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Applying Agile and Scrum Methodologies to Improve Public Health Informatics Project Implementation and Delivery

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Abstract
Public health informatics (PHI) projects are increasingly critical for supporting data-driven decision-making, disease surveillance, and health system responsiveness. However, traditional project management approaches, often characterized by rigid, linear processes, struggle to accommodate the dynamic and evolving needs of public health environments. The adoption of Agile and Scrum methodologies presents a transformative opportunity to enhance PHI project implementation and delivery through iterative development, continuous stakeholder engagement, and adaptive planning. Agile methodology emphasizes flexibility, incremental delivery of functional components, and rapid responsiveness to feedback—principles that align well with the fluid nature of public health priorities. Scrum, as a structured Agile framework, operationalizes these principles through defined roles (Product Owner, Scrum Master, Development Team), time-boxed sprints, daily stand-ups, and iterative reviews, fostering a collaborative and transparent project environment. By structuring PHI initiatives into manageable sprint cycles, teams can deliver Minimum Viable Products (MVPs) that offer immediate utility, while progressively refining system features based on stakeholder input. Implementing Agile and Scrum in PHI projects accelerates the development of critical informatics tools, such as real-time surveillance dashboards, immunization registries, and emergency response platforms. It enhances cross-disciplinary collaboration among informaticians, epidemiologists, and public health officials, ensuring solutions remain aligned with end-user needs. Despite challenges—including aligning Agile workflows with public sector procurement processes and addressing cultural resistance—targeted training, leadership buy-in, and iterative pilot implementations can drive successful adoption. Looking forward, integrating Agile practices with DevOps and expanding their application to large-scale, multi-agency PHI programs will further enhance system agility, interoperability, and delivery speed. Agile and Scrum methodologies thus represent vital frameworks for advancing public health informatics governance, ensuring timely, effective responses to emerging health challenges in an increasingly data-driven world.

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1. Introduction

Public Health Informatics (PHI) serves as a cornerstone in the modern health landscape, enabling data-driven decision-making, real-time disease surveillance, resource optimization, and population health management (Osamika *et al*., 2021; Hassan *et al*., 2021). As public health challenges become more complex—ranging from infectious disease outbreaks to chronic disease

monitoring and health equity interventions—the need for efficient, adaptive, and collaborative project management approaches has never been more critical (Katsina *et al*., 2021; Halliday, 2021). Effective project management in PHI ensures that informatics solutions are developed, deployed, and refined in alignment with the evolving needs of public health systems, policymakers, and communities. The capacity to manage these projects efficiently determines how quickly and accurately data can be transformed into actionable insights, directly impacting public health outcomes (Adeyemo *et al*., 2021; Osamika *et al*., 2021).

Despite the recognized importance of robust project management, many PHI initiatives remain constrained by the traditional "waterfall" project management model. Waterfall methodologies follow a linear sequence of phases—requirements gathering, design, development, testing, deployment—often with little room for iteration once a phase is completed (Ajayi and Akanji, 2021; Ogbeta *et al*., 2021). While this structured approach offers clear milestones and documentation, it presents significant limitations in the context of public health projects, where requirements frequently evolve due to emergent health threats, policy shifts, and stakeholder feedback. The rigidity of waterfall models can lead to delays in solution delivery, reduced stakeholder engagement, and misalignment between project outputs and the dynamic operational realities of public health practice (Ayinde *et al*., 2021; Onaghinor *et al*., 2021).

For example, during rapidly unfolding public health emergencies such as pandemic responses, relying on fixed-scope, long-cycle development processes can result in informatics tools being rendered obsolete or inadequate by the time they are deployed. Furthermore, waterfall methodologies often lack mechanisms for continuous feedback, limiting the capacity to adapt to user needs and emergent data requirements (Olajide *et al*., 2021; Onaghinor *et al*., 2021). These limitations have driven the search for more agile, responsive project management approaches capable of handling the unpredictability and urgency inherent in PHI projects (Mustapha *et al*., 2021; Komi *et al*., 2021).

Agile methodologies have emerged as a compelling alternative, offering a flexible, iterative framework that emphasizes collaboration, incremental delivery, and adaptive planning. Rooted in the principles of the Agile Manifesto, these methodologies prioritize customer collaboration over contract negotiation, responding to change over following a rigid plan, and delivering working solutions over exhaustive documentation (Komi *et al*., 2021; Uddoh *et al*., 2021). Agile breaks down large, complex projects into smaller, manageable iterations or "sprints," allowing for the continuous delivery of functional components that can be evaluated and refined based on stakeholder feedback. This approach is particularly well-suited to the fluid environment of public health, where rapid response, iterative learning, and cross-functional collaboration are critical to success (Onaghinor *et al*., 2021; Komi *et al*., 2021).

Scrum, a specific implementation framework within the Agile family, provides a structured yet adaptable approach to operationalizing Agile principles. Scrum defines clear roles—including the Product Owner (responsible for prioritizing project features based on public health needs), Scrum Master (who facilitates the process and removes impediments), and the Development Team (comprising informatics specialists, epidemiologists, data analysts, and other subject matter experts). The framework organizes work into time-boxed sprints, typically lasting two to four weeks, during which a prioritized set of deliverables is developed, tested, and reviewed (Ogunnowo *et al*., 2021; Kufile *et al*., 2021).

Daily stand-up meetings promote transparency and real-time problem-solving, while sprint reviews and retrospectives ensure that lessons learned are continuously incorporated into future iterations. Scrum artifacts, such as the Product Backlog and Sprint Backlog, provide a living roadmap that evolves with the project's progress and stakeholder input. This iterative cycle of planning, execution, feedback, and adaptation ensures that PHI projects remain aligned with shifting requirements, resource constraints, and emergent public health priorities.

The integration of Agile and Scrum methodologies into public health informatics project management holds significant promise in addressing longstanding challenges associated with traditional approaches. Agile's emphasis on stakeholder collaboration fosters continuous engagement with public health officials, clinicians, policymakers, and community partners, ensuring that informatics solutions are user-centric and contextually relevant (Uddoh *et al*., 2021; Lawal *et al*., 2021). The incremental delivery of Minimum Viable Products (MVPs) enables public health agencies to derive immediate value from partially complete systems, rather than waiting for full-scale deployments. This is especially critical in scenarios where timely access to even limited functionality can influence public health outcomes, such as during outbreak investigations or emergency response efforts.

Moreover, Agile and Scrum methodologies enhance project visibility, accountability, and team cohesion. Regular sprint reviews provide structured opportunities for stakeholders to assess progress, provide feedback, and recalibrate priorities, fostering a sense of shared ownership and collective problem-solving (Lach and Rosenblum, 2018; Layton and Morrow, 2018). For project teams, Scrum rituals such as retrospectives encourage a culture of continuous improvement, allowing teams to refine their workflows, address bottlenecks, and enhance productivity over time.

