



Vaccine development as a public service:

Public service logic in the development of the Oxford AstraZeneca COVID-19 vaccine

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Abstract:

This paper examines the development of the Oxford AstraZeneca vaccine during the COVID-19 pandemic as a paradigmatic example of an effective public-private partnership and ground-breaking innovation in drug development. Central to this successful approach was the Vaccine Taskforce (VTF), a novel state entity which distinguished itself by taking responsibility for the outcome of the vaccine development process, necessitating an active role in the process. In this paper, the development of the Oxford AstraZeneca vaccine is reimagined as a new public service delivered by the VTF, identifying the important role of public service logic (PSL) in the design and delivery of the vaccine. Accordingly, the paper employs service design blueprinting, a common technique used in the design of public services, as an analytical framework. Blueprinting enables a comprehensive analysis of the resources and expertise mobilised by both public and private actors, documents the highly innovative process that enabled the fastest vaccine development in history, and materialises the unique role that the state played in maintaining an essential connective tissue between all parties to enable the mindset that underpinned success. The results of the service blueprinting highlight that the state can play a broader role in drug development, moving beyond facilitating private actors and becoming an active participant in the innovation process, further suggesting that the engagement of PSL with existing innovation commons can shape the motivations of private actors in the creation of public value. Extending the design lens, the paper concludes by examining the question: how might we see the development of new drugs as a public service?

1. Introduction

In 2020, the record for developing a vaccine from pathogen detection to being approved for use was broken (Chakraborty et al. 2023). The previous record had been set decades earlier by the development of the mumps vaccine (Stuart 2021). This record was not broken by shaving off days or weeks from the process that was used in the 1970s, but by reducing it by over three years. To add to the unprecedented speed of development, this new record was not set by one pioneering team of vaccinologists, but by ten separate teams simultaneously, all competing for scarce resources, using different processes on different continents and occasionally working with partners who had no prior experience in the development of vaccines (Saleh et al. 2021). However, it was not simply the speed of development that was unusual.

In recent years, some large biopharmaceutical companies have been critiqued for focusing too closely on the financial rather than the health benefits of their operations (Lazonick et al. 2017). The financialisation of biopharmaceuticals, it is argued, has reduced innovation in the discovery of new drugs. Further, when new drugs are discovered, they are released to the market with strategies aimed at maximum profit (Moerman and Van Der Laan 2006). It is long established that when developing pricing strategies for new drugs, firms that own the intellectual property for these drugs set a price that reflects the financial value of averted health costs. This means that if a drug is effective for treating a condition and the condition is very severe, the cost of the drug will be incredibly high (Roy 2017, 2023). Following this logic, it would be reasonable to assume that an effective vaccine for a dangerous pandemic would be the most expensive drug ever. It is, therefore, even more confounding that any private firms seeking to develop COVID-19 vaccines so rapidly would freely choose to do so with a commitment to making no profit from the vaccine during the pandemic (Fortner 2022).

Among the vaccines developed in response to the COVID-19 pandemic, one is distinguished as having been not only the most widely administered, with 3 billion doses delivered up to the end of 2021, but also the one which continues to generate no profit¹ for its owner in low-income countries (AstraZeneca 2021). The circumstances of the development of this vaccine entirely transformed both the process and prices of typical drug discovery. While the conditions under which the vaccine was developed have been highlighted as highly novel and involved the development of unique relationships between actors (including a novel role for state actors) (Bloom et al. 2021), there has yet to be a holistic investigation of how the myriad actors that contributed to the creation of the vaccine were able to collaborate so rapidly and effectively.

The creation of vaccines in response to the COVID-19 pandemic saw the formation of many new and unique partnerships. Among these new collaborative relationships was a more active role for state actors. In April 2020, the UK Government announced the newly created Vaccine Taskforce (VTF), which was designed to support and speed up the development of COVID-19 vaccines (BEIS 2020). The success of the VTF in rapidly delivering a supply of novel vaccines for the UK population has led many policymakers to advocate for a 'VTF-type approach' in delivering ongoing healthcare missions as part of the UK Life Sciences Vision (HM Government 2021, p. 10). This VTF-type approach is summarised as the creation of a 'single, empowered decision-maker to mobilise private and public sector science and investment' (HM Government 2021, p. 10), and the creation of 'accountable leaders with the authority and industrial experience required to deliver complex programmes of work' (HM Government 2021, p. 59). This paper does not argue that these aspects of the VTF-type approach are unimportant, but identifies that these capabilities alone are unlikely to lead to success.

¹ In early 2020 AstraZeneca and Oxford University agreed that the vaccine would generate no profit during the pandemic (which officially ended in May 2023 (WHO 2023)) and no profit from low-income countries in perpetuity (AstraZeneca 2020).

This paper instead argues that the VTF effectively positioned the development and distribution of the Oxford AstraZeneca vaccine as a new public service. As a result, vaccine development was governed by public service logic (PSL) (Osborne 2020), in which value creation is conceived as a collaborative action between stakeholders. This approach differs significantly from a facilitative state approach for drug development created through innovation policy. These approaches often rely on creating specific incentive structures, which cause private organisations in pursuit of competitive advantage to behave in ways that support a specific desired societal outcome (for example, Andreoni 2016; Mazzucato 2016). The introduction of the values-based collective value creation of PSL differs in that it considers that desired societal outcomes may be, in some circumstances, shared by the private organisations involved.

PSL specifically identifies that, as with all services, value is created through the interaction of service delivery organisations and the users of their services (Osborne et al. 2013). This has been investigated with regard to COVID-19 mass vaccination programmes as a way of reconceptualising the value produced by such programmes as generated by user engagement (Osborne et al. 2024). The paper further argues that extending the application of PSL beyond interactions between users and delivery organisations, to the interactions between organisations involved in the production of innovation, provides a new way of conceptualising collaborative value creation in the creation of drugs that address societal challenges. Therefore, this paper argues that PSL enabled the VTF to take a more proactive role in developing the vaccine, specifically by intervening at all stages of the process to resolve challenges, ultimately ensuring the project's success.

The paper seeks to build a case for more active state involvement in the creation of new drugs (section 2), identify the data available for garnering a nuanced understanding of the vaccine development process (section 3), demonstrate with this data that the VTF's actions during the COVID-19 pandemic can be conceived as a new public service (section 4), and utilise a public service blueprint to precisely identify how this approach enabled the more active role taken by the VTF (section 5). Finally, a prototype is proposed for a potential UK Public Drug Delivery Service based on these findings (Section 6).

