

Group Assignment: Phase-1 COVID-19 vaccine delivery strategy

Prescriptive Analytics (Fall 2025)

Assigned: 2025-11-10 • **Due:** 2025-12-07 11.55pm

Assignment overview

This group assignment is designed to have you demonstrate your understanding of the concepts covered in the course. You will work on a small modeling exercise including a role-playing component, simulating a real-world project and proposal set-up and presenting/pitching your results live on December 8th.

Grading

- Group assignment: **35%** of final grade

What to submit

- Report, slides (PDF) & accompanying code

Submission

Submit all via Moodle on time

Notes

There is no single “correct” solution. Be creative, apply course concepts thoughtfully, and present your work clearly and professionally.

Introduction

It is December 2020. You are working in a team of consultants specialized in the optimization of supply chains. The team has just **received an invitation for an urgent public tender from the UK government’s Vaccine Taskforce (VTF)**, which was established in April 2020 by the government’s Chief Scientific Advisor, Sir Patrick Vallance, to drive forward, expedite, and co-ordinate efforts to ensure that the UK population would have access to a clinically safe and effective vaccine against COVID-19 ¹.

Concretely, the VTF has sent an RFP (request for proposal) for the **design of a Phase-1 COVID-19 vaccine delivery strategy starting from January 2021**, which optimally allocates, distributes, and administers the limited supply of two vaccine types across England maximizing protection for those most at risk.

The strategy must respect prioritization rules, account for regional capacity limits, and consider limited availability of two vaccines. Therefore, the VTF has provided you with key requirements and additional data to support your proposal (see Tender details below). Your mission is to **convince the key stakeholders at the VTF that you are the best consultancy for this job, showcasing your expertise**.

This assignment is structured to simulate a real-world scenario where you will join an alignment meeting with Sir Patrick Vallance, who is heading the task force (represented by Prof. Strauss and Jan Overberg) to get a deeper understanding of the VTF’s key objectives. Use the meeting insights to build a prescriptive model generating valuable insights, draft a proposal report, and communicate your findings during a live pitch meeting in class on December 8th.

¹<https://www.gov.uk/government/publications/uk-covid-19-vaccines-delivery-plan/uk-covid-19-vaccines-delivery-plan>

Tender details

At this point in time, December 2020, the UK with the help of the VTF has so far secured access to 367 million doses from 7 vaccine developers across 4 different formats (viral vectored vaccines, recombinant protein-based adjuvanted vaccines, whole inactivated viral vaccines and mRNA vaccines), with an expected cost of £2.9bn across the five final contracts signed to date.

Table 1: portfolio overview

Vaccine type	Vaccine	No of doses	Status
Adenovirus	Oxford/AstraZeneca	100 million	Approved and in deployment
Adenovirus	Janssen	30 million	Phase 3 trials
mRNA	Pfizer/BioNTech	40 million	Approved and in deployment
mRNA	Moderna	17 million	Approved
Protein Adjuvant	GlaxoSmithKline/Sanofi Pasteur	60 million	Phase 1/2 trials
Protein Adjuvant	Novavax	60 million	Phase 3 trials
Inactivated whole virus	Valneva	60 million	Phase 1/2 trials

Figure 1: Vaccine Portfolio Overview of contracted No of doses

For the **first Phase, which is planned as a one-off wave in January 2021, two of the three approved vaccines have been confirmed** for on-time delivery to the VTF's central warehouse: **10% of the contracted doses of Oxford/Astrazeneca and 10% of the contracted doses of Pfizer/BioNTech**. These are the relevant doses for the Phase-1 delivery and administration strategy. More precisely, these doses need to be allocated to the right people in 9 regions across England (8 regional districts & London).

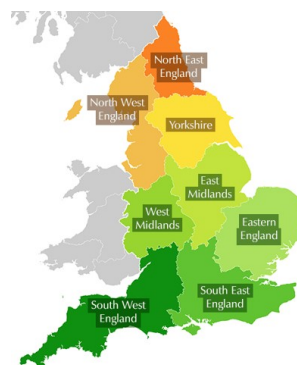


Figure 2: Supply regions excl. London (coloring for presentation purposes only)

According to the **Joint Committee on Vaccination and Immunisation (JCVI)**², the independent medical and scientific expert body, which advises the UK government on prioritization for all vaccines, the first priorities for the current COVID-19 vaccination program should be the **prevention of COVID-19 mortality and the protection of health and social care staff and systems**.

