Evaluating user adaptations and perceptions of OpenELIS in sustaining its implementation in Côte d'Ivoire: A Qualitative Study

Rahmeh AbuShweimeh

A thesis

submitted in partial fulfillment of the

requirements for the degree of

Master of Public Health

University of Washington

2025

Committee:

Deepa Rao

Lucy Perrone

Program Authorized to Offer Degree:

Global Health

University of Washington

Abstract

Evaluating user adaptations and perceptions of OpenELIS in sustaining its implementation in Côte d'Ivoire: A Qualitative Study

Rahmeh AbuShweimeh

Chair of the Supervisory Committee:

Deepa Rao

Department of Global Health

Background:

Sustainability remains one of the most persistent challenges facing digital health interventions in low- and middle-income countries (LMICs). OpenELIS (OE), a laboratory information system introduced across Côte d'Ivoire's public health laboratories with donor support, offers an opportunity to examine how digital health systems evolve in resource-constrained settings and what factors may shape their long-term adoption and institutionalization.

Methods:

This qualitative study analyzed stakeholder perspectives on the implementation and sustainability of OE across 37 laboratories in Côte d'Ivoire. In-depth interviews were conducted with laboratory personnel, information technology staff, and other stakeholders involved in OE use. A hybrid inductive-deductive thematic analysis was performed using the Consolidated Framework for Implementation Research (CFIR) and the Dynamic Sustainability Framework

(DSF) to guide coding and interpretation. Analytic memoing and reflexivity practices, including a positionality statement, were used throughout the process to ensure rigor.

Results:

Findings were organized into four interconnected themes: (1) system readiness and infrastructure; (2) leadership and workforce capacity; (3) system adaptation and workflow alignment; and (4) perceptions of sustainability and donor dependency. Participants described how inconsistent infrastructure, informal leadership structures, staff turnover, and limited training disrupted OE implementation. However, adaptive transitions—such as the shift from OE Basic to OE Classic—improved usability and trust. Concerns about future sustainability were prevalent, especially in the absence of national transition plans and institutional ownership. These findings map onto CFIR's Outer and Inner Setting domains and DSF's emphasis on the dynamic interplay between intervention, setting, and broader ecological factors.

Conclusions:

The study highlights the complexity of sustaining donor-funded digital health tools in LMICs. Implementation success does not guarantee long-term sustainability without adequate investment in infrastructure, human capacity, and national ownership. Integrating implementation science frameworks such as CFIR and DSF can support more context-responsive digital health strategies that evolve with systems over time. Lessons from the OE experience in Côte d'Ivoire can inform broader efforts to strengthen digital health sustainability in similar settings.

Introduction

Although global mortality rates from infectious diseases have declined in recent years, conditions such as HIV, tuberculosis (TB), and malaria remain serious public health challenges in the Western African region (1–3). Côte d'Ivoire (CI), a francophone country in West Africa, continues to grapple with a high infectious diseases burden particularly HIV and TB (4), reporting 420,000 people living with HIV (PLHIV) and a TB incidence rate of 128 per 100,000 population (5,6). These burdens are compounded by the country's historical legacy of French colonization and ongoing political and economic instability (7–9).

In addition to these structural challenges, CI's health system suffers from aging infrastructure, inequitable access to care, and severe workforce shortages with approximately two physicians per 10,000 people (10). The country's rapidly growing population, which has doubled in the last two decades, further exacerbates the strain on healthcare services (11,12). As a result, workforce burnout, high attrition, and limited capacity for accurate diagnosis and laboratory testing hinder progress toward universal health coverage and disease control (13–17). To address these systemic weaknesses, there is a critical need for innovative, cost-effective health technologies that can reduce provider burden and strengthen service delivery.

In response, the US President's Emergency Plan for AIDS Relief (PEPFAR) Program has prioritized HIV testing and counseling (HTC) interventions in CI (17), aiming to support the UNAIDS 95-95-95 targets: ensuring that 95% of people living with HIV (PLHIV) know their status, 95% of those diagnosed receive antiretroviral therapy (ART), and 95% of those on treatment achieve viral load suppression (18–20). However, standalone HIV testing services, delivered without strong linkage to care, laboratory infrastructure, or long-term treatment follow-up, proved insufficient to sustainably reduce the HIV burden. This gap highlighted the need for broader structural solutions, including integrated laboratory systems and improved data management tools to support continuity of care (21,22).

