

# Enhancing Health Insurance Coverage Through Digital Innovation: Lessons From the Bayelsa Health Insurance Management Information System

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## Research Article

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## Abstract

### Background:

Access to quality healthcare remains a major challenge in Nigeria, where weak infrastructure, limited financing, and low health insurance coverage continue to impede progress toward Universal Health Coverage (UHC). Despite health insurance reforms in the National Health Act and the National Health Insurance Authority (NHIA) Act, implementation challenges persist, particularly at the state level. In Bayelsa State, the Bayelsa Health Insurance Scheme (BHIS) was established to improve access; however, inefficiencies in claims processing, data management, and administrative workflows limited its effectiveness.

### Description:

To strengthen system efficiency and expand coverage, the Corona Management Systems Health Insurance Management Information System (CHIMIS) was developed and deployed for BHIS. Designed through an agile, co-creation process involving BHIS leadership, the Information and Communications Technology (ICT) teams of BHIS, healthcare providers, and the Corona Management Systems team, CHIMIS integrates enrolment, claims management, provider payment, and real-time analytics within a secure digital platform. Training, pilot testing, and phased scale-up enabled smooth adoption, while offline functionality ensured service continuity in low-connectivity areas. Interactive dashboards support evidence-based decision-making and programme monitoring.

### Lessons Learned:

Key lessons from implementation include the importance of early stakeholder engagement, continuous capacity building, and iterative system adaptation to local realities. Sustainable financing through government and donor contributions strengthened coverage for vulnerable groups, while structured employer-based mechanisms boosted enrolment in the Formal Sector. Data quality assurance, dedicated IT support, and offline capability were critical for maintaining operational resilience and user trust.

### Conclusion:

The CHIMIS design and deployment demonstrate the transformative potential of digital innovations in improving enrolment management, accountability, and health system performance. High enrolment in the Formal Sector (51.2%) and Vulnerable Population Programme (41.3%) reflects the impact of policy-aligned, equity-driven digital health interventions. Context-specific design, policy alignment, and participatory implementation remain essential for scaling similar innovations across Nigeria and other low- and middle-income countries striving for UHC.

## INTRODUCTION

Access to quality healthcare remains a persistent challenge in many African countries, including Nigeria, where a high disease burden, compounded by inadequate infrastructure, limited health workforce, and insufficient funding, significantly impede progress towards Universal Health Coverage (UHC)(1). Universal Health Coverage (UHC) ensures that everyone can obtain the complete spectrum of essential and high-quality health services at the right time and place, without experiencing financial strain(2). This encompasses the entire range of vital health services, including prevention, treatment, rehabilitation, palliative care, and health promotion throughout the lifespan(1). However, progress towards UHC has been faltering, especially in low- and middle-income countries (LMIC) due to inadequate health financing and a

weak health system(3). Before COVID-19, the percentage of the global population incurring catastrophic health expenditures was on the rise, increasing from 9.6% in 2000 to 13.5% in 2019. In 2019, out-of-pocket health spending dragged 344 million people further into extreme poverty and 2 billion into relative poverty globally(1).

In Nigeria, the situation remains particularly dire. According to the 2018 Nigeria Demographic and Health Survey, of those between the ages of 15 and 49, only 3% reported being covered by health insurance.(4). This limited coverage underscores the urgency for reforms. While the passage of the National Health Insurance Authority (NHIA) Act and the introduction of the Vulnerable Group Fund (VGF) represent important steps toward equity, implementation has been inconsistent due to political, socioeconomic, and cultural challenges(5). Fragmentation across state-level schemes and the absence of digital infrastructure to support a cohesive and efficient health insurance system further constrain progress.

Despite NHIA's coordinating mandate and a notable increase in health technology research in Nigeria since 2010, the practical application and reach of health insurance schemes remain persistently low (6,7). Less than 10% of Nigerians are covered by the NHIA, and over 70% continue to pay out-of-pocket for healthcare, leading to substantial financial hardship for households(6,7).

Beyond low coverage, healthcare providers also face substantial barriers, including delayed reimbursements, low payment rates, increased administrative complexities, and perceived unprofitability from participating in government insurance schemes, deterring their engagement(2). Many rely on paper-based systems, leading to poor data quality and limited capacity for monitoring and evaluation.(8) These operational inefficiencies contribute to low public trust, minimal awareness and unaffordability of premiums, especially in rural areas. (8) As a result, Nigeria remains far from achieving universal health coverage, leaving most of its population vulnerable to both health and financial risks. Moreover, with a growing burden of both communicable diseases like malaria and tuberculosis, and non-communicable diseases now estimated to account for nearly 29% of deaths, there is an urgent need for scalable digital health insurance solutions that can support equitable access to healthcare (9).

Digital Health Technologies (DHTs) including Health Insurance Management Systems (HIMS) have emerged as pivotal solutions to revolutionise healthcare delivery and expand insurance coverage in LMICs like Nigeria (10,11). Tools such as mobile health (mHealth) applications, telemedicine platforms and AI driven systems have demonstrated immense potential to enhance patient care quality, expand quality access to services, and generate actionable data for informed decision-making (10,12,13). Specifically, digital health insurance systems can significantly improve enrolment by offering user-friendly interfaces, built-in fraud prevention features and efficient claims processing (12).

Bayelsa State reflects many of these national challenges(14). To improve access, the Bayelsa State Government launched the Bayelsa State Health Services Scheme (BSHSS) in 2013, which later transitioned into the Bayelsa Health Insurance Scheme (BHIS) in 2017 (15). BHIS was established to complement the National Health Insurance Scheme (NHIS) and to improve access to healthcare for residents of Bayelsa State (14,16). Under the scheme, enrollees are expected to receive care at accredited health facilities without making out-of-pocket payments at the point of service for most treatments, including clinical consultations (14,16). However, a recent evaluation reported only moderate accessibility, average quality of care with technological and administrative delays often hindering timely service(14). They specifically recommended addressing delays caused by technological challenges and administrative bottlenecks, particularly in the process of generating authorisation codes, as well as improving the timeliness of care delivery(14).

