DRAFT IMPLEMENTATION PLAN FOR A FORECASTING TOOL

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List of Abbreviations and Acronyms

Abbreviation / Acronym		Meaning
GDPR	General Data Protection Regulation	A legal framework that sets guidelines for the collection and processing of personal data within the EU
ICU	Intensive Care Unit	A specialized hospital department providing intensive treatment and monitoring for critically ill patients
MFA	Multi-Factor Authentication	A security system that requires multiple methods of authentication to verify a user's identity
MS	Member State	Refers to a country that is a member of the EU
NCD	Non-Communicable Disease	A category of diseases that are not infectious and cannot be passed from person to person, like diabetes and heart disease
NGO	Non-Governmental Organization	A non-profit organization that operates independently of governments, often to address social, environmental, or humanitarian issues
NPI	Non-Pharmaceutical intervention	Public health strategies to control the spread of diseases without pharmaceutical measures, such as social distancing

The purpose of EUVABECO is to deliver to Member States implementation plans for several tools able to support existing or future vaccination practices.

These implementation plans are practical guides for a Member State to decide upon the launch of an implementation project, assign adequate resources, deploy the given tool and keep it operational after deployment.

They are structured with three main sections:

- *Description of the tool is a functional analysis of the tool with an overview, the stakeholders using or contributing to the use of the tool, their respective functional requirements, the non-functional requirements, and a collection of use cases illustrating the desired functions.*
- *Prerequisites lists the contextual conditions that must be met before the project is launched, and a few workarounds that could be used to anticipate upon their fulfilment.*
- *Implementation addresses the actual implementation, with the architecture, resources, workflow and planning for the build phase, and the missions to be ensured during the run phase to keep the tool operational.*

1 Description of the tool

This section describes functionally the intended tool and its usage. It does not correspond to any specific implementation of the tool.

1.1 Objectives

This section is the overall rationale for the tool.

Modelling and forecasting play a critical role in public health by providing a systematic approach to understanding how diseases spread from person to person and how interventions can alter their trajectories. Accurate models allow for the anticipation of potential scenarios, enabling timely and informed decision-making. This foresight is vital in preventing or mitigating the impact of health crises, as it helps identify which strategies are most likely to succeed under varying conditions. In essence, modelling and forecasting bridge the gap between theoretical planning and practical implementation, offering a data-driven foundation for public health policy.

The **Modelling and Forecasting Application** is designed to predict and analyze the potential impact of a wide range of public health interventions—whether pharmaceutical, non-pharmaceutical, or a combination of both—on the outcomes of future outbreaks, epidemics, and pandemics. This application serves as an essential resource for strategic planning, enabling public health authorities to allocate resources effectively and assess the potential effectiveness of different intervention strategies.

Rooted in robust epidemiological models, the application offers predictive insights that are crucial for decision-making in public health crises, by accurately and reliably forecasting data of infectious outbreaks, epidemics, and pandemics.

The application's predictive model is parameterized using a variety of data sources:

- infection and outcome studies relevant to the pathogen of interest;
- current infection metrics (incidence rates) across the regions of implementing member states (MS);
- regional data on outcomes such as hospitalizations, intensive care unit (ICU) admissions, and deaths in implementing MS;
- implemented interventions (e.g., vaccination campaigns) in different regions;

- specifics of local outbreak responses, including non-pharmaceutical interventions (NPIs);
- regional healthcare specifics, such as the availability and state of ICU and hospitalization facilities.

Simulation Outputs

The simulator forecasts the impact of interventions, either pharmaceutical, non-pharmaceutical, o a combination of both, on:

- incidence (infection) rates per age group over time;
- hospitalization rates per age group over time;
- ICU admissions per age group over time;
- demand for specialized treatments (e.g. ventilation) per age group over time;
- mortality rates per age group over time.

This output can assist in future resource allocation needs, such as hospital and ICU beds, and the requirement for specialized treatments. Moreover, it can be used as an educational tool to inform the general public.

1.2 Involved stakeholders and their expectations

These are all the actors within the implementing Member State using or contributing to the use of the tool once it has been implemented. Their expectations are requirements for any implementation of the tool.

