proportion of their population over time. This means all participants should, to the extent possible, reach 3% coverage as well as following milestones at the same time, up to 20%[3]. Additionally, participants have expressed their product preferences, and their desire for consistency between allocated products which are taken into account (detailed in question 7).

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[3] This would require full SRA, not limited SRA, e.g. conditional to batches
[4] Once WHO EUL is granted, a global policy recommendation will be issued by WHO. If supply prospects are favourable (APA or LTA), the allocation is triggered
[5] With exceptions for less populous participants due to logistics constraints
[6] With the exception of the Pfizer vaccine which has specific characteristics and is not likely to be used to cover the full request for any one participant
[7] For AMC Participants and Committed Purchase participants

An allocation round is a complex optimization problem requiring the distribution of multiple vaccines for ~ 190 participants. The algorithm's role comes into play by processing the participant and vaccine data and optimizing the allocation of vaccines for three competing objectives:

- Equality of doses received proportionally to population
- Match between product and participant preference
- Consistency of product received - aiming to allocate a single product when possible

This complexity increases as the COVAX portfolio grows in supply and in number of vaccines to be allocated[8] therefore an allocation algorithm was warranted to support allocation processes.

4) When will the Allocation Algorithm be run?

The Allocation Algorithm will be run by the Joint Allocation Taskforce (JAT)[9] for each allocation round. The signal for an allocation round is the Global Regulatory Approval (EUL/PQ and/or SRA) as well as a SAGE policy recommendation and available supply.

[8] Based on Products in the COVAX portfolio that have Emergency Use Listing, Pre-Qualification or Stringent Regulatory Approval and available supply

[9] See section on Governance

The Allocation Logic and Algorithm

5) How does the Allocation algorithm work? What logic is used behind it?

The Allocation Algorithm Logic consists of 5 key steps illustrated in Exhibit 1

A. Establish a supply forecast
B. Establish the demand constraints
C. Establish the demand envelope
D. Match supply to demand preferences
E. Establish delivery sequence

Steps A – C can be grouped as pre-processing, where input data is consolidated from participants and vaccine suppliers. Step D takes the outcome from pre-processing and runs optimization to find the best allocation solution. Step E determines how the optimization outcome is implemented in the field.

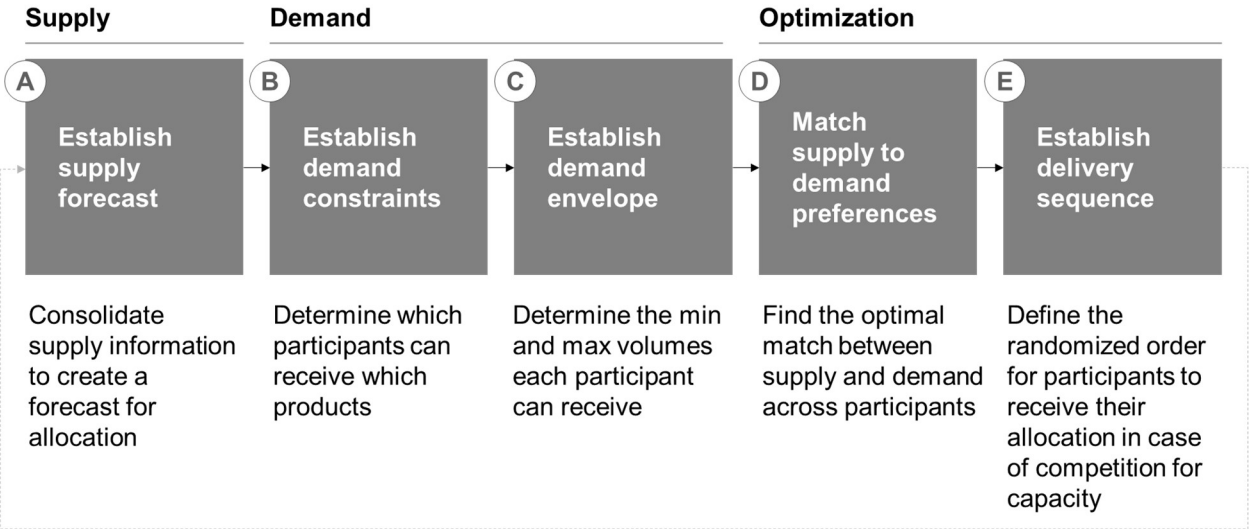

Exhibit 1: 5 key steps of the Allocation Algorithm logic

5.A Establish supply forecast

The JAT will be provided with a forecast outlining which vaccines can be allocated during the round, the available volumes, as well as its key characteristic as shown in an illustrative example on Exhibit 2. These key characteristics pertain to vaccine platform, product regulatory status, cold chain conditions, etc.