2. The state, innovation and the creation of public value

Innovation performs a vital function within economies as it provides a mechanism for reorganising and renewing actors to increase productivity and competitiveness (Andreoni 2018). Standard conceptions of innovation are focused on heroic, innovative firms that work to transform the economy singlehandedly. In fact, this is almost never the case, as innovation requires ecosystems of actors to effectively collaborate, and share vital skills and knowledge that contribute to the production of radical innovations (Lundvall 2010). Given that the policy challenge of 'keeping industrial ecosystems along a trajectory of diversification and innovative industrial renewal is of paramount importance in mature economies' (Andreoni, 2018 p. 1638), and that innovation can generate significant benefits for society (Perez 2002) a significant role exists for states in the production of innovation.

However, beyond goals of economic growth, the state has a responsibility to act in the public interest or for the public good. This concept, however, is borne of the idea that specific goods and services that are required by the public cannot or would not be effectively provided by the market (Bozeman 2002). The notion of public value can provide an understanding of value creation that eschews a market-fixing role for the public sector, allowing for a more active and interactive role (Mazzucato and Ryan-Collins 2019), and, in practice, provides governments

with a more practical approach to evaluating the impact of their activities (Kelly et al. 2002). According to PSL, public value is not limited to the immediate outputs of public service delivery, but includes broader impacts on society, such as increased social equity, improved public health and enhanced civic engagement. As a result, the value created by these outputs is co-created through the interactions between public service organisations and their users. This relational approach highlights the importance of stakeholder engagement and collaboration in generating value, emphasising that public value is realised through collaborative processes and relationships that facilitate service delivery (Osborne et al. 2013).

Innovation commons play a crucial role in creating public value by fostering cooperation among individuals addressing high-uncertainty challenges in innovation. These commons provide a collaborative platform for knowledge sharing and resource pooling, enabling access to critical, context-specific information essential for action. Such shared information, gained through experience, is invaluable for navigating complex innovation trajectories. Like the PSL framework, innovation commons are highly collaborative systems that generate value through stakeholder interactions. They address societal innovation problems as collective action challenges, pooling resources through non-market approaches to govern and direct innovation toward societal needs (Potts 2018).

2.1 Innovation and collaboration

Examinations of systems of innovation have identified that more significant linkages between organisations can provide opportunities for the knowledge and technology transfer that drive greater innovation (Pavitt, 1984). These connections and interactions are important to the production of innovation within such ecosystems (Edquist 1997), with the literature identifying that 'these linkages increase the probability of successful innovation' (Andersen and Lundvall 1997, p. 244). These structural interdependencies mean that all firms, including those actively in competition, collaborate to create greater value in the system through inter-organisational learning and the pooling of capabilities (Andreoni 2018). Examinations of systems of innovation have identified that not only do greater linkages between organisations provide opportunities for the learning that drives greater innovation, but also that cooperation between firms is an essential part of achieving greater specialisation of firms within this system. This can allow greater focus of investment within individual firms, while ensuring that needed capabilities are found elsewhere in the system (Lundvall 2010).

Crucially, this system understanding allows for appreciation that there are a wide variety of actors involved in the production of innovation, which influence each other's behaviour even where their motivations, goals and markets are fundamentally different. The variety of inputs required for successful radical innovation means that innovations within a single firm cannot be considered in isolation and, in fact, can be considered as shared outcomes from the interactions of an ecosystem (Baldwin & von Hippel 2011). Interconnectivity between firms, therefore, is fundamental to the generation of innovation, and the routines that develop to manage and coordinate this connectivity within an ecosystem of firms are a key determinant in their success (Nelson & Winter 1985). By taking a systemic view of the production of innovation, we can understand the factors which shape the innovation processes that occur between organisations (Nelson 1993).

This is particularly true for bridging the gaps between the research organisations and the organisations that seek to apply and commercialise this research (Oh et al. 2016). The triple helix is a model for understanding the tri-lateral relations that occur between the state, universities and industry in the production of innovation. The model emphasises that the connections between these institutions are so fundamental and deep that they do not just produce new products and services by combining knowledge and resources, but they

fundamentally change the nature of the institutions themselves through mutual exposure (Etzkowitz and Leydesdorff 2000). As a result, innovation partnerships between public and private actors can indirectly lead to shared values and approaches to specific challenges.

2.2 Challenges in biopharmaceutical collaboration

Creating innovative new drugs is a highly collaborative process; formulating new molecular compounds (NMCs) often requires years of painstaking work, combining the input of a wide array of specialists. Once a new compound is discovered, it will often go through years of testing, requiring collaboration with specialists in drug trials, and regulators and thousands of volunteers in these trials. Should a drug be lucky enough to be approved for use, highly specialised manufacturing processes need to be created, built and constantly monitored for quality control. The final step in the chain is the delivery mechanism of the new drug to the patient who needs it, often an incredibly challenging feat in itself (IFPMA 2019). While this process is often entirely attributed to the organisation that holds the IP for the relevant drug, the process requires the coordinated input of a vast number of suppliers, from manufacturers of the relevant biological substrates to speciality couriers (Bussell et al. 2021).

The development of new drugs is, at its very essence, a team effort. First, it involves many heterogeneous actors, including commercial firms, regulatory agencies, universities, research centres and governments, whose roles vary greatly and occur at different stages of the drug development process (Malerba and Orsenigo 2015). Second, the complexity of the challenges themselves requires heavily integrated forms of collaboration (Mazzucato and Roy 2019). Given the deeply integrated and complex nature of biopharmaceutical collaboration, and the significant commitment of resources required for the partnerships to be effective (Munos 2006), objectives for partnerships are identified through protracted negotiations, which also agree on organisational structures, funding models and suitable intellectual property (IP) frameworks (Stevens and Huys 2018). Due to these specific challenges, collaboration in the biopharmaceutical industry and, therefore, the creation of new drugs, is a slow and resource-intensive processes. It often requires decades of work for new drugs to be produced from lab to job (IFPMA 2019).