The involved stakeholders include:

Academic and Research Institutions: Offer insights into disease dynamics, providing expertise on disease transmission and progression, advise on model parameters, and interpret the application's predictions for practical use.

Public Health Authorities: Provide epidemiological data, set public health priorities, and implement interventions based on the model's predictions.

Government Agencies: Leverage predictions to inform public policies, allocate resources, and oversee the implementation of public health interventions.

International Organizations: Offer guidelines, coordinate international efforts, and ensure the application aligns with global health standards.

Healthcare Providers: Use predictions for resource planning, monitor intervention effectiveness, and provide ground-level data for model validation.

Non-Governmental Organizations (NGOs): Support intervention efforts, provide on-the-ground data, and advocate for necessary resources and policies.

Technology and Software Development Companies: Design and maintain the forecasting tool, ensure user-friendliness, and handle technical support.

Community and Patient Advocacy Groups: Ensure that the tool addresses community needs, advocate for equitable resource allocation, and provide feedback on tool usability.

Funding Bodies: Provide financial resources for development, deployment, and maintenance of the application.

Private Sector Partners: Offer technical solutions, collaborate on intervention strategies, and possibly co-fund the project.

Media and Communication Experts: Communicate the tool's predictions and importance to the public, manage public relations, and educate stakeholders on its use and benefits.

Citizens/Patients: Expect clear communication about the tool's predictions and how it affects public health measures, as well as equitable access to interventions. They also anticipate proper data protection measures to ensure the privacy and security of their personal health information. Additionally, they provide feedback on health outcomes and experiences with the interventions, contributing to the tool's validation and improvement.

1.3 Constraints

Constraints are the non-functional requirements on the tool. They do not correspond to a function to be performed by the tool, but not respecting them would impair the viability of the tool.

Sustainability Requirements: The application must adhere to sustainability principles across economic, social, and environmental dimensions. This includes optimizing resource use and minimizing environmental impact during operation and development phases, ensuring economic feasibility for long-term deployment, and promoting social responsibility by ensuring that the tool's benefits are accessible across different populations:

1. **Economic Sustainability**: Optimizing resource use and minimizing costs for future viability can be achieved through several strategic approaches. Utilizing open-source software helps reduce licensing costs, allowing greater budget flexibility over time. Choosing a cost-effective technology stack ensures the project maintains high performance without overspending on unnecessary features or technologies. Implementing scalable infrastructure solutions enables the system to grow with demand, avoiding the need for costly overhauls or underutilized resources. Additionally, using cloud services with pricing models that align with actual usage helps prevent overspending and ensures the system remains adaptable to changing needs. Employing energy-efficient options for the application or data centres contributes to long-term cost savings while supporting sustainability efforts. Cost management tools play a key role in monitoring expenditures and preventing unexpected financial burdens, further securing the financial health of the project. Regular preventative maintenance and performance optimization ensure that the system remains functional and efficient, avoiding the higher costs associated with major repairs or downtimes. Long-term financial planning, including securing grants and funding, allows the project to have a stable financial foundation, while conducting cost-benefit analyses ensures that resources are used wisely and effectively. Public-private partnerships can provide additional funding and expertise, sharing the financial and operational burden of development. Local capacity building through training and support helps reduce reliance on external vendors and creates sustainable, in-house expertise. Continuous user feedback integration ensures that the system remains relevant, adaptable, and user-friendly, as well as cost-effective.
2. **Environmental Sustainability**: The application is developed and operated with a focus on minimizing environmental impact, employing a range of strategies to reduce energy consumption. Optimized algorithms and data structures are employed to ensure efficient use of computational resources, minimizing unnecessary energy usage and reducing the need for redundant processes. By carefully managing energy-intensive operations like on-demand data processing, the application ensures that such activities are performed only when necessary, further cutting down on resource consumption. The use of environmentally friendly cloud providers is a key consideration, with a preference for those that utilize renewable energy sources to power their data centres. Additionally, the application may run on energy-efficient hardware, further lowering its overall carbon footprint. Performance optimization of the application itself ensures that it runs smoothly and efficiently, minimizing the computational resources needed at any given time. Lifecycle management is an important aspect of the application's development, ensuring that the most energy-efficient models and frameworks are used throughout the product's life. The application also features energy usage monitoring,

enabling continuous evaluation and optimization of its energy consumption patterns. Where possible, tasks like data processing are scheduled during off-peak hours, reducing the environmental strain on energy grids. This multifaceted approach ensures that the application not only meets performance and operational goals but also aligns with broader environmental sustainability targets, contributing to a lower carbon footprint and reducing its overall ecological impact.