	Vaccine A		Vaccine B
	Site A1	**Site A2**	**Site B1**
	10M within 8 weeks by Q2 2021	**10M** within 8 weeks (by April 2021)	**20M** by June 2021
Platform	✓ mRNA	✓ mRNA	❑ mRNA
	❑ Inactivated	❑ Inactivated	✓ Inactivated
	❑ Viral Vector	❑ Viral Vector	❑ Viral Vector
Regulatory status	✓ PQ	✓ PQ	✓ PQ
	✓ EUL	✓ EUL	✓ EUL
	✓ SRA	✓ SRA	✓ SRA
Cold chain	❑ 2-8 C	❑ 2-8 C	✓ 2-8 C
	❑ -20 C	❑ -20 C	❑ -20 C
	✓ -70 C	✓ -70 C	❑ -70 C
Other	5 Doses / vial	10 Doses / vial	10 Doses / vial
	2 Doses / regimen	2 Doses / regimen	2 Doses / regimen
	10$ Price / dose	10$ Price / dose	5$ Price / dose

Exhibit 2: Illustrative example of available supply for an Allocation round and the 12 vaccine characteristics – PQ: Pre-Qualification; EUL: Emergency Use Listing SRA: Stringent Regulatory approval

5.B Establish demand constraints

Eligibility of each participant for the allocation round as well as for each vaccine/site will be checked prior to the allocation against several criteria as shown on Exhibit 3 for the different groups of participants (AMC participants, committed purchasers with and without a price cap, optional purchasers, as well as any specific earmarking due to deals).

Participants have joined the facility under different participation models and adhered to the Facility's Terms and Conditions[10]:

- AMC: COVAX's Advanced Market Commitment is the financing instrument that will fund and support the participation of 92 lower-middle and low-income economies in the COVAX Facility. COVAX AMC participants confirmed participation in the AMC by submitting their completed and signed Vaccine Request[11].
- Committed purchasers : Participants are self-financing their doses and commit to purchase allocations of approved vaccines from the Facility. Because participants provide a financial guarantee, they are asked to make a lower upfront payment
- Optional purchasers: Participants are self-financing their doses and make an upfront payment covering its full pro-rata share of the investments required by the Facility to enter into agreements with manufacturers and accelerate scale/access. In return, these participants receive the ability to decide which candidates they are interested in purchasing from their

[10] Link to COVAX T&C's: https://www.gavi.org/sites/default/files/covid/covax/COVAX-Facility_Terms_and_Conditions-Self-Financing-Participants.pdf ; Link to other Legal agreements with COVAX Facility: https://www.gavi.org/sites/default/files/covid/covax/COVAX-Self-financing-Participants-Legal-Agreements-and-Explanatory-Note.pdf

[11] Link to VRF: https://www.gavi.org/news/document-library/covax-amc-vaccine-request-terms-conditions-and-application-form & application guidance : https://www.gavi.org/sites/default/files/covid/covax/covax-amc/COVAX-AMC-APPLICATION-GUIDANCE.pdf

allocation of the Facility's portfolio. While the upfront payment for the Optional Purchase is larger than for the Committed Purchase, the all-inclusive costs are expected to be the same for both arrangements.