2.3 Biopharmaceutical innovation and public value

In addition to its complexity, innovation in the biopharmaceutical industry is unique in its role in serving the public good. Successful biopharmaceutical innovation provides the economic benefits associated with industrial growth, but can also generate effective treatments for life-altering diseases, directly improving the quality of life for those impacted. It is for this reason that innovation outcomes in this industry are particularly interesting for understanding the relationship between innovation and public value (for example, Mazzucato and Li 2021). A common theme in this research is that the biopharmaceutical industry is heavily shaped by financial interests, which restricts innovation (Naci et al. 2015; Tulum and Lazonick 2018). This can cause firms to focus their activities only on drugs that are likely to be highly profitable, neglecting the diseases that have limited markets because they are rare (Melnikova 2012) or are prevalent in parts of the world with limited funding for purchasing drugs (Trouiller et al. 2002).

In addition to these limitations on the innovation process itself, when pharmaceutical innovation results in significant breakthroughs, pricing structures for these impactful drugs are highly restrictive. In practice, this means that despite successful innovation, the drugs created are often not available to the populations that need them (Roy 2017, 2023). The tensions between the biopharmaceutical industry's financial incentives and the need to meet public needs with innovative drugs, it can be argued, creates a critical and specific role for state actors in the development of new drugs.

2.4 A role for states beyond pharmaceutical facilitation

Historically, state actors have resolved market failures in drug development, providing financial incentives to firms that engage in potentially less profitable activities, such as additional funding and tax relief for the development of treatments for rare diseases (Panju and Bell 2010). Within the UK, UK Research and Innovation (UKRI) manages the Industrial Strategy Challenge Fund (ISCF) and the Strategic Priorities Fund (SPF), which provide public funding for R&D in areas of strategic priority, including the discovery of novel drugs (UKRI 2020), and more recently a significant aspect of the UK Life Sciences Vision is to provide dedicated funding to encourage private organisations to engage in areas of particular need (HM Government 2021). Expanding from this market-fixing role, state actors, building on an ecosystem understanding of innovation, provide support to the biopharmaceutical industry designed to support effective inter-organisational linkages. These initiatives are designed to address barriers to the efficient operation of innovative industrial ecosystems. Technology and Innovation Centres (TICs), such as the Catapult Network in the UK (Kerry & Danson 2016), foster networks between relevant actors to support innovative industries. The UK biopharmaceutical industry is supported by two such TICs, the Cell and Gene Therapy and the Medicines Discovery catapults. Each of these public organisations aims to engage small, medium and large private firms to provide infrastructure and support for collaboration that aims to make these industries more productive and fuel growth (Catapult Network 2021).

The types of government support described above are vital to the effective functioning of the UK's thriving biopharmaceutical industry and contribute to the UK's long-held status as a global hub for drug development and related research (Enterprise Ireland 2019). However, both market and system-fixing approaches are predicated upon the notion that private organisations, given the appropriate conditions, will produce the desired outcomes from their activities. This, however, does not acknowledge the essential role that non-private actors play beyond facilitating the value creation of private organisations (Mazzucato & Ryan-Collins 2019) and, with the biopharmaceutical industry specifically, there is increased advocacy for the state to take a more active role in the creation of new drugs (Mazzucato et al. 2020; Mazzucato and Li 2021). This approach can provide a more active mandate for government intervention and has a significant positive impact on existing innovation systems (Woolthuis et al. 2005).

Innovation policy attempts to influence the goals of private actors in an ecosystem by creating new incentive structures that they can use to pursue advantage over their competitors (Andreoni 2016). For example, a package of policies created new incentive structures for the pharmaceutical sector in Ireland in the early 2000s, resulting in the sector's rapid growth (Hannon et al. 2011). In combination, these policies aim to tilt the playing field (Mazzucato and Perez 2015), encouraging private actors motivated by their own financial interests to behave in new ways that are favoured by the state. These mechanisms, it has been argued, allow states to engage in market-shaping, encouraging ecosystems of actors to work toward state goals and address societal challenges (Mazzucato 2016). Within the drug development ecosystem, such approaches can, therefore, be used to align pharmaceutical firms' commercial interests with areas of specific public need, potentially encouraging the creation of essential new drugs (UCL Institute for Innovation and Public Purpose 2018).

However, it can be argued that commercially focused incentives contradict the more collaborative and non-financially motivated activities that are identified in studies of innovation commons (Potts 2018). The much-studied DARPA model provides an illustrative example of the deployment of new incentive structures which serve to align the interests of private firms to state objectives (Bonvillian et al. 2019; Bonvillian and Van Atta 2011; Colatat 2015). However, in addition to these market-shaping approaches, Bonvillian & Weiss (2015) identify alternative approaches to value creation that are inherently collaborative in nature. In these instances, the

agency is able to 'take a different approach, enabling and enhancing innovation by examining a sector's innovation environment, including the institutions and barriers within it, assessing their strengths, evaluating means for improvement, and policies and steps to strengthen the system, fill system gaps, and overcome barriers' (Bonvillian 2018, p. 900).

2.5 The active role of the UK Government in COVID-19 vaccine development

During the COVID-19 pandemic, the UK Government acted to facilitate the creation of a vaccine for the disease. It provided unprecedented financial support for vaccine development, earmarking £250 million to fund the development of a vaccine (DIFD 2020) and making advanced purchase agreements for hundreds of millions of doses of vaccines in development (BEIS 2020). In addition to these critical facilitative roles, the UK Government established the VTF, a new state entity with a mandate to obtain access to vaccines for distribution to the UK population and beyond, in order to achieve lasting immunity to COVID-19. The new agency was to work closely with the NHS to distribute these vaccines to the UK population at no cost at the point of use (DHSC 2023). The agency, initially led by a biopharmaceutical venture capitalist, Dame Kate Bingham, was staffed by experienced civil servants and experts seconded from industry (Bingham and Hames 2022).

Rather than simply developing new incentive structures to encourage the creation of the needed vaccine that the government would then procure, the VTF consistently took the view that its work should 'focus on outcomes, not process' (Bingham and Hames 2022, p. 108). This focus effectively made the VTF responsible not only for acquiring vaccines, but for all steps that led to the delivery of these vaccines to the UK population. It can be argued that this approach established a de facto UK public vaccine development service requiring the VTF to go beyond simply supporting the UK biopharmaceutical ecosystem and to become a primary actor in the system, taking responsibility for filling system gaps and overcoming barriers.