3. **Social Responsibility**: The tool's benefits are designed to be accessible to diverse populations, ensuring inclusivity, equity, and social responsibility. This is achieved by applying universal design principles, which focus on creating an inclusive environment that accommodates everyone, including individuals with disabilities. By embedding features like customizable interfaces, and keyboard navigation, the tool ensures universal access. Furthermore, multilingual support ensures that users from different linguistic backgrounds can benefit from the tool. Additionally, community engagement is at the core of the tool's development, incorporating feedback from the people it aims to serve, including needs assessments, outreach, and sensitivity training to ensure the tool reflects and addresses the real-world concerns of diverse user groups. The tool strives to create meaningful social impact, serving as a platform for health education and awareness, particularly in regions where healthcare resources are limited.

Information Security Requirements: Given the sensitive nature of health data, implementing robust security measures is critical to ensure data protection and compliance with regulations:

1. **Data transmission security**: securing data transmissions between implementing MS institutions and servers is essential to prevent unauthorized access or breaches during data exchange. This can be achieved by using secure communication protocols to encrypt the data in transit.
2. **Data encryption for stored information**: it ensures that even if unauthorized access occurs, the data remains unreadable and protected. Regularly updating security protocols is necessary to guard against emerging vulnerabilities, keeping the system resilient against evolving threats.
3. **Regular security audits, protocols, and compliance with international security standards**: it is mandatory to maintain high security standards and address any potential risks. Implementing strong access control and authentication mechanisms ensures that only authorized personnel can access sensitive health data.
4. **Access control and authentication**: authentication protocols, such as Multi-Factor authentication (MFA), can add an extra layer of protection, reducing the risk of unauthorized access.
5. **Data integrity and availability**: it guarantees that the data remains accurate, complete, and accessible when needed. Backup solutions and redundancy systems help maintain availability in the event of failures.
6. **User training and awareness**: They are vital components of a comprehensive security strategy. Educating users about potential threats, safe data handling practices, and how to recognize phishing attempts or other risks helps mitigate human error, which is a common vulnerability in data security systems.

Together, these measures provide a robust framework for securing health data and safeguarding it against threats.

Personal Data Protection: The application will handle sensitive personal and health-related data, requiring a robust data governance framework that adheres to the highest standards of data protection and privacy laws. This framework includes the following key elements:

1. **Strict adherence to data protection laws**: Compliance with all relevant regulations, such as GDPR and other local or international data protection standards, ensuring that personal data is handled responsibly and legally.
2. **Data anonymization**: Where possible, the application will anonymize data to protect individuals' identities, reducing the risk of unauthorized re-identification and safeguarding personal information.
3. **Informed consent**: The application will obtain clear, informed consent from users before collecting, processing, or sharing their data. Consent forms will be easy to understand and provide transparency about how the data will be used, ensuring users are fully aware of their rights.
4. **Clear data retention and deletion policies**: Well-defined policies will govern how long personal data is stored, ensuring that it is retained only as long as necessary for its intended purpose. Users will also have the option to request deletion of their data in accordance with applicable laws.
5. **User rights and access**: Users will have full access to their data, with the ability to review, correct, and request deletion of personal information. The application will provide an easy-to-navigate platform for users to exercise these rights.
6. **Data minimization**: The application will follow the principle of data minimization, collecting only the data necessary to fulfil its purposes. This reduces the exposure of sensitive information and limits risks associated with data breaches.
7. **Secure data handling**: The application will implement industry-leading security measures, such as encryption, secure transmission protocols, and access controls, to protect personal data from unauthorized access, breaches, and cyberattacks.
8. **Transparency and accountability**: The application will be fully transparent about its data handling practices, including detailed privacy policies and clear communication regarding any updates or changes. Accountability mechanisms will ensure that data privacy responsibilities are upheld.
9. **Third-party data sharing**: If the application shares data with third parties, this will be done in strict compliance with privacy laws. Clear contracts and data-sharing agreements will be in place, ensuring that third parties follow equivalent data protection standards and only access data for specified, legitimate purposes.