These challenges are indicative of a dire need for innovative approaches to improve the implementation and sustainability of health insurance programs in the state. To address these gaps, the CMS (Corona Management Systems) Health Insurance Management Information System (CHIMIS) was developed. CHIMIS is an innovative, multi-platform system designed to enhance health insurance scheme operations. It connects enrollees, healthcare providers, and State

Health Insurance Agencies to improve efficiency and strengthen health equity. CHIMIS supports enrolment, service provision, claims management, and data management, enabling future actuarial studies. By digitizing workflows and reducing administrative bottlenecks, CHIMIS offers the potential to improve service delivery, enhance accountability, and ultimately increase trust and participation in BHIS.

This paper discusses the development and implementation of CHIMIS in Bayelsa State, and the lessons learned. By providing practical insights from Bayelsa's experience, this study seeks to offer valuable guidance for the future scaling of digital health insurance solutions across Nigeria and other LMICs striving for UHC.

## 2.1 DESIGN APPROACH

We drew on Labrique et al. (2018) framework for scaling digital health solutions in low- and middle-income countries, which highlights five critical factors: addressing unmet needs with user input, ensuring stakeholder engagement, using adaptable technology, aligning with policy goals, and enabling system infrastructure(17,18). These principles informed the design process of CHIMIS. The process began with co-creation workshops involving the Executive Secretary (ES) of the Bayelsa Health Insurance Scheme (BHIS), BHIS staff, and CMS team. The workshops were used to define system requirements, prioritise functionalities (such as enrolment workflows, claims management, and reporting), and ensure alignment with BHIS's operational processes. Following this, iterative planning sessions were held with BHIS staff to refine features and workflows. This step emphasised simplicity and adaptability, ensuring that the technology could be effectively used across different units of the scheme. In parallel, the BHIS ICT unit was engaged to provide technical input and prepare for system deployment. Detailed specifications, including system architecture, user roles, and data integration protocols, were documented and shared with the team to enable their active involvement in implementation and support. Finally, alignment with National Health Insurance Authority (NHIA) standards and existing BHIS policies was incorporated throughout the design phase to ensure regulatory compliance and facilitate integration with broader health financing frameworks.

To operationalise this process, we drew on the System Development Life Cycle (SDLC) as the overarching framework(19). SDLC provides a structured pathway for planning, designing, testing, and deploying information systems. Among the different models of SDLC, we selected the Agile development model (Fig. 1)(20). The Agile cycles provided a flexible structure that enabled rapid problem-solving, continuous improvement, and alignment with the overall goal of building a scalable and sustainable health insurance management system (21,22). This allowed iterative design sprints, where prototypes were shared with the stakeholders for testing and feedback. Each cycle of refinement allowed the development team to incorporate real-time input, prioritise user needs, and adapt the system to emerging policy requirements. This iterative approach not only ensured that the software remained user-centric and contextually appropriate but also strengthened stakeholder ownership by keeping them engaged throughout the development process.

## 2.2 SYSTEM ARCHITECTURE

The CHIMIS platform was designed with a modular and layered architecture that integrates technical infrastructure with operational workflows for provider payment, claims management, and quality assurance (Figs. 2 and 3). The data flow of the request form is presented in supplementary material. At the system core (Fig. 2), client applications (web and mobile) interact with the controller and service layers via REST and WebSocket protocols, enabling real-time enrolment, encounter submission, and claims processing. The service layer orchestrates tasks across the data layer, cache, and external services, with MongoDB used for persistent storage, Redis for caching and message queuing, and an object store for secure media management. Queue consumers manage asynchronous tasks such as claim validation and payment computation, while static gateways serve supporting resources. This design ensures scalability, reliability, and seamless integration with third-party services.

Operationally, the architecture aligns technical automation with human oversight to ensure transparency and accountability (Fig. 3). The capitation process is fully automated through a system Cron job - automation of a repetitive computing task by executing scripts or commands on a predefined schedule - that computes payments based on the number of enrolled clients per health facility, generating payment advice and invoices. Preauthorization management is initiated by healthcare provider administrators, whose submissions are routed through scheme administrators for approval or rejection. Approved records feed into the claims module, which applies a tiered review structure. Claims progress through sequential levels of administrative review, from lowest-level officers to final administrators, before final approval is granted, with the system enforcing validation checks at each stage. While encounter management documents each visit by a BHIS enrollee to a health facility within a time frame. Each visit generates an encounter report, which is neither approved nor rejected but provides essential data for Planning, Research and Statistics (PRS) analysis. The claims data are not only central to financial transactions but also repurposed for quality assurance and Planning, Research, and Statistics (PRS) analysis. Outputs are displayed on monitoring dashboards, enabling real-time performance tracking and evidence-based decision-making.

## 2.3 SECURITY AND PRIVACY CONSIDERATIONS

Safeguarding health and financial information were a core requirement in the design of CHIMIS. The system applies a layered security strategy combining technical and governance controls. Role-based access control with strong authentication ensures that users only interact with data relevant to their responsibilities, while all beneficiary and provider records are encrypted both in transit and at rest. Immutable audit trails are maintained for every transaction to promote accountability, and routine secure backups support continuity in low-connectivity environments(23).

To protect privacy, CHIMIS uses data minimisation and pseudonymization before data are made available for Planning, Research, and Statistics (PRS) dashboards or secondary analyses, aligning with best practices for de-identification in health information systems (24). Fraud detection safeguards are also embedded, with automated anomaly-flagging rules to identify duplicate or suspicious claims for further review, echoing evidence that layered controls reduce risks of abuse in digital health insurance platform (25) Finally, compliance with Nigeria's data-protection laws was built into the system, supported by governance mechanisms such as consent management, data-sharing agreements, and defined retention policies (26).

Beyond these architectural protections, operational mechanisms reinforce system integrity. Following enrolment, beneficiaries are issued digitally generated E-cards containing cryptographic verification features to prevent forgery and allow real-time authentication by providers and agency staff. Claims processing is similarly restricted by programmatic validation: individual claim forms can only be generated for beneficiaries with verified enrolment numbers, with key fields auto-populated directly from the database to minimise manipulation. At the provider level, CHIMIS enforces strict authentication protocols, accepting claims submissions exclusively from verified healthcare facilities, thereby ensuring that all financial transactions originate from legitimate sources within the system.