3. Data

To date, there has been limited investigation of the specific activities conducted by the various parties involved in developing the Oxford AstraZeneca vaccine. However, a significant volume of literature has been produced by the actors directly involved in the development and delivery of the vaccine, which provides granular first-hand accounts of the process. Taken together, this literature provides a highly detailed account of the specific actions taken by a wide range of actors, often describing certain activities from various perspectives. Analysis of this data allows for the construction of a comprehensive timeline of activities, including the motivations of individual actors and how specific activities were perceived by other stakeholders. The analysis, therefore, provides the necessary information to build a blueprint of the various roles taken by stakeholders in the development process and provides insight into the specific motivations and intentions of those involved.

For the purposes of this study, documents were acquired through a systematic search of actor-owned websites, specifically www.astrazeneca.com, www.ox.ac.uk and www.gov.uk. This literature was acquired using the search term 'Oxford AstraZeneca COVID-19 Vaccine', which yielded 127 documents and web pages. These documents were manually reviewed for specific references to the collaboration. This process identified 56 relevant documents for analysis. In line with the methodology proposed by Mahood et al. (2014), the search engine Google.com was used to identify additional actor-generated literature not housed on these websites, using the search term 'Oxford AstraZeneca COVID-19 Vaccine'. This yielded two further actor-generated manuscripts produced by key individuals from the University of Oxford and the VTF.

Following the investigation of collaborative vaccine development by Villazul & Vargas (2020), the study employed a grounded theory methodology to investigate the development of the Oxford AstraZeneca COVID-19 vaccine. This grounded approach was used to identify behaviour patterns and key factors that led to the vaccine's rapid development and deployment.

4. COVID-19 vaccine development as a public service

This paper argues that the VTF's actions were fundamentally shaped by a public service approach. To understand how the VTF's actions established a new form of public service during the COVID-19 pandemic, we need to explore the nature of public service delivery. This can then be compared to the approach taken by the VTF in the development and delivery of the Oxford AstraZeneca vaccine to ascertain that it is feasible to reimagine the actions of the VTF as public service delivery.

4.1 What is a public service?

Public services in the UK, such as healthcare, education and policing, are fundamentally different in nature to corporations providing services to the public and to activities conducted by the Government that do not serve the public directly. Private corporations, including social media, banking and consulting firms, claim that their activities are a service to the public (Deloitte 2022; Goldman Sachs 2011; Twitter 2020). While these organisations do provide services to people, they principally provide their services to those who wish to pay for them. As a result, the value of their services is only for a select group of individuals. While it can be argued that these services provide general value at a societal level, the organisations themselves are not directly generating that value. Similarly, states also conduct various activities that are not considered acts of public service, such as upgrading public buildings to make them more energy efficient (DESNZ, 2024). Still, while these provide benefits, including lowering costs or energy usage, they operate on a different approach to public service delivery.

PSL represents a paradigm shift in understanding public services, emphasising a service-dominant rather than a product-dominant logic (Osborne et al. 2013). Rooted in service management and marketing theory, PSL views public services as processes that create value through the interactions between service providers and users rather than merely delivering predefined outputs. This framework underscores the co-production of services, where users are not passive recipients but active participants whose engagement and feedback are crucial in shaping the service experience and outcomes. The essence of PSL lies in its focus on value creation within public service ecosystems, which are dynamic and comprised of multiple actors, including government agencies, non-profits and the community. This approach aligns with the concept of service-dominant logic in the private sector, but is tailored to the unique context of public services, which operate under different imperatives such as equity, social justice and public accountability (Osborne 2020). PSL advocates for a holistic view of public services, where value is co-created through continuous interactions and feedback loops, and eschews the prioritisation of efficiency (Radnor & Osborne 2013).

To exemplify the way in which PSL shapes the role of government, we can examine the way in which the state delivers healthcare services in the UK. There are many public, private and voluntary actors enrolled in the delivery of this service, and in ideal conditions the central government funds local bodies (in the form of primary care trusts) to deliver these services. At the central level, coordinating functions support procurement and other core services. However, should any of the primary care trusts find themselves unable to deliver the services, the central government's resources can be mobilised to cover the shortfall, taking the services into what is

referred to as 'special measures' (Fulop et al. 2023; Lalani and Hogan 2023). In this approach, the state not only acts as a funder of these services, but also, based on the understanding that the value of healthcare services is generated by engagement with citizens, acts to guarantee delivery of these services to the public. In this way, the delivery of a public service can allow state actors to act as 'God of the Gaps',² intervening at any stage to ensure its value to the public is maintained.

4.2 The role of the VTF reimagined as a public service

Spicker (2009) asserts that a public service can be distinguished based on four essential attributes: its foundation in public policy, its direct service to the public, its redistributive function and its operation as a trust.

4.2.1 A foundation in public policy. As the examples above demonstrate, a public service cannot simply be designated as a service provided to the public or an action conducted by the public sector. Since we cannot necessarily identify a public service by whom delivers it, it becomes more relevant to examine how the service is created. Public services are fundamentally characterised by their development for public policy reasons, aimed at furthering policymakers' desired objectives (Spicker 2009).

In early January 2020, in response to the emergence of the COVID-19 pandemic, policymakers established clear objectives concerning the UK's vaccine strategy. Several policy solutions were proposed to further those aims and, of these options, the VTF was created to operationalise the state's goal (BEIS 2020).

4.2.2 Direct service to the public. Public services not only need to provide benefits to individuals, but for them to be considered services, the value generated should be through their delivery. As we have established above, who is involved in delivery does not define a public service (private and voluntary organisations deliver many established public services) and, as a result, how they are delivered becomes more critical. Public services, therefore, can be defined as being delivered with a particular set of values driven by a sense of mutual responsibility and solidarity, aiming to be praiseworthy, other-regarding and inclusive (Spicker 2009).

The VTF was created to facilitate an act of production: creating a COVID-19 vaccine. However, given the breadth of its mandate and the diverse ecosystem it was required to operate within, it went beyond the mere facilitation of vaccine production. By interpreting its mandate as ensuring the UK vaccinated its population, rather than ensuring the UK had access to a vaccine, the VTF was responsible for constant ongoing engagement with stakeholders throughout the ecosystem, often producing nothing directly other than trusted relationships. Broader than this, in its ongoing relational service delivery, even though many of the actors in the ecosystem were private, profit-making entities, the logic of the vaccine delivery, at least in the case of the Oxford AstraZeneca vaccine, was highly cooperative and mutual (Bingham and Hames 2022).