This comprehensive approach ensures that the application not only protects personal and health-related data but also builds trust with its users by prioritizing privacy, security, and ethical data handling throughout its operations.

1.4 Use cases

The use cases are illustrative scenarios representing how the actors identified above could use the tool to meet their expectations. They are as many use cases as needed to describe every desired function of the tool.

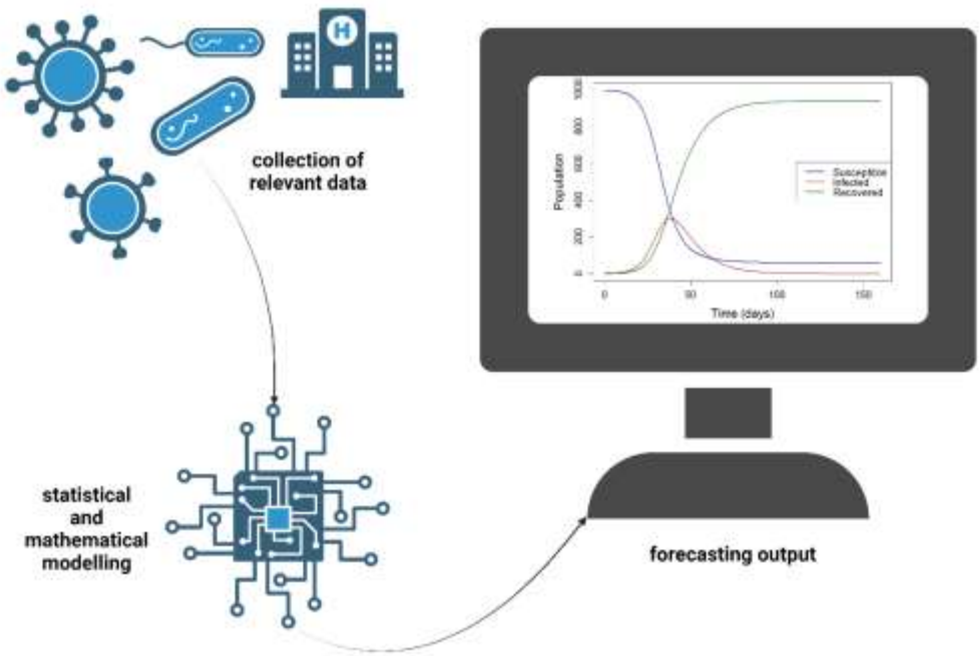
1.4.1 Forecasting Outcomes

- A MS assesses the projected impact of interventions (e.g., NPIs, vaccination campaigns) on key healthcare and epidemiological outcomes at the country or state level during an outbreak, including incidence rates, hospitalizations, ICU admissions, the need for specialized treatments (e.g., mechanical ventilation), and the expected number of outbreak-related deaths.
- In addition to assessing health system resilience (e.g., primary healthcare capacity), a MS also examines the potential impact on critical aspects of the health system, such as the

pharmaceutical supply chain (e.g., availability of essential medicines) and other logistical elements necessary for maintaining care continuity.

- A MS addresses the potential for health inequalities and the disproportionate effect of interventions on vulnerable populations, ensuring that strategies are equitable and that at-risk groups receive adequate support and care during the outbreak.
- The continuity of routine health services, particularly those delivered through primary healthcare (e.g., maternal and child health services, prenatal and postnatal care, non-communicable disease (NCD) management, routine immunization programs), is carefully monitored to minimize disruptions and ensure that essential healthcare needs are met, even during outbreak responses.

Figure 1 (below) pictorially illustrating the process of infectious disease modelling and forecasting, starting with the collection of relevant data, followed by statistical and mathematical modelling, leading to a forecasting output showing the dynamics of disease spread over time, which can inform local public health policies.