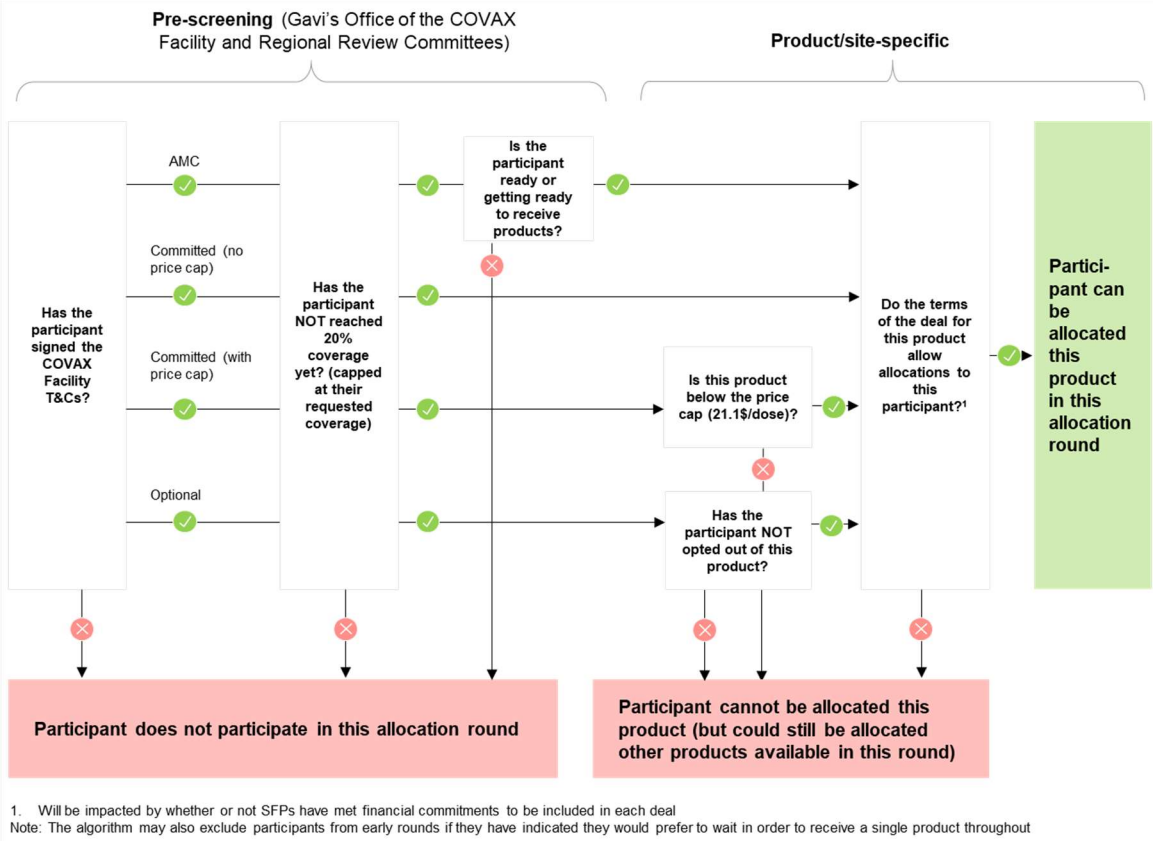

Exhibit 3 : Illustrative approach to screening participants and establishing demand constraints (non exhaustive, some checks are performed outside of the algorithm e.g. funds availability)

5.C Establish demand envelope

Based on steps 5.A and 5.B, a range of maximum and minimum allocation is fixed per participant. This range is determined by constraints such as minimum shipment quantity or the pro-rata share that optional participants can receive for each deal with manufacturers. As an example:

- The minimum allocation for each participant would be the minimum shipment/allocation quantity (defined by cost and logistics constraints),
- The maximum allocation allowable for each participant is based on how many doses they have requested in Phase 1 (subtracting previous allocations),
- While optional purchasers will get doses proportionally to their population as for the others, a check is run for optional purchasers to ensure that they obtain no more and no less than their pro-rata share by the end of each deal that they did not opt out of (the pro-rata share is the

amount of doses per deal that optional participants are entitled to as per their terms and conditions[12]).

5.D Match supply to demand preferences

The algorithm optimizes allocation by weighing the three key objectives of equality, product consistency and product preference as mentioned above.