4.3.3 Redistribution. Following on from the values of public service delivery, public services demonstrate the principle of serving the public good over generating profit. In doing this, public services break the direct relationship between payment and receipt of services, which is present in commercial environments. While it is not always the case that public services are free at the point of use, the fact that the logic of the market does not exclusively lead them ensures that any resource allocation is redistributive (Spicker, 2009).

The service provided by the VTF approach to vaccine development and distribution diverged

² 'God of the Gaps' is a term to describe a theological position in which gaps in scientific understanding are attributed to the actions of an intelligent and otherwise unseen force (Coulson, 1955).

significantly from the logic of the market. The vaccines that it helped develop, manufacture and distribute were procured on the UK Government's behalf at various prices. However, regardless of the cost of the vaccines produced or the number of resources committed to delivering the vaccine, all members of the UK public were offered an effective vaccine at no cost. Building on this, the VTF took specific action to allocate vaccines at the point of need, vaccinating the elderly and the vulnerable rather than more impactful economic actors (another option that was considered) (Bingham and Hames 2022).

4.2.4 Operation as a trust. Finally, by their nature, public services require an intermediary, in this case the state, to engage with other parties to provide something the public needs. This breaks the typical relationship between buyer and seller that typifies services provided through market mechanisms. This trust approach is further typified by the state acting not just as a commissioner of services, but also by bearing the principal responsibility for the service provision (Spicker, 2009).

The VTF initially financed the development of vaccines directly and subsequently pre-procured a vaccine supply to guarantee the developers' demand (DHSC 2023). This alone would have helped secure the UK a supply of vaccines to respond to the pandemic. However, going beyond this remit, the VTF supported the vaccine producers in resolving issues in the development process, ensured citizens had access to these vaccines and provided vaccine developers with broad indemnities. In this way, the VTF effectively took responsibility for the vaccine from lab to jab (Balawejder et al. 2021). Taken together, the VTF's actions in 2020 regarding the development of the Oxford AstraZeneca vaccine satisfy the conditions for a public service (see Figure 1).

Figure 1. Features of a public service in the role of the VTF in the development of the Oxford AstraZeneca vaccine (Source: author)

Features of Public Service (Spicker 2009)	The role of the VTF in the development of the Oxford AstraZeneca Covid-19 Vaccine
A foundation in public policy	VTF established to deliver UK government vaccine strategy in April 2020 (BEIS 2020).
Direct service to the public	VTF maintains an ongoing relationship with all stakeholders, in which mutual cooperative values emerge (Bingham & Hames 2022).
Redistribution	VTF approach to vaccine development and distribution not led by market forces and priority is given to vaccinating the vulnerable (Bingham & Hames 2022).
Operation as a trust	VTF addressed emergent issues and providing indemnities, taking responsibility for the delivery of the vaccine to citizens (Balawejder et al. 2021).

Assessing the VTF against public service attributes strongly suggests that PSL guided the VTF's activities. The analysis highlights the actor's emphasis on collaborative, equitable and policy-driven public service delivery. The VTF conceived the value of its activities as stemming from user engagement with the service at the delivery stage. Additionally, during the vaccine's development, the actor engaged in the co-production of outcomes through trust-based relationships, consistently informed by the societal benefits it aimed to generate.

5. Understanding the actions of the VTF: analysis by service blueprint

Having demonstrated that the VTF was the delivery body for a novel public service in the UK in 2020, the paper is able to understand the UK public vaccine development service from the perspective of service design. Through a service design lens, service blueprinting can provide a granular understanding of the actions of the myriad actors and their interactions. By constructing a blueprint for the development of the Oxford AstraZeneca vaccine, we can isolate the specific actions of the VTF within the vaccine development process to understand the extent to which it represented a DARPA-like model of active participation in the production of innovation.

5.1 What is service design?

Service design is an interdisciplinary approach that combines methods and principles from both design and service management to create user-centred services that deliver value and enhance user experiences. At its core, service design focuses on understanding the needs and behaviours of service users, employing a variety of tools and techniques, such as journey mapping, prototyping and user feedback to design or improve services (Stickdorn and Schneider 2012). It emphasises the importance of co-creation, where service providers and users collaboratively develop solutions, ensuring that the services are both effective and meaningful to those who use them (Trischler et al. 2018).

The essence of service design lies in its holistic view of service experiences, and consideration of every touchpoint and interaction between the service provider and the user. In this way it aims to create seamless, accessible and engaging experiences that meet or exceed user expectations (Trischler and Westman Trischler 2022). Service design is not limited to the private sector; it has significant applications within the public sector, where the focus on user needs and service quality is increasingly recognised as vital for delivering efficient and effective public services (Bason 2010). In the public sector, service design offers a pathway to innovation and reform, enabling government entities to design services that are more aligned with the needs of the public. This approach is crucial for improving the quality and accessibility of public services, fostering greater user satisfaction and enhancing trust in government institutions (Holmlid & Evenson 2008; Kimbell 2011; Sangiorgi 2011).

The use of service design in the public sector not only leads to the development of better services, but also promotes a culture of continuous improvement and innovation (Curry and Herbert 1998). This focus on continuous iteration and co-creation with stakeholders effectively harnesses a design mindset to work reflexively with adaptive systems, responding to an evolving context and changes in needs as they arise. This aspect of service design allows us to view the role of the VTF during the COVID-19 pandemic and an initial iteration of a UK public drug development service, and invite further iterations of this emergent service for potential application outside of a pandemic context.

5.2 The value of service blueprints

Service blueprints are strategic tools used in service design to visualise the service delivery process, showcasing the interactions among stakeholders, as well as the internal processes that support these interactions. These blueprints are detailed diagrams that can differentiate between activities that occur in the frontstage (visible interactions between stakeholders) and backstage (internal actions taken to support the frontstage activities). Each of these components is meticulously outlined to illustrate how they interconnect and impact the overall service delivery (Bitner et al. 2008). Creating a service blueprint involves identifying and

documenting the service journey, and then delineating the frontstage and backstage actions required to facilitate that journey. This process not only highlights the interactions between stakeholders, but also the supporting processes that underpin the delivery of a service. By mapping out these components, it is possible to identify inefficiencies, redundancies and opportunities for improvement within service delivery models (Shostack, 1984).