2 Prerequisites

The effectiveness of the modelling process is heavily dependent on the availability of high-quality data that is timely and geographically detailed.

- Incidence data regarding and outbreak stratified by region/age/sex of the infected individuals over time.
- Vaccine coverage data stratified by region/age/sex of the vaccinated individuals.
- Hospitalizations stratified by region/age/sex of infected individuals.
- ICU admissions stratified by region/age/sex of infected individuals.
- Outcome data (e.g. deaths) stratified by region/age/sex of infected individuals.
- Information regarding implemented NPIs over time during an outbreak.
- Demographic data per region as baseline information.

2.1 Assessment of prerequisites

Prerequisites represent a context or resources that are not specific to the tool but needed for its implementation or operation. They form a general background that should exist to guarantee the correct operation of the tool, once deployed.

2.1.1 Operational

Each implementing MS has to ensure that their designated authorities have clear roles and responsibilities defined, including data governance, security policies, and regular reporting to higher authorities; besides providing comprehensive training programs for these authorities to understand and operate the tool effectively.

2.1.2 Legal and ethical

The forecasting tool can be developed using existing datasets. However, to enhance model predictions and establish MS-specific baselines, implementing MS should provide the following anonymized health data. To support this, a robust data governance framework is essential, encompassing the following key components:

- **Comprehensive Data Governance Framework:** This framework should include provisions for data stewardship, access controls, audit trails, and accountability mechanisms to ensure secure and transparent management of health data.
- **Ethical Oversight:** Implementing MS should establish or involve an ethical review board to oversee the use of health data, ensuring that its collection, sharing, and analysis comply with ethical standards and relevant regulations, protecting individual privacy and rights.
- **Data Sharing Agreements:** Clear data sharing agreements must be in place, outlining protocols for data handling, privacy safeguards, data ownership, and permissible usage. These agreements will foster trust among implementing MS and ensure adherence to privacy laws and ethical standards while enabling the effective use of data for forecasting.

2.1.3 Political

Political prerequisites ensure the tool's acceptability among political representatives and other influential stakeholders in the implementing MS. The viability of deploying a new health tool not only hinges on its legal and ethical compliance but also significantly on political approval, which may influence its adoption, uptake, and sustainability. This involves navigating various political landscapes and securing the necessary endorsements to avoid resistance that could delay or prevent implementation.

- **Policy Alignment**: Ensuring that the tool aligns with public health strategies of each implementing MS. Demonstrating how the tool supports existing policy goals can facilitate more robust political support. More specifically, this can be achieved by developing context-specific use cases, through stakeholder engagement (meetings/workshops/webinars to keep political representatives informed and actively involved, and feedback mechanisms to capture and address concerns/suggestions to ensure alignment).
- **Continuous Engagement**: Maintaining an ongoing dialogue with the stakeholders to keep them informed and involved in the development and rollout phases. Engagement helps in managing expectations and mitigating any misalignments or misunderstandings.
- **Clear Communication**: Developing clear and comprehensive communication strategies that outline the benefits of the tool, its functionality, and its potential impact on public health outcomes. These strategies include stakeholder mapping, advocacy campaigns/media outreach/public announcements, and educational campaigns.

- **Transparency Initiatives**: Implementing transparency measures and metrics (such as regular monitoring, publication of regular reports on the tools development progress, data usage, and impact assessments) that allow political stakeholders to view and understand the tool's development processes and data handling practices. This builds trust and reduces perceived risks.
- **Pilot Demonstrations**: Implementing pilot projects to demonstrate the tool's effectiveness and directly address any concerns from political representatives.

2.1.4 Technical

The implementation of the forecasting tool requires the following technical infrastructure to allow service:

- Modern multi-core server with sufficient RAM (>= 64GB) and moderate hard-disk space (>= 1 TB) including redundancy infrastructure and backup capabilities.
- High-speed internet connectivity and ability access the servers from all implementing MS.
- Ability for remote server surveillance and data connection to the server infrastructure (e.g. liberal firewall settings).
- Scalability (ensuring that proper options have been considered from the project outset).
- Presence of a disaster recovery plan for system failure.
- Regular review of licenses to ensure compliance/no interruption in operations.
- Presence of alerts to issues.

