CORA Cork Open Research Archive
Cartlann Taighde Oscailte Chorcaí

Title	Barriers and facilitators to COVID-19 vaccination programme implementation in Ireland: a qualitative study of implementation stakeholders using CFIR
Authors	Kandulu, Chikondi C.;Fleming, Aoife;O'Mahony, Aoife;McHugh, Sheena;Shorter, Gillian W.;Berry, Emma;Shields, Caoimhe;Sahar, Najam;Moore, Anne C.;Sahm, Laura J.
Publication date	2026-08-30
Original Citation	Kandulu, C C, Fleming, A, O'Mahony, A, McHugh, S, Shorter, G W, Berry, E, Shields, C, Sahar, N, Moore, A C & Sahm, L J 2026, 'Barriers and facilitators to COVID-19 vaccination programme implementation in Ireland: a qualitative study of implementation stakeholders using CFIR', Vaccine, vol. 89, 128909, pp. 1-18. https://doi.org/10.1016/j.vaccine.2026.128909
Type of publication	Article (peer-reviewed)
Link to publisher's version	10.1016/j.vaccine.2026.128909
Rights	© 2026, the Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license. http://creativecommons.org/licenses/by/4.0/ - https://creativecommons.org/licenses/by/4.0/
Download date	2026-11-17 10:38:30
Item downloaded from	https://hdl.handle.net/10468/19073

UCC
University College Cork, Ireland
Coláiste na hOllscoile Corcaigh

Vaccine 89 (2026) 128909

Contents lists available at ScienceDirect

Vaccine

journal homepage: www.elsevier.com/locate/vaccine

Original article

Barriers and facilitators to COVID-19 vaccination programme implementation in Ireland: a qualitative study of implementation stakeholders using CFIR

Chikondi C. Kandulu [a], Aoife Fleming [a,b], Aoife O'Mahony [a,c], Sheena McHugh [c], Gillian W. Shorter [d,e,f], Emma Berry [d], Caoimhe Shields [d], Najam Sahar [d], Anne C. Moore [g,h], Laura J. Sahm [a,b,*]

[a] Pharmaceutical Care Research Group, University College Cork, College Rd Cork, Ireland
[b] Pharmacy Department, Mercy University Hospital, Grenville Place, Cork T12 WE28, Ireland
[c] School of Public Health, University College Cork, College Rd Cork, T12 K8AF, Ireland
[d] School of Psychology, Queen's University Belfast, BT9 5BN, UK
[e] School of Nursing and Midwifery, Trinity College Dublin, The University of Dublin, Ireland
[f] TreAdd Research Group on Treatment and Addictions, Tampere University, Finland
[g] School of Biochemistry and Cell Biology, University College Cork, T12XF62, Ireland
[h] National Institute for Bioprocessing Research and Training, Dublin, A94 X099, Ireland

ARTICLE INFO

Keywords:
COVID-19 vaccination
Vaccine implementation
Stakeholder perspectives
Health systems
CFIR
Pandemic preparedness

ABSTRACT

Background: Effective vaccine implementation strategies are critical for successful deployment of national vaccination programmes, particularly during public health emergencies such as COVID-19. Reflecting on implementation can facilitate future pandemic preparedness and health system resilience.
Aim: This study interviewed key implementation stakeholders to identify factors influencing COVID-19 vaccine implementation in Ireland.
Methods: Online semi-structured interviews were conducted with sixteen stakeholders involved in policy or decision-making regarding COVID-19 vaccine implementation at national, regional, and local levels in the Republic of Ireland. The updated Consolidated Framework for Implementation Research (CFIR) guided data collection and framework analysis, to identify perceived implementation barriers and facilitators.
Results: Factors across innovation, process, individual, and organisational domains shaped implementation. Delayed or evolving evidence, alongside vaccine design and complexity, presented barriers. Process-related factors were influential, including adapting delivery approaches (e.g. scaling up to mass vaccination centres), engaging vaccine deliverers (e.g. in acute settings, pharmacy, and general practice), engaging recipients, and planning to operationalise vaccination at scale. Individual factors included opinion leaders, motivation and professional capability. Within the inner setting (Irish government and health system), resource availability, organisational infrastructure, policy frameworks, relational connections, communication, and access to information were critical for delivery. Outer setting factors, including partnerships and policy direction, were also influential.
Conclusions: COVID-19 vaccine implementation in Ireland was shaped by various system, organisational, and individual factors, alongside rapid adaptation. These findings highlight the importance of sustained investment in staffing, organisational infrastructure, and coordinated policy frameworks to support effective vaccination programmes and strengthen preparedness for future public health emergencies.

* Corresponding author at: Pharmaceutical Care Research Group, University College Cork, College Rd Cork, Ireland.
E-mail addresses: chikondikandulu@umail.ucc.ie (C.C. Kandulu), a.fleming@ucc.ie (A. Fleming), AoifeOMahony@ucc.ie (A. O'Mahony), S.McHugh@ucc.ie (S. McHugh), g.shorter@qub.ac.uk (G.W. Shorter), e.berry@qub.ac.uk (E. Berry), cshields11@qub.ac.uk (C. Shields), n.sahar@qub.ac.uk (N. Sahar), anne.moore@ucc.ie (A.C. Moore), L.Sahm@ucc.ie (L.J. Sahm).

https://doi.org/10.1016/j.vaccine.2026.128909
Received 18 April 2026; Received in revised form 8 June 2026; Accepted 1 July 2026
Available online 6 July 2026
0264-410X/© 2026 The Authors. Published by Elsevier Ltd. This is an open access article under the CC BY license (http://creativecommons.org/licenses/by/4.0/).

1. Introduction

The COVID-19 pandemic caused significant morbidity and mortality, including in Ireland [1]. In response, vaccination programmes were implemented at unprecedented speed and their rapid adaptation and roll-out within the pandemic context placed considerable demands on healthcare systems [2,3]. Emerging international evidence demonstrates that successful implementation of COVID-19 vaccination programmes depended on interacting factors across multiple levels of the healthcare system [2,4] e.g., system-level capacity, procurement strategies, and the ability to leverage existing infrastructure like primary care networks, were critical for large-scale implementation [2,4–6]. However, implementation could be undermined by systemic barriers, e.g. rigid or centralised processes that failed to account for local realities [7]. The clarity of guidance, coordination, and communication systems also shaped implementation according to studies carried out in Ireland and internationally [4,8,9]. Healthcare professionals (HCPs) played a central role in delivery, with partnerships, collaboration, and teamwork as facilitators [10,11], while sufficient workforce capacity was also important [5,10,12]. Overall, COVID-19 vaccination programme implementation was a complex process influenced by vaccine availability and wider organisational, system-level, and stakeholder-related factors [4]. In Ireland, delayed use of community pharmacies exemplified how systemic and political factors can create bottlenecks when community assets are not leveraged in a timely manner [8]. However, as their scope was limited to pharmacy delivery, further investigation of the wider multi-modal implementation approach is warranted. Vaccination programmes were therefore not only a public health intervention but also a stress test of healthcare systems' capacity to mobilise resources, coordinate across sectors, and adapt to rapidly evolving scientific evidence and public expectations. Given the unprecedented situation, approaches were deployed swiftly and remain insufficiently examined.

Implementation science examines how health interventions are implemented within real-world healthcare systems. The Consolidated Framework for Implementation Research (CFIR) is a widely used determinant framework that identifies factors influencing implementation across five domains: innovation, individuals, inner setting, outer setting, and implementation process [13,14]. CFIR has been applied extensively to study implementation of health interventions, supporting systematic identification of barriers and facilitators and informing the selection of strategies to improve implementation effectiveness [15]. Applying implementation science frameworks to pandemic vaccination programmes can provide critical insights into how health systems respond to large-scale implementation challenges [16–18] and how preparedness and healthcare system resilience can be strengthened for future public health emergencies [19,20].

In Ireland, vaccination programmes are delivered by the Health Service Executive (HSE) and coordinated through the National Immunisation Office (NIO). The national COVID-19 vaccination programme commenced in December 2020 and was delivered through multiple models, including (i) mass vaccination centres, (ii) acute hospitals, (iii) general practice, (iv) community pharmacies, and (v) mobile vaccination teams. Strategic oversight was provided by a national High-Level Task Force, and rollout was prioritised based on risk of severe disease and exposure [21]. Ireland achieved extremely high uptake, with 97.8% of adults aged 18 or over completing a primary vaccination course by late 2022 [22]. This very high uptake makes Ireland an important case through which to examine not only the challenges of COVID-19 vaccine implementation, but also the factors perceived to support successful large-scale delivery. Understanding these factors in this context is essential to inform future vaccination programmes, particularly as healthcare systems seek to strengthen pandemic preparedness and achieve global immunisation goals, including those outlined in the WHO Immunisation Agenda 2030 [23].

While a growing international literature has examined implementation of COVID-19 vaccination programmes across different countries and health systems, comparable national-level implementation research from Ireland remains limited, particularly from an implementation science perspective. This is important because Ireland represents a high-uptake case from which lessons may be drawn not only about implementation challenges, but also about the organisational, contextual, and process factors perceived to support successful large-scale delivery. Where evidence from the Irish context does exist, this has provided valuable but relatively narrow insights. One study evaluated delivery of the vaccine to individuals experiencing homelessness in Cork city, outlining factors influencing delivery for a traditionally hard-to-reach group [24]. A qualitative case study of community pharmacy involvement in Ireland's COVID-19 vaccination programme also highlighted technical, socio-political, institutional, and regulatory factors which delayed deployment of these community pharmacies within the programme [8]. Large-scale, national-level implementation research from Ireland remains lacking. This study aimed to examine the perspectives of key stakeholders regarding the factors influencing implementation of the COVID-19 vaccination programme in Ireland using CFIR [14]. Specifically, it sought to identify barriers and facilitators influencing programme implementation from implementers' viewpoints. By applying an implementation science lens to the Irish experience, this study could clarify how large-scale vaccination programmes can be implemented effectively, to inform future immunisation strategies and strengthen health system preparedness in Ireland and internationally.

2. Methodology

2.1. Study design

This qualitative study used semi-structured interviews to explore implementation stakeholders' perspectives on factors influencing COVID-19 vaccination programme implementation in Ireland. Reporting follows the Consolidated Criteria for Reporting Qualitative studies (COREQ) checklist [25] (Appendix 1). Data collection and analysis were guided by CFIR [14], to identify factors influencing implementation across multiple health system levels.

2.2. Ethics

Ethics Approval was granted by the University College Cork Social Research Ethics Committee (reference number: 2024-239). Participants received an information sheet and provided written informed consent before participation. Participation was voluntary, and all data were anonymised to ensure confidentiality.

2.3. Participant selection

Stakeholders aged over 18 years who were involved in COVID-19 vaccine implementation at national, regional, or local levels in Ireland were eligible to participate. Eligible participants included implementation stakeholders with diverse disciplinary backgrounds including but not limited to, medicine, pharmacy, nursing, public health, and healthcare management. Individuals without direct involvement in vaccine implementation (e.g. healthcare professionals involved in delivering vaccines but not in the wider decision-making regarding implementation of the vaccine programme) or providing perspectives outside the Irish healthcare system or implementation context were not eligible for inclusion. Participants were initially identified through the research team's professional networks and invited via email. This approach was used to recruit stakeholders with relevant experience across various roles, organisations, and geographic regions, and participants were asked to suggest other eligible stakeholders and/or share study information within their networks.

2.4. Operationalisation of CFIR domains

CFIR domains were operationalised to reflect the Irish COVID-19 vaccination context (see Table 1), with specific constructs within each domain applied deductively during coding and analysis, as detailed in the study codebook (Appendix 3). Here, the updated CFIR refers to the 2022 revision of the framework [14]. The innovation domain was defined as COVID-19 vaccines. Within the Individual domain, individuals that could be mentioned by the participants included vaccine implementers (i.e., those involved in policy or decision-making regarding the programme implementation), vaccine deliverers (i.e. healthcare professionals administering the vaccines) and vaccine recipients. The Inner setting domain encompassed the Irish public health system and agencies involved in policy-making or high-level decision-making about the vaccination programme including government departments, the Health Service Executive (HSE), including the HSE's contracted services (general practices, pharmacies, and other healthcare settings where the vaccine was administered), and the National Immunisation Office (NIO). The Outer setting domain included the wider Irish public, the broader global and European setting, national advisory and regulatory bodies, such as Ireland's National Immunisation Technical Advisory Group (NITAG, previously the National Immunisation Advisory Committee, NIAC), the Health Information and Quality Authority (HIQA) and professional organisations such as the Pharmaceutical Society of Ireland, Irish Pharmacy Union, and Irish College of General Practitioners (ICGPs). The Process domain referred to activities undertaken to plan, deliver, adapt or evaluate the vaccination programme's implementation. Fig. 1 and Table 1 demonstrate the CFIR domains and their components as they relate to the innovation, implementation process, inner setting and outer setting.