Despite their benefits, the application of Agile and Scrum in public sector environments, including public health, is not without challenges. Public health agencies often operate within governance structures that emphasize strict compliance, extensive documentation, and fixed-scope contracts, which can conflict with Agile's iterative, flexible ethos. Cultural resistance to change, limited Agile expertise among public health professionals, and the complexity of aligning Agile practices with public sector procurement processes represent common barriers. However, through strategic adaptation, pilot implementations, and targeted capacity-building efforts, these challenges can be mitigated, paving the way for broader adoption.

This aims to explore how Agile and Scrum methodologies can enhance public health informatics project implementation, stakeholder collaboration, and delivery outcomes. By examining the practical application of these methodologies within PHI contexts, identifying benefits, challenges, and mitigation strategies, and envisioning future innovation opportunities, we seek to provide a roadmap for public health agencies to leverage Agile frameworks in driving more efficient, responsive, and impactful informatics initiatives.

2. Methodology

A systematic review was conducted following the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) methodology to examine the application of Agile and Scrum methodologies in enhancing public health informatics (PHI) project implementation and delivery. The review aimed to identify existing literature, best practices, challenges, and emerging insights on Agile-driven PHI project management approaches. An extensive search was performed across multiple academic and grey literature databases, including PubMed, Scopus, IEEE Xplore, Web of Science, and Google Scholar, covering publications from 2000 to 2025. Search terms included combinations of "Agile methodology," "Scrum framework," "public health informatics," "project management," "health IT," "iterative development," and "health systems implementation." Additional manual searches were conducted in public health agency repositories, technical reports, and conference proceedings to capture non-indexed but relevant materials.

Inclusion criteria encompassed empirical studies, case reports, conceptual frameworks, and policy analyses that specifically addressed the application of Agile or Scrum in public health informatics contexts. Studies focused on Agile practices in broader healthcare IT projects were considered if they presented transferable insights for PHI environments. Exclusion criteria involved publications that focused exclusively on software engineering theory without a public health application or those that addressed non-informatics public health interventions. Screening was conducted in two stages: initial title and abstract review to exclude irrelevant records, followed by full-text analysis to assess methodological relevance and alignment with the review objective.

Data extraction focused on project settings, Agile or Scrum methodologies applied, roles of stakeholders, project outcomes, challenges encountered, and documented benefits of iterative project management in PHI contexts. Thematic synthesis was employed to analyze extracted data, identifying recurring patterns, emerging themes, and contextual factors influencing the success of Agile-driven PHI projects. Key findings were categorized into four thematic domains: iterative delivery of public health informatics solutions, stakeholder engagement and collaboration dynamics, adaptability to emergent health priorities, and barriers to Agile adoption in public health governance structures.

A total of 67 articles and technical reports met the inclusion criteria and were synthesized in the final review. The findings informed the development of a conceptual framework illustrating how Agile and Scrum methodologies can enhance PHI project efficiency, responsiveness, and stakeholder alignment. Insights from the review also guided the identification of practical implementation strategies, success factors, and mitigation approaches for common challenges, contributing to evidence-based recommendations for advancing Agile practices in public health informatics governance.

2.1 Principles of Agile Methodology in Public Health Informatics

Public Health Informatics (PHI) projects often operate in complex and dynamic environments characterized by shifting priorities, evolving health challenges, and diverse stakeholder needs. Traditional linear project management approaches, such as the waterfall model, struggle to accommodate this inherent complexity and unpredictability (Ahmad *et al*., 2018; Torrance, 2019) In response, Agile methodology has emerged as a highly effective framework for managing PHI projects, offering principles that prioritize adaptability, stakeholder engagement, rapid delivery, and continuous improvement. By embracing Agile methodologies, public health agencies can develop informatics solutions that are more responsive, user-centered, and aligned with real-world operational needs.

A core principle of Agile methodology is its emphasis on iterative development and rapid delivery of functional components. Unlike waterfall models that require complete specification of requirements upfront and deliver solutions in a single, large-scale release, Agile breaks down projects into smaller, manageable increments known as "iterations" or "sprints." Each iteration results in the development of a functional component or Minimum Viable Product (MVP) that can be immediately tested, evaluated, and refined. This iterative approach allows PHI teams to deliver working software or system features early and often, ensuring that valuable functionality reaches end-users quickly, even before the full system is completed.

In the context of public health informatics, where timely access to data and tools can directly influence health outcomes, the ability to rapidly deliver incremental functionality is critical. For example, during an infectious disease outbreak, an initial iteration may focus on deploying a basic case tracking dashboard, while subsequent sprints progressively add features such as contact tracing modules, automated alerts, and epidemiological analytics. This approach ensures that public health officials have access to actionable tools when they need them most, rather than waiting for a fully built solution at the end of a long development cycle.

Another foundational principle of Agile methodology is the prioritization of stakeholder feedback and adaptive planning. Agile recognizes that user needs and project requirements are rarely static, especially in public health environments where new data, policy changes, and emergent health threats can rapidly alter project priorities. Agile frameworks, such as Scrum, incorporate structured mechanisms for frequent stakeholder engagement through sprint reviews, product backlog refinement, and regular feedback loops (Alhazmi and Huang, 2020; Bhavsar *et al*., 2020). These practices ensure that the development process remains aligned with evolving stakeholder expectations and contextual realities.

In PHI projects, stakeholders include a wide array of actors—public health officials, epidemiologists, clinicians, IT specialists, policymakers, and community representatives—each bringing unique perspectives and requirements. Agile's emphasis on continuous stakeholder involvement fosters a collaborative environment where feedback is not only welcomed but actively sought throughout the project lifecycle. This feedback-driven approach enables PHI teams to pivot priorities, adjust development trajectories, and refine system functionalities based on real-time insights from those who will ultimately use the informatics tools in practice.

Promoting cross-functional team collaboration is another central tenet of Agile methodology that aligns closely with the interdisciplinary nature of public health informatics. Agile frameworks advocate for self-organizing, cross-functional teams that bring together diverse skill sets necessary for successful project execution. In PHI contexts, this involves assembling teams comprising informaticians,

software developers, epidemiologists, data analysts, public health program managers, and end-users. The close collaboration among these stakeholders facilitates a shared understanding of project goals, accelerates problem-solving, and enhances the relevance of developed solutions.

Daily stand-up meetings (Scrum daily scrums) foster regular communication within cross-functional teams, enabling members to synchronize efforts, identify impediments, and collaboratively address challenges in real-time. By breaking down traditional departmental silos, Agile promotes a culture of shared ownership and collective responsibility for project outcomes (Motingoe and Langerman, 2019; Naslund and Kale, 2020). This collaborative ethos is particularly valuable in public health settings, where the complexity of informatics solutions often requires seamless integration of technical expertise with domain-specific public health knowledge.