Therefore, for Phase-1, the committee has **a) derived a criticality score** representing the comparative value of the administration of a dose per vaccine type and age group for both Pfizer/BioNTech and Oxford/AstraZeneca, which should guide the prioritization of whom the vaccine should first be administered to by age.

²<https://www.gov.uk/government/groups/joint-committee-on-vaccination-and-immunisation>

There are 6 age groups (80+, 70-79, 60-69, 50-59, 30-49, <30). As the aim is to protect the greatest number of at-risk people possible (here reflecting the mortality risk), older people receive higher priority, hence, a higher score. The "benefit" represented by the criticality score of having one person assigned with one dose is quantified according to the following table:

Unit benefit	80+	70-79	60-69	50-59	30-49	<30
Pfizer	10	9	7	5	3	1
AstraZeneca	10	6	2	1	0	0

Note, the two vaccine types show different criticality scores as the efficacy in reducing mortality and lowering transmission risks once vaccinated by age group differs³. Further, the JCVI **b) estimated the number of frontline health and social care workers per age group**. The committee estimates that

- 1% of 60-69 year olds
- 2% of range 50-59 year olds
- 3% of range 30-49 year olds

of the population are either a frontline health or a social care worker (the committee assumed the share is distributed equally across all regions for simplicity). **It is critical to guarantee that these workers receive a dose** as the protection of health and social care staff is critical to avoid a collapse of the health system. Find the additional population data according to the 2020 Census in the Appendix.

As regional lockdowns are ongoing, we are facing capacity constraints to handle the logistics of the vaccines per region. One critical constraint is the **space constraint** in the transport vehicles available for distribution of the vaccine to the regions. Each region has a limited vaccine boxing capacity measured in boxing units. Total boxing capacity (in units) per region can be found in the Appendix in Table 2. It is important to note that due to different packaging requirements, one dose of Pfizer requires a boxing capacity of 2 units, and one dose of Astrazeneca requires 1 boxing unit of capacity. An operationally feasible plan must consider these operational limitations.

Another critical component of the strategy we ask you to provide is a plan on **how to best administer the vaccine** to the people, as the benefit only occurs once the patient has received the vaccine. Questions we seek to answer are

- What type of sites are needed to cater to the different age groups' needs?
- What are the appropriate and necessary delivery models?
- What capacity of administered doses per day do you expect per site and delivery model, i.e., what is the total time to completion of Phase-1?

Note, there is one month left until the first vaccine is administered, so only existing infrastructure requiring minor modifications can be used for administration.

Note, independent of the delivery models you come up with, we, the VTF, have decided to **limit the individual sites/modes of delivery to only deliver one vaccine type**. In our eyes, this approach trades-off convenience of the administrators, the use of supply and maximizes use of all vaccine site capacity. We task you to quantify the required site capacities for phase 1 per delivery mode. Make assumptions where necessary. Feel free to leverage publicly available information to back-up your assumptions.

³While both vaccines show a positive reduction of mortality in high age groups, only Pfizer shows positive effects for young age groups with almost no mortality risk as the vaccine effectively lowers the risk of transmission

When designing your delivery strategy, please consider one additional limitation we face in our central warehouse. Per region, we can only supply 5 sites/delivery modes per day due to administrative constraints. E.g., if you decide to design 5 vaccination centers in London, all of them can be supplied within one day. Every additional 5 sites require another day of delivery (assume 5 working days per week).

Task 1 — Tender detail understanding

Begin by familiarizing yourselves with the tender details. Make sure to thoroughly read through the details and distill relevant constraints outlined by the VTF. Further, make sure to scan the available data and how the existing data can help you in the design of constraints as well as inform which modeling approach may be needed here.