2.5. Data collection

A semi-structured interview topic guide (Appendix 2) was developed based on findings from a prior scoping review of the international evidence [4] and informed by relevant constructs from CFIR [13]. This explored experiences of COVID-19 vaccine implementation, at any time prior to the interview date in early 2025. including perceived barriers, facilitators, and lessons for future vaccination programmes. The guide was piloted with an implementation stakeholder who was not included

Table 1
Operationalisation of CFIR domains in the study context. Overview of how the updated consolidated framework for implementation research (CFIR) domains were defined and applied to the Irish COVID-19 vaccination programme.

CFIR Domain	Definition
Innovation	COVID-19 vaccines, i.e., all types administered in Ireland
Individuals	**Vaccine implementers** Policy-makers or decision-makers regarding the programme implementation **Vaccine deliverers** Healthcare professionals administering the vaccines **Vaccine recipients** People receiving the vaccine.
The inner setting	Irish Government departments, The Irish Health Service Executive (HSE), including the HSE's contracted services (GPs, pharmacies) Other healthcare settings (which administered vaccines), National Immunisation Office
The outer setting	Irish public, National advisory and regulatory bodies, such as Ireland's National Immunisation Technical Advisory Group (NITAG, previously the National Immunisation Advisory Committee, NIAC) Health Information and Quality Authority (HIQA) Professional organisations i.e. Pharmaceutical Society of Ireland, Irish Pharmacy Union, and Irish College of General Practitioners The broader global and European setting.
Process	Activities undertaken to plan, deliver, adapt or evaluate the vaccination programme's implementation

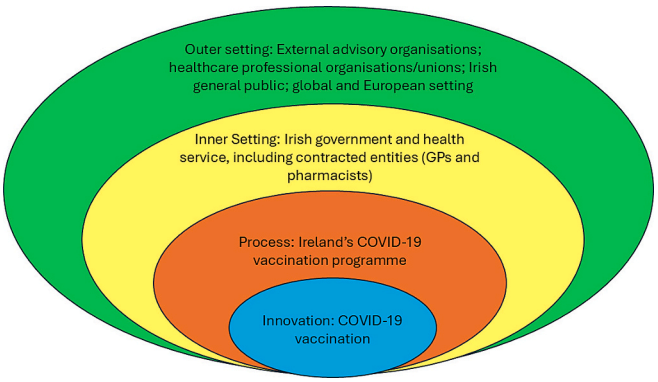


Fig. 1. Operationalisation of CFIR domains in this study. Overview of how the innovation, implementation process, inner setting, and outer setting were defined in the Irish COVID-19 vaccination context.

the study sample and iteratively modified prior to data collection.

A demographic questionnaire collected data on participants' age, sex, educational background, role during COVID-19 vaccination and professional experience.

Interviews were conducted between February and May 2025 by two trained and experienced female researchers (CCK and one of either LJS or AF), online via videoconferencing. The duration ranged between 25 and 60 min. Interviews were audio-recorded with participant consent. Data collection concluded when data saturation was achieved, defined as the point at which no new relevant insights emerged [26].

2.6. Data analysis and management

Interviews were transcribed verbatim and checked against audio recordings for accuracy. Two researchers independently (CCK and either LJS or AF) anonymised and redacted transcripts. Data familiarisation, independent coding, review and discussion was conducted by CCK and AOM. At intervals, transcripts were coded jointly to ensure consistency, and uncertainties were resolved through discussion with a third researcher (LJS, AF, or SMcH) until consensus was reached. Coding was conducted manually in Microsoft Word and Excel using initial open coding, then hybrid framework analysis; deductive coding used updated CFIR constructs as a priori codes [14], supplemented by inductive codes for data that did not map to existing constructs.

The codebook guided the coding process, incorporating tailored definitions of CFIR domains and constructs to fit the study context (Appendix 3). Definitions were iteratively refined to reflect context and emerging findings. This hybrid deductive-inductive approach ensured analysis remained grounded in the established implementation framework while accommodating novel findings, as per similar approaches from implementation research [27,28]. Where possible, factors were subsequently coded to specific delivery models, such as mass vaccination centres, mobile vaccination, GP or pharmacy. Where models could not be identified explicitly, or factors were influential across the inner setting, this was coded as 'overall'.

2.7. Reflexivity

The research team included researchers with expertise in medicine, vaccinology, pharmacy, public health, psychology, and implementation science, and experience in qualitative research. Some researchers had professional familiarity with the Irish health system but no relationships with participants. Reflexive practices included independent coding, team discussions to examine assumptions, and iterative refinement of analytic frameworks. Diverse disciplinary perspectives supported critical interpretation.

3. Results

Twenty-four participants were invited to participate, of whom 16 took part. In the following section, results from the analysis of those 16 interviews are presented through CFIR framework and its five domains.: *Innovation*, *Implementation Process*, *Individuals*, *Inner Setting*, and *Outer Setting*. The analysis is primarily descriptive and focuses on how participants characterised factors as barriers, facilitators, or both within the Irish COVID-19 vaccination programme. Fig. 2 displays the factors identified and whether these were perceived as barriers, facilitators, or both. Table 2 indicates whether factors applied to particular vaccine delivery models, while Table 3 provides additional example quotes illustrating each construct identified in the study.

3.1. Innovation

The **evidence-base** regarding COVID-19 vaccines primarily involved published literature, including trial data of efficacy. Where present, evidence could be a facilitator by informing implementation. For example, the existence of evidence was highlighted as a facilitator to the implementation, due to its role in informing decision-making, guidance, or policy development:

> *"guidelines would be a determined based on, you know, evidence review and, you know, review of the national epidemiological and clinical situation*" (P03).

Meanwhile, lack of available evidence was a barrier as it created uncertainty for those responsible for programme implementation and decision-making. However, the volume and quality of emerging evidence could also be a barrier.

> *"just the volume of it. There was just so much coming out and it was hard to sift through the noise, […] it was hard to kind of, you know, provide impartial, informed evidence-based advice at times because […], sometimes the evidence was so poor," (*P06).

Complexity related to the multiple steps required to prepare and administer the vaccine, and was reported as a barrier. Training for vaccine deliverers was considered an important strategy to support implementation. Several participants raised the challenges of strict vaccine storage and cold-chain transportation between sites.

> *"it could only be out of the fridge a certain amount of time and […] only had so much hours travel time[…] we would have to keep our own temperature if we moved anywhere".* (P13).

Participants also noted the complex **design** of the vaccine (i.e. requirements for how the vaccine had to be assembled, stored, and/or packaged) all of which determined how the vaccine should be handled and used in practice. The complex COVID-19 vaccine design in the early pandemic phases brought challenges in relation to storage, preparation, and administration. For example, the ultra-low-temperature storage (−80 °C) requirement and the use of multidose vials introduced logistical complexities for large-scale vaccine delivery, requiring careful planning around storage, transport, handling, and vaccine extraction procedures. Due to the challenges of meeting these complex requirements, the vaccine design was a barrier to vaccine implementation. The subsequent easing of strict cold-chain storage over time was a facilitator for implementation, broadening the range of viable delivery contexts and reducing reliance on highly specialised infrastructure.

Adaptability of the innovation referred to whether there was scope for flexibility regarding modifying or tailoring vaccine use in certain contexts. Early in the programme, there was minimal potential to adjust vaccine use which was a barrier, but as product characteristics evolved and new vaccines became available, this facilitated more vaccine choice and reduced waste.

3.2. Implementation process

Overall, **adapting** the implementation process (which is distinct from the adaptability of the vaccine, within the Innovation domain) was typically framed as a facilitator. This referred to reshaping typical vaccination processes and iteratively reconfiguring approaches to achieve rapid scale and reach, ensuring all population groups had access. Delivery models were staged and layered over time. For example, models progressed from healthcare workers' vaccination in hospitals initially, then HSE teams in nursing homes before GPs and mass vaccination centres "*came on board*" in early 2021, with community pharmacies joining later, in June 2021 (P16). Adapting delivery models improved access to vaccination, adding providers and settings such as

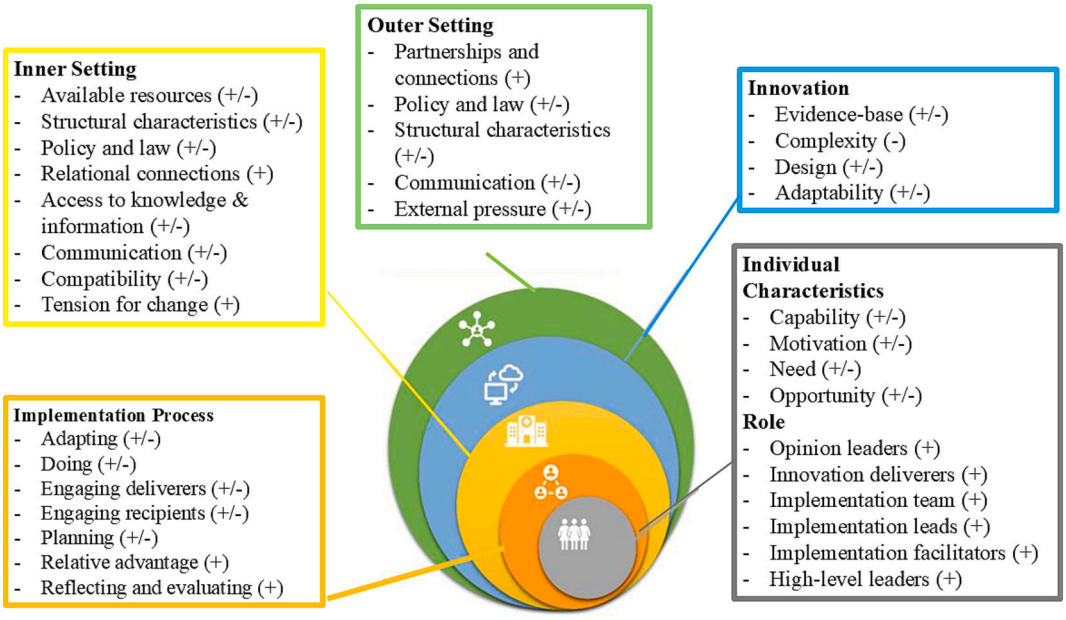


Fig. 2. Overview of factors identified across CFIR domains. A plus sign (+) indicates that the factor functioned as a facilitator, a minus sign (−) indicates a barrier, and both symbols indicate that the factor was identified as both a barrier and a facilitator.

Table 2
Barriers and facilitators to implementation of the COVID-19 vaccination programme in Ireland across delivery models. Summary of factors identified in the analysis, their classification as barriers, facilitators, or both, and their relevance to specific COVID-19 vaccination delivery models.