## 2.4 IMPLEMENTATION STRATEGY

### Training and Capacity Building

Implementation of CHIMIS began with a structured onboarding process for Bayelsa Health Insurance Scheme (BHIS) staff. Secure login credentials were created for key personnel, enabling role-based access. Training followed a cascade model. In the first tier, BHIS leadership and core ICT staff received comprehensive training across all system modules, with hands-on practice tailored to departmental functions such as enrolment, accounts, claims processing, and Health Planning, Research and Statistics (HPRS). The second tier involved BHIS staff training healthcare providers (HCPs) on modules relevant to service delivery, while the third tier focused on joint post-deployment supervision and mentorship by BHIS and CMS ICT teams. This multi-level approach ensured technical competence, promoted sustainability, and

established BHIS ICT staff as long-term system custodians. Training materials included manuals, instructional videos, and quick reference guides to reinforce learning.

## **Pilot and Scale Up**

Before deploying CHIMIS for the Bayelsa State Health Insurance Scheme, the implementation process began with a comprehensive data migration exercise. A data dump was received from the existing on-premises system, which the IT team subjected to extensive cleaning and validation to ensure data integrity. Duplicate records were removed, formats were standardised, and inconsistencies were resolved. Once the dataset met the required quality standards, it was securely ingested into CHIMIS through an encrypted data migration pipeline, ensuring continuity of operations and preserving all historical enrolment records. Following the successful migration, a pilot deployment was conducted across selected health facilities to test CHIMIS in routine operations. This phase included enrollee data integration using biometric verification, real-time claims processing, and onboarding of healthcare providers onto the platform. Continuous monitoring during the pilot enabled iterative refinements such as streamlining enrolment workflows and optimising claims submission processes to enhance user experience and operational efficiency. Early milestones included successful computation of the first capitation, submission and approval of inaugural claims, and integration of feedback loops to capture user experiences. The enrolment strategy during the pilot began with the formal sector, focusing on government employees to test the system's robustness. Building on this foundation, the scheme progressively expanded to the informal sector, capturing private individuals, community groups, and associations. Dedicated packages were developed for students across educational levels, enabling schools to onboard into the scheme. On the provider side, BHCPF-funded primary healthcare facilities, selected private providers, and tertiary hospitals were onboarded, creating a diversified delivery network. To sustain growth beyond the pilot, the Business Development Team employed community-driven and mass media strategies, including town hall meetings, podcasts, radio jingles, and television campaigns to increase public awareness and drive enrolment uptake across diverse population groups.

## **Stakeholder Engagement**

Throughout training, piloting, and scale-up, stakeholder engagement remained central. Regular consultations with BHIS leadership, state officials, healthcare providers, and ICT teams ensured that implementation was responsive to local needs, aligned with policy priorities, and embedded within existing institutional workflows. This participatory approach fostered ownership and trust, which were critical for sustaining adoption.

# **DASHBOARD INTERFACE AND ENROLMENT OUTCOMES**

To facilitate real-time monitoring and evidence-based decision-making, CHIMIS incorporates an interactive dashboard interface that consolidates enrolment, claims, capitation, and quality assurance data into a unified view. The dashboard not only supports routine operations but also provides the analytical backbone for Planning, Research, and Statistics (PRS) functions. Visualising system outputs in a user-friendly manner enhances transparency, enables timely feedback, and supports continuous performance improvement (Fig. 4). Enrolment outcome from 2017 to 2025 is presented in Fig. 5.

The enrolment cut across five main programme categories: the Vulnerable Population Programme (VPP), Formal Sector, Informal Sector, and Student Programme. The Vulnerable Population Programme (VPP), which targets children under five years and the elderly, is funded through subprogrammes including Comprehensive Emergency Obstetric and Newborn Care (CEmONC), BHIS/Global Assess Canada (GAC), BHIS/ Henry Sariake Dickson (HSD), BHIS/United Nations Children's Fund (UNICEF), BHCPF, and the Bayelsa Equity Fund. Collectively, these programmes accounted for 97,425 enrollees. Among the subprogrammes, the Bayelsa Equity Fund recorded the highest number of enrollees (46,631), followed by the BHCPF (41,782) and BHIS/UNICEF (8,884).

Within the Formal Sector, enrolment totalled 120,967 enrolees (51.2%). This category comprises both principal enrolees, such as civil servants, political appointees, state interns, nursing students, and pensioners, and their registered family members (dependants, spouses, and extra dependants). Each principal enrolee is entitled to register up to four biological children and one spouse under their health plan. For civil servants, coverage typically extends to four children, while for other categories, it covers one spouse and up to three children as dependents. Any additional family member enrolled beyond this limit is classified as an extra dependent. Among all formal sector subcategories, civil servants recorded the highest enrolment, with 38,606 individuals. The Informal Sector comprised 6,847 enrolees (2.9%), mainly individuals and association members who independently subscribed to the health insurance scheme and registered their household members under their coverage. Unlike the formal sector, where dependents such as a spouse and up to three or four children (depending on the category) are covered under the principal enrolee's plan at no additional cost, enrolees in the informal sector are required to pay separately for each family member they wish to include in the scheme. Under the Student Programme, there were 1,953 enrolees in total (0.8%), comprising 1,935 from tertiary institutions, 18 from secondary schools, and 66 from primary or nursery schools. Overall, enrolment was dominated by the Formal Sector (51.2%) and the Vulnerable Population Programme (VPP) (41.3%). The high enrolment in the VPP underscores the state's commitment to protecting vulnerable groups through government-subsidised health insurance, demonstrating the effectiveness of equity-driven policies in extending coverage to children under five years and the elderly. Similarly, the strong performance of the formal sector reflects the programme's success in leveraging structured employer-based mechanisms to achieve institutional coverage expansion.

## LESSONS LEARNED

The deployment of CHIMIS and the observed enrolment performance across programme categories provide several critical lessons for future digital health scale-ups and insurance scheme expansions.

### Importance of Early Stakeholder Engagement

Early and inclusive engagement of all operational departments including the leadership, ICT, claims, finance, marketing, and the Policy, Research and Statistics (PRS) team of BHIS promoted ownership and responsiveness during CHIMIS deployment. Beyond internal alignment, deliberate external engagement strategies were also implemented to accelerate coverage growth. The Business Development Team adopted a multi-channel outreach model that combined community-driven and mass media approaches, including town hall announcements, podcasts, daily radio jingles, and television campaigns, to increase public awareness and drive enrolment across all population groups. This participatory and media-based engagement not only improved programme visibility but also reinforced trust among potential enrolees, contributing to the strong uptake observed in the Formal Sector and the steady expansion of the VPP. This finding aligns with earlier studies (18,27) which emphasise the role of structured stakeholder communication and localised awareness strategies in sustaining health insurance enrolment.