For optimal results, the algorithm gives most weight to the equality objectives. Based on the optimization algorithm, each participant is allocated a number of doses per vaccine. All supply available in a round will be allocated and the algorithm will automatically adjust the allocation quantities to accommodate shipping size (i.e., round up or down so that the allocation amount can be shipped based on carton and tray size)

Weighing is implemented by giving more importance to some objectives (equality in this case) when the algorithm assesses a solution. This means that if a solution is more equal and a bit less aligned with another objective, the algorithm will prefer it over a solution which is a bit less equal but more aligned with the other objectives.

5.E Establish delivery sequence

The algorithm output will contain a ranking of participants to serve as a prioritization list for the delivery sequence. This sequence will be followed to fulfil and ship allocations to participants in case of competition for capacity.

See question 9 of this explainer for a more detailed explanation.

6) What does the Allocation Algorithm take into consideration?

Each step of the Algorithm logic takes information from the COVAX Facility and the Procurement Coordinator/Partners (UNICEF Supply Division / PAHO Revolving Fund) as shown in Exhibit 4

[12] Link to COVAX T&C's: https://www.gavi.org/sites/default/files/covid/covax/COVAX-Facility_Terms_and_Conditions-Self-Financing-Participants.pdf

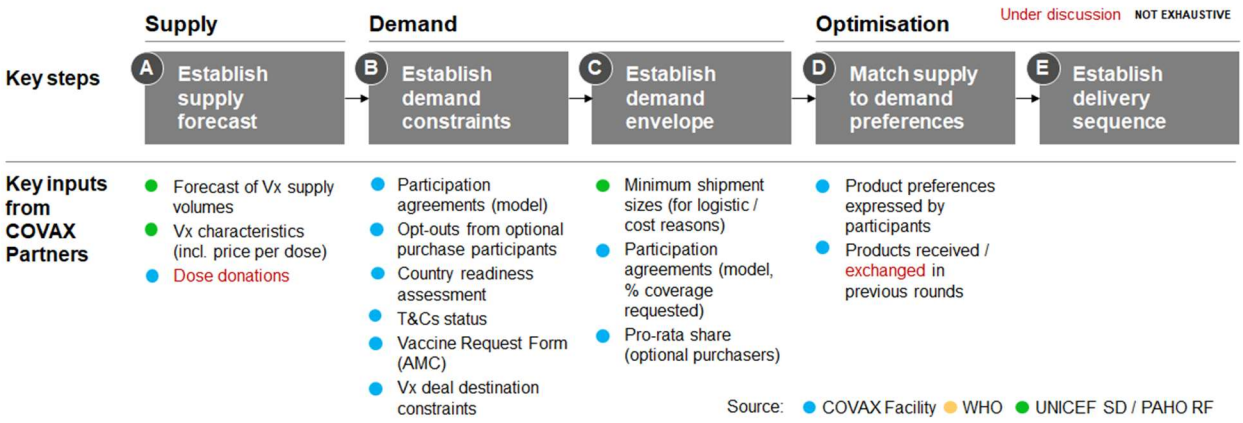

Exhibit 4: List of inputs into the Allocation logic and Algorithm

The algorithm takes multiple factors into account to arrive at an optimal solution. These factors can be divided into three categories:

a) Supply Forecast and Vaccine Characteristics

This category provides information on the vaccines provided in a round, including the supply forecast, vaccine characteristics (platform, regulatory status, cold chain storage requirement, dose regimen, price per dose, and vial size), limitations on destinations for certain manufacturers or deals (e.g. based on licensing), and minimum shipment and batch/pallet size.

b) Demand Constraints

This category provides information on which participants are ready for a round and which match between vaccine and participants are acceptable (e.g. based on opt-outs). Inputs include participation model, optional purchase opt-outs, committed purchase price opt-outs, cost-sharing commitment status, participant readiness, terms & conditions and completion of the vaccine request form (VRF)

c) Demand Envelope

This category provides the minimum and maximum allocation a participant may receive in a round. Inputs include the coverage requested, total population, historical allocation from previous rounds, *pro-rata* share (for optional participants only), minimum shipment size and round minimum allocation.

7) What is optimization and how is it used in the allocation algorithm?

Optimization is a quantitative method for finding the best solution to a problem that has many possible solutions. Three components are used to define the problem's goals, feasible solutions, and decision variables. For the Allocation Algorithm, optimization is used to mathematically find a vaccine allocation that optimizes the Facility's goals of equality, preference, and consistency.

a) Objectives – What are the goals for optimization?