Factor	Description of factor	Nature of factor	Models influenced by factor	n of participants
Innovation domain				
Innovation – evidence base	The evidence base regarding the innovation refers to information or evidence about the COVID-19 vaccines' robustness or effectiveness.	Barrier or facilitator	Overall	6
Innovation – complexity	Innovation complexity related to the relative complexity or difficulty of the vaccine such as the nature and number of steps involved in its administration.	Barrier	Overall; Primary care (GP)	6
Innovation – design	The design of the vaccine related to how it was designed and packaged, including how it was assembled, bundled, and presented, covering the flow, format, and organisation of vaccine components and any associated materials such as guidance or provider-facing tools, all of which determined how the vaccine should be handled and used in practice.	Barrier or facilitator	Overall	5
Innovation – adaptability	Adaptability referred to whether the vaccine could be modified, tailored, or refined to fit local contexts or needs. This includes references to rigidity, inflexibility, or a lack of permission to change components or constitution of the vaccine.	Barrier or facilitator	Overall; Mass vaccination centres	3
Process domain				
Process - adapting	Adapting captures the process of adapting the vaccine programme, for example, changing implementation components, delivery models, or work processes, such as in response to emerging needs or constraints.	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals (early stage)	15
Process - doing	Doing refers to the active process of implementing the vaccine programme in practice i.e. carrying out the work of delivery, enacting plans, and translating strategy into action	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	15
Process – engaging – innovation deliverers	Engaging – Innovation Deliverers refers to the processes used to attract, recruit, motivate, or sustain the involvement of those responsible for delivering the vaccine (e.g., GPs, pharmacists, nurses, hospital staff, and other frontline providers).	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	10
Process – engaging – innovation recipients	Engaging – Innovation Recipients refers to the processes used to attract, inform, reassure, and sustain the participation of those receiving the vaccine	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy); Acute hospitals	11
Process - planning	Planning refers to identifying roles and responsibilities, outlining specific steps and milestones, and defining goals and measures for vaccine programme implementation in advance.	Barrier or facilitator	Overall; Mobile vaccination; Mass vaccination centres	9
Process – relative advantage	Process – Relative Advantage refers to stakeholders' perceptions of the advantages of one delivery strategy or model over another. It captures explicit or implicit comparisons between delivery approaches (e.g., mass vaccination centres, primary care, mobile delivery).	Facilitator	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy and GP)	8
Process – reflecting and evaluating	Reflecting and Evaluating referred to the process of reviewing how implementation was progressing, assessing what was working or not, and using that information to inform improvement. This could include formal evaluation activities as well as informal reflection, feedback loops, and learning from experience.	Facilitator	Overall	4
Individual domain - roles				
Individual – roles – opinion leaders	Opinion Leaders refers to individuals who were trusted, influential, or respected within a community or professional group and who shaped others' views and behaviours through their credibility, visibility, or authority.	Facilitator	Overall; Mass vaccination centres; Primary care (GP); Acute hospitals	9
Individual – roles – innovation deliverers	Innovation Deliverers refers to the individuals directly responsible for administering the vaccine (e.g., nurses, doctors, GPs, pharmacists, hospital staff)	Facilitator	Overall; Mass vaccination centres; Primary care (GP); Acute hospitals	7
Individual – roles – implementation team	Implementation team refers to the teams of individuals responsible for coordinating, operationalising, and sustaining delivery of the vaccination programme. This includes multidisciplinary groups working across planning, logistics, clinical delivery, communications, ICT, estates, or public health.	Facilitator	Overall; Mobile vaccination	6
Individual – roles – implementation leads	Implementation Lead refers to individuals with formal responsibility for directing and overseeing the vaccination programme at national, regional, or site level.	Facilitator	Overall; Mass vaccination centres; Acute hospitals	4

(*continued on next page*)

Table 2 (*continued*)

Factor	Description of factor	Nature of factor	Models influenced by factor	n of participants
Individual – roles – implementation facilitators	Implementation Facilitators refers to individuals whose primary function is to support, the work of implementation, such as providing subject matter and/or implementation expertise to support the implementation lead and team members or implementation process.	Facilitator	Overall	5
Individual – roles - high-level leaders	High-Level Leaders refers to senior figures with overarching authority and system-wide influence such as government officials, national programme leaders, or regional executives whose decisions shaped policy direction, resourcing, and/or the overall legitimacy of implementation. These leaders operated above the level of day-to-day delivery, but their actions established the conditions under which implementation becomes possible.	Facilitator	Overall; Mobile vaccination; Mass vaccination centres; Acute hospitals	3
Individual domain - characteristics				
Individual – characteristic – capability	Capability refers to the skills, competencies, and preparedness of individuals to carry out their roles in implementation. In this study, capability encompasses the capacities of those delivering vaccination, those implementing and coordinating the programme, and, where relevant, recipients' ability to engage with vaccination processes.	Barrier or facilitator	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres	9
Individual – characteristic – motivation	Motivation refers to the degree to which individuals are willing or driven to engage with vaccination, whether as implementers and deliverers, or as recipients. It captures both positive drivers (e.g., commitment, solidarity or perceived benefit) and demotivating forces (e.g., vaccine fatigue, fear or a sense of declining urgency), and this could shift over time.	Barrier or facilitator	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy)	14
Individual – characteristic – need	Need refers to the extent to which individuals experienced a personal requirement for vaccination or for support in relation to vaccination. As an individual characteristic, this construct captures how people perceived their own need, whether as recipients or, more rarely in this study, as deliverers, rather than how the system identified or responded to needs	Barrier or facilitator	Overall; Mass vaccination centres; Primary care (Pharmacy)	5
Individual – characteristic – opportunity	Opportunity refers to the extent to which individuals have the opportunity to engage with vaccination either as recipients (the opportunity to attend, access, or participate) or as implementers (the opportunity to contribute, to be involved, or to act).	Primarily facilitator, occasionally barrier	Overall; Acute hospitals	3
Inner setting domain				
Inner setting – available resources - funding	Available Resources – Funding refers to the extent to which financial resources were available to support implementation. This includes the capacity to rapidly procure infrastructure, staff, equipment, and space, and to absorb exceptional costs associated with large-scale delivery	Primarily facilitator, occasionally a barrier	Overall; Mass vaccination centres	8
Inner setting – available resources – materials and equipment	Available Resources – Materials and Equipment refers to the availability and adequacy of the physical resources required to deliver vaccination, including cold-chain infrastructure, clinical equipment (e.g. syringes, PPE), and other site-level materials.	Primarily barrier, sometimes an facilitator	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy and GP)	13
Inner setting – available resources - spaces	Available Resources – Spaces refers to the physical environments in which vaccination could occur, including the availability, suitability, and adaptability of buildings and rooms for safe, efficient delivery. This includes clinical spaces in existing services as well as repurposed environments.	Barrier or facilitator	Overall; Mass vaccination centres; Primary care (Pharmacy and GP)	7
Inner setting – available resources - staff	Available Resources – Staff refers to the adequacy, availability, and deployment of staff to support implementation. This construct captures whether there were sufficient numbers of appropriately skilled people to deliver and coordinate vaccination, and how staffing levels shaped what could be done, when, and at what scale.	Barrier or facilitator	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	12
Inner setting – available resources - time	Available Resources – Time refers to the extent to which sufficient time was available to plan, prepare, and deliver the vaccination programme	Barrier	Overall; Mass vaccination centres	6
Inner setting – Structural characteristics – IT infrastructure	IT infrastructure refers to technological systems for tele-communication, electronic documentation, and data storage, management, reporting, and analysis that support functional performance of the Inner Setting.	Barrier or facilitator	Overall; Mass vaccination centres; Primary care (Pharmacy and GP)	12

(*continued on next page*)

Table 2 (*continued*)

Factor	Description of factor	Nature of factor	Models influenced by factor	n of participants
Inner setting – Structural characteristics – work infrastructure	Work infrastructure refers to the organisation of tasks and responsibilities within and between diverse individuals and teams in the inner setting, including reporting structures, delegation and workload distribution, roles and responsibilities	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination (including nursing homes); Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	15
Inner setting – Structural characteristics – physical infrastructure	Physical infrastructure refers to the built environments within which vaccination occurred., such as their layout and organisation	Barrier or facilitator	Overall; Mass vaccination centres	6
Inner setting – policy and law	Policies and laws referred to the formal rules, regulations, and policy frameworks within which vaccination was implemented. This could include national public health policy, emergency legislation, contractual arrangements, indemnity and scope-of-practice rules, and operational guidance that determined who could deliver vaccination and under what conditions.	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy)	16
Inner setting – relational connections	Relational Connections refers to the formal and informal relationships, networks, and teams within and across Inner Setting boundaries. This construct captures how social ties or interactions within and across teams in the inner setting shaped the implementation of the programme.	Facilitator	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	11
Inner setting – access to knowledge and information	Access to Knowledge and Information refers to whether individuals and teams had timely, accurate, and usable information about vaccination, including clinical guidance, operational procedures, training materials, and updates as evidence and policy evolved	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	12
Inner setting – communication	Communication refers to the formal and informal channels through which information moved within the system, including how guidance, decisions, updates, and messages were shared across organisations, teams, and roles	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination; Mass vaccination centres; Primary care (Pharmacy and GP); Acute hospitals	15
Inner setting – compatibility	Compatibility referred to the degree to which the vaccination programme aligned with existing workflows, systems and processes, capturing whether the innovation fit with what services already did or whether it disrupted established ways of working.	Primarily facilitator, occasionally barrier	Overall; Primary care (Pharmacy and GP)	7
Inner setting – Tension for change	Tension for Change referred to the perceived need for change within the system, i.e. the extent to which existing conditions were seen as unacceptable or unsustainable, necessitating urgent action for change.	Facilitator	Overall; Mobile vaccination (including nursing homes)	8
Outer setting domain				
Outer setting – Partnerships and connections	Partnerships and Connections refers to the relationships between organisations and sectors outside the implementing system that shape delivery, and/or the partnerships between outer setting and inner setting organisations or entities This could include formal and informal collaborations with other health agencies, professional bodies, community organisations, the private sector, and international partners	Facilitator	Overall; Mass vaccination centres; Primary care (Pharmacy and GPs)	15
Outer setting – policy and law	Policy and Law in the outer setting refers to the national and international policy frameworks, legislation, and authoritative guidance that originated outside the inner setting and shaped what was permissible, required, or prioritised in the inner setting. This included European policy, and also recognises the role of external organisations within Ireland in informing policy and guidance for the inner setting, such as from the National Immunisation Advisory Committee (NIAC) and Health Information Quality Authority (HIQA).	Primarily facilitator, occasionally barrier	Overall; Mobile vaccination; Mass vaccination clinics; Primary care (Pharmacy)	14
Outer setting – Structural characteristics	Work infrastructure refers to the organisation of tasks and responsibilities within and between diverse individuals and teams in the outer setting, including reporting structures, delegation and workload distribution, roles and responsibilities	Primarily facilitator, occasionally barrier	Overall; Primary care (Pharmacy)	5
Outer setting – communication	Outer Setting – Communication refers to the ways in which information, guidance, and messaging originating outside the implementing system were conveyed within the outer setting and/or from the outer to the inner setting	Primarily facilitator, occasionally barrier	Overall; Primary care (Pharmacy)	5
Outer setting – external pressure	External Pressure refers to forces originating outside the implementing system that create urgency, demand, or constraint for action, such as societal pressure	Barrier or facilitator	Overall; Mass vaccination centres; Primary care	4

Table 3
Example quotes illustrating results per CFIR domain and construct. Additional participant quotations supporting the interpretation of constructs identified in the analysis.

Factor	Example quotes
Innovation Domain	
Innovation – evidence base	"guidelines would be a determined based on, you know, evidence review and, you know, review of the national epidemiological and clinical situation" (P03)
Innovation – complexity	"before, you know, all the vaccines, like, from the school's vaccination team, even the flu vaccine,they were all pre fill. But with this vaccine, you know, we had to have the consumables on site. The very early, I suppose version of the vaccine had to be diluted with water for injection. But sometimes it might not. And so, you know, all those kind of logistical kind of challenges as well" (P01)
	"it could only be out of the fridge a certain amount of time and it could only had so much hours travel time, so this was hugely important because we would have to keep our own template if we moved anywhere". (P13)
Innovation – design	"initially in April 2021, I think it was a five-day period that we had to use the vaccines we received and then that also […] impacted vaccine wastage. […] Then we got much longer usage periods. So they could be stored in regular fridges between 2 and 8°. So that made a huge difference" (P16)
Innovation – adaptability	"the fact that it was there was different types of them I supposed helped. Because people, I don't know, some people had an aversion to mRNA. Maybe they were kind of misinformed or whatever You know, I suppose the the fact that, you know, some of them could be given by different settings helped." (P06).
	"The statutory instruments were changed 'cause we were the first site. When we got, we found that there were extra doses in the vials that we use them rather than dispose of them. At the time, under the EMA rollout rules, it wasn't allowed. But […] we decided locally to start using it. After it went back to national team that we were doing it anyway, they changed the statutory instrument to allow the remaining vaccination to be used and to be added up to make full vaccination" (P02)
Process Domain	
Process - adapting	"the strategy and the vaccination hubs, obviously that that was something that was completely new, but it worked very well" (P03).
	"We then set up what we call the home vaccination team, so the GPs would identify people who were housebound and who would not, you know, for whatever reason, would not be able to get into the GP surgery. So we then set up a mobile vaccination clinic, then that will go out to these people's houses" (P01).
Process - doing	"as things were starting and progressing, we'd realized that we need A B and C." (P05)
	"a lot of logistical difficulties" (P07)
Process – engaging – innovation deliverers	"We did have a lot of redeployment, which was great for particularly for nurses, maybe that couldn't continue the work in the community" (P12).
	"Because for pharmacies, it was [they're] very strongly regulated, so they would be reliant on, you know, if they're going to do something new, a new vaccine, they need legislation. They need statutory instrument. So they're just, there were just various other pieces that needed to happen for pharmacies to be involved. So by the time they came on board […] that initial kind of flurry had settled". (P01).
Process – engaging – innovation recipients	"so actually in [County] especially they use the GAA as a way of promoting vaccination in the in the young, you know and if that's what you're asking, the involving social inclusion and in the community was a way of targeting that group, of finding means to communicate with them and it's because of that we actually brought vaccines to them." (P13)
Process - planning	"There's oversight and there's accountability in relation to that. You know, rather than each area doing doing their own thing […] everything was so comprehensive that came from the NIO". (P01).
	"Personally, I thought that there was time lost […] I think it was clear […] that the vaccine was coming, that there was going to be a huge amount of people that were going to need to be vaccinated. And I thought there was a delay there." (P16)
Process – relative advantage	"the advantage of a mass vaccination center was that you could deliver large volume so you could deliver, you could prepare, deliver and store large volumes of vaccine in a mass vaccination center and deliver large numbers of doses in a relatively short period of time. And that then would preserve capacity in general practice for the normal workload that needs to take place in general practice." (P05)
	"I think the idea of the whole mass vaccination centres was always get people who aren't registered with the GP but that's not really maybe taking into account why people don't engage with healthcare systems so like.[…] if those people […] don't want to know the GP but the pharmacist, OK, they might want to visit the pharmacy". (P01)
Process – reflecting and evaluating	"I think we learned as well. As time went on, so the policy became stronger because, you know, you would have run into difficulties of, oh, you know, you know, what would I say, different things from the SPC (Summary of Product characteristics)". (P01)
Individual Domain	
Individual – roles – opinion leaders	"we've done these, 'I got my COVID-19 badges' so that we could kind of create a little bit of a buzz on social media. You know there was a lot of, you know, social sharing. […] we really wanted to kind of, I suppose, make the most of that people were, you know, influencing their own networks in that regard. And people are really, really proud to get the vaccine." (P15)
	"We would have worked with, I suppose, Community champions for [want] of a better way of putting it, opinion leaders. […] Just to try and counter some of the messages that were being propagated that weren't always based on truth." (P07).
Individual – roles – innovation deliverers	"GPs in the vaccination centres were well, we in the military we would refer to them as a force multiplier. So like a small resource had a massive effect and you know, enhancing the rest of your force So I would say that you