### Sustainable Funding Model

The VPP's performance, representing 41.3% of total enrolment, demonstrates the impact of government and donor funding (notably from CEMONC, BHS/GAC, BHS/HSD, BHS/UNICEF, BHCPF, and the Bayelsa Equity Fund) in extending coverage to vulnerable groups, including children under five and the elderly. The Bayelsa Equity Fund, which accounted for the largest share within this category, exemplifies how targeted financial protection mechanisms can sustain coverage for at-risk populations. The Formal Sector Programme, funded through structured employer and payroll deductions, achieved the highest enrolment share (51.2%) due to its policy-backed financing mechanism and the inclusion of dependents and spouses. Each principal enrolee, typically a civil servant, pensioner, or state intern, could register up to four biological children and one spouse without additional payment, ensuring automatic family coverage. This embedded financing model enhanced retention and stability, underscoring the importance of policy-aligned funding structures for

long-term sustainability. This embedded financing model enhanced retention and stability, underscoring the importance of policy-aligned funding structures for long-term sustainability.

Such multi-source financing aligns with the global strategy on digital health (28). The World Health Organisation (WHO) noted that blended funding models combining government, donor, and payroll-based mechanisms increase the resilience of social health insurance programmes in low- and middle-income countries.

### **Data Quality, System Adaptability, and Continuous Capacity Building Are Critical for Performance**

The CHIMIS deployment reaffirmed that comprehensive data cleaning prior to system migration is essential for maintaining data integrity and preventing service disruptions. In the Formal Sector, where large enrolment volumes were processed, early detection and correction of data inconsistencies proved vital to sustaining reliable coverage records. Continuous user training and post-deployment technical support enhanced staff confidence and operational efficiency, especially among field officers managing enrolments in the VPP and Formal Sector. Repeated user acceptance testing (UAT) and integration of user feedback enabled iterative improvements that made CHIMIS more adaptable to field realities.

### **Offline Functionality and IT Support Sustain Operational Resilience**

The offline enrolment capability of CHIMIS enabled uninterrupted service delivery in rural communities where internet connectivity was unreliable, ensuring equitable access within the VPP. Dedicated on-site and remote IT teams provided timely technical support, reduced downtime, and strengthened user confidence in the system's reliability. Beyond maintaining connectivity, the experience highlighted that the long-term success of digital health systems depends on how well they reflect local realities. In the design, the team incorporated Bayelsa State's operational context, existing health workflows, infrastructure constraints, and varying levels of digital access. In low-connectivity areas, certain processes were redesigned to operate seamlessly offline or with minimal technology dependence. These context-driven adaptations enhanced usability, promoted inclusiveness, and fostered strong local ownership of the system. This approach is also consistent with the global strategy on digital health recommendations, emphasising the role of robust system infrastructure and sustained technical assistance in digital health rollouts(28).

### **Policy Alignment and Clear Service Agreements Promote Accountability**

A well-defined business model and Service Level Agreement (SLA) between the implementing partner and the Bayelsa Health Insurance Scheme (BHIS) proved critical in ensuring accountability, defining payment schedules, and guiding future system enhancements. Policy alignment with state health financing objectives helped maintain funding flows for both the Formal Sector and VPP, preventing coverage disruption and reinforcing institutional ownership

## **CONCLUSION**

The implementation of the Bayelsa Health Insurance Scheme (BHIS) through the CHIMIS platform underscores the transformative potential of digital innovations in expanding access to healthcare and strengthening health system governance. The findings revealed that enrolment was largely dominated by the Formal Sector (51.2%) and the Vulnerable Population Programme (VPP, 41.3%), highlighting the effectiveness of structured employer-based schemes and government-subsidised programmes in driving coverage expansion. These results affirm that when digital systems are well-aligned with policy objectives, supported by stakeholder engagement, and tailored to local realities, they can significantly enhance enrolment management and claims management accountability within health insurance systems. In contrast, lower enrolment in the informal and student programmes highlights persistent challenges in reaching populations outside formal employment structures. Several operational lessons emerged from the CHIMIS deployment. Early stakeholder engagement, flexible technological design, and alignment with local context were critical to system

acceptance and sustainability. Adaptations such as offline enrolment capability and real-time IT support not only ensured continuity of service in rural areas but also strengthened local ownership. Equally, effective communication and multi-channel awareness campaigns expanded community participation and enhanced programme visibility. These experiences collectively reinforce the importance of coupling technological innovation with social and institutional readiness when scaling digital health interventions.

## Declarations

### Ethics approval and consent to participate

Not applicable

### Consent for publication

Not applicable

### Availability of data and materials

The enrolment data used in this study are not publicly available due to institutional data protection policies. However, they can be made available following reasonable requests to and formal approval from the Bayelsa Health Insurance Scheme (BHIS).

### Competing interests

The authors declare that they have no competing interests

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### Authors' contributions

TS: prepared and wrote the initial draft, coordinated the research activity planning and execution. WO, SA, designed and implemented the computer code and supporting algorithms for the CHIMIS software. CN, CCA, IN, ID, AF, JBI, NE, DA, GI, OO and ZA critically reviewed and edited the manuscript. GE provided leadership over the research activity planning and execution. DA provided leadership over the software development and the algorithm. CK provided leadership of project design, supervision of project delivery, and supervisory authorship of our manuscript. All authors read and approved the manuscript

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## References

1. Alafa I, Ndifreke U-U, Uwak U (2024) Evaluation of Bayelsa Health Insurance Scheme (BHIS) and Healthcare Delivery in Bayelsa State, Nigeria (2017–2022). *NG J Social Dev* 13(2):296–308. <https://doi.org/10.4314/ngjsd.v13i2.19>