Objectives are to minimize inequality, maximize participant product preference, and guarantee product consistency (see question 3). These define how the algorithm evaluates all possible solutions and determines the best one. As an example, the algorithm's objective to minimize inequality is defined as population coverage differences between participants over time.

b) Constraints – How are feasible solutions defined?

Constraints are the restrictions placed on the set of solutions. They define which solutions are feasible or acceptable among all possible solutions. They are rigid considerations that are not subject to improvement. There are no rewards for fulfilling constraints; they are simply conditions that must be met. An example from the allocation algorithm is the requirement to allocate all doses available in a round.

c) Variables – What values change to find solutions?

Decision variables are the parameters to be changed to find feasible solutions. They can be thought of as decisions the solver makes to achieve the objective goals. An example from the allocation algorithm is the number of vaccine pallets assigned to a participant in a round.

The general approach to solving an optimization problem involves changing the variables to find solutions that satisfy all constraints. The objectives are then used to evaluate the best solution out of all possible solutions.

7.1 What is the allocation algorithm optimizing for?

Optimization components are defined by shipping logistics, deal terms, and the seven objectives for Phase 1 listed in Question 2. Exhibit 5 lists the objectives, constraints, and variables used by the algorithm to determine an optimal vaccine allocation.

Objectives What are the goals for optimization?	Constraints What solutions are feasible?	Variables What values change to find solutions?
•Minimize population coverage inequality across participants •Maximize participant preference for products •Minimize unique products allocated to participants	•Maximum and minimum demand per participant •Optional participants must receive their *pro-rata* share over the course of a deal •Participants can only be assigned acceptable products •All supply must be allocated •Vaccine supply forecast for round •Minimum shipment size per product •Batch/shipping pallet size per product •Allocation capped at 20% •All participants must be allocated something •Unique products limit	•Number of batches/shipping pallets of assigned product to a participant •Product assignment to a participant •Achievable equity line

Exhibit 5: Objectives, Constraints, and Decision Variables used by the Allocation Algorithm

7.2 How does the algorithm and solver find the optimal solution?

The allocation algorithm and solver (the program that calculates for the optimization) find the optimal solution using linear programming, an established technique supported by 75 years of research. Linear programming models the constraints and objectives as linear functions and has a proven ability to arrive at a global optimal solution.

Before the solver, the algorithm converts the input data (supply forecasts, vaccine characteristics, demand constraints, and demand envelopes) and optimization goals into linear functions to act as constraints and objectives, respectively. It then defines the variables that can change.

These solvers[13] can be thought of as an efficient search procedure, allowing the solver to filter all possible solutions into a smaller set for evaluation. The solver strategically traverses through this smaller set of solutions until the optimal solution is found.

Due to the complexity of the objectives, constraints, and variables in an allocation round, the solver splits the optimization problem into two parts: the relaxed and final solve. The relaxed solve allows the solver to take an initial pass at the problem with fewer constraints. The goal is to solve a few components and then pass them on to the next part. The final solve takes the solution from the relaxed solve and improves on it until it reaches a high-quality solution that satisfies all constraints. The relaxed solve mimics the quick production of a first draft, while the final solve represents the detailed editing required to complete a final draft. This two-step process has sped up the algorithm processing time and significantly increases its ability to reach an optimal solution.

7.3 How does the algorithm ensure equitable allocation of COVAX doses?

The algorithm contributes to equitable access by ensuring participants reach equal total population coverage[14] at the end of a round. Total coverage is defined as the proportion of a participant's population covered by vaccines[15] allocated in the current round and all previous rounds. Given an allocation round supply forecast, the algorithm is designed to identify the highest total coverage level it can achieve in as many participants as possible. This coverage level is defined as the achievable equity line and is used by the first optimization objective to minimize total coverage differences across participants.