(*continued on next page*)

Table 3 (*continued*)

Factor	Example quotes
	know GPs because of the particular skill set they had were kind of force multipliers" (P05).
Individual – roles – implementation team	"we've a good team, we've a strong team, we work very hard, very hard for each other." (P10).
Individual – roles – implementation leads	"one of the first things they asked for was leads in each region and what they got in each region was the Director of Nursing in the acute hospitals because it rolled out to the acute hospitals first […] the regional directors of nursing, which they are now called, they were chief directors of nursing for the leads in each region. […] So that was an enabler, identifying key people in each area. Having a national team and as the news came out and as the information came out and it was, you know, cascaded down so that we could work off that information." (P13)
Individual – roles – implementation facilitators	"You had someone from the GPs, you had someone from pharmacy nationally. And the clinical programmes, some of them like sepsis And […] the Health protection and and infectious diseases" (P13).
Individual – roles - high-level leaders	"It was reassuring to have, you know, the engagement between the National Immunisation Advisory Committee and the Chief Medical Officer and, you know, having people like Deputy Chief medical officers who sat with NIAC during those meetings and acted as a conduit." (P09)
Individual – characteristic – capability	"the staff didn't always necessarily have the skill sets that they needed because they may have been completely new into public health" (P07). "we started with the nurses who really were like… very proficient around vaccination. So very much our schools' vaccination team and some of our public health nurses were involved in the schools' vaccination team… They were actually the leads on this and they were often our managers on site" (P01).
Individual – characteristic – motivation	"There was an awful lot of kind of community spirits, I suppose, and togetherness, just in advance of that. So I think that really helped. You know, there was a […] sense of. All in it together." (P15) "I think the main driver at a population level would have been fear of hospitalization or mortality relating to COVID […] as the pandemic progressed […] there was less fear." (P01)
Individual – characteristic – need	"It would be, I suppose, like the travellers and the Roma and some of… the disadvantaged communities. Whose uptake generally for healthcare is lower and their uptake of vaccines would be lower as well. And that's usually a combination of lack of access… maybe not able to use online systems or digital… lack of information, lack of understanding", (P13). "I think healthcare workers were acutely aware of the need for a safe and effective vaccine that would get away from the kind of devastating reports that people were hearing of the fatalities that were happening […] the fact that it was happening among healthcare workers as well brings it a bit closer to home" (P09)
Individual – characteristic – opportunity	"I had already established contacts in each hospital and had worked with them as a peer as well when they were and and I would have already been there go to person for vaccinations in the acute hospitals, they would always have come to me, so that was an enabler. I already had that network OK and and so did my colleagues around the country. And so that was an enabler as well. We were already an established role for vaccination and we had the links to all the hospitals and because we knew how many peer vaccinators we had, I had the terminology. I knew what people required" (P13) "the deployment and targeting of of vaccination, you know, to health care workers […]The vaccine was provided on site and you know, people were vaccinated at work. We know that our uptake was, you know, huge. You know, was probably above 95% as well. So I really don't know how that could have been done any better." (P03)
Inner Setting Domain	
Inner setting – available resources - funding	"at that time we were told we could spend as much as we wanted. But as time went on, […] we had to be accountable for all of, for all of the money and making sure that, you know, we were making the best use, you know, of the finite resources that we have within the healthcare system. And, you know, looking at, you know. Ways in which we could, you know, kind of optimize delivery" (P01)
Inner setting – available resources – materials and equipment	"for some of those kind of, those smaller kind of those satellite sites even looking at what we had. […] in a lot of ways, we had to work within what we had and then from time to time, we had to actually either buy fridges or move fridges at very short notice. […] what we did find in the early days and particularly around the nursing homes when we're going out those kind of smaller sites, some of those nursing homes, particularly the smaller ones mightn't have had a very, I suppose reliable pharmaceutical grade fridge. So then we had to come up with ideas as to how to get that vaccine out there on time for this, for the on site teams", (P01)
Inner setting – available resources - spaces	"There was structures in place, you know, we had the facilities in that, every pharmacy in Ireland has a designated consultation room within which a vaccination could take place" (P11)
Inner setting – available resources - staff	"the value of all the retired staff, doctors, nurses that came back from retirement to help out for vaccinations was like we would never have managed it without them because they they, you know, all the doctors that we had, all the nurses and all the health care professionals that came back from retirement to help out for this so it was critical, but you know the shortfall then was trying to find staff and I suppose there was strict guidance that it had to be particular staff at the beginning[…] so that was a barrier because we were challenged to get the staffing required for mass vaccination." (P13)
Inner setting – available resources - time	"just the sheer the sheer speed of the implementation was huge, like in at the time it was, you know, it was breathtaking, almost how quick everything needed to go" P15
Inner setting – Structural characteristics – IT infrastructure	"Having nothing, this old regional systems out there for children's vaccinations. There's a system for schools vaccinations, but nothing for a national system. So that was a big barrier. It led to lots of backlogs of those early vaccines because the hospitals didn't have access to the system" P12

(*continued on next page*)

Table 3 (*continued*)

Factor	Example quotes
	"the biggest hurdle was probably having a vaccine history for a patient or even a shared care records so that you could see what conditions patients had, […] there was no actual integrated information system available. Where everybody could look at it, ensure that they hadn't been vaccinated. Now as the as the programme evolved, we have the emergence of covax and there is pharmaVAX now which provides a full vaccination history for flu, COVID-19 and pneumococcal. So that's been a very positive piece that has come out of all of this" (P11)
Inner setting – Structural characteristics – work infrastructure	"that was an enabler, identifying key people in each area. Having a national team and as the news came out and as the information came out and it was, you know, cascaded down so that we could work off that information. So it became very apparent very soon that we needed work streams for IT. Work streams for education. Work streams for for operations" (P13).
	"It was having that multidisciplinary, multi professional structure where everybody worked together. And then that led to Ireland achieving one of the highest vaccination rates" (P12).
Inner setting – Structural characteristics – physical infrastructure	"like some of these, like sites where we were vaccinating, they mightn't have been used as […] healthcare facilities for a long time. So again, trying to make sure like […] Do you have toilets for people? All of those particular pieces as well, because we were using, I suppose, places where you know we didn't want to interfere in the kind of day-to-day running of the of the health services. As well, so trying to find places that were kind of suitable for these mass vaccination clinics as well" (P01).
	"there was an existing national cold chain there and I know that other services were employed to provide delivery of the vaccines, but that they sought at the first instance to use traditional routes that were already established and expanded those to facilitate nationwide delivery of increased quantities" (P11).
Inner setting – policy and law	"In the start, because it was very slow and I suppose in the start because the all the development of the policies was slow, it kind of did slow things down a little bit because you know again, we couldn't have our nursing colleagues going out delivering the vaccination program. Until we had all the policies and procedures and everything in place, but I think as time went on and once we had, you know, a very strong overarching policy. Then that really helped" (P01)
	"we were having meetings being told, oh, yeah, the national policy and procedure and guideline that will be published tomorrow. But this is what's going to be in it. […]. Sometimes we had to hope that what we had been told was in the PPPG was actually what was going to happen" (P01)
Inner setting – relational connections	"with the roll out of the campaign, I suppose the relationships got solidified with the HSE team, the stakeholder group who were coordinating the operations of the COVID-19 vaccine. So, we would have had a huge amount of input from those within the HSE who were coordinating the programmes also with the NIO, the National Immunisation Office, who operationalised the NIAC guidance there, would have been a huge amount of relationship there. And also a lot of coordination stock with the national cold chain." (P11)
Inner setting – access to knowledge and information	"there was no tracking. On whether people were educated correctly, so you couldn't ascertain if people were educated correctly. […] once it went up on HSEland [the Irish Health Service's national online learning and development portal], it became more streamlined. And you could actually request a certificate of people to ensure that they had done correct training." (P13)
	"during the pandemic, in terms of keeping GPs up to date every once a week on a Wednesday, the College of General Practice had a one hour webinar and we were getting like between 2500 and 4000 people each week on the webinar. And that's how we were going to notifying GPs of updates." (P05)
Inner setting – communication	"the communication from government was pretty clear […] the messages were fairly clear messages of endorsement of the vaccines. And so, you had the same messages coming. From government leaders as the CMO and deputy CMO. And various other public representatives. And that was very helpful. There was probably less space for noise around". (P07)
	"If we're thinking about marginalised groups who may not otherwise have always come forward for vaccines… it's important to kind of make it as accessible to them as possible… your communication to them as well. Migrant groups. The traveller community." (P07)
	"we would have a translation into other languages, particularly the Roma. […] We all had information available in Braille" (P01)
Inner setting – compatibility	"the infrastructures that were available were probably the biggest drivers for the implementation. […] There were delivery avenues already opened through the public health system like, you know, say for instance, to the health centres. And to GPs and to pharmacies. And there was national cold chain route there. […] adaptations have to be made given the unique storage of the vaccines in comparison to what had been managed in Ireland previously." (P11).
Inner setting – Tension for change	"looking at events in places like Italy and other countries internationally, but you know similar countries. Similar advanced healthcare systems really struggling, you know, […] underlined the need for a safe and effective vaccine." (P09)
Outer Setting Domain	
Outer setting – Partnerships and connections	"if you think back there was recommendations that pregnant women would be vaccinated and for a lot of people that was quite an uncomfortable thing to consider at the time. So we would have worked closely with the the RCPI and so they they have an obs/gynae (obstetrics and gynaecology) lead there. And what they did, they worked with NIAC and they also looked at the national and international evidence as well and came up with FAQ's and they were the trusted voice when it came to information for pregnant women. So it wasn't the HSE who was telling

(*continued on next page*)

Table 3 (*continued*)

Factor	Example quotes
	you to do, If you're pregnant to get vaccinated. It was actually, you know, your maternity services, who were supporting that. And so it's really important that you know the HSE isn't the only trusted voice in the room and the HSE isn't always the trusted voice in the room. So it's really important that you know you work with other people, and we can work together so that we know who's doing which piece because the big thing as well is during the time of COVID." P04
	"We are part of […] a network of NITAGs across Europe" (P09)
Outer setting – policy and law	"there would always be a time delay from NIAC's decision To to to do something. There'll be a time lag of a few weeks, so you'd know something was coming, but you couldn't implement it until everything else slotted in, so you needed, and once the chapter it had to go to a committee, then to be discussed and then education developed to match it. The chapter had to be updated in the NIAC Immunisation book as well as so there was a time delay from a decision. To actually delivering that vaccine Of weeks, yeah. "(P13)
	"the Pharmaceutical Society would have come out with their guidance, you know, around ethics and accountability for pharmacist, the nurses would have done the same thing as well, but I suppose within our HSE policy the NIO would have identified, you know, the different grades and the different responsibilities for everybody" (P01)
Outer setting – Structural characteristics	"With great difficulty. […], there were weekly COVID meetings, […] outside of clinical hours. […] You know you're trying to balance it. Morning meetings, the main NIAC meetings were usually, I think, at 6:00 in the evening. So it was juggling it with the regular commitment. You know that that has evolved the the meetings are now in work hours. A lot of hours. it has evolved to be better from a work life balance perspective. But there was a lot of extra hours required for reading the background reading." (P09).
Outer setting – communication	"We would have carefully crafted like press releases and stuff like that. You know social media outputs and stuff like that. So like all of our stuff is like reports, appendices are all published, you know, in the interest of transparency and stuff like that, […]We'd work with the communications team, our in-House Communications team to prepare all the press releases and social media and […] I would have been briefing my manager and questions that might have been asked, tricky questions you know what you would say? You know how you would deal with them. Yeah. So, there was a lot going on. […] HIQA would always just present, you know it's own its own you know, […] generally speaking, HIQA You know, we like to be in control of our own message and stuff. So, it's kind of better if you do that on your own" (P06)
Outer setting – external pressure	"obviously there was an urgency around it and there was a strong public appetite for it and a lot of political pressure to implement it effectively and at scale and at speed." (P07)
	"people only wanted Pfizer. And they didn't want Moderna.And then there was a bit of bad press around AstraZeneca, yet it was still out there for taking and that was hard sell when there was bad press around it because people didn't want to take it and they would turn up for vaccination, even though they would have gotten invite saying you were invited for your AstraZeneca vaccine today or tomorrow they would turn up and say I don't want it and say, well, that's all we have on offer today. You know, so that was negative that we could have done without, I suppose.You know, so the negative press around some vaccines didn't help." (P13)

pharmacy-based vaccination. Mobile vaccination supported delivery to vulnerable groups and those in residential care.