Agile methodology also places a strong emphasis on the value of continuous improvement and flexibility. The iterative nature of Agile processes, combined with structured reflection activities such as sprint retrospectives, creates opportunities for teams to regularly assess their performance, identify process inefficiencies, and implement improvements in subsequent sprints. This culture of continuous learning and adaptation ensures that PHI projects evolve not only in terms of technical deliverables but also in terms of team effectiveness, workflow optimization, and stakeholder satisfaction.

In public health informatics, where projects must often respond to unpredictable health events and changing stakeholder needs, the flexibility inherent in Agile methodologies is particularly advantageous. Agile frameworks accommodate scope adjustments, priority shifts, and emergent requirements without derailing project timelines or compromising quality. For example, a PHI project initially focused on developing a chronic disease surveillance system may need to incorporate additional functionalities to support emergent pandemic monitoring. Agile's adaptive planning mechanisms enable teams to incorporate these new priorities seamlessly, reallocating resources and adjusting development backlogs as needed.

Furthermore, the principle of continuous improvement extends to the quality and usability of PHI solutions. Frequent user testing and iterative refinements ensure that informatics tools are continuously enhanced based on real-world usage and feedback. This iterative enhancement cycle enhances user satisfaction, promotes higher adoption rates, and ensures that informatics solutions remain fit-for-purpose as public health needs evolve.

In addition to improving project execution, Agile's continuous improvement philosophy fosters a mindset of innovation and agility within public health agencies. Teams are encouraged to experiment with new technologies, workflows, and collaborative practices, creating an environment where innovation is not only possible but systematically cultivated. This cultural shift towards agility and learning is essential for public health organizations seeking to remain responsive and effective in a rapidly changing health landscape.

The principles of Agile methodology—iterative development, stakeholder-centered adaptive planning, cross-functional collaboration, and a relentless focus on continuous improvement and flexibility—offer a robust framework for enhancing public health informatics project implementation. By embracing these principles, public health agencies can navigate the complexities of informatics projects with greater efficiency, responsiveness, and stakeholder alignment. Agile methodologies not only accelerate the delivery of critical informatics tools but also foster a collaborative, adaptive, and innovation-driven culture that is essential for advancing public health outcomes in an increasingly dynamic environment (Migueis *et al*., 2018; Garden *et al*., 2019).

2.2 Scrum Framework Adaptation for PHI Projects

Public Health Informatics (PHI) projects demand flexible and collaborative project management frameworks that can accommodate rapidly evolving requirements, diverse stakeholder expectations, and the urgency of public health responses. Scrum, a widely adopted Agile framework, offers a structured yet adaptable methodology for managing complex projects through iterative development cycles, continuous stakeholder engagement, and collaborative team dynamics. Adapting Scrum to PHI projects involves aligning its core roles, events, and artifacts with the unique operational realities of public health environments, thereby enhancing project efficiency, transparency, and outcome relevance (Wijnands and Stolze, 2018; Rush and Connolly, 2020).

A fundamental component of Scrum adaptation in PHI projects is the clear definition of roles to ensure accountability and effective collaboration. The Product Owner (PO), typically a public health program lead or senior stakeholder, is responsible for articulating project vision, prioritizing features based on public health needs, and serving as the primary liaison between stakeholders and the development team. The PO ensures that the informatics solutions being developed align with policy objectives, user requirements, and operational constraints. The Scrum Master (SM) acts as the facilitator of the Scrum process, ensuring adherence to Agile principles, removing obstacles that impede team progress, and fostering a collaborative environment. In PHI projects, the SM often plays a crucial role in navigating organizational bureaucracy, managing interdepartmental dependencies, and promoting Agile culture within traditionally hierarchical structures. The Development Team in PHI contexts is inherently cross-functional, comprising informatics specialists, software developers, data analysts, epidemiologists, public health practitioners, and policy analysts. This multidisciplinary composition ensures that technical solutions are grounded in domain-specific expertise and are responsive to real-world public health challenges.

Sprint planning is a critical Scrum event that enables PHI teams to structure their work into manageable, time-boxed iterations, typically lasting two to four weeks. During sprint planning, the Product Owner collaborates with the development team to identify high-priority features from the Product Backlog, a comprehensive list of desired functionalities, user stories, and enhancements. In PHI projects, this backlog may include features such as real-time disease surveillance dashboards, immunization tracking modules, data visualization tools, interoperability interfaces, and automated reporting functionalities. The team then selects a subset of these items to populate the Sprint Backlog, committing to deliver specific, measurable increments of functionality by the sprint's end (Melnyk *et al*., 2020; Götz *et al*., 2020). Modular development during sprint cycles allows PHI teams to progressively build and refine complex informatics solutions, ensuring that usable components are delivered regularly while accommodating emergent

priorities.

Daily stand-up meetings, also known as daily Scrums, are brief, time-boxed sessions that promote team alignment, transparency, and real-time problem-solving. In the context of PHI projects, where multidisciplinary teams work across varying domains, daily stand-ups serve as vital touchpoints for synchronizing efforts, sharing progress updates, and identifying impediments that could hinder sprint goals. Each team member briefly reports on what they accomplished since the last stand-up, what they plan to work on next, and any blockers they are facing. This cadence of daily communication fosters a culture of accountability and collective ownership, enabling teams to address challenges proactively and maintain sprint momentum. For example, if a data analyst encounters issues with accessing an external data source, the Scrum Master can facilitate swift coordination with IT security teams to resolve the blockage, ensuring that development timelines remain on track.

At the end of each sprint, sprint reviews and sprint retrospectives are conducted to facilitate iterative feedback loops and continuous improvement. The Sprint Review involves presenting the completed work increment to stakeholders for feedback and validation. In PHI projects, this could involve demonstrating a new data visualization dashboard to public health officials or showcasing an updated reporting module to compliance teams. Stakeholder feedback gathered during sprint reviews is invaluable for refining product features, adjusting priorities, and ensuring alignment with user expectations. The Sprint Retrospective, on the other hand, is an internal team reflection session focused on process improvement. During the retrospective, the Scrum team evaluates what went well during the sprint, what challenges were encountered, and identifies actionable strategies for enhancing team performance in future sprints. These retrospectives foster a culture of continuous learning and adaptive planning, which is critical in the ever-changing landscape of public health informatics.

Scrum artifacts play a pivotal role in maintaining project transparency, tracking progress, and managing scope. The Product Backlog serves as a dynamic repository of all desired features, enhancements, and technical tasks associated with the PHI project. Managed by the Product Owner, the backlog is continuously refined based on stakeholder feedback, emerging public health needs, and technical feasibility assessments. Items in the backlog are prioritized to ensure that the most valuable functionalities are addressed in early sprints. The Sprint Backlog represents the subset of Product Backlog items selected for development during a specific sprint, along with a clear plan for delivering them. The Sprint Backlog is owned by the development team, who commit to completing the selected items within the sprint's timeframe. The Increment refers to the sum of all completed Product Backlog items during a sprint that meet the team's Definition of Done. In PHI projects, increments often take the form of functional software modules, updated dashboards, or enhanced data pipelines that can be demonstrated, tested, and deployed for immediate use.