For most participants, the algorithm will increase their total coverage at roughly equal rates. Some participants' total coverage, however, may fall behind if they miss a previous round (e.g. if a participant is not ready) . In this case, the algorithm will allocate extra doses to bring the participant's total coverage up to the current round's achievable equity line. Other participants may jump ahead due to

[13] The details of these search algorithm are proprietary but are based on the Simplex Method
[14] From COVAX doses
[15] Depends on the dose regimen two vaccine per individual in case of a two-dose vaccine

small populations[16] or *pro-rata* shares (this is made in order optimize delivery cost and keep into account the minimum shipment size). For participants with small populations, the minimum allocations set by shipping logistics may disproportionately increase their total coverage levels above the achievable equity line. For *pro-rata* shares, optional participants may receive a disproportionate surge in allocations when a deal expires. In either case, the participants are excluded from the current round's achievable equity line and thus equality optimization objective to prevent further inequality[17]. In subsequent rounds, the algorithm will allocate no more than the minimum allocation to participants who are ahead to allow other participants to catch up.

7.4 How does the algorithm take into account participants' preferences?

The algorithm uses preferences to match participants with their most desirable vaccine products. In the Vaccine Request Form/Vaccine Information Form, participants ranked a list of vaccine characteristics in order of preference. The algorithm uses this ranking to calculate a preference score based on how well vaccine characteristics match a participant's preferences. A higher score means a vaccine product is more desirable to a participant. The second optimization objective (match with vaccine preference) then uses these scores to assign vaccine products to maximize desirable matches.

7.5 How does the algorithm aim for vaccine product consistency?

The third optimization objective was designed to deliver vaccine product consistency by minimizing the number of unique products assigned to each participant. The goal is to provide consistency for vaccination programs and prevent participants from receiving multiple vaccines with different characteristics. Separate incentives are used to encourage consistency in a single round versus across multiple rounds. In a single round, the objective applies a penalty for assigning multiple products to a participant, incentivizing the model to select single products whenever possible. Across multiple rounds, a multiplying factor is applied to the preference score per vaccine for a participant's previously assigned vaccines to incentivize the solver to continue allocating those round over round.

7.6 How does the algorithm balance the three goals?

The algorithm balances the three goals of equality, consistency, and preference using multiple-objective optimization. This method combines the objectives from each goal into a master objective for the overall optimization problem. Weights are assigned to each objective to reflect their relative importance in relation to others. For the first allocation round, the weights for the equality, consistency and preference objectives are set at 50%, 25% and 25% respectively. Those weights have yielded results in simulation that are aligned with the Fair Allocation Framework.

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[16] Which can be allocated a minimum allocation size that would represent a larger coverage than other participants, to optimize for logistics cost and constraints

[17] If they were included, the algorithm would attempt to match the same total coverage level in all participants. It would run out of supply before this process was completed, resulting in unequal total coverage levels and low solution quality.

Calibration may be required for later rounds, as the optimization complexity increases with a large quantity of products, to set the objective weights, which is conducted under the guidance of the JAT.

Weighing is implemented by giving more importance to some objectives when the algorithm assesses a solution. This means that if a solution is more equal and a bit less aligned with another objective, the algorithm will prefer it over a solution which is a bit less equal but more aligned with the other objectives.

8) How does the Algorithm take price into account?

Price is currently taken into account in the Allocation Algorithm in two ways:

First, for all participants who submitted Vaccine Request Forms (AMC participants) and Vaccine Information Forms (Self-Financing Participants) notified the facility of their preference ranking. Price is one of the 12 characteristics that were ranked by participants ant that are taken into account when matching a participant with a vaccine. If Price was ranked high in the preferences provided, the algorithm will aim to match the participant with lower priced vaccines, as well as the other characteristics, as price is only one of the 12 preferences. However, as the objectives of equity of coverage, vaccine consistency and vaccine preference match can be competing objectives, there is no guarantee that the algorithm will allocate a less expensive vaccine based on preference alone.

Second, for Committed Purchasers with a price opt-out, the algorithm will automatically consider them non-eligible for any vaccine costing more than the opt-out threshold, having been set at USD21.1 per dose.

9) How does the Algorithm set the timeline for delivery?

The timeline for delivery of the allocated vaccines will depend on many factors outside of the scope of the allocation, such as participant regulatory timelines, the overall time to place the Purchase Order at the manufacturer, the manufacturer lead time and the shipment lead time.