> *"people maybe who were more vulnerable, who mightn't have a PPS number who might not be living here legally […] then when we brought… the pharmacies into it"* (P01).

However, while adapting implementation processes was an effective responsive mechanism, it also created instability, unpredictability and/or increased workload for implementers and deliverers, so occasionally presented as a barrier. Challenges in adapting the process were also briefly noted in terms of the more recent transition back to normal vaccine delivery models following the closure of mass vaccination centres.

The active process and daily reality of vaccine delivery, enacting plans, and translating strategy into action refers to **doing** the vaccination implementation. This included tasks such as establishing practical systems and communication infrastructure like specific email addresses for GPs to track delivery to housebound patients. This practical operational work was described as a "learning experience", with logistics and quality processes evolving as delivery progressed; *"as things were starting and progressing, we'd realised that we need A, B and C"* (P05). Putting these functional channels in place so that vaccination could happen was primarily considered to be a facilitator for implementation. For example in mass vaccination centres, this process reflected the practical work of building reliable delivery routines and safeguarding delivery quality to support high-volume vaccination; in primary care, it was expressed more commonly as establishing systems and processes to enable GPs to deliver vaccines quickly and efficiently in familiar settings. However, practical challenges or delays in being able or permitted to act sometimes functioned as a barrier. For example, infection outbreaks in nursing homes created logistical challenges for administering vaccines in in those settings; these kinds of hindrances were noted as barriers to the process of 'doing' vaccination.

Engaging innovation (vaccine) deliverers was primarily a facilitator that included national strategies such as mobilisation and redeployment of staff from secondary or primary care into vaccination delivery (e.g. GPs, pharmacists, hospital staff). Successful engagement of deliverers was framed as a prerequisite for the scale, speed, and feasibility of the vaccination programme while any absence or delay in this engagement was implied as a potential barrier. For example, time-consuming legislation changes were required to allow pharmacists to vaccinate. **Engaging innovation recipients** was predominantly a facilitator, highlighting the importance of public communication, culturally and linguistically appropriate materials to enable uptake, particularly in the context of vaccine hesitancy and misinformation. Many participants emphasised that successful engagement had to go beyond generic messaging, via traditional and digital means, to achieve reach and equitable provision. Communications and engagement strategies required continuous revision and updating as delivery models and policies changed.

> *"they use the GAA [Gaelic Athletic Association] as a way of promoting vaccination in the in the young, […] involving social inclusion and in the community was a way of targeting that group, of finding means to communicate with them and it's because of that we actually brought vaccines to them." (*P13).

Planning programme roles, responsibilities and implementation strategy was often considered a facilitator but was often described as reactive rather than anticipatory, particularly at early stages and "*a lot of the policy was being written as it was needed"* (P01). This contributed to uncertainty and slowed momentum, constituting a barrier. Planning was contingent on resources and infrastructure. Participants discussed the **relative advantage** of different delivery models as a facilitator e.g. mass vaccination provided speed and scale, reducing GPs' workload. However, the accessibility of GP practices and pharmacies based in smaller urban and rural settings also facilitated access, while mobile vaccination and outreach to nursing homes or disability residential services addressed gaps left by other models.

Reflecting on and evaluating the implementation's progression was largely seen as a facilitator, underpinning the programme's capacity to learn and refine delivery in real time. It was portrayed mainly as an ongoing informal self-reflection process rather than formal feedback evaluations.

3.3. Individuals

3.3.1. Individual roles

Opinion leaders such as trusted, or influential community champions or health professionals helped shape public and professional responses to vaccination through trust and visibility. They were essential for translating policies into something socially credible, often through relational influence rather than top-down messaging.

> "*I'd be looking to what other public health professionals were doing. You know, I'm sure members of different communities were looking at what their various peers were doing, but amplifying the messages of endorsement for vaccines would have surely helped. And I would have seen that in a few different areas of my professional work as well. Not just. Not just family life.*" *(P07)*.

Social media, local radio personalities and vaccine champions in marginalised groups such as Roma, were also perceived to positively influence vaccine uptake and served as public role models.

Vaccine programme success was also contingent on **Innovation deliverers**, i.e., GPs, pharmacists, nurses, and other HCPs administering vaccines. Implementation capacity resided not only in the healthcare system but in the people employed. The professional autonomy, community reach and skills of GPs were noted as a "*force multiplier*", (P05), extending vaccine reach.

> *"GPs are hugely important now as well as community pharmacies. And while […] they're not specifically involved in the guidelines. They're involved in delivery of vaccination"* (P03).

Implementation teams were vital to the team-based endeavour of vaccination which involved coordinating logistics, ICT, clinical delivery, estates (the HSE's infrastructure management department), and public health across professional boundaries and organisations. **Implementation facilitators** supported teams and leads by providing evidence, implementation expertise, and practical solutions. These included experts from organisations such as NIAC, HIQA, the Royal College of Physicians, the HSE and their communications department. **Implementation leads**, with formal responsibility for directing vaccination programmes at national, regional or local level were viewed as pivotal facilitators, providing direction and support to implementation teams and deliverers. **High-level leaders** with overarching authority and system-wide influence included government officials, national programme leaders or regional executives; they shaped policy direction, resourcing and legitimacy, creating the political and organisational conditions for rapid, large-scale vaccination.

> *"It was reassuring to have, you know, the engagement between the National Immunization Advisory Committee and the Chief Medical Officer and, you know, having people like Deputy Chief medical officers who sat with NIAC during those meetings and acted as a conduit."* (P09).

3.3.2. Individual characteristics

The characteristics of the individuals involved in delivery or implementation also influenced implementation. Individual's capability, motivation, needs, and opportunities each functioned as both barriers and facilitators to some extent.

Capability refers to the skills, competencies, and preparedness of individuals who delivered vaccinations or implemented/co-ordinated the programme. For some it was thought "*the staff didn't always necessarily have the skill sets that they needed because they may have been completely new into public health*" *(P07)*.

This lack of capability could act as a barrier. In contrast, those with experience strengthened and supported capability within teams, constituting a facilitator: *"we started with the nurses who really were like… very proficient around vaccination. So very much our schools' vaccination team and some of our public health nurses were involved in the schools' vaccination team… They were actually the leads on this and they were often our managers on site"* (P01).

Motivation refers to the degree to which individuals are willing or driven to engage with the vaccination programme, as implementers, deliverers, or recipients. Motivation of those responsible for implementing and delivering vaccination was framed predominantly as a facilitator. Participants described a strong sense of collective purpose, civic duty, and professional commitment that sustained extraordinary levels of effort over a prolonged period. Recipient motivation was more variable, shifting over the course of the pandemic. This captured drivers such as the beliefs about consequences which could be positive (e.g., perceived benefit) and thus an implementation facilitator, or negative (e.g., vaccine fatigue, fear or declining urgency) and thus constitute a barrier: *"I think the main driver at a population level would have been fear of hospitalization or mortality relating to COVID […] as the pandemic progressed […] there was less fear."* (P01).

Need refers to the extent to which individuals appeared to feel a personal need for vaccination or related support for vaccination, and could be a barrier or facilitator to vaccine uptake. This construct referred to participants' perceptions of their own personal need or desire to be vaccinated rather than to needs being due to mandatory vaccination policies or formal requirements, because Ireland did not have general mandatory vaccination policies. Therefore the data mainly focused on recipients' needs regarding the vaccine (framed in terms of vulnerability, access, and perceived risk) though was also briefly noted in relation to deliverers' needs, which also referred to their perceived need to be vaccinated in order to be protected from the virus: *"I think healthcare workers were acutely aware of the need for a safe and effective vaccine that would get away from the kind of devastating reports that people were hearing of the fatalities that were happening […] the fact that it was happening among healthcare workers as well brings it a bit closer to home"* (P09).

Perceptions of need for the vaccine appeared to reduce somewhat over time, as the public perceived less urgency or importance of subsequent vaccine doses.

Opportunity refers to the extent to which individuals could engage with vaccination either as recipients (the opportunity to attend, access, or participate) or implementers (the opportunity to contribute or be involved in programme implementation). For implementers, their opportunity for involvement in the programme implementation often appeared to be due to their existing roles and professional experience. For healthcare professionals, easy access to get vaccinated was a facilitator for uptake: *"every healthcare worker here [in the hospital] would have had the opportunity to avail of on-site vaccination and it was promoted […] it was hugely convenient for people who wanted to get the vaccine. There were lots of opportunities and availability here to get the vaccine"*. (P03).

3.4. Inner setting

In this study the **inner setting** encapsulated the public health system including Irish government, Department of Health, and *"from the CEO of the HSE, down to the vaccinator"* (P01). This included the HSE and its teams/departments, clinical delivery sites including GPs, pharmacies, mass vaccination centres and mobile vaccination. Overall, the inner setting encompassed settings in which policy for the Irish COVID-19 vaccination programme was being created and the clinical settings where it was enacted.

3.4.1. Available resources

Available resources were a common factor mentioned. **Funding**, that is the availability of financial resources to support implementation, enabled capacity to rapidly procure infrastructure, staff, equipment, and space, and absorb exceptional costs associated with large-scale delivery, was framed as an important facilitator.

Materials and Equipment refers to availability and adequacy of specific tangible resources required for vaccine delivery, including cold-chain equipment (e.g. refrigerators, temperature monitoring devices), clinical equipment (e.g. syringes, PPE), documentation and consent forms and other site-level materials. Shortages or delays in resource availability acted as barriers, particularly during early rollout. Over time, these constraints were largely resolved, and resource availability became, to an extent, a facilitator. Material constraints were particularly salient for mass vaccination centres, where scale magnified resource demands. Participants described the need for large volumes of clinical equipment, furniture, and refrigeration. "*Even the basic things […] like sites where we were vaccinating, they mightn't have been used as […] healthcare facilities for a long time. So again, trying to make sure like do you have tables? Do you have chairs?"* (P02).

Spaces refers to the physical environments in which vaccination could occur, including the availability, suitability, and adaptability of buildings and rooms for safe, efficient delivery. This includes clinical spaces in existing services, and repurposed environments. This construct could be a barrier or facilitator, and was most salient for mass vaccination centres, where the scale of delivery made space a central determinant of what was possible.

Staff refers to adequacy and availability of staff to support implementation, including whether there were sufficient numbers of appropriately skilled people to deliver and coordinate vaccination, and how staffing levels shaped what could be done, when, and at what scale. Early on, staff availability shaped programme pace, and which delivery models were viable. In primary care models, the availability of suitably trained staff was highlighted as a facilitator:

> *"So we had already trained workforce, pharmacists have been delivering flu since 2011 […] So we had a trained vaccination professional cohort who were there available to provide the service"* (P11).

Time refers to the extent to which sufficient time was available to plan, prepare, and deliver the vaccination programme. Time was consistently framed as scarce, particularly earlier in the programme, which constituted a consistent barrier:

> *"the last minute aspect of the policies coming down and then being expected to implement them the next day just because of the media pressure and the pressure from the government and the Minister. But that was just the environment that everybody was in"* (P12).