Further, form an initial hypothesis on the objective function. Prepare to test your hypotheses during the meeting with Sir Vallance. Additionally, brainstorm sites, delivery models and additional operational limitations that may arise by site and delivery model. Make sure to consider these in the design of your Phase-1 delivery plan.

Task 2 — Meeting w/ Sir Vallance

Each group will each have a 20-minute meeting with Sir Patrick Vallance (represented by Prof. Strauss or Mr. Overberg). He is the leader of the VTF and will have a major influence on who will win the tender. Be prepared to ask relevant questions, test your hypotheses and use the time to gain a deeper understanding of his motivation, his priorities, and critical strategy components.

Keep it professional - business apparel is expected! Treat the 20min as a real client interaction. You are welcome to use generative AI tools to help prepare for the meeting (use the role-play mode in ChatGPT to have it play the consultant and you Sir Vallance, instructing it to ask you a few questions, one at a time, such that it can take your answers into account.)

Task 3 — Modeling and Proposal Preparation

70 pts

With the insights from the meeting with Sir Vallance, design and solve the model to identify the optimal delivery strategy. Synthesize the model's output into a concise report, which should take the form of a formal project proposal, as a consultancy might submit to a government client.

Again, you are encouraged to make use of generative AI tools to support you in designing the document (as well as to support you in coding). However, these tools won't be able to replace your critical thinking and creativity in translating the problem into an optimization model and then synthesizing the results and insights back to the client. In particular, the report should be very clear on the identified insights; it is not sufficient to output the numbers without any intuition/graphic/supporting facts that help the reader gain confidence in your solution. Instead, I expect a detailed justification of why this is the optimal solution, in a language accessible to non-data scientists.

Feel free to make reasonable assumptions where necessary, as long as you highlight them as such. The report is subject to a limit of 1,800 words. Also submit your R code/Python code that underpins your results. For your model, it is completely fine to stick to the methods covered in class.

Please note, one focus of this assignment is on finding an "optimal" solution but more importantly to give you an opportunity to go through a simplified optimization project for a practical problem. I am seeking to assess your ability to translate the real-life problem into a suitable small optimization project, model it, and then translate the results back into a meaningful message to a non-technical client.

Task 4 — Pitch Presentation

30 pts

Prepare a presentation of at most 10min to convey your findings to Sir Vallance and his team. While discussing your model, focus on the implications and insights of your results and how they align with the objective but also why "they make sense" - make Sir Vallance and his team believe what they are seeing.

Keep it professional - business apparel is expected! The evaluation will be based on presentation style, content, media, appropriateness for the audience, and how convincing the pitch is, i.e., to what extent it addresses and solves the problem at hand. To that end, make sure that you motivate your findings properly such that it is very clear what the implications of your findings are and how they help the VTF achieve their objectives. Structure the pitch according to what was covered on the subject in class.

Appendix

Regions/age group	80+	70-79	60-69	50-59	30-49	<30
NORTH EAST	141,046	247,406	321,867	374,722	644,385	951,337
NORTH WEST	365,581	644,544	805,580	1,012,335	1,843,054	2,696,362
YORKSHIRE AND THE HUMBER	278,810	481,845	604,754	748,490	1,362,920	2,049,531
EAST MIDLANDS	248,075	449,080	545,037	679,642	1,191,124	1,752,625
WEST MIDLANDS	304,678	515,243	620,733	792,926	1,486,019	2,242,330
EAST	349,870	579,443	684,405	867,001	1,602,799	2,185,643
LONDON	303,460	476,851	723,718	1,078,660	2,878,016	3,541,783
SOUTH EAST	513,283	836,494	994,575	1,286,973	2,334,470	3,251,470
SOUTH WEST	350,796	593,214	680,444	796,384	1,335,016	1,903,289

Table 1: Population by region and age group (counts).

Region	Capacity
NORTH EAST	150,000
NORTH WEST	2,210,237
YORKSHIRE AND THE HUMBER	1,657,905
EAST MIDLANDS	1,459,675
WEST MIDLANDS	1,788,579
EAST	1,880,748
LONDON	2,700,746
SOUTH EAST	2,765,180
SOUTH WEST	1,697,743

Table 2: Regional boxing capacity.