Given the complex nature of public services, and the need for highly collaborative and inter-organisational approaches to deliver these services, service blueprints are particularly valuable in the public sector (Radnor & Osborne, 2013). By taking a meta-organisational view of public service delivery, a blueprint can reveal points of interdisciplinary and inter-organisational dependency, and illuminate the key actions and inputs that are required to deliver at each of these critical moments (Bitner et al. 2008).

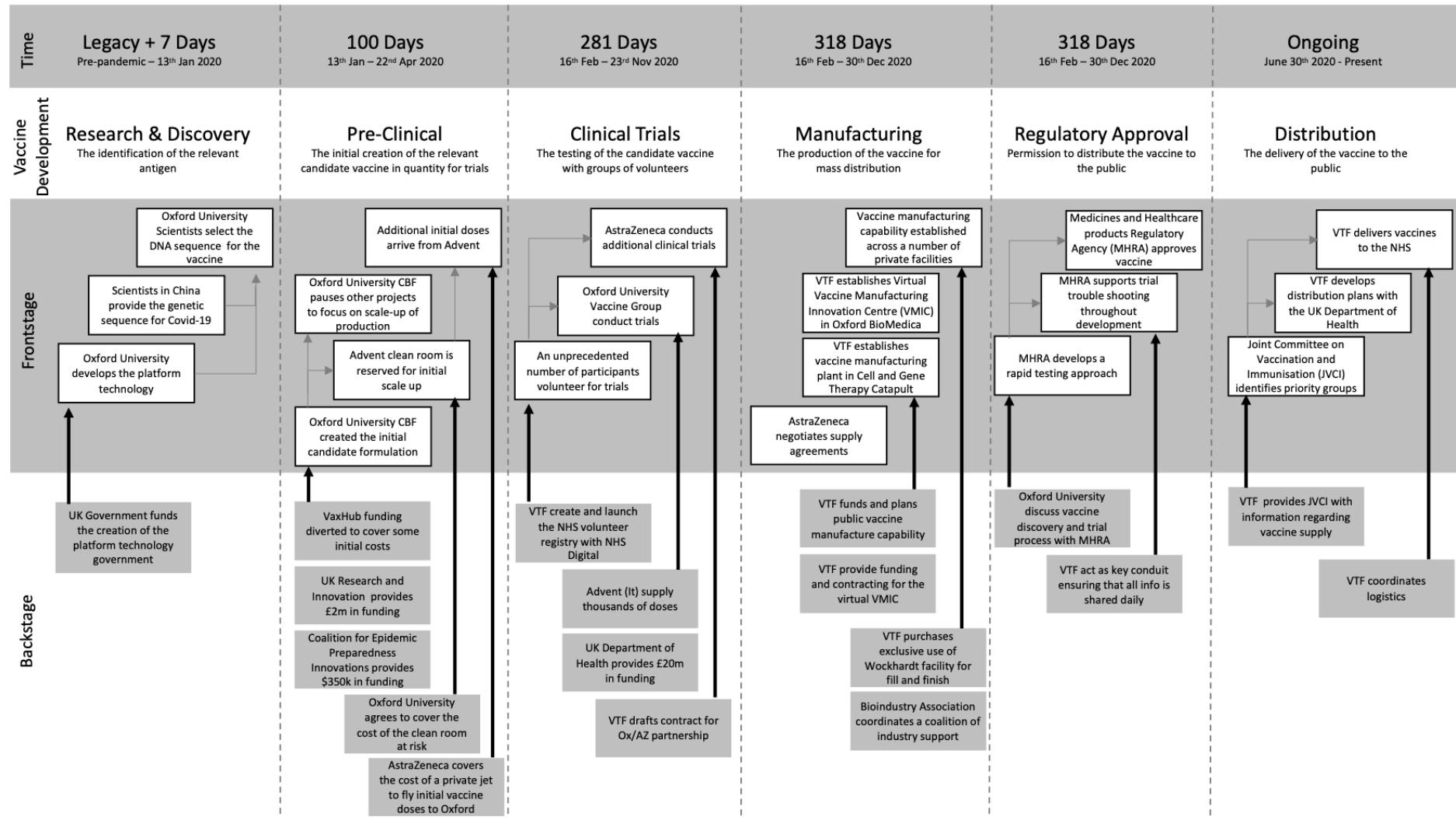
Building a blueprint for a public service is traditionally conducted by bringing together stakeholders for the service. In this way, diverse perspectives are gathered, providing a multiparty perspective on the service's delivery. This multiparty perspective generates a holistic view of the service, including all the various front and backstage activities required for its delivery, illuminating the various interdependencies between the service providers (Nilsson 2021). The blueprint, in this case, rather than acting as a tool for engaging interdisciplinary stakeholders, allows us to unpick the specific roles of the various stakeholders. By understanding the role of each stakeholder in delivery, the novel actions and interactions that lead to rapid and radical innovation in vaccine development are revealed both in the front and backstage of the development process.

5.3 The vaccine development service blueprint

To support the effective analysis of the VTF's activities, in the case of the development of the Oxford AstraZeneca vaccine, frontstage activities were defined as those actions taken by stakeholders who were directly responsible for the development and delivery of the vaccine. Backstage activities are, therefore, identified as the facilitative and supporting actions provided to these active stakeholders. As a result, the frontstage section of the blueprint represents active participation in the innovation process, while the backstage is reserved for facilitating the process.

While service blueprints traditionally display the service chronologically, a distinct feature of the Oxford AstraZeneca vaccine was that activities usually conducted in series were conducted in parallel (BEIS 2020). As a result, the blueprint is presented against the typical steps in the vaccine development process: research and discovery, pre-clinical, clinical trials, manufacturing and regulatory approval (for example, Balawejder et al. 2021; IFPMA 2019). Given that the development of the Oxford AstraZeneca vaccine also included the delivery of the vaccine to the public, an additional step of distribution has been included in the process.

Figure 2. A service blueprint for the development of the Oxford AstraZeneca vaccine (Source: author)



5.4 Analysing the blueprint

The blueprint provides a unique insight into the development of the vaccine, identifying that a heterogeneous group of actors were critical in delivering the vaccine. In line with the expectations for biopharmaceutical collaboration, each stage of the development process requires a different combination of actors. However, the blueprint demonstrates that the VTF plays a significant role across the various stages of the vaccine development journey and, at times, a highly active frontstage role. Analysis of the blueprint reveals three distinct phases for VTF engagement in the development process.