2. Alawode GO, Adewole DA (2021) Assessment of the design and implementation challenges of the National Health Insurance Scheme in Nigeria: a qualitative study among sub-national level actors, healthcare and insurance providers. *BMC Public Health* 21(1):124. <https://doi.org/10.1186/s12889-020-10133-5>
3. Baxter R, Pressman RS (2020) *Software Engineering A Practitioner 's Approach* (9th ed.)
4. Bayelsa State Government (2019) *Bayelsa Health Insurance Scheme Law, 2019*
5. Chevrier R, Foufi V, Gaudet-Blavignac C, Robert A, Lovis C (2019) Use and Understanding of Anonymization and De-Identification in the Biomedical Literature: Scoping Review. *J Med Internet Res* 21(5):e13484. <https://doi.org/10.2196/13484>
6. Chiejina A (2024) Data is life: Achieving Nigeria's digital-in-health approach. *Nigeria Health Watch*. <https://articles.nigeriahealthwatch.com/data-is-life-achieving-nigerias-digital-in-health-approach/>
7. Effiong FB, Dine RD, Hassan IA, Olawuyi DA, Isong IK, Adewole DA (2025) Coverage and predictors of enrolment in the state-supported health insurance schemes in Nigeria: a quantitative multi-site study. *BMC Public Health* 25(1):2125. <https://doi.org/10.1186/s12889-025-23329-4>
8. Egwudo AE, Jegede AO, Oyeniyi TA, Ezekwelu NJ, Abdu-Aguye SN, Okwuraiwe AP, Onyeaghala CA, Ozoude TO, Suleiman MO, Aziken GO, Okeke OP, Abodunrin OR, Eleje GU, Akinsolu FT, Sobande OO (2025) Integrating digital health technologies into the healthcare system: Challenges and opportunities in Nigeria. *PLOS Digit Health* 4(7):e0000928. <https://doi.org/10.1371/journal.pdig.0000928>
9. Eze OI, Iseolorunkanmi A, Adeloye D (2024) The National Health Insurance Scheme (NHIS) in Nigeria: current issues and implementation challenges. *Journal of Global Health Economics and Policy*, 4. <https://doi.org/10.52872/001c.120197>
10. Fabere B, Ozims SJ, Ezekwesiri CO (2025) Evaluation of Healthcare Delivery System in Bayelsa State, Nigeria. *Int J Med Evaluation Phys Rep (IJMEPR)*, 9(1). <https://iiardjournals.org/get/IJMEPR/VOL.%209%20NO.%201%202025/EVALUATION%20OF%20HEALTHCARE%2041-59.pdf>
11. Federal Republic of Nigeria (2022) *National Health Insurance Authority Act, 2022*. <https://www.nhis.gov.ng/download/nhia-act-2022/>
12. Federal Republic of Nigeria (2023) *Federal Republic of Nigeria Official Gazette Extraordinary*. [https://cert.gov.ng/ngcert/resources/Nigeria\\_Data\\_Protection\\_Act\\_2023.pdf?](https://cert.gov.ng/ngcert/resources/Nigeria_Data_Protection_Act_2023.pdf?)
13. Fernández-Alemán JL, Señor IC, Lozoya PÁO, Toval A (2013) Security and privacy in electronic health records: A systematic literature review. *J Biomed Inform* 46(3):541–562. <https://doi.org/10.1016/j.jbi.2012.12.003>
14. Hamid Z, Khalique F, Mahmood S, Daud A, Bukhari A, Alshemaimri B (2024) Healthcare insurance fraud detection using data mining. *BMC Med Inf Decis Mak* 24(1):112. <https://doi.org/10.1186/s12911-024-02512-4>
15. Highsmith J (2009) *Agile Project Management: Creating Innovative Products*, 2nd edn. Addison-Wesley Professional
16. Ibeneme S, Ukor N, Ongom M, Dasa T, Muneene D, Okeibunor J (2020) Strengthening capacities among digital health leaders for the development and implementation of national digital health programs in Nigeria. *BMC Proceedings*, 14(10), 1–12. <https://doi.org/10.1186/S12919-020-00193-1/FIGURES/1>
17. ITHOOT. (2021), May 18 *5 Main Types of SDLC Models: Overview*. ITHOOT. <https://ithoot.com/blog/5-main-types-of-sdlc-models-overview>
18. Kendall KE, Kendall JE (2011) *Systems Analysis and Design*, 8th edn. Pearson Prentice Hall
19. Labrique AB, Wadhvani C, Williams KA, Lamptey P, Hesp C, Luk R, Aerts A (2018) Best practices in scaling digital health in low- and middle-income countries. *Globalization Health* 14(1):1–8. <https://doi.org/10.1186/S12992-018-0424-Z/FIGURES/3>

20. McGinnis JM, Fineberg HV, Dzau VJ (2021) Advancing the Learning Health System. *N Engl J Med* 385(1):1–5. <https://doi.org/10.1056/NEJMp2103872>
21. National Population Commission (NPC) [Nigeria]; ICF (2019) *Nigeria Demographic and Health Survey 2018*. <https://www.dhsprogram.com/pubs/pdf/FR359/FR359.pdf>
22. Oke GI, Sibomana O (2025) Adoption of Digital Health Technology in Nigeria: A Scoping Review of Current Trends and Future Directions. *Adv Public Health* 2025(1). <https://doi.org/10.1155/adph/4246285>
23. Okuzu O, Malaga R, Okereafor K, Amos U, Dosunmu A, Oyenyin A, Adeoye V, Sambo MN, Ebenso B (2022) Role of digital health insurance management systems in scaling health insurance coverage in low- and Middle-Income Countries: A case study from Nigeria. *Front Digit Health* 4. <https://doi.org/10.3389/fdgth.2022.1008458>
24. Olu O, Muneene D, Bataringaya JE, Nahimana M-R, Ba H, Turgeon Y, Karamagi HC, Dovlo D (2019) How Can Digital Health Technologies Contribute to Sustainable Attainment of Universal Health Coverage in Africa? A Perspective. *Frontiers in Public Health*, 7. <https://doi.org/10.3389/fpubh.2019.00341>
25. WHO (2021) *Global strategy on digital health 2020–2025*. World Health Organisation. <https://www.who.int/publications/i/item/9789240020924>
26. World Health Organization (2016) *Noncommunicable diseases country profile: Nigeria, 2016*. <https://www.who.int/publications/i/item/9789241511742>
27. World Health Organization (2025) Universal health coverage (UHC) fact sheet. World Health Organization. [https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-\(uhc\)](https://www.who.int/news-room/fact-sheets/detail/universal-health-coverage-(uhc))
28. *Tracking universal health coverage: 2023 global monitoring report*. WHO and World Health Organization, W. B, Bank W (2023) <https://www.who.int/publications/i/item/9789240080379>