Adapting Scrum artifacts to PHI contexts ensures that project scope remains transparent and manageable, facilitating alignment among diverse stakeholders. Visualization tools such as burndown charts and task boards can be employed to track sprint progress, offering real-time visibility into workload distribution and project velocity (Korimbocus *et al*., 2019; Keith, 2020). These tools enable public health agencies to monitor project health, anticipate delivery timelines, and allocate resources effectively.

Scrum's emphasis on empirical process control—where progress is assessed through frequent inspections and adaptations—aligns well with the operational realities of public health informatics. By structuring PHI projects into iterative sprints, Scrum enables teams to respond to emerging health threats, policy changes, and stakeholder needs with agility and precision. Moreover, the collaborative rituals and transparent artifacts embedded within the Scrum framework foster a culture of shared ownership, continuous improvement, and stakeholder alignment that is essential for the successful delivery of PHI initiatives.

Adapting the Scrum framework to public health informatics projects offers a structured yet flexible approach to managing complexity, fostering collaboration, and delivering high-impact informatics solutions. By clearly defining roles, leveraging modular sprint planning, promoting daily team alignment, and instituting iterative feedback mechanisms, PHI teams can enhance project efficiency, responsiveness, and relevance. The disciplined use of Scrum artifacts ensures that project scope and progress remain transparent, enabling public health agencies to navigate the dynamic informatics landscape with agility and confidence.

2.3 Benefits of Agile and Scrum in Public Health Informatics

Public Health Informatics (PHI) projects are inherently complex, often requiring the integration of diverse data sources, compliance with regulatory mandates, and alignment with rapidly evolving public health priorities as shown in figure 1. Traditional linear project management methodologies frequently struggle to accommodate these dynamic environments, resulting in delayed system deployments, misaligned stakeholder expectations, and rigid solutions ill-suited to real-world needs. Agile and Scrum methodologies, by contrast, offer a flexible, iterative framework that enhances collaboration, accelerates delivery, and improves outcome relevance. The adoption of these frameworks in PHI projects yields significant benefits, including enhanced stakeholder engagement, faster deployment of usable tools, improved responsiveness to shifting requirements, increased project transparency, and stronger multidisciplinary collaboration (Rajagopalan and Srivastava, 2018; Chew *et al*., 2020).

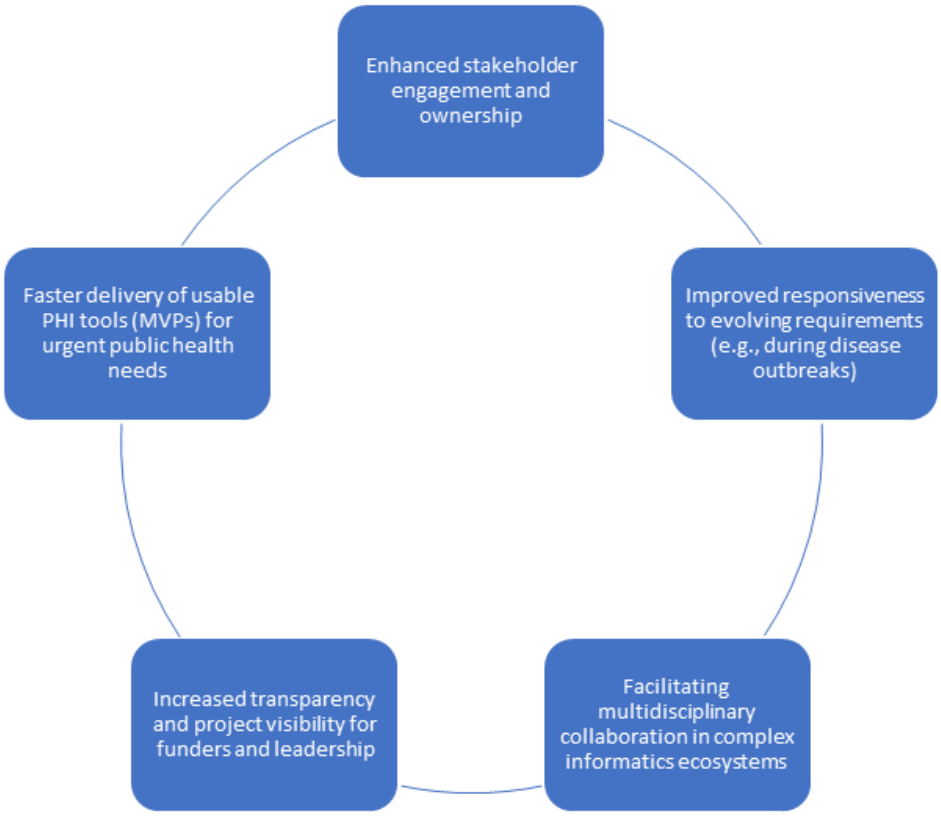

Fig 1: Benefits of Agile and Scrum in Public Health Informatics

One of the most profound advantages of Agile and Scrum in PHI projects is the enhanced stakeholder engagement and ownership throughout the project lifecycle. Unlike traditional models where stakeholders are primarily involved during initial requirements gathering and final delivery, Agile emphasizes continuous collaboration with stakeholders through sprint reviews, backlog refinement sessions, and frequent feedback loops. In PHI contexts, stakeholders encompass a broad array of actors, including public health officials, epidemiologists, clinicians, data scientists, IT specialists, and community representatives. Scrum's structured rituals create consistent opportunities for these diverse stakeholders to engage with development teams, review incremental progress, and influence the project's direction based on emerging needs and contextual realities.

This continuous engagement fosters a sense of shared ownership and accountability, ensuring that the informatics solutions being developed are aligned with user expectations and operational requirements. Stakeholders are no longer passive recipients of end products but active contributors to their evolution. As a result, the likelihood of system adoption and satisfaction increases significantly, while the risk of misaligned functionalities is reduced. In public health scenarios where user buy-in is critical to the success of informatics interventions, this enhanced engagement is particularly valuable.

Agile and Scrum frameworks also facilitate the faster delivery of usable PHI tools, particularly Minimum Viable Products (MVPs), to address urgent public health needs. Through time-boxed sprints and modular development cycles, project teams can develop, test, and deploy functional system components incrementally, rather than waiting for the completion of a full-scale solution. This approach is crucial in public health settings where the timeliness of data and tools directly impacts response effectiveness.

For example, during infectious disease outbreaks, the need for real-time surveillance dashboards, contact tracing modules, and automated reporting systems is immediate. Agile methodologies enable PHI teams to deliver basic functional versions of these tools within short development cycles, providing public health agencies with immediate capabilities that can be refined in subsequent iterations. This rapid deployment of MVPs ensures that public health practitioners have access to critical informatics support during the most crucial phases of health emergencies.