Structural Characteristics were the underlying organisational and infrastructural features of where vaccination occurred. This encompassed three sub-constructs: **IT infrastructure** (digital systems that supported vaccination), **work infrastructure** (organisational systems that structured how vaccination is done), and **physical infrastructure** (i.e. the layout and accessibility of the vaccination rooms or centres, storage rooms and other physical features of the settings in which vaccination occurred). Together, these features shaped what was operationally possible, how quickly new models could be established, and how easily vaccination could be delivered at scale. Delays, problems or inefficiencies in these infrastructures acted as barriers, while the availability of stronger or more appropriate infrastructure, such as the introduction of the national electronic vaccine record, could act as important structural facilitators for implementation.

Policies and laws denoted the rules, regulations, and policy frameworks governing vaccination implementation, including national public health policy, emergency legislation, contractual arrangements, indemnity and scope-of-practice rules, and operational guidance. This was primarily a key facilitator for implementation, but delays or restrictions in policies could constitute a barrier. For example, in primary care, particularly pharmacy, contractual and regulatory arrangements acted as gatekeepers. Willingness and capacity to contribute existed, but formal frameworks were required before professionals could deliver vaccinations, particularly off-site:

> *"there was also an update to allow Community pharmacy and update policy to allow Community pharmacist to vaccinate off site for COVID. Before that, they could only vaccinate on their premises and there was a change policy to allow community pharmacist to vaccinate offsite"* (P16).

Relational Connections were the formal and informal relationships, networks, and teams within and across Inner Setting boundaries. These social ties or interactions strongly facilitated programme implementation. Relational ties sometimes substituted for formal processes and thus the implementation programme advanced through existing connections. This facilitated rapid engagement and problem-solving and buffered against uncertainty. However, this could also restrict other professionals' involvement in implementation:

> *"It was definitely seat of the pants stuff and it seemed to be nationally they would have picked on just a few people they knew in the healthcare system. […] There was no formal choice of who got involved and stuff. People just got asked, but they, somebody knew them"* (P02).

Access to Knowledge and Information referred to whether individuals and teams had timely, accurate, and usable information about vaccination, including clinical guidance, operational procedures, training materials, and updates as evidence and policy evolved. This was typically seen as a facilitator, though could also present difficulties. For example, several participants emphasised how frequently knowledge had to be revised due to new information: "*then for each time a new vaccine came on on stream. They would have to do a HSEland [training provided through the Irish Health Service's national online training portal] like a webinar, really training."* (P01).

Communication refers to the formal and informal channels through which information moved within the system, including how guidance, decisions, updates, and messages were shared across organisations, teams, and roles. Communication was consistently framed as a facilitator. Several participants described the intensity and regularity of national communication early in the pandemic as being important.

> "*So at the beginning of COVID every single week, the HSE held a briefing […] journalists were invited into a room […] they were able to ask questions to like our CEO, the higher management in the HSE."* (P04).

Communication also referred to efforts made by the inner setting to communicate outwards to the public, particularly those for whom communication approaches had to be adapted such as for migrants, Travellers, and Braille users.

> "*we would have a translation into other languages, particularly the Roma. […] We all had information available in Braille*" (P01).

Compatibility referred to the degree to which the vaccination programme aligned with existing workflows, systems and processes, capturing whether the programme fit with what services already did or disrupted established ways of working. Compatibility was primarily a facilitator, and implementers mentioned that they "*sought at the first*

instance to use traditional routes that were already established and expanded those" (P11).

Tension for Change was a powerful facilitator that referred to perceived need for change within the system, i.e. the extent to which existing conditions were unacceptable or unsustainable, necessitating urgent action.

> *"we had outbreaks everywhere. And even when we were just starting with the residential care facilities as the highest priority group, while also trying to get vaccines into those settings, you had to be conscious of the fact that like a COVID outbreak at that stage was not only a threat to the residents in there, but to the vaccinators who were supposed to be going in."* (P07).

3.5. Outer setting

The outer setting is most clearly exemplified in the data in opposition or in relation to the inner setting, as in descriptions regarding the involvement of outer setting organisations such as NIAC and HIQA.

> "*Generally speaking, the division is the Department of Health are the Policy Makers. HIQA are evidence generators*" (P06).

Within the outer setting, a range of constructs influenced programme implementation, including partnerships and connections, policy and law, structural characteristics (work infrastructure), communication, and external pressure. In addition to working together or informing policy and recommendations, **Partnerships and Connections** became foundational to specific delivery models, including for mass vaccination centres.

> *"We had humongous support from the army… from, you know, various community groups that would assist us."* (P06).

Outer setting **policy and law** referred to national and international policy frameworks, legislation, and authoritative guidance originating outside the inner setting and shaping what was permissible, required, or prioritised in the inner setting. This included European policy, and external organisations within Ireland who informed policy and guidance, such as NIAC and HIQA. These external policies and recommendations provided support and legitimacy for implementation but also introduced delays and dependence, therefore functioning simultaneously as facilitators and constraints.

> "*Chapter 5A of the national immunisation guidelines was kind of being written by NIAC as vaccine information became available. So I mean chapter 5A and the clinical guidelines for COVID-19 vaccine were probably two of the main things that I would reference in terms of the clinical administration of vaccine."* (P05).

Structural Characteristics in the outer setting focused on work infrastructure. Participants described COVID-19 vaccination as unfolding within a dense external architecture of committees, departments, and regulatory bodies. These structures shaped what could be decided, how quickly, and by whom. Although clear responsibilities and workload management was generally enabling, the organisation and delegation of workload and responsibilities within outer setting organisations could present challenges.

Communication refers to how information, guidance, and messaging originating outside the implementing system were conveyed within the outer setting and/or from the outer to inner setting. Communication of evidence from the outer setting was an essential facilitator in informing the inner setting's work; however, one participant described the burden of translating emerging evidence into operational recommendations, "*synthesizing the evidence and… doing it quickly*". (P06).

External Pressure refers to forces originating outside the implementing system that created urgency, demand, or constraint for action. This appeared almost entirely as societal pressure, encompassing public expectations, fear, media attention, and the wider social and political climate of the pandemic. Vaccination was framed not only as a technical intervention but a symbol of safety, hope, and resolution, which facilitated uptake.

> "*obviously there was an urgency around it and there was a strong public appetite for it and a lot of political pressure to implement it effectively and at scale and at speed."* (P07).

Conversely, the pressure from those who were sceptical of the vaccine was also perceived as a barrier: *"you remember all the negative connotations they were at the beginning of the vaccinations. […] So a lot of negativity, I suppose we came across a lot of it out in the vaccination centres where you had people coming to the vaccination centres in protest and challenging the vaccine you know,"* (P13).

4. Discussion

The qualitative insights from key stakeholders in this study found that factors across innovation, process, individual, inner setting, and outer setting domains shaped implementation of the COVID-19 programme in Ireland. This aligns with emerging international evidence demonstrating that COVID-19 vaccination implementation depended upon interacting factors across healthcare system levels, including system capacity, procurement strategies, governance structures, and the ability to leverage existing primary care infrastructure [2,4–6]. Our findings indicate vaccine availability alone was insufficient; successful delivery required organisational infrastructure and resources, workforce mobilisation, adaptive processes, and coordinated policy leadership and governance.

Consistent with our finding that delays and uncertainty in the vaccine evidence base posed challenges for implementers, Vickery et al. highlight how the pandemic strained evidence-informed decision-making, with policy advisors struggling to access, translate, and apply evidence under conditions of rapid change and uncertainty, reinforcing the need for timely, actionable evidence systems during health emergencies [29]. Concerns about insufficient, or evolving, evidence hindering delivery were also reported by frontline healthcare workers in the UK [30]. Vaccine design, and complexity of storage and administration requirements, further impacted implementation, particularly during early rollout, echoing findings from other countries [31,32]. Conversely, some vaccine products such as single-dose vaccines could simplify implementation [4]. Our findings regarding the vaccine itself are also reflected in official international lessons documents. The COVID-19 Vaccine Delivery Partnership [33] identifies rapid product development, multiple vaccine products, stringent storage requirements, short shelf-lives, and unusual handling procedures as distinctive features of COVID-19 vaccine introduction. Similarly, the European Centre for Disease Prevention and Control's (ECDC) technical report on rollout in the EU/EEA noted that different vaccine products created complex logistical and administration challenges, including storage, transport, and dose-management requirements, as well as communication challenges relating to the efficacy and safety of different vaccine products [34]. These observations align closely with our findings on evolving evidence and the operational challenges caused by the vaccine design and complexity.

Continuous adaptation of delivery strategies, including scaling to mass vaccination centres and utilising primary care and pharmacy settings, was essential to operationalising vaccination at scale. This is consistent with evidence highlighting flexibility, iterative adaptation, and model diversification, as critical to successful implementation [7]. Supporting previous studies, mass vaccination centres presented challenges but were crucial in reaching large numbers of recipients [35–37], while primary care such as GPs and community pharmacies afforded local accessibility [7,8,36]. Mobile approaches were less prominent in our study but improved access and equity [38]. Processes of engaging vaccine deliverers (e.g. re-deployment), and recipients, were also central, aligning with findings across countries [3,39,40–42]. The Saolta

COVID-19 Vaccination Programme End of Programme Report [43], focusing on the COVID-19 vaccination programme in the west of Ireland, similarly describes a staged and adaptive rollout, rapid establishment of programme governance and workstreams, and major operational pressures relating to and delivery across multiple settings. This supports our finding that implementation depended on adaptive delivery models and the capacity to reconfigure services over time. Likewise, the ECDC technical report [34] highlighted the need to expand vaccination sites, prepare for mass vaccination, and increase mobile or home-based vaccination for people who could not travel, supporting our findings about the importance of adapting processes to achieve accessible and targeted delivery models.

Partnership of stakeholders supported implementation and influenced engagement. Opinion leaders such as community champions facilitated recipient engagement, particularly from marginalised and underserved populations, as also reported elsewhere [40,44]. Chater et al., found reflective motivation and social opportunity were key influences on vaccine uptake and echo this need for tailored, community co-created messaging for inclusive implementation [45]. Existing skills or capacity of deliverers and implementers could support, or hinder, implementation [36]. Likewise, high motivation among implementation stakeholders and vaccine deliverers facilitated implementation despite heavy workloads and stress, as reported in the UK [36]. Meanwhile, fluctuations in recipient motivation influenced vaccine uptake over time, a finding also evidenced in previous research [46–48]. In the absence of official evaluations of the COVID-19 vaccination programme in Ireland, official inquiry and technical reports from other countries, also reinforce our findings on communication, trust, and recipient engagement. The UK Covid-19 Inquiry [49] concluded that the most effective strategy for improving uptake combined outreach informed by local knowledge with listening to communities and using trusted voices from within those communities, supporting our findings about factors that facilitated recipient engagement. The Australian Commonwealth Government COVID-19 Response Inquiry [50] likewise found that early engagement with community-based organisations, community leaders, and local government was key, and that inconsistent vaccine communication and poor explanation of changing advice undermined confidence and slowed rollout. Consistent with this, the ECDC technical report [34] identified misinformation and disinformation, communication about prioritisation, and communication about the efficacy and safety of different vaccine products as important recipient-engagement challenges across the EU/EEA.

Inner setting factors such as organisational resources, like staffing, infrastructure, and operational capacity, were critical. This has been widely reported, though most studies appear to focus on lower- and middle-income countries (LMIC) [51,52]. Across countries, structural characteristics such as IT and data information systems, workforce infrastructure, and physical infrastructure, were key determinants of implementation [3,36,53,54], supporting our findings. Likewise, clear organisational communication, access to information or training, and relational connections between stakeholders, supported coordination and adaptation, consistent with existing evidence [7,30,46,55,56]. National policy and professional regulatory frameworks provided necessary structure and authority for programme delivery facilitating a coherent rollout in this and other studies [2,36,57]. However, international evidence also cautions that rigid or overly centralised processes can undermine implementation where local realities and contexts are insufficiently considered [7]. The Saolta end-of-programme report [43] also supports our inner setting findings in an Irish setting, describing rapid establishment of a central programme team and steering structures, dedicated workstreams for workforce, communication, sites, consumables and ICT, and early challenges with the Covax and data systems, all of which underline the importance of organisational infrastructure, staffing, communication, and digital capacity for vaccine implementation. These patterns are also consistent with the Vaccine Delivery Partnership's global lessons report [33], which emphasised workforce surge capacity, digital registries, and the burden created where new logistics or reporting systems were disconnected from existing systems.