The Vaccine Allocation Decision prepared by the Joint Allocation Taskforce will however contain both the allocated number of doses per vaccine for each participant as well as a ranking of participants for the delivery sequence.

It is important to note that the delivery sequence will only serve in case of competition for capacity. Indeed, in the interest of not having idle doses, if a participant is not ready, they will be moved to the end of the delivery sequence and the next participant in line will be served. This process is illustrated on Exhibit 6.

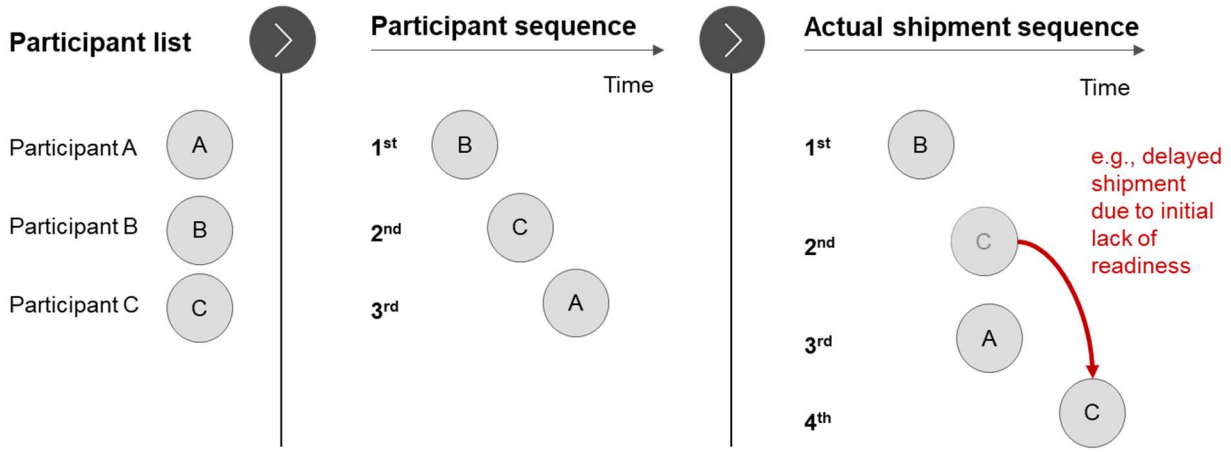

Exhibit 6: Illustration of the delivery sequence and adaptations to avoid idle doses

10) How does the Algorithm account for the COVAX Buffer?

The Buffer aims to ensure access to vaccines for high-risk[18] populations in humanitarian settings that are not covered in national vaccine deployment plans, and provide a contingency provision for emergency release of doses to help tackle the most severe clusters of mortality where normal vaccine allocation timelines may be too slow. Up to 5% of COVAX vaccine doses would potentially be deployed via the Buffer. Doses would be progressively financed through the AMC as its funding increases, with the final number depending on dose availability, estimations of need, and fundraising success.

Each round, the allocation algorithm would set aside up to 5% of the doses available for the COVAX Buffer, based on the demand for the Buffer in that specific allocation round. If the demand for that round does not reach the 5% of available supply, the dose should not sit idle to serve the Buffer (i.e. if the demand is 3% for one round, the remaining 2% would be allocated among other COVAX participants). However, the buffer would be able to catch up if demand exceeds 5% for the following rounds.

The design of the COVAX Buffer is still ongoing and a working group is setting up processes to allocate these volumes.

[18] As per SAGE recommendations.
More information on the COVAX Buffer can be found in this board paper on COVAX Facility operationalization available online. GAVI. COVAX Facility Operationalisation and Vaccine programme, 15 December 2020.

Governance and use of the Allocation Algorithm

11) How will the Allocation Mechanism for vaccines be governed?

Two bodies are directly involved in the Allocation of COVAX Facility Vaccines:

- The Independent Allocation Validation Group (IAVG).
- The Joint Allocation Taskforce (JAT).

These bodies will operate in tandem with the COVAX Facility governance. The composition of the IAVG can be found here

11.1 Allocation governance structure

The JAT will receive relevant inputs from the Office if the COVAX Facility, WHO Allocation Unit, procurement agencies (UNICEF SD, PAHO RF), and participants. The JAT will prepare Vaccine Allocation Decision (VAD) proposals based on the Allocation Algorithm output, which would then be passed on to the IAVG.