Another key benefit of Agile and Scrum is their capacity to improve responsiveness to evolving requirements, a necessity in the dynamic world of public health. Public health priorities are rarely static; they are shaped by factors such as emergent health threats, policy changes, funding fluctuations, and stakeholder feedback. Traditional waterfall models, with their fixed-scope, long-cycle development processes, struggle to accommodate these shifts without significant delays and rework. Agile, by design, thrives in environments characterized by uncertainty and change.

Scrum frameworks facilitate adaptive planning through regularly updated product backlogs, sprint planning sessions, and sprint reviews. These mechanisms allow PHI teams to continuously reassess priorities, incorporate new requirements, and pivot development trajectories based on real-time feedback (Haani and Ananya, 2018; Kusaka, 2019). For instance, a PHI project initially focused on chronic disease management dashboards can seamlessly integrate new features for pandemic surveillance if required, without derailing overall project momentum. This inherent adaptability ensures that informatics solutions remain relevant, timely, and aligned with the shifting landscape of public health needs.

Agile and Scrum practices also contribute to increased transparency and project visibility for funders and leadership,

which is essential in the often-politicized and resource-constrained environment of public health. Scrum artifacts such as product backlogs, sprint backlogs, burndown charts, and increment demonstrations provide clear, real-time insights into project progress, scope, and performance. Regular sprint reviews enable leadership and funders to directly observe deliverables, assess alignment with strategic objectives, and provide course corrections when necessary.

This visibility fosters trust and accountability, as stakeholders are continuously informed about project status, challenges, and achievements. Transparent reporting structures reduce the risk of project mismanagement and allow for informed decision-making regarding resource allocation, priority adjustments, and timeline recalibrations. For funders and policymakers, this level of project oversight is invaluable, ensuring that investments in PHI initiatives yield tangible, timely, and impactful outcomes.

Lastly, Agile and Scrum methodologies significantly enhance the facilitation of multidisciplinary collaboration in complex informatics ecosystems. PHI projects often require the integration of diverse expertise across domains, including epidemiology, data science, software development, health policy, and community engagement. Traditional project management approaches, with their siloed workflows and rigid handoff structures, frequently impede cross-functional collaboration, leading to communication gaps, misunderstandings, and suboptimal solutions.

Scrum's emphasis on cross-functional, self-organizing teams breaks down these silos, fostering an environment where diverse disciplines collaborate in a cohesive, iterative workflow. Daily stand-up meetings, sprint planning sessions, and retrospectives create structured forums for knowledge exchange, joint problem-solving, and collaborative decision-making. By embedding multidisciplinary collaboration into the core operational fabric of PHI projects, Agile and Scrum ensure that informatics solutions are technically robust, contextually relevant, and operationally feasible.

Moreover, Scrum rituals cultivate a culture of continuous learning and process improvement within PHI teams. Retrospectives, in particular, provide a systematic mechanism for teams to reflect on their performance, identify collaboration challenges, and implement strategies to enhance team dynamics and productivity. This culture of reflection and adaptation not only improves project outcomes but also strengthens team cohesion and resilience, which are critical attributes in the demanding and high-stakes field of public health.

The application of Agile and Scrum methodologies in Public Health Informatics offers a multitude of benefits that address longstanding challenges in project execution, stakeholder engagement, and solution relevance. By fostering continuous stakeholder involvement, enabling rapid deployment of MVPs, enhancing responsiveness to emergent requirements, increasing project transparency, and facilitating multidisciplinary collaboration, Agile and Scrum provide a robust framework for driving successful PHI initiatives (Dezi *et al*., 2018; Guşeilă *et al*., 2019). As public health systems continue to grapple with complex and evolving challenges, the adoption of these flexible, collaborative methodologies will be instrumental in ensuring the timely and effective delivery of informatics solutions that support population health outcomes.

2.4 Implementation Scenario Examples

The application of Agile and Scrum methodologies in Public Health Informatics (PHI) is not merely a theoretical construct but a practical framework that has demonstrated success across various real-world scenarios. From developing real-time disease surveillance dashboards to deploying contact tracing platforms and enhancing immunization systems, Agile's iterative, collaborative approach enables public health agencies to deliver timely, responsive, and high-impact informatics solutions (Dong *et al*., 2020; Schulz *et al*., 2020). This explores key implementation scenarios and case examples where Agile and Scrum have transformed PHI project outcomes, demonstrating the adaptability and effectiveness of these methodologies in diverse public health contexts.

A compelling example of Agile application in PHI is the development of real-time disease surveillance dashboards using Scrum sprints. Disease surveillance requires up-to-date, accurate, and accessible data to support timely decision-making and intervention strategies. Traditional project management approaches often fail to deliver surveillance tools quickly enough to meet the dynamic demands of disease monitoring. By employing Scrum, PHI teams can structure the development of surveillance dashboards into modular sprint cycles, each delivering incremental functionality that builds towards a comprehensive, user-centered solution.

In practice, the initial sprint may focus on establishing core data pipelines and a basic interface that visualizes key epidemiological metrics, such as case counts, incidence rates, and geographical distribution. Subsequent sprints can enhance the dashboard with advanced analytics, interactive visualizations, and drill-down capabilities for granular data exploration. Throughout the process, sprint reviews engage stakeholders—including epidemiologists, public health officials, and IT administrators—to gather feedback and reprioritize backlog items based on emerging needs. This iterative approach ensures that the surveillance dashboard evolves in alignment with user expectations and public health priorities, delivering usable components early in the project lifecycle while continuously refining system capabilities.

Another prominent implementation scenario is the rapid deployment of COVID-19 contact tracing platforms, which exemplifies Agile's capacity for fast, flexible responses to public health emergencies. The onset of the COVID-19 pandemic underscored the urgent need for scalable, digital contact tracing solutions to monitor and control virus transmission. Traditional waterfall project methodologies, with their lengthy development cycles and rigid scope, were ill-suited to the immediacy of the pandemic response. In contrast, Agile and Scrum enabled PHI teams to rapidly design, develop, and deploy digital contact tracing platforms in a matter of weeks.

Agile teams began by collaborating with public health authorities to define the minimum viable features required for immediate deployment, such as case entry forms, exposure notification functionalities, and basic reporting dashboards. These core features were developed in initial sprints, with user testing and stakeholder feedback informing iterative refinements. As the platforms went live, subsequent sprints focused on integrating advanced functionalities like Bluetooth proximity tracking, automated data encryption for privacy protection, and interoperability with national

surveillance systems. The Agile framework's flexibility allowed teams to adapt swiftly to evolving public health guidelines, technological constraints, and privacy regulations, ensuring that the contact tracing solutions remained effective, compliant, and aligned with the pandemic's progression.

The iterative enhancement of immunization information systems (IIS) provides another illustrative case of Agile's impact on PHI project delivery. Immunization registries are critical for tracking vaccination coverage, managing vaccine inventories, and supporting outbreak prevention strategies. However, legacy IIS platforms often suffer from outdated interfaces, limited interoperability, and inadequate reporting functionalities. Transitioning to a modernized IIS requires a development approach that accommodates continuous user feedback, policy-driven feature adjustments, and technological integrations with electronic health records (EHRs) (Scuttari, 2019; Leal-Arcas *et al*., 2020).