To address these structural gaps, PEPFAR and other global health stakeholders have invested in modernizing laboratory infrastructure, particularly through the scale-up of viral load testing and the implementation of electronic laboratory information systems (eLIS) (23). eLIS platforms are designed to streamline laboratory data management, enhance interoperability with electronic medical records (EMRs), and improve the quality and timeliness of clinical decision-making (21,24–26). Their adoption represents a major advancement in health system responsiveness and data-driven public health planning, particularly in settings transitioning away from paper-based systems (26,27).

Until 2009, laboratories in Côte d'Ivoire relied exclusively on paper-based documents and records, limiting evaluation access to facility and system-level laboratory services data (28). In response, the Ministry of Health (MOH) launched the National Laboratory Strategic Policy and Plan (2012–2015), which prioritized strengthening the laboratory quality management systems (LQMS) and enhancing electronic capabilities of laboratory information management systems in HIV priority health service area (29). OpenELIS was the open source softwarre selected for implementation at these laboratories (30). In 2016, the U.S. Centers for Disease Control and Prevention (CDC), through PEPFAR funding, partnered with the International Training and

Education Center for Health (I-TECH) at the University of Washington to implement the LABQUASI project. Over this five-year period, OpenELIS was deployed in 108 laboratories nationwide, supporting greater access to data for HIV, TB, food safety, and routine laboratory diagnostics.

Programmatic impact evaluations were conducted as part of LABQUASI to assess OpenELIS's impact and sustainability. These studies aimed at 1) generating evidence on how OE has influenced laboratory quality and public health service delivery, and 2) to identify facilitators and barriers to its sustained use. In particular, this study focuses on sustainability, an often-overlooked aspect in global health research and programming. Despite increasing attention to sustainability in US government bi-lateral -funded programs, there remains a lack of standardized frameworks and empirical guidance for sustaining eLIS platforms in low- and middle-income countries (LMICs) (31–34). The literature on implementation sustainability in laboratory systems remains sparse, especially from countries in francophone Africa (35).

This study seeks to fill a gap in our knowledge about sustainability factors by exploring how OpenELIS has been adapted and sustained in Côte d'Ivoire. Using robust implementation science frameworks, it aims to generate actionable recommendations for governments, donors, and implementing partners to support long-term institutionalization of digital health systems in LMICs.

Problem and Rationale

The U.S. President's Emergency Plan for AIDS Relief (PEPFAR) emphasizes the importance of supporting countries in implementing and sustaining health interventions through local ownership to ensure long-term impact and autonomy (36). However, sustaining donor-funded public health programs beyond their funding cycles—particularly during periods with limited monitoring and evaluation (M&E)—remains a persistent challenge across low- and middle-income countries (LMICs) (37,38). This concern is especially pressing in Côte d'Ivoire (CI), where funding for the LABQUASI and LABQUASI II projects are expected to end in 2026.

As these LABQUASI projects conclude, stakeholders have raised concerns that without continued financial, technical, and human resource support, several negative outcomes may emerge:

- OpenELIS may no longer receive adequate technical and financial support.
- The quality of laboratory services could decline.
- Training and retention of qualified laboratory personnel in OpenELIS use may be interrupted.
- Adaptations required to maintain OpenELIS system alignment with evolving local needs may go unassessed.
- Unresolved technical issues may lead to reduced use or complete discontinuation of OpenELIS.

These risks underscore the need to assess and understand the conditions that support sustainability and local ownership of digital health systems like OpenELIS.

General Objectives

Despite the increasing adoption of electronic laboratory information systems (eLIS) in LMICs, there is a notable gap in the literature on best practices for their design, implementation, and sustainability—particularly in francophone countries (39). Moreover, the application of implementation science frameworks in the evaluation of national-scale digital health interventions remains limited.

This study seeks to evaluate the OpenELIS intervention in CI by identifying the key resources, strategies, and contextual factors that have enabled its successful implementation and continued use. It also aims to explore the perceptions of stakeholders—including the Ministry of Health—regarding their capacity to sustain the system beyond donor support. The evaluation ultimately aspires to inform policy, improve laboratory information systems, and contribute to the country's progress toward achieving UNAIDS targets (40). Since this study was conducted, several papers have now