## Figures

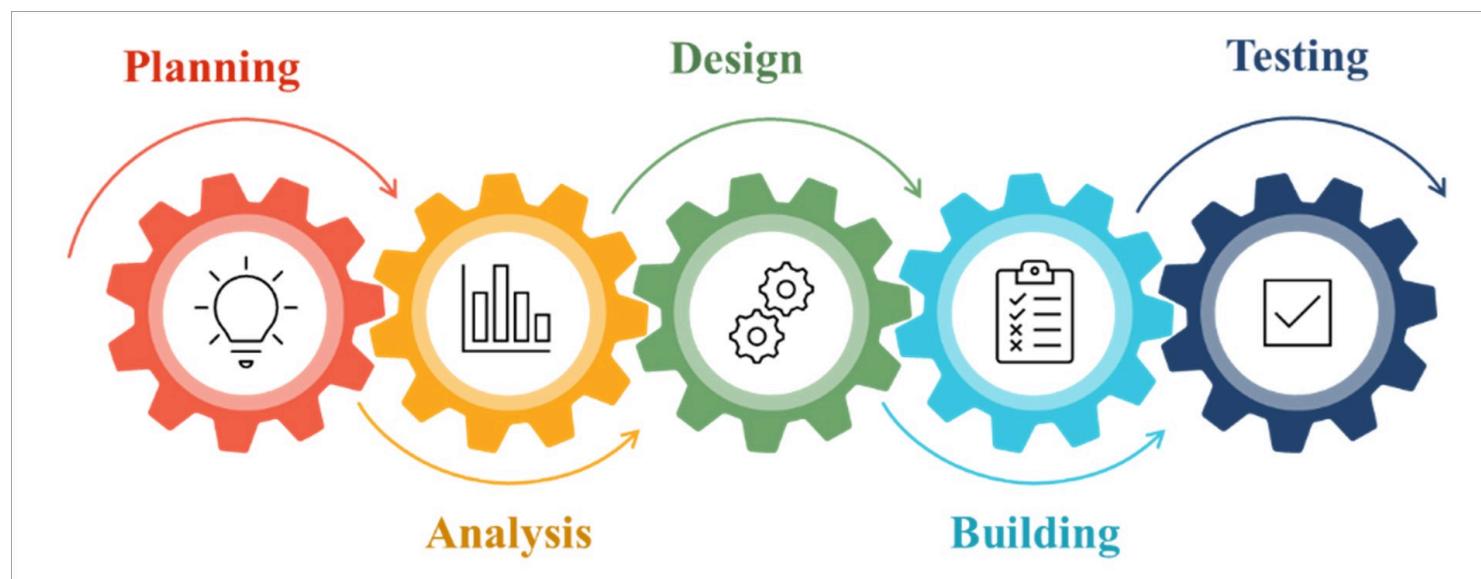


**Figure 1**

Agile development model

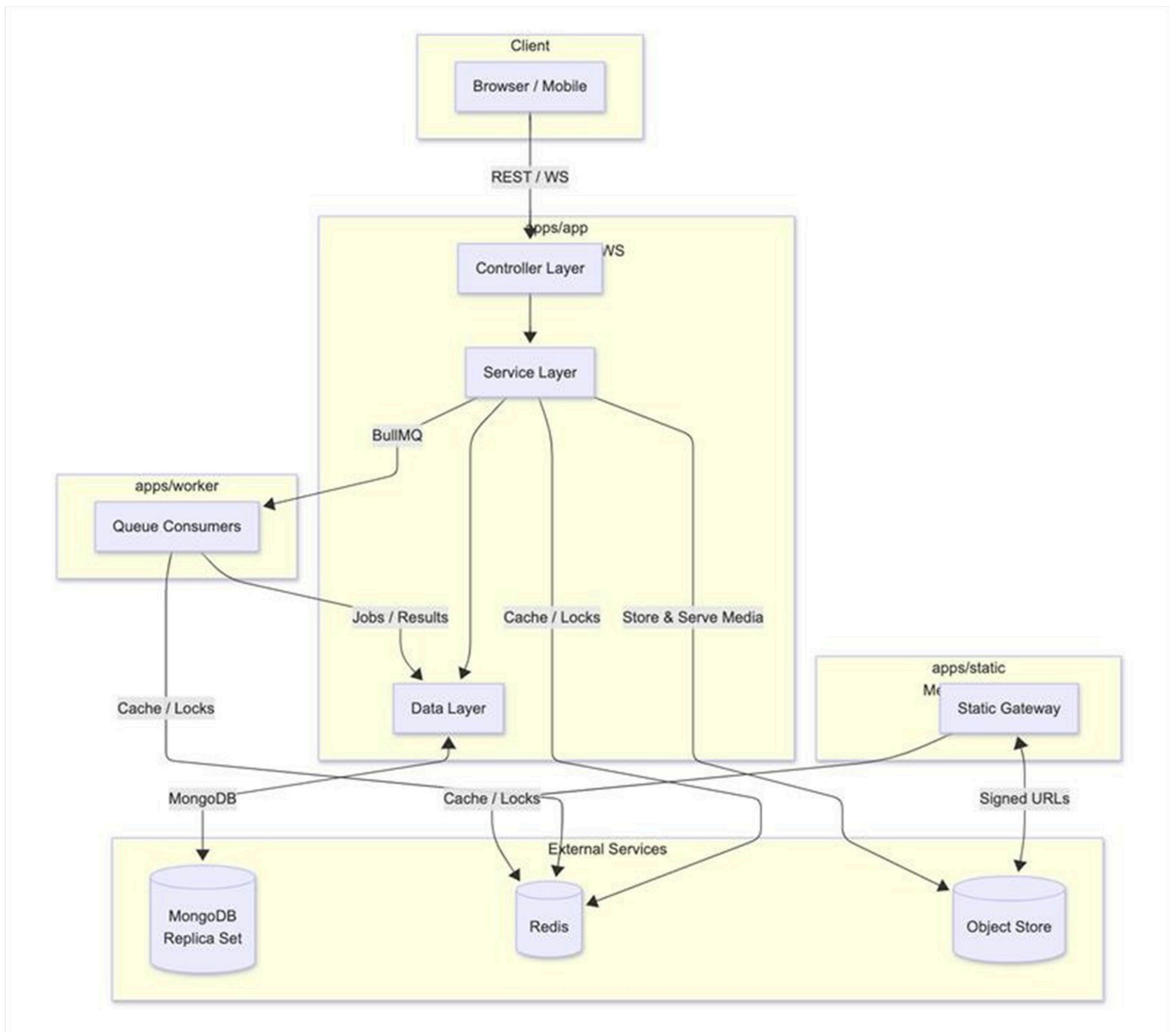


Figure 2

CHIMIS design Architecture