Outer setting factors were less prominent, though international or European policies provided critical structural support for the inner setting's policymaking and implementation, as well as prioritisation frameworks, as echoed by Palmer et al. and Kandulu et al. [3,4]. National external advisory bodies also informed policy-making and implementation. Strong partnerships and coordination, including with these advisory groups, have similarly been identified internationally as contributing to national policies, and/or decision-making regarding vaccine rollout [2,58].

In summary, this study's findings are strongly supported by international research. This consistency indicates that many of the factors shaping COVID-19 vaccination programme implementation are structural and recurrent across health systems. This strengthens confidence in the transferability of these findings and reinforces the value of implementation science frameworks for informing pandemic preparedness planning. Recognising factors that recur across diverse settings enables proactive planning, allowing health systems to anticipate predictable implementation challenges, and invest in the capacities most likely to influence success. Therefore, our findings' alignment with international evidence enhances the utility of this study for informing future vaccine programme design and pandemic preparedness strategies.

Our findings highlight priority actions for strengthening future vaccination programmes. Preparedness must extend beyond vaccine procurement to sustained investment in implementation capacity, including an agile, adequately resourced, multidisciplinary workforce, and governance structures that enable rapid yet locally responsive decision-making [4,7,59]. Preparedness frameworks should be maintained and regularly updated so they can be swiftly operationalised [2,59]. Digital infrastructure should be strengthened to support integrated life-course immunisation records and real-time monitoring, building on systems developed during COVID-19 [59,60]. Clear, coordinated communication and community engagement mechanisms, are essential to maintain trust and accessibility across diverse populations [4,8,23,61]. Finally, flexible delivery models, and cross-sector collaborations, developed during the pandemic should be preserved and embedded within routine systems, ensuring that crisis-driven innovations are sustained rather than lost as emergency funding recedes [2,5,8,59]. While some of these factors were more specific to the pandemic context, many others reflect broader system capabilities that are also relevant to routine vaccination programmes such as staffing, communication, IT infrastructure and flexible delivery models. Therefore, the findings imply a need to build on the infrastructure, partnerships, and implementation capacity developed during COVID-19, and apply these more sustainably within routine vaccination programmes.

This study has several strengths. It captured perspectives from stakeholders involved in Ireland's COVID-19 vaccine programme implementation across national, regional, and local levels, illustrating factors across multiple health system levels. Qualitative methods, here semi-structured interviews and framework analysis, also effectively examine complex implementation processes and contextual factors that quantitative approaches might miss [62].

However, the study also has some limitations. In particular, this analysis was primarily descriptive and conducted at a system level, reflecting the study's focus on implementation stakeholders who were directly involved in policy and programme decision-making, rather than frontline vaccine delivery or members of the public. More in-depth interviews with other stakeholder groups, such as frontline vaccinators or vaccine recipients, may have generated richer detail on how specific factors operated in practice. It is therefore a limitation that the study may not capture all factors relevant to vaccine delivery or uptake from the perspectives of those other groups. Additionally, participants' accounts may have been influenced by retrospective recall or later reflection on events, as several years could have passed between the

experiences described and these interviews. However, retrospective qualitative interviews can still provide valuable insight into how implementation was experienced and understood over time [63]. As a qualitative study situated within the Irish health system, the findings are context-specific and should be interpreted in relation to that setting. Nevertheless, the use of CFIR supports comparison with findings from other studies and may enhance the transferability of insights to similar health system contexts [14,15]. A further limitation is that this study did not include documentary analysis. Triangulation of findings using documentary analysis might have provided additional insight into governance, operational delivery, and implementation challenges. However, we did not identify a published national-level evaluation of Ireland's COVID-19 vaccination rollout. Ireland's Independent COVID-19 Evaluation is ongoing and recently released consultation and overview materials from that evaluation thus far have a broader focus on the pandemic response in general and on views of the general public, rather than a formal evaluation of the vaccination programme or views of those involved in implementation decisions or policy-making [64]. The most relevant Irish documentary source identified from an implementation perspective was the Saolta COVID-19 Vaccination Programme End of Programme Report, a retrospective operational report from Saolta University Health Care Group which led the regional vaccination programme in the west and north-west of Ireland [43]. As this report is regional rather than national in scope and more operational than analytic, it was not considered sufficient on its own to justify adding a document-analysis component at this stage. Instead, relevant insights from this report have been incorporated throughout the discussion for contextual comparison, alongside official inquiry reports from the UK [49] and Australia [50] and relevant reports from the ECDC [34] and COVID-19 Vaccine Delivery Partnership [33].

In conclusion, implementation of the COVID-19 vaccination programme in Ireland was shaped by interacting factors across innovation, process, individual, organisational, and policy domains. The success of implementation depended on a wide range of factors, including adaptive processes, motivated and capable stakeholders, and supportive policy and organisational environments. This can inform future vaccination programmes and emphasise the need for investment, in routine national vaccination programmes, and health system preparedness for future public health emergencies.

CRediT authorship contribution statement

Chikondi C. Kandulu: Writing – review & editing, Writing – original draft, Visualization, Validation, Project administration, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Aoife Fleming:** Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization. **Aoife O'Mahony:** Writing – review & editing, Writing – original draft, Validation, Formal analysis, Data curation. **Sheena McHugh:** Writing – review & editing, Validation, Methodology. **Gillian W. Shorter:** Writing – review & editing, Funding acquisition. **Emma Berry:** Writing – review & editing, Funding acquisition. **Caoimhe Shields:** Writing – review & editing. **Najam Sahar:** Writing – review & editing. **Anne C. Moore:** Writing – review & editing, Funding acquisition, Conceptualization. **Laura J. Sahm:** Writing – review & editing, Validation, Supervision, Resources, Methodology, Investigation, Funding acquisition, Data curation, Conceptualization.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Acknowledgements

This study was funded by the All-island Vaccine Research and Training Alliance (AIVRT). AIVRT is a Strand 2 project funded under the North South Research Programme (NSRP). The NSRP is a collaborative scheme funded through the Government's Shared Island Fund. It is being administered by the Higher Education Authority (HEA) on behalf of the Department of Further and Higher Education, Research, Innovation and Science. The authors would also like to thank all implementation stakeholders who participated in this study.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.vaccine.2026.128909.

Data availability

The qualitative data generated and analysed during this study are not publicly available due to the confidential and potentially identifiable nature of participant interview data. Participants recruited held senior or specialised roles within a relatively small professional community and shared information about roles, organisations, and experiences that could compromise anonymity if their identifies were disclosed. For these reasons, and in line with the conditions of ethical approval and informed consent, the interview transcripts are not available for public sharing and minimal details regarding the participant characteristics are indicated in the manuscript.

References

[1] Shang W, Wang Y, Yuan J, Guo Z, Liu J, Liu M. Global excess mortality during COVID-19 pandemic: a systematic review and meta-analysis. Vaccines 2022;10(10):1702. https://doi.org/10.3390/vaccines10101702.
[2] Tupps C, Curry D, Edwards A, Bazant E, Moen A, Mounts AW, et al. COVID-19 vaccination implementation in six lower- and middle-income countries: successes, challenges, and lessons for pandemic preparedness. PLOS Glob. Public Health 2025;5(5):e0004417. https://doi.org/10.1371/journal.pgph.0004417.
[3] Palmer K, Nemer L, Datta SS, Menne BM. COVID-19 vaccination roll-outs in small countries within the European region; lessons from eleven countries in the World Health Organization's small countries initiative. Front. Public Health 2022;10:959227. https://doi.org/10.3389/fpubh.2022.959227.
[4] Kandulu CC, Sahm LJ, Saab MM, O'Driscoll M, McCarthy M, Shorter GW, et al. A scoping review of factors affecting COVID-19 vaccination uptake and deployment in global healthcare systems. Vaccines 2024;12(10):1093. https://doi.org/10.3390/vaccines12101093.
[5] Aggarwal M, Kokorelias KM, Glazier RH, Katz A, Shiers-Hanley JE, Upshur REG. What is the role of primary care in the COVID-19 vaccine roll-out and the barriers and facilitators to an equitable vaccine roll-out? A rapid scoping review of nine jurisdictions. BMJ Open 2023;13(4):e065306. https://doi.org/10.1136/BMJOPEN-2022-065306.
[6] Al Ghafri T, Al Balushi L, Al Balushi Z, Al Kiyumi L, Bait Ishaq A, Al Harthi J. The experience of an accelerated COVID-19 immunization campaign in Oman: a review within the WHO health system building blocks framework. Vaccines 2025;13:1002. https://doi.org/10.3390/VACCINES13101002.
[7] Mounier-Jack S, Paterson P, Bell S, Letley L, Kasstan B, Chantler T. Covid-19 vaccine roll-out in England: a qualitative evaluation. PLoS One 2023;18(6). https://doi.org/10.1371/JOURNAL.PONE.0286529.
[8] Koay A, Devitt C. What obstructs health policy implementation? A multi-method qualitative case study of the delayed deployment of community pharmacies in Ireland's national COVID-19 vaccination programme. Qual. Health Res. 2025;35(13):1464–80. https://doi.org/10.1177/10497323241302239.
[9] Byrne-Davis LMT, Turner RR, Amatya S, Ashton C, Bull ER, Chater AM, et al. Using behavioural science in public health settings during the COVID-19 pandemic: the experience of public health practitioners and behavioural scientists. Acta Psychol. 2022;224:103527. https://doi.org/10.1016/j.actpsy.2022.103527.
[10] Oversby S, Hamilton EM, Ratsch A, Kitchener S. Barriers and enablers to implementation of COVID-19 vaccine programs in a rural and regional Queensland: a provider perspective. Aust. J. Rural Health 2023;31(6):1191–202. https://doi.org/10.1111/AJR.13046.
[11] Nabia S, Wonodi CB, Vilajeliu A, Sussman S, Olson K, Cooke R, et al. Experiences, enablers, and challenges in service delivery and integration of COVID-19 vaccines: a rapid systematic review. Vaccines 2023;11(5). https://doi.org/10.3390/VACCINES11050974.
[12] Jimoh AU, Filani O, Awobeku D, Isiaka SD, Dauda M, Adeshina EO, et al. Qualitative assessment of the enablers and barriers of COVID-19 vaccination integration, into routine immunization programme at primary health care facilities