Applying Scrum methodologies, PHI teams can re-engineer IIS platforms through a series of focused sprints. Early sprints may prioritize improving data entry workflows and developing user-friendly interfaces for immunization providers. Stakeholder engagement through sprint reviews ensures that enhancements are tailored to provider needs and operational contexts. Subsequent sprints can address backend functionalities, such as real-time data synchronization with EHR systems, automated vaccine inventory management, and compliance reporting tools. The Scrum framework's iterative structure allows the project to evolve alongside changes in vaccination policies, emerging requirements for digital vaccination certificates, and integration needs with national immunization initiatives. This continuous enhancement model ensures that the IIS remains a robust, user-centric tool capable of supporting public health immunization efforts effectively.

Agile and Scrum methodologies are also instrumental in enabling rapid responses to public health emergencies and policy shifts, where adaptability and speed are paramount. Public health agencies frequently encounter situations where new regulations, funding opportunities, or emergent health threats necessitate swift informatics interventions. Traditional project management approaches, which emphasize exhaustive documentation and fixed-scope contracts, are often too slow and inflexible to address these rapidly unfolding scenarios.

For instance, during the early stages of a public health emergency, agencies may require the rapid development of situational awareness dashboards that consolidate diverse data sources—hospital capacities, laboratory testing results, mobility data, and social determinants of health indicators. By employing Scrum, PHI teams can prioritize the most critical features in the product backlog, organize them into sprints, and deliver functional versions of the dashboard within compressed timelines. Daily stand-ups facilitate real-time coordination across multidisciplinary teams, while sprint reviews allow public health leadership to assess progress and adjust priorities based on the evolving crisis landscape.

Additionally, Agile's adaptability is valuable when responding to policy-driven shifts, such as new reporting mandates or data governance frameworks. Rather than re-engineering entire systems, Agile teams can introduce targeted features through focused sprints, ensuring compliance with new policies while maintaining project momentum. For example, if a jurisdiction introduces a new data privacy regulation, Agile teams can prioritize the development of enhanced encryption protocols, access control mechanisms, and audit logging features within their sprint cycles, ensuring timely compliance without derailing overarching project objectives.

In all these scenarios, the key to successful Agile implementation lies in fostering a culture of collaboration, transparency, and continuous feedback. By embedding Agile principles into the fabric of PHI projects, public health agencies can navigate complexity with agility, deliver impactful solutions with speed, and maintain alignment with stakeholder expectations and policy imperatives.

The application of Agile and Scrum methodologies in PHI project implementation enables public health agencies to develop and deploy informatics solutions that are timely, user-centered, and adaptable to evolving needs. Whether in the context of real-time disease surveillance, pandemic response, immunization system modernization, or emergency-driven interventions, Agile frameworks provide a structured yet flexible approach that enhances project agility, stakeholder engagement, and solution relevance. These methodologies empower PHI teams to transform complex challenges into manageable, iterative workflows, ensuring that informatics tools deliver meaningful impact in dynamic public health landscapes.

2.5 Challenges and Mitigation Strategies

While Agile and Scrum methodologies offer significant advantages for managing complex Public Health Informatics (PHI) projects, their successful implementation in public sector environments is not without challenges as shown in figure 2. Public health agencies often operate within rigid governance structures, procurement constraints, and deeply ingrained organizational cultures that can complicate Agile adoption (Lai, 2018; Spayd and Madore, 2020). Additionally, practical concerns such as scope management, documentation compliance, and workforce readiness present further hurdles. Addressing these challenges requires deliberate strategies that align Agile principles with public sector realities while fostering an environment conducive to iterative, collaborative, and responsive project execution.

One of the foremost challenges is aligning Agile workflows with public sector governance and procurement processes. Traditional government procurement models are designed for waterfall-like project structures with fixed scopes, predefined deliverables, and rigid timelines. These models often mandate exhaustive up-front documentation, milestone-based payment schedules, and stringent change control processes—all of which conflict with Agile's iterative and adaptive nature. This misalignment can constrain the flexibility needed for Agile sprints and backlog reprioritizations.

To mitigate this challenge, public health agencies must advocate for Agile-friendly procurement frameworks that accommodate iterative deliverables and flexible scope adjustments. This may involve developing modular contracting models that break large projects into smaller, independently funded phases aligned with sprint cycles. Additionally, engaging procurement and legal teams early in the project to educate them on Agile principles can foster greater alignment and flexibility in contractual structures. Transparent communication with funders and governance bodies about the benefits of iterative delivery—such as early

value realization and adaptive risk management—can further build support for Agile-aligned procurement practices.

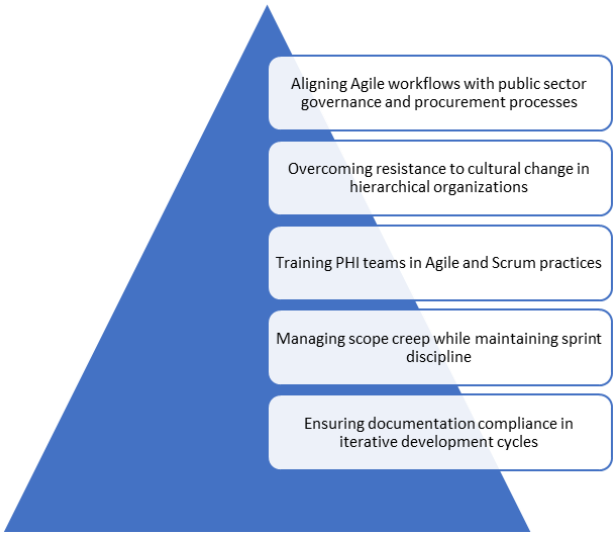

Fig 2: Challenges and Mitigation Strategies

Another critical challenge is overcoming resistance to cultural change in hierarchical organizations. Public health agencies are traditionally hierarchical, with decision-making concentrated at higher levels and workflows designed for predictability and control. Agile, by contrast, promotes decentralized decision-making, self-organizing teams, and adaptive planning—an approach that may clash with established organizational norms and managerial mindsets.

Overcoming this resistance requires a strategic change management approach. Leadership buy-in is essential; agency leaders must champion Agile adoption, model collaborative behaviors, and create a safe environment for experimentation and learning. Conducting Agile awareness workshops for executives, managers, and staff can demystify the methodology and highlight its relevance to public health missions (Wiraeus and Creelman, 2019; Hidalgo, 2019). Early "Agile pilot projects" can serve as proof-of-concept initiatives that demonstrate tangible benefits, helping to build internal momentum and trust. Furthermore, framing Agile adoption not as a radical overhaul but as an evolution toward more responsive and citizen-centered governance can reduce apprehension and foster a sense of shared purpose.