5.4.1 Phase 1: pre-VTF. The state did not initiate the development of vaccines, but acted to support emergent projects. In the initial phases of development, the vaccine was initiated and managed exclusively by researchers at the University of Oxford. These initial activities, which covered the research and discovery, and pre-clinical phases, of vaccine development, were spearheaded by the university, but supported by significant novel contributions from other actors, including private actors coordinated by the UK Bioindustry Association (BIA). In addition, initial financial support from the UK Government, Coalition for Epidemic Preparedness Innovations (CEPI) and the University of Oxford itself was crucial to the initial stages of vaccine discovery. However, it became apparent that the development of the vaccine required activities that were outside the usual practice of the university actors. As a result, a partnership was initiated with AstraZeneca to develop the vaccine. During this time, the VTF was inactive in the development process, suggesting that before PSL was established by state actors, an innovation commons had emerged, shaping the behaviour of the relevant actors.

5.4.2 Phase 2: harmonising collaboration. An agreement was made to deliver the vaccine at no profit and this decision may have led to very high levels of solidarity among the principal actors. It is uncertain why the principal actors decided to create the vaccine under a no-profit agreement as their partnership was formed. However, the VTF took the highly unusual role of drafting the contract between the two principal actors, effectively overseeing the terms in which these actors would engage. Whether or not it was the VTF that created the not-for-profit conditions is not identifiable in the blueprint. However, what is clear is that this novel state activity was undoubtedly an opportunity for the state to influence the values of the project, emphasising the unique role that the VTF had in harmonising the collaboration of third parties. During this phase the VTF was also able to mobilise and direct government support for the collaborators, including providing funding and other services to the active participants and facilitating the process of clinical trial volunteering.

5.4.3 Phase 3: proactively addressing gaps. As new barriers emerged in the development process, they were initially resolved by university actors expanding their usual responsibilities and regularly acting at risk.³ The partnership with AstraZeneca represented a distinct shift in the vaccine development process in the pre-clinical, clinical trials and manufacturing stages. With the addition of AstraZeneca in these phases, a new shared governance approach seems to have emerged. Within these aspects of the development process, barriers that emerged were managed jointly by researchers at the University of Oxford and AstraZeneca to ensure that the development process could unfold at greater speed.⁴

3 For example, the highly unusual act of the University of Oxford agreeing to cover the cost of the Advent clean room at the pre-clinical stage allowed the project to proceed with limited funding.

4 This change to joint problem-solving was exemplified by an incident in which essential vaccine stock was transported from Advent in Italy to Oxford by private jet. In this incident, vaccine stocks were unable to be transported through normal channels due to the pandemic. This issue was identified by researchers in Oxford, who proposed the solution of using a private jet. They then discussed this with the AstraZeneca project team, who provided the financial support to transport the vaccine doses in this way, allowing the clinical trials to proceed as needed.

The VTF's entry into the collaboration at the clinical trials, manufacturing, regulatory approval and distribution stages shifted the governance of the development process once more. In this phase, the VTF adopted a frontstage role. The VTF proactively identified challenges in the manufacturing and distribution steps, and commissioned private organisations to fill specific roles in the manufacturing process, ultimately ensuring that the vaccines were manufactured and delivered to the relevant NHS sites for distribution. During this phase, the VTF owned the implementation of these essential engagements with the development process, for example, by procuring the services of a highly specialised contractor to resolve issues with production lines. The VTF continually exercised this role, essentially utilising its own deep understanding of vaccine development to forecast issues before any of the other actors reported them. In another example, the VTF identified the need for, and led the creation of, a virtual Vaccine Manufacturing Innovation Centre (VMIC) inside Oxford BioMedica. This solved a significant issue for the development of the vaccine and appears to have been entirely the result of the forensic approach of the VTF.

The role of the VTF, building on the initial coordination of the BIA, also appears to have formalised the connections between many stakeholders from across the ecosystem, allowing a significant amount of knowledge, skills and resource-sharing. This enabled all stakeholders involved in the collaboration to acquire new capabilities, allowing many diverse actors to expand their remit and embrace greater uncertainty. The VTF, however, did not expand upon a specialist role; its generalist role and outcome responsibility both enabled and required it to act at all stages of the process, adopting a 'god of the gaps' approach. This approach ensured that in the areas of most uncertainty, the other principal actors could operate effectively in their specialist areas at speed.

6. Conclusion and implications for policy

The service blueprint of the public service approach to vaccine development, as delivered by the VTF in 2020, clearly demonstrates that in the race to vaccinate the population in response to the COVID-19 pandemic, the VTF took both a frontstage and backstage role in vaccine development.

In its backstage role, the VTF provided funding and resources that facilitated the activities of the actors that led to the design, manufacture and delivery of the vaccine. The VTF worked side by side with these organisations to ensure they had access to the resources they needed. Among these resources was a significant amount of finance, collaboration infrastructure and legal indemnities. The state facilitated participation to a radical degree, while also entirely de-risking the involvement of other non-state actors. It is certainly true that this type of support⁵ was critical to the success of the Oxford AstraZeneca vaccine. However, this traditional backstage innovation policy perspective is only part of the role that the state played.

The frontstage activities of the VTF exemplify a more active role for the state in drug development and innovation more broadly, in which the state acts directly in whatever way is necessary to ensure the successful production of innovation. In the case of the Oxford AstraZeneca vaccine, these activities included procuring manufacturing capability, building new facilities and troubleshooting the manufacturing process. By becoming a frontstage actor in the development of the Oxford AstraZeneca vaccine, the VTF appears to have engaged with

⁵ Notwithstanding the material support that the state had provided to the biopharmaceutical industry in the decades leading up to the COVID-19 pandemic (Cross et al. 2021).

the UK biopharmaceutical ecosystem in a similar way to those described by Bonvillian (2018) regarding the innovation organisation model of DARPA.⁶ However, the VTF diverged from this model in that by focusing on the outcome of the innovation process, it became a guarantor for the delivery of the outcome of the innovation process for the needs of the public, effectively adopting a public service logic. Rather than aiming to generate economic growth or create a specific technology,⁷ the primary goal of the VTF was to achieve lasting immunity for the UK population (DHSC 2023). This responsibility for delivery to the public necessitated direct intervention in the innovation process at various stages. It can be argued from this evidence that the application of public service logic provided a state entity with the mandate to take principal responsibility for the successful outcome of the innovation process. From this perspective, the more active 'god of the gaps' approach to state engagement in the production of the innovation to deliver its public service mandate became a necessity, requiring a state to make the best use of its relevant skills, capabilities, resources and networks.