2.1.5 Human resource capacity

To effectively implement the forecasting tool, the following human resource capacities are required:

- User Training and Support: Develop a comprehensive training program for all users to ensure they can utilize the tool efficiently and effectively. This program should include both initial training and ongoing learning modules as the tool evolves.
- Establish a dedicated support team or focal point responsible for addressing user queries, troubleshooting issues, and providing continuous help and guidance. This support mechanism should be accessible and responsive, ensuring that users can rely on timely assistance whenever needed.

This ensures both initial competency and long-term sustainability of tool usage through structured training and accessible support.

2.2 Filling the gaps

Meeting the prerequisites is generally a long-term action that goes far beyond the scope of the implementation plans. This section presents workarounds that could help to initiate the implementation despite the lack of some prerequisites, although background effort will be required to catch up.

- **Technical Limitations**: If an implementing MS cannot host the necessary server structures and provide technical assistance for maintenance, other partners could fill this gap if no legal concerns are brought forward, by sharing regional infrastructure. If these limitations or roadblocks do not allow the implementation of tooling infrastructure for a MS, the specific pilot cannot be implemented.
- **Data availability:** If not sufficient or fine-grained health, demographic or health policy data can be provided, the desired forecasting precision and accuracy might not be reached. However, the forecasting tool should be robust enough to handle data gaps and limitations.

When Compensation Is Not Possible:

There are circumstances where the lack of prerequisites cannot be compensated for through workarounds, particularly in the case of critical political, legal, or ethical prerequisites.

- **Political Roadblocks**: If the tool lacks necessary political support or faces significant opposition that cannot be mitigated through engagement or advocacy, it might be unwise to proceed. The risk of launching in such an environment could lead to failure, wasting resources, and potentially harming stakeholder relationships.
- **Legal and Ethical Non-compliance**: Compromising on legal or ethical standards is not a viable workaround. If compliance with these prerequisites cannot be ensured before implementation, the forecasting tool can only be informed by the already available data and data gathered from the literature and cannot be fully tailored to the MS-specific situation.

3 Implementing

3.1 Build

This section is the core of the implementation plan. It details how the tool is constituted, which roles should be present in the project team, the tasks they will have to perform, and a typical planning for implementation. It can be complemented with further supporting resources elaborated during the EUVABECO project.

3.1.1 Architecture

- One server instance or container (such as Docker) per implementing MS.
- Tooling web frontend/user interface and backend developed with open-source programming languages (such as the R programming language and the Shiny package).
- Local storage databases implementation and hosting.
- Communication to external service APIs will be implemented in open-source programming languages (such as the R programming language and the Plumber package).

3.1.2 Project team

- Technical: Epidemiological modellers, Full-stack engineers
- Data providers: Implementing MS (see stakeholders)
- Project managers
- Data privacy officers
- Testers

3.1.3 Workflow

1. Data for intervention analysis (concerning the infectious disease of interest) will be fetched from the literature.
2. Data requirements will be documented and discussed with the implementing MS.
3. Data will be cleaned, pre-processed, and standardized/harmonized based also on the specific case definition in each implementing MS.
4. Setup of local storage databases from the implementing MS.
5. Setup of a data transfer pipeline (including anonymization of sensitive data) to feed the training of the underlying epidemiological model.
6. Implementation of the epidemiological models will be implemented in open-source software (such as R).
7. Implementation of the Server backend implemented in open-source programming languages (such as R and Plumber).
8. Implementation of the Server frontend implemented in open-source programming languages (such as R and Shiny).
9. Validation of the service with historical/current data of the infectious disease of interest.