The IAVG would then validate this proposal ensuring it is technically informed and free from conflict of interest. The validated VAD would then be passed on to the COVAX Facility, procurement agencies and self-procuring participants to be implemented.

This process is illustrated in Exhibit 7

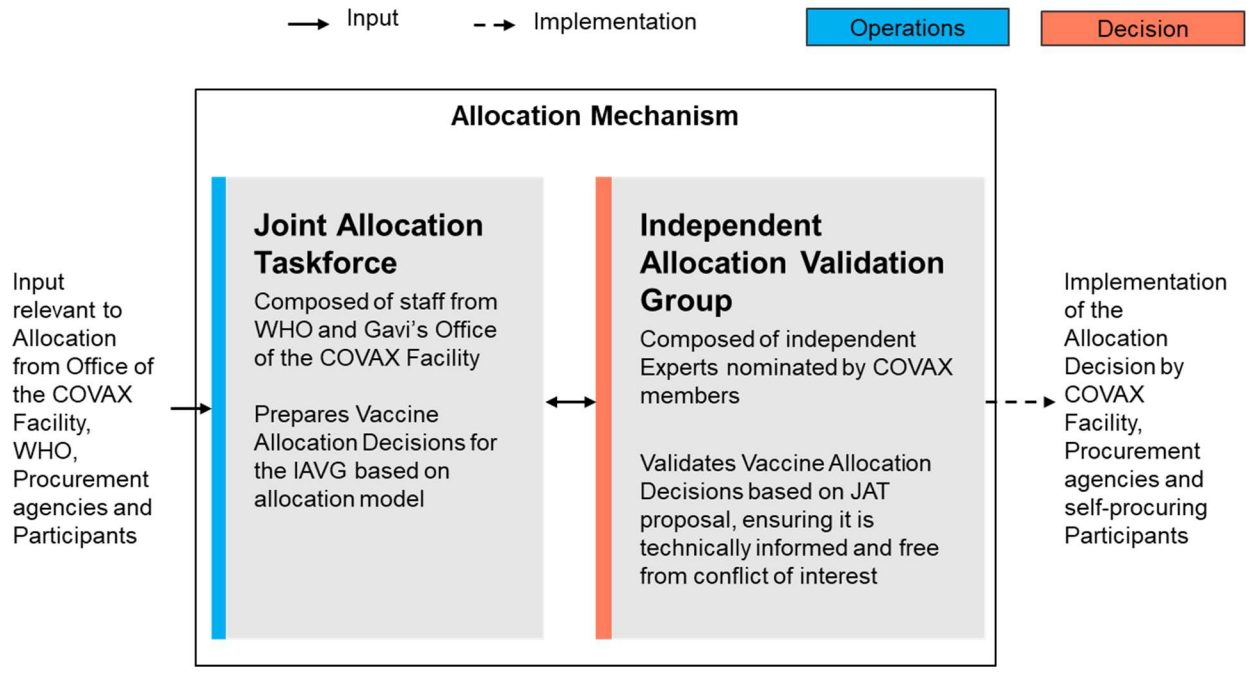

Exhibit 7: Allocation Governance Structure

12) What transparency will be given over the Algorithm?

The aim of the Allocation Framework and Algorithm is to enable fair and equitable access to COVAX Facility vaccines. In order to maintain trust in that process, the allocation outputs will be made public.

Additionally, the finalised code of the Allocation Algorithm as well as technical documentation is in preparation and planned to be published in the coming months.

13) When will the results of the Algorithm be communicated?

Every time an allocation round is run, upon validation of the VAD by the IAVG and JAT, the results will be:

1. Communicated to the COVAX Facility and the Procurement Coordinators for implementation
2. Communicated to the participants through the COVAX Facility or Procurement coordinators
3. Made publicly available

This process is aimed to be repeated every time an allocation round is triggered.

14) What steps have been taken to secure the process and the data?

The algorithm and all information related to allocation is held with the utmost care and security. WHO employs a range of technologies, processes, policies and security measures to protect our systems from loss, misuse, unauthorized access or disclosure, alteration, or destruction.