A further challenge lies in training PHI teams in Agile and Scrum practices. Many public health professionals, including informaticians, epidemiologists, and program managers, may lack prior exposure to Agile frameworks. Without adequate training, teams may struggle to internalize Agile roles, rituals, and principles, resulting in fragmented implementation or superficial compliance with Agile terminology without genuine process transformation.

To address this, agencies should invest in structured Agile and Scrum training programs tailored to the PHI context. This includes onboarding sessions that introduce core concepts, practical workshops that simulate Scrum ceremonies (such as sprint planning and retrospectives), and role-specific coaching for Product Owners, Scrum Masters, and team members. Partnering with Agile coaches who have experience in public sector projects can ensure that training is contextually relevant and addresses unique challenges faced by public health teams. Establishing Communities of Practice (CoPs) within the organization can also provide ongoing peer learning opportunities and foster a culture of continuous Agile maturity.

Managing scope creep while maintaining sprint discipline is another common challenge in PHI projects. Public health environments are dynamic, with evolving priorities, emergent stakeholder requests, and policy shifts that can tempt teams to expand sprint scopes impulsively. Uncontrolled scope creep can disrupt sprint cadence, overwhelm teams, and dilute focus, ultimately compromising the quality and timeliness of deliverables.

Mitigating scope creep requires a disciplined backlog management process. The Product Owner plays a pivotal role in prioritizing features, managing stakeholder expectations, and ensuring that new requests are evaluated and integrated into the Product Backlog—not directly into active sprints. Transparent backlog grooming sessions allow teams to reassess priorities collaboratively, ensuring that sprint commitments remain achievable. Establishing a clear "Definition of Done" for backlog items helps prevent ambiguous requirements from being introduced mid-sprint. Additionally, educating stakeholders on the Agile principle of delivering incremental value can reduce pressure to include non-critical features prematurely, fostering a shared understanding of iterative development benefits.

A final challenge pertains to ensuring documentation compliance in iterative development cycles, especially given the stringent reporting and audit requirements prevalent in public health projects. Traditional project methodologies emphasize comprehensive up-front documentation and static design specifications, whereas Agile focuses on lightweight, just-in-time documentation that evolves alongside the product. This divergence can create tension in environments where documentation is essential for regulatory compliance, grant reporting, and knowledge transfer.

To bridge this gap, PHI teams should adopt Agile documentation practices that balance compliance needs with development agility. Documentation should be treated as an integral part of sprint deliverables, with specific documentation tasks incorporated into the Sprint Backlog and Definition of Done criteria. Maintaining living documents—such as evolving system design wikis, user stories, and acceptance criteria—ensures that documentation remains current and reflective of the system's iterative evolution. Automating documentation generation through integrated development and project management tools (e.g., JIRA Confluence, DevOps pipelines) can further streamline the process. Engaging compliance officers and auditors early in the Agile process to co-design documentation expectations can align regulatory requirements with Agile workflows, fostering mutual understanding and reducing friction.

While the application of Agile and Scrum methodologies in Public Health Informatics projects offers numerous benefits, it also presents distinct challenges that stem from public sector governance constraints, organizational culture, workforce readiness, scope management complexities, and compliance obligations. By proactively addressing these challenges through Agile-friendly procurement reforms, strategic change management, targeted training, disciplined backlog management, and adaptive documentation strategies, public health agencies can harness the full potential of Agile methodologies (Lappi *et al.*, 2018; Noceti, 2018). Such deliberate, context-sensitive adaptations ensure that Agile practices are not only adopted but also sustained effectively, leading to more responsive, collaborative, and impactful PHI

project outcomes.

2.6 Future Directions and Opportunities

As public health informatics (PHI) becomes increasingly central to managing population health, disease surveillance, and healthcare delivery optimization, the need for agile, adaptable project management methodologies continues to grow (Jordanova *et al*., 2019; Davidson, 2020). Agile and Scrum frameworks have already demonstrated their effectiveness in enhancing project responsiveness, stakeholder engagement, and incremental delivery of PHI solutions. However, as informatics initiatives expand in scale and complexity, new opportunities are emerging to evolve Agile practices further as shown in figure 3. Future directions include scaling Agile frameworks for large, multi-agency programs, integrating DevOps for continuous delivery, utilizing Agile metrics for performance monitoring, and leveraging Agile to advance interoperability and data-sharing across public health systems.

A critical future direction lies in scaling Agile frameworks to support large, multi-agency PHI programs. While Agile and Scrum have traditionally been applied to small, cross-functional teams working on discrete projects, public health initiatives often span multiple agencies, departments, and jurisdictions. Large-scale PHI programs, such as national immunization registries, integrated disease surveillance platforms, and public health data exchanges, require coordination across numerous stakeholders with varying priorities, technical capacities, and governance structures.

Scaling Agile in these contexts necessitates the adoption of frameworks like Scaled Agile Framework (SAFe), Large-Scale Scrum (LeSS), or Disciplined Agile Delivery (DAD). These frameworks provide structured approaches to coordinate multiple Agile teams working in parallel while ensuring alignment with overarching program objectives. By establishing roles such as Release Train Engineers, Product Managers, and Solution Architects, scaled Agile frameworks can synchronize team-level sprints with broader program-level milestones. Additionally, Program Increment (PI) Planning events foster cross-team collaboration, dependency management, and strategic backlog prioritization across agencies. Scaling Agile in this manner ensures that large PHI initiatives retain the adaptability and stakeholder focus of Agile while managing the complexity of multi-agency coordination.

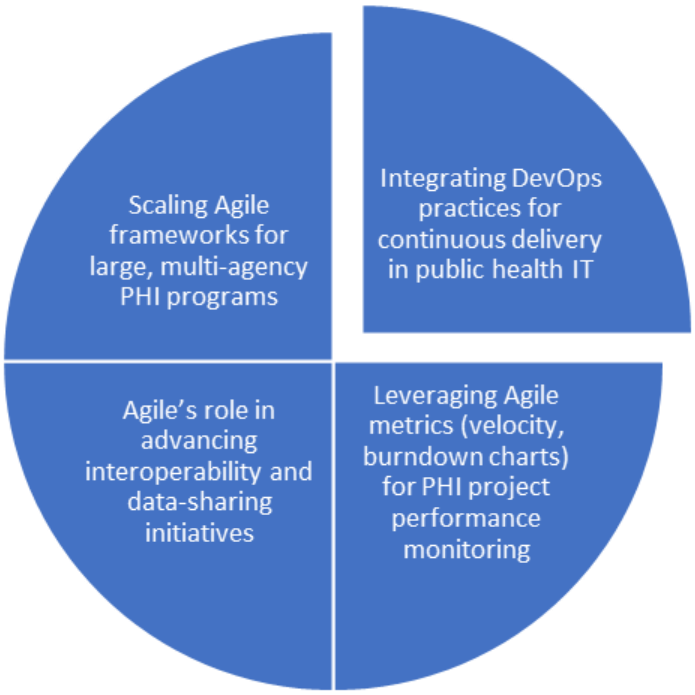

Fig 3: Future Directions and Opportunities

Another promising opportunity involves integrating DevOps practices into Agile-driven public health IT projects to enable continuous delivery and deployment. DevOps, which emphasizes the seamless integration of development and operations processes, complements Agile's iterative development cycles by automating code integration, testing, deployment, and monitoring workflows. For PHI projects, where rapid deployment of new features and system updates is essential to meet evolving public health needs, DevOps practices such as Continuous Integration/Continuous Deployment (CI/CD) pipelines can significantly enhance delivery speed and reliability.