in Ekiti state, Nigeria. Discov. Public Health 2024;21(1):94. https://doi.org/10.1186/S12982-024-00217-7/TABLES/2.
[13] Damschroder LJ, Aron DC, Keith RE, Kirsh SR, Alexander JA, Lowery JC. Fostering implementation of health services research findings into practice: a consolidated framework for advancing implementation science. Implement. Sci. 2009;4(1). https://doi.org/10.1186/1748-5908-4-50.
[14] Damschroder LJ, Reardon CM, Widerquist MAO, Lowery J. The updated consolidated framework for implementation research based on user feedback. Implement. Sci. 2022;17(1). https://doi.org/10.1186/S13012-022-01245-0.
[15] Kirk MA, Kelley C, Yankey N, Birken SA, Abadie B, Damschroder L. A systematic review of the use of the consolidated framework for implementation research. Implement. Sci. 2016;11(1). https://doi.org/10.1186/S13012-016-0437-Z.
[16] Chen JC, Gutierrez G, Kamran R, Terry J, Telliyan A, Zaks C, et al. Evaluation of COVID-19 vaccine implementation in a large safety net health system. Front. Health Serv. 2023;3. https://doi.org/10.3389/FRHS.2023.1152523/PDF.
[17] Plesons M, Soto Sugar SE, Chimbaru R, McDonald G, Friedman L, Thompson E, et al. COVID-19 vaccine implementation at a syringe services program: experiences of frontline staff. BMC Health Serv. Res. 2024;24(1). https://doi.org/10.1186/S12913-024-11691-9.
[18] Taddio A, McGilton KS, Zheng N, Yeung L, Lafleur B, Fung JST, et al. COVID-19 vaccination delivery in long-term-care using the CARD (comfort ask relax distract) system: mixed methods study of implementation drivers. Can. J. Pain 2022;6(1):173–84. https://doi.org/10.1080/24740527.2022.2115880.
[19] Fisher G, Smith CL, Pagano L, Spanos S, Zurynski Y, Braithwaite J. Leveraging implementation science to solve the big problems: a scoping review of health system preparations for the effects of pandemics and climate change. Lancet Planet Health 2025;9(4):e326-36. https://doi.org/10.1016/S2542-5196(25)00056-7.
[20] Zimmerman S, Gaugler JE, Nkimbeng M. COVID-19 vaccination and implementationscience: how one can benefit the other. J. Am. Med. Dir. Assoc. 2021;22(11):2223. https://doi.org/10.1016/J.JAMDA.2021.09.018.
[21] Department of Health. COVID-19 Vaccination Strategy and Implementation Plan. https://www.gov.ie/en/department-of-health/publications/covid-19-vaccination-strategy-and-implementation-plan/. 2020 [Accessed 12th February 2026].
[22] Health Protection Surveillance Centre. COVID-19 vaccination uptake in Ireland: surveillance report. 2022. https://www.hpsc.ie/a-z/respiratory/coronavirus/novelcoronavirus/vaccination/covid-19vaccinationuptakereports/2022/Covax%20slides%20for%20HPSC%20web%20based%20report%2020221219%20v1.0.pdf. 2022 [Accessed 12th February 2026].
[23] World Health Organisation. Immunization agenda 2030: a global strategy to leave no one behind. World Health Organisation. https://cdn.who.int/media/docs/default-source/immunization/strategy/ia2030/ia2030-draft-4-wha_b8850379-1fce-4847-bfd1-5d2c9d9e32f8.pdf?sfvrsn=5389656e_69&download=true. 2020 [Accessed 12th February 2026].
[24] Phillips G, Racine E, Naughton AM, Lane J, Kearney PM. Understanding uptake of the COVID-19 vaccination among the homeless: a mixed methods evaluation. PLoS One 2025;20(1):e0312617. https://doi.org/10.1371/JOURNAL.PONE.0312617.
[25] Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. Int. J. Qual. Health Care 2007;19(6):349–57. https://doi.org/10.1093/intqhc/mzm042.
[26] Ahmed SK. Sample size for saturation in qualitative research: debates, definitions, and strategies. J. Med. Surg. Public Health 2025;5:100171. https://doi.org/10.1016/j.glmedi.2024.100171.
[27] Means AR, Kemp CG, Gwayi-Chore MC, Gimbel S, Soi C, Sherr K, et al. Evaluating and optimizing the consolidated framework for implementation research (CFIR) for use in low- and middle-income countries: a systematic review. Implement. Sci. 2020;15(1). https://doi.org/10.1186/S13012-020-0977-0.
[28] Rodrigues IB, Fahim C, Garad Y, Presseau J, Hoens AM, Braimoh J, et al. Developing the intersectionality supplemented consolidated framework for implementation research (CFIR) and tools for intersectionality considerations. BMC Med. Res. Methodol. 2023;23(1). https://doi.org/10.1186/S12874-023-02083-4.
[29] Vickery J, Atkinson P, Lin L, Rubin O, Upshur R, Yeoh EK, et al. Challenges to evidence-informed decision-making in the context of pandemics: qualitative study of COVID-19 policy advisor perspectives. BMJ Glob. Health 2022;7(4):8268. https://doi.org/10.1136/BMJGH-2021-008268.
[30] Manby L, Dowrick A, Karia A, Maio L, Buck C, Singleton G, et al. Healthcare workers' perceptions and attitudes towards the UK's COVID-19 vaccination programme: a rapid qualitative appraisal. BMJ Open 2022;12(2). https://doi.org/10.1136/BMJOPEN-2021-051775.
[31] Tlhakanelo JT, JEO Ataguba, Pagiwa V, Ramabu N, Kadimo K, DM Muriithi GN Achala, et al. A qualitative analysis exploring barriers and enablers to distribution, delivery, and access to COVID-19 vaccines in Botswana. Front Health Serv. 2025;5:1609056. https://doi.org/10.3389/FRHS.2025.1609056/TEXT.
[32] Fahrni ML, Ismail IAN, Refi DM, Almeman A, Yaakob NC, Saman KM, et al. Management of COVID-19 vaccines cold chain logistics: a scoping review. J. Pharm. Policy Pract. 2022;15(1):16. https://doi.org/10.1186/S40545-022-00411-5.
[33] COVID-19 Vaccine Delivery Partnership. The COVID-19 Vaccination Response: Country experiences, best practices, and lessons. 2023. https://www.who.int/publications/m/item/the-covid-19-vaccination-response–country-experiences–best-practices–and-lessons [Accessed 2nd June 2026].
[34] European Centre for Disease Protection and Control. Rollout of COVID-19 vaccines in the EU/EEA: challenges and good practice. 2021. https://www.ecdc.europa.eu/en/publications-data/rollout-covid-19-vaccines-eueea-challenges-and-good-practice [Accessed 2nd June 2026].
[35] Kholina K, Harmon SHE, Graham JE. An equitable vaccine delivery system: lessons from the COVID-19 vaccine rollout in Canada. PLoS One 2022;17(12). https://doi.org/10.1371/JOURNAL.PONE.0279929.
[36] Ismail S, Chantler T, Paterson P, Letley L, Bell S, Mounier-Jack S. Adapting SARS-CoV-2 vaccination delivery in England to population needs: a thematic analysis of providers and commissioner's perceptions. BMC Health Serv. Res. 2023;23(1). https://doi.org/10.1186/S12913-023-09350-6.
[37] Danek S, Achelrod D, Wichmann O, Schwendicke F. The role of vaccination centers in a national mass immunization campaign-policymaker insights from the German COVID-19 pandemic vaccine roll-out. Vaccines 2023;11(10). https://doi.org/10.3390/VACCINES11101552.
[38] Alcendor DJ, Juarez PD, Matthews-Juarez P, Simon S, Nash C, Lewis K, et al. Meharry medical college mobile vaccination program: implications for increasing COVID-19 vaccine uptake among minority communities in middle Tennessee. Vaccines 2022;10(2). https://doi.org/10.3390/VACCINES10020211.
[39] Alderotti G, Corvo MF, Buscemi P, Stacchini L, Giorgetti D, Lorini C, et al. Communicating with patients about COVID-19 vaccination: a qualitative study on vaccinators in Tuscany region, Italy. Vaccines 2023;11(2):223. https://doi.org/10.3390/VACCINES11020223/S1.
[40] Blake-Hepburn D, Kadio K, Rahman S, Khan MH, Abdi S, Fadel SA, et al. The role of trust in engaging community-based task forces and agencies among minoritized communities during a public health emergency. Can. J. Public Health 2025. https://doi.org/10.17269/S41997-025-01074-W.
[41] O'Reilly F, McLoughlin M, Hamilton D, Todd J. Pop-up COVID-19 vaccination clinics for vulnerable groups in the midlands. Rural Remote Health 2023;23(1):8161. https://doi.org/10.22605/RRH8161.
[42] Epton T, Lawes-Wickwar S, Ghio D, Shorter GW, Whittaker E, Arden MA, et al. Optimising vaccination uptake for Covid-19. British Psychological Society; 2021. https://cms.bps.org.uk/sites/default/files/2022-06/Optimising%20vaccine%20uptake.pdf. [Accessed 10th April 2026].
[43] Saolta. The Saolta COVID-19 vaccination programme: end of programme report. 2023. https://www.saolta.ie/sites/default/files/publications/Saolta%20COVID-19%20Vaccination%20End%20of%20Programme%20Report.pdf. [Accessed 28th May 2026].
[44] Vanderslott S, Joynes-Burgess K, Kadambari S, O'Dwyer E, Alidu L, Vandrevala T. Examining the role of community champions to promote vaccine uptake in under-served communities in the United Kingdom: lessons from the COVID-19 pandemic. SSM Qualit. Res. Health 2024;5:100436. https://doi.org/10.1016/J.SSMQR.2024.100436.
[45] Chater AM, Brook-Rowland P, Tolani F, Christopher E, Hart J, Byrne-Davis LMT, et al. Understanding a constellation of eight COVID-19 disease prevention behaviours using the COM-B model and the theoretical domains framework: a qualitative study using the behaviour change wheel. Front. Public Health 2023;11:1130875. https://doi.org/10.3389/fpubh.2023.1130875.
[46] Crawshaw J, Konnyu K, Castillo G, van Allen Z, Grimshaw JM, Presseau J. Behavioural determinants of COVID-19 vaccination acceptance among healthcare workers: a rapid review. Public Health 2022;210:123. https://doi.org/10.1016/J.PUHE.2022.06.003.
[47] Schmitz M, Luminet O, Klein O, Morbée S, Van den Bergh O, Van Oost P, et al. Predicting vaccine uptake during COVID-19 crisis: a motivational approach. Vaccine 2021;40(2):288. https://doi.org/10.1016/J.VACCINE.2021.11.068.
[48] Bodas M, Kaim A, Velan B, Ziv A, Jaffe E, Adini B. Overcoming the effect of pandemic fatigue on vaccine hesitancy—will belief in science triumph? J. Nurs. Scholarsh. 2023;55(1):262–71. https://doi.org/10.1111/JNU.12778.
[49] UK Cabinet Office. UK Covid-19 inquiry: vaccines and therapeutics (Module 4) report. 2026. https://covid19.public-inquiry.uk/documents/module-4-full-report/ [Accessed 3rd June 2026].
[50] Commonwealth of Australia. Commonwealth Government. COVID-19 response inquiry report. 2024. https://www.pmc.gov.au/sites/default/files/resource/download/covid-19-response-inquiry-report.pdf. [Accessed 3rd June 2026].
[51] Masresha B, Poy A, Weldegebriel G, Mbuyita S, Fussum D, Bwaka A, et al. Progress with COVID-19 vaccination in the WHO African region in 2021. Pan Afr. Med. J. 2022;41(Suppl. 2):8. https://doi.org/10.11604/PAMJ.SUPP.2022.41.2.34102.
[52] Kawalkar U, Balkar V, Naitam D, Choudhari S, Sharma M, Pawar H, et al. Barriers and facilitators of COVID-19 vaccination outreach program in rural India: a qualitative study. Cureus 2023;15(3):e35800. https://doi.org/10.7759/cureus.35800.
[53] Volkmann AM, Goldin S, McMurren B, Gapare C, Anne Pratt B, Frost L, et al. Leveraging seasonal influenza health worker vaccination programmes for COVID-19 vaccine introduction: a global qualitative analysis. Vaccine 2024;42(Suppl. 4):125534. https://doi.org/10.1016/j.vaccine.2023.12.044.
[54] Signorelli C, Pennisi F, D'Amelio AC, Conversano M, Cinquetti S, Blandi L, et al. Vaccinating in different settings: best practices from Italian regions. Vaccines 2025;13:16. https://doi.org/10.3390/vaccines13010016.
[55] Michel DE, Iqbal A, Faehrmann L, Tadić I, Ezfy EP, Chen TF, et al. Using an online nominal group technique to determine key implementation factors for COVID-19 vaccination programmes in community pharmacies. 2021. https://doi.org/10.21203/RS.3.RS-556819/V1.
[56] Rosen B, Waitzberg R, Israeli A. Israel's rapid rollout of vaccinations for COVID-19. Isr. J. Health Policy Res. 2021;10:6. https://doi.org/10.1186/s13584-021-00440-6.
[57] Hasan T, Beardsley J, Marais BJ, Nguyen TA, Fox GJ. The implementation of mass-vaccination against SARS-CoV-2: a systematic review of existing strategies and guidelines. Vaccines 2021;9(4):326. https://doi.org/10.3390/vaccines9040326.
[58] Kahn AL, Steffen CA, Henaff L, MacDonald NE, Morgan C, Faden R, et al. COVID-19 vaccine policy development in a sample of 44 countries – key findings from a

December 2021 survey of National Immunization Technical Advisory Groups (NITAGs). Vaccine 2022;41(3):676–83. https://doi.org/10.1016/J.VACCINE.2022.11.029.
[59] OECD. Ready for the next crisis? Investing in health system resilience OECD health policy studies. 2023. https://doi.org/10.1787/1e53cf80-en [Accessed 10th April 2026].
[60] Patel C, Cheung OY, Takoar R, Gauthier-Coles C, Sargent GM, Makanga E, et al. Data use for immunisation decision-making and the role of an electronic immunisation register in Vanuatu. Discov. Public Health 2025;22:557. https://doi.org/10.1186/s12982-025-00949-0.
[61] Lawes-Wickwar S, Ghio D, Tang MY, Keyworth C, Stanescu S, Westbrook J, et al. A rapid systematic review of public responses to health messages encouraging vaccination against infectious diseases in a pandemic or epidemic. Vaccines 2021;9(2):72. https://doi.org/10.3390/vaccines9020072.
[62] Green J, Thorogood N. Qualitative methods for health research. 4th ed. SAGE Publications Ltd; 2018. https://doi.org/10.4135/9781036234386.
[63] Patton M. Qualitative research and evaluation methods. 4th ed. Thousand Oaks: Sage Publications; 2015. https://www.scirp.org/reference/referencespapers?referenceid=1915688.
[64] COVID-19 Evaluation. 2026. https://www.covid19evaluation.ie/ [Accessed 29th May 2026].