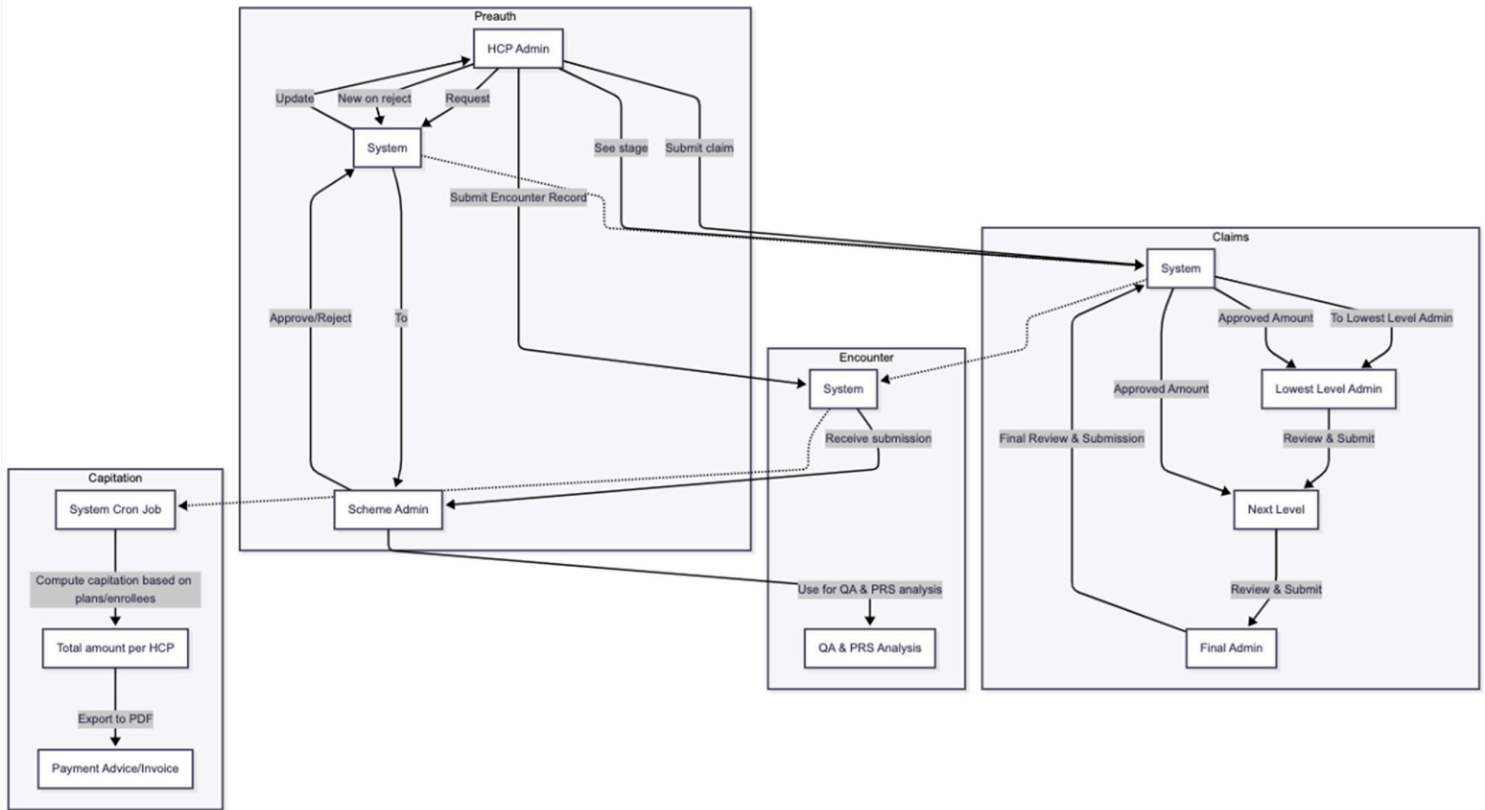


Figure 3

CHIMIS workflow Architecture

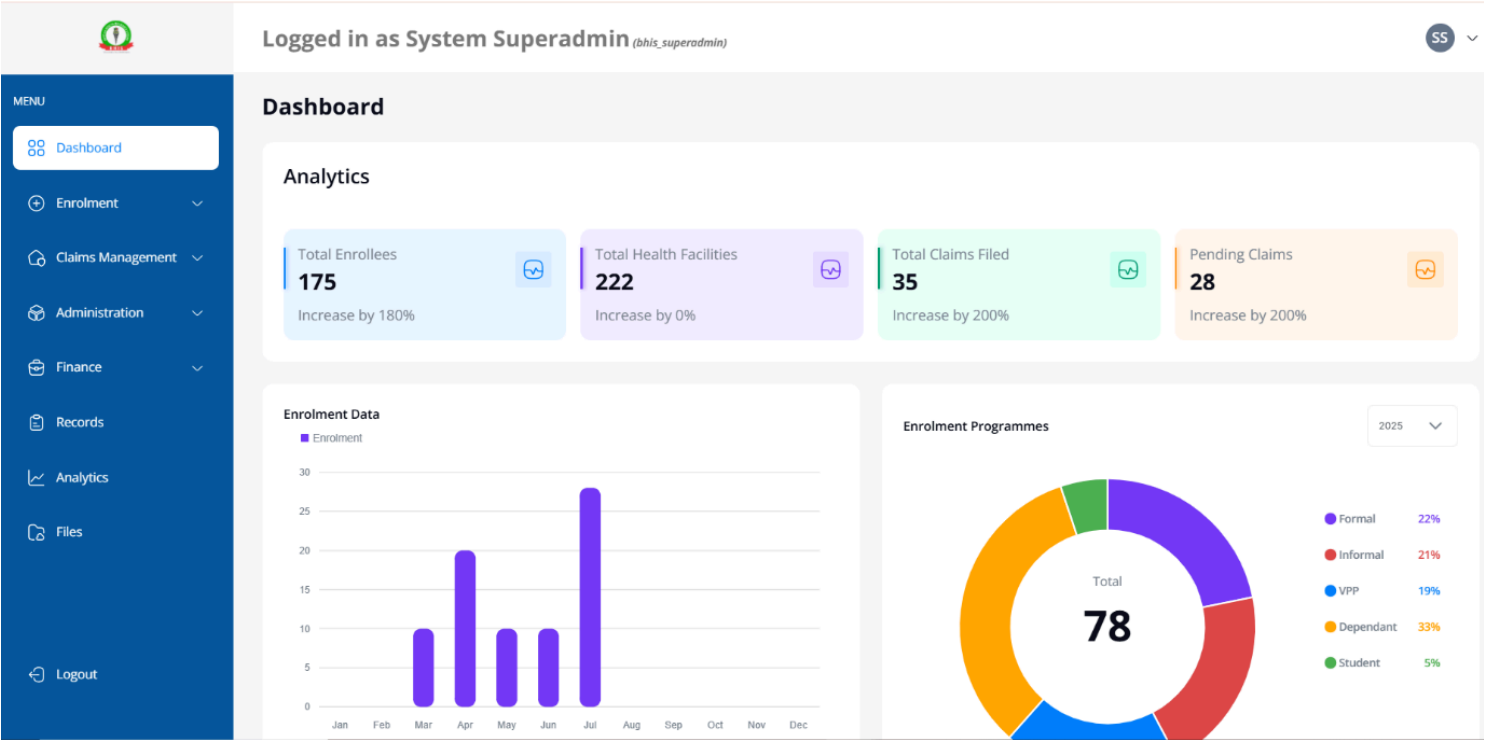


Figure 4

CHIMIS Dashboard Interface

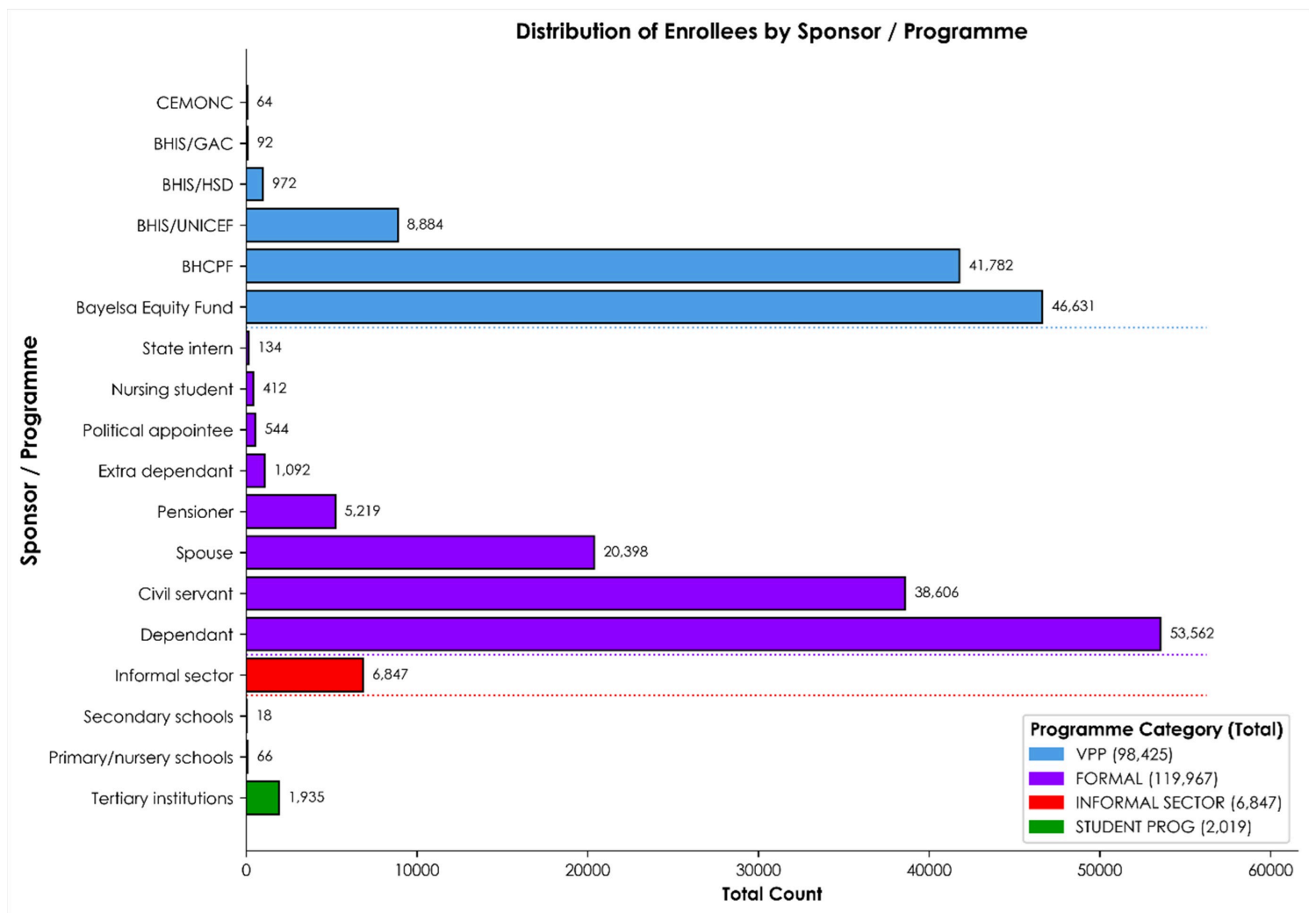


**Figure 5**

Distribution of Enrolees by Programmes

## Supplementary Files

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- [SupplementaryMaterialForCHIMISmanuscript.docx](#)