By embedding DevOps toolchains into PHI Agile workflows, teams can automate repetitive tasks like test execution, code validation, and environment provisioning, thereby reducing manual errors and accelerating deployment cycles (Alluri *et al*., 2020; Henney and Gee, 2020). Automated monitoring and feedback loops also ensure that deployed PHI solutions remain performant, secure, and aligned with user requirements. For example, a DevOps-enabled PHI team could deploy iterative updates to a disease surveillance dashboard in near-real-time, incorporating new data visualization features, bug fixes, and data source integrations without service disruptions. The synergy between Agile and DevOps fosters a culture of continuous improvement, collaboration, and operational excellence, which is critical for sustaining high-quality public health informatics services.

Leveraging Agile metrics for PHI project performance monitoring represents another vital opportunity for enhancing transparency, accountability, and outcome

measurement. Agile provides a suite of quantitative metrics—such as team velocity, sprint burndown charts, cumulative flow diagrams, and lead time—that can be harnessed to monitor project progress, predict delivery timelines, and identify process inefficiencies. In the context of PHI projects, where funders, policymakers, and public health leaders require clear visibility into project health and return on investment, these metrics can serve as powerful tools for evidence-based decision-making.

Velocity metrics track the amount of work completed by a team in each sprint, providing insights into team capacity and throughput over time. Burndown charts visualize sprint progress by plotting remaining work against time, enabling teams and stakeholders to assess whether deliverables are on track. Cumulative flow diagrams highlight workflow bottlenecks and inefficiencies, while lead time and cycle time metrics measure the speed at which user stories move from backlog to delivery. By systematically collecting and analyzing these metrics, PHI project managers can make data-driven adjustments to team processes, resource allocations, and backlog prioritizations.

Furthermore, presenting Agile metrics in accessible dashboards allows public health leadership and funders to monitor program performance in real time, fostering a culture of transparency and continuous improvement. Integrating these metrics with project governance frameworks can bridge the gap between Agile's iterative processes and public sector accountability requirements, aligning operational agility with strategic oversight.

Agile methodologies also hold significant potential in advancing interoperability and data-sharing initiatives across public health ecosystems. One of the perennial challenges in PHI is the fragmentation of data across disparate systems, agencies, and jurisdictions, which hampers timely access to comprehensive health information. Agile's iterative, collaborative approach can be instrumental in driving interoperability efforts by enabling rapid prototyping, stakeholder engagement, and incremental development of data exchange standards and interfaces.

For instance, Agile sprints can be structured around the development of specific Application Programming Interfaces (APIs), data integration pipelines, and Health Level Seven (HL7) Fast Healthcare Interoperability Resources (FHIR) modules that facilitate seamless data exchange between public health agencies, healthcare providers, laboratories, and surveillance platforms. Regular sprint reviews and backlog refinement sessions ensure that interoperability priorities remain aligned with stakeholder needs, regulatory mandates, and technological constraints (Correia *et al*., 2019; Ferriter *et al*., 2019).

Agile's emphasis on collaborative problem-solving also promotes the establishment of cross-agency working groups, where informaticians, policy analysts, and IT specialists co-create interoperability solutions in iterative cycles. This approach fosters shared ownership of data-sharing initiatives, accelerates consensus-building around standards, and ensures that interoperability solutions are not only technically robust but also aligned with operational workflows and policy contexts. Additionally, Agile's flexibility allows PHI teams to adapt to evolving data governance frameworks, privacy regulations, and emerging technologies, ensuring that interoperability initiatives remain responsive and future-proof.

Looking ahead, Agile methodologies will also play a pivotal role in supporting public health's transition to Learning Health Systems (LHS), where continuous data feedback loops inform evidence-based practice improvements. By enabling iterative development of informatics tools, rapid incorporation of user feedback, and continuous deployment of enhancements, Agile fosters the agility and learning culture necessary for LHS maturity. PHI teams can leverage Agile to develop and refine population health analytics platforms, real-time surveillance systems, and community engagement tools that support data-driven public health interventions (Schulz *et al*., 2020; Dobbins *et al*., 2020).

The future of Agile in Public Health Informatics is marked by significant opportunities for scaling its principles to large, multi-agency programs, integrating DevOps for continuous delivery, harnessing Agile metrics for performance monitoring, and advancing interoperability across fragmented data ecosystems. As public health challenges grow in complexity and urgency, Agile's adaptive, collaborative, and iterative approach will be indispensable in driving the development of responsive, user-centered informatics solutions. By strategically embracing these future directions, public health agencies can transform their informatics capabilities, fostering agile, data-driven health systems that are well-equipped to meet the evolving needs of populations and public health missions.

3. Conclusion

The application of Agile and Scrum methodologies has profoundly transformed Public Health Informatics (PHI) by fostering project agility, enhancing stakeholder collaboration, and accelerating the delivery of impactful informatics solutions. Unlike traditional project management approaches that often falter in dynamic public health environments, Agile's iterative cycles and Scrum's structured team rituals facilitate continuous stakeholder engagement, adaptive planning, and rapid response to evolving health priorities. These frameworks empower PHI teams to deliver functional tools incrementally, foster cross-disciplinary collaboration, and maintain alignment with operational needs, ultimately leading to more responsive and effective public health interventions.

Looking forward, institutionalizing Agile practices within public health informatics governance structures is essential to sustaining these gains. Public health agencies must embed Agile principles into their strategic frameworks, procurement models, and organizational cultures, ensuring that iterative development, stakeholder co-creation, and continuous improvement become standard practice. This institutionalization will require leadership commitment, capacity building through targeted Agile training programs, and the adaptation of regulatory and funding mechanisms to support modular, flexible project delivery. By aligning governance processes with Agile's core tenets, agencies can enhance the scalability, sustainability, and resilience of their informatics capabilities.

Given the increasing complexity of public health challenges, the call to action for agencies is clear: to embrace Agile and Scrum as foundational pillars for managing PHI projects. Iterative, collaborative project management is no longer a luxury but a necessity for developing informatics systems that are timely, user-centered, and adaptable to emergent health crises. By fostering a culture of agility, transparency,

and stakeholder-driven innovation, public health agencies can accelerate the development of informatics solutions that improve population health outcomes, strengthen health system resilience, and advance data-driven public health governance in an era of unprecedented complexity.

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