10. Testing of the service from the implementing MS.

3.1.4 Typical planning

The project is structured to execute tasks in a sequence that allows for continuous evaluation and adjustment, ensuring that the end-product meets the defined requirements. Key achievements include:

- **Initial Data Gathering, Cleaning/Pre-Processing, and Analysis:** Identification and collection of current epidemiological data and past intervention outcomes.
- **Model Development and Initial Testing**: Development of the epidemiological models, followed by initial testing using historical data.
- **User Interface/Backend System Development, System Integration, and Alpha Testing:** Iterative improvement of models based on initial testing results and users' feedback and integration of final models into the web-based tool and alpha testing with controlled user groups.
- **Beta Testing and Model Refinement:** Extended testing with broader user groups and refinement of models based on feedback.
- **Final Validation and Launch Preparation**: Final adjustments, validation against project goals, and preparation for launch (preparation of user manuals, documentation, training materials, and planning of a launch event).
- **Launch and Post-Launch Evaluation:** Official release of the tool.

3.1.5 Build resources

The following resources support the build phase:

- **Development Frameworks and Tools**: Provision of programming codes and computational resources for model development and tool hosting.
- **Data Management Guidelines:** Guidelines on data handling, anonymization, and security measures.
- **Reference Architectures and Code Examples**: Access to reference architectures for server setup, API implementation and front-end development.
- **Material for Training and Support:** webinars, Moodle, FAQs.

3.1.6 Verification

Indicators and Objectives:

- **Data Integrity**: Ensure that all data received from implementing MS are correctly processed and stored in line with relevant data protection laws and regulations through regular security audits and updates.
- **Model Accuracy**: Target a minimum predictive accuracy of 85% when validated against historical infectious disease data.

Measurement Methods:

- **Data Integrity**: Automated data validation checks upon ingestion into the database.
- **Model Accuracy**: Comparison of model outputs (incidence/hospitalizations/ICU patients/ventilated patients/deaths) with actual historical infectious disease data, adjusting for known variations.
- **System Uptime**: Monitoring tools to track and report system availability and performance metrics.

3.2 Run

Once the tool has been deployed, there is still a need for lasting resources to support its adoption and ensure its maintenance. This section details these further actions.

3.2.1 Governance

The governance structure for the Modelling and Forecasting Application is designed to ensure smooth operation, maintenance, and continuous improvement of the tool across all implementing MS. Here's a detailed overview of the roles and decision-making processes:

Operational Responsibility:

Each MS will have its designated authorities responsible for the day-to-day operation of the tool within its jurisdiction. These authorities will manage the local databases, handle the local server operations, and ensure the tool's integration with national health systems.

- **Technical Teams**: IT specialists will handle the standard operating protocols (SOPs), technical maintenance, including software updates and data integrity checks, as well as training of users.
- **Central Technical Support Team:** A central technical support team will be established, likely within a lead organization or agency, to provide specialized support for more complex issues and updates that individual MS technical teams cannot address. It will handle presence of protocols, service level agreements, centralized knowledge base, and support documentation.
- **Local IT Departments**: In each implementing MS, local IT departments will be responsible for regular maintenance tasks such as hardware checks, security updates, and minor software patches, as well as presence of protocols. Periodic audits will ensure maintenance of protocols is correctly implemented and areas for improvement are identified.

Decision-Making Processes for Keeping the Tool Active:

- **Operational Feedback Loop**: Each implementing MS will implement a feedback mechanism to gather insights from end-users and technical staff about the tool's functionality and impact. This feedback will be reviewed during regular operational meetings to drive continuous improvement and ensure the tool meets user needs effectively.

This governance structure is designed to ensure that the tool not only remains operational and well-maintained but also continues to evolve in response to new challenges and opportunities, reflecting the collaborative effort of all stakeholders involved.

3.2.2 Monitoring

Indicators, Measurement Method, and Objectives:

1. **System Uptime**
   - **Indicator:** Percentage of operational uptime excluding scheduled maintenance.
   - **Measurement Method:** Automated monitoring tools to track system status.
   - **Objective:** Maintain system uptime of 95% or higher per calendar month.
2. **Data Accuracy:**
   - **Indicator:** Accuracy of data processed and stored.
   - **Measurement Method**: Regular audits and cross-validation with source data (training versus validation data, spatial and temporal data-splits).
   - **Objective**: Achieve and maintain data accuracy of 95% or above.

1. Response Time to Critical Issues:
   - **Indicator:** Average response time to critical system issues.
   - **Measurement Method:** Incident tracking software and user reports.
   - **Objective:** Respond to critical issues within 24 hours of identification.

3.2.3 Communication