The COVID-19 pandemic created a unique environment in which highly novel state actions were taken, which has led many to question how the legacy of this crisis context might lead to the renewal of state activities (Joyce et al. 2023; Mazzucato and Kattel 2020). Evidence from this paper suggests that in addition to the pandemic context, PSL and the more active role of the state that it enabled were critical to shaping innovation outcomes. Furthermore, given that the private organisations involved in developing the Oxford AstraZeneca vaccine took little or no profit from their involvement, despite having the opportunity to do so, this further suggests that, under certain conditions, PSL may have the ability to shape markets by creating more collaborative, value-led ecosystems that do not require the state to financially encourage private actors to address societal needs. Thus, the case represents a potential alignment of PSL with the emergence of an innovation commons around the creation of the vaccine. Further research is required to understand both the conditions under which PSL interacts with innovation commons to shape the behaviour of private actors and the mechanisms by which the motivations of these actors are influenced.⁸

6.1 How might we imagine vaccine development as a public service?

Given the importance of rapid drug development in response to future pandemics (Cabinet Office 2021), there remains a clear case for creating a UK Public Drug Development Service.

Examination of the Oxford AstraZeneca vaccine development process identifies the many entities in the UK that have the goal of developing needed drugs, from the organisations that possess the design skills (universities, biopharmaceutical firms, biopharmaceutical suppliers), the finance (the Wellcome Trust, CEPI, UKRI) and the manufacturing capability (VMIC, Oxford BioMedica) to the globally respected regulatory body (Medicines and Healthcare products Regulatory Agency, MHRA). This rich ecosystem is supported by various actors that enable the broader ecosystem to work more effectively together to innovate in their desired directions (BIA, Drug Discover Catapult, Cell and Gene Therapy Catapult). To supplement this ecosystem, in 2021 the Government launched its UK Life Sciences Vision, which pledges support for the sector, including access to new goals, funding, institutions and data. The document further identifies an 'opportunity to take a VTF-type approach' and recognises the importance of the 'at-risk mindset', but does not acknowledge the foundational role that the adoption of a public

6 This aim of this paper is not to conduct a comprehensive comparison of the VTF and DARPA, and the comparison is only drawn here to highlight that the more active role in the innovation process is not unique among innovation agencies.

7 These were both secondary goals of the VTF.

8 Specifically, further work is required to understand how the opportunity to acquire new knowledge, skills and capabilities influences the motivation of actors in such collaborative ecosystems, building on the non-monetary motivations identified in peer production (Benkler 2017).

service approach played in shaping the activities of VTF and ultimately directing successful biopharmaceutical innovation toward public need (HM Government 2021). A UK Public Drug Delivery Service would be able to harness PSL to address additional public needs beyond a pandemic context.

6.2 A prototype for the UK Public Drug Delivery Service

To embed a public service approach into our support of drug development, we must return to the features highlighted by Spicker (2009).

6.2.1 Foundation in public policy. While the public actors that play a role in the ecosystem, such as UKRI, MHRA and VMIC, have their foundations in public policy, what is needed in this area is an act of public policy for the creation of a specific drug that would advance policymakers' objectives by addressing an important and salient public need. The pandemic convinced policymakers of the need for a new drug, but in the absence of such conditions, it is also possible to identify the need for new drugs, such as the US Cancer Moonshot (National Cancer Institute 2022).

6.2.2 Service to the public. The creation of drugs as a public service would need to be delivered according to public service values. The COVID-19 pandemic demonstrated that despite significant financial pressures, private organisations are willing to address public needs without a profit incentive. While there is no requirement for there to be no profit in the delivery of public services, it is crucial that these commercial concerns do not override the public value-creation processes. It may be that by imposing conditionalities the state can maintain the value of public service that ultimately subordinates profit-seeking, as in the Governor of California's initiative to create affordable insulin (Ca.gov 2023).

6.2.3 Redistribution. By connecting drug purchasers and delivery entities, such as the National Institute for Health and Care Excellence (NICE) and NHS Medicines Procurement and Supply Chain (MPSC), drugs developed could be used in NHS care outcomes at no or limited cost to the user. In this way, such drugs would enter the NHS supply chain, but at a reduced cost. This effectively transfers part of the redistributive costs away from the NHS and distributes them across the drug development ecosystem.

6.2.4 Operation as a trust. To operate the service as a trust, a body is needed in place of the VTF that can focus across a portfolio of needed drugs. This body would need the mandate to deliver these drugs to the public rather than a mandate to support the life sciences ecosystem. To execute this public service mandate, the body would have to take primary responsibility for developing these drugs from lab to job, operating as a god of gaps, to own the creation of innovative drug development and delivery processes. This entity might follow an ARPA-H model, specifically in its 'scalable solutions' focus area, in which the entity aims to ensure that new drugs are quickly made available to the US population (ARPA-H.Gov 2024).

As Spicker (2009) outlines, focusing on any one of these areas is not enough,⁹ addressing them in concert is essential to creating a public service. In line with service design principles, the ideas discussed above constitute only a speculative prototype rather than a proposal for a UK Public Drug Development Service (see figure 3).

⁹ The UK Life Sciences Vision partially addresses some aspects, but crucially not all of these areas (HM Government 2021).

Figure 3. Features of a prototype UK Public Drug Delivery Service (Source: author)

Features of Public Service (Spicker, 2009)	The UK Public Drug Development Service prototype
A foundation in public policy	Identification of a therapeutic area where a new drug is needed
Direct service to the public	A commitment that drugs produced are created on a mutual basis with values of solidarity
Redistribution	Drugs are provided to those who need them for free by the NHS
Operation as a trust	A VTF-style mandate with state ensured delivery allowing for God-of-the-Gaps interventions in development

The paper invites the iteration of these ideas and the interrogation of the assumptions behind them. These include: (1) how might the goals of the UK Life Sciences Vision, which currently focuses more on industrial efficiency, be evolved into goals around therapeutic areas and, therefore, directed towards resolving human problems; (2) how might conditionalities be used to shape not just the contracts between stakeholders, but the values of the collaboration; (3) how might current NHS drug procurement budgets be adapted to share more costs across the drug development ecosystem; and, finally, (4) how might a public service delivery body ensure that it has the right skills, expertise and capacity to intervene at any stage in a highly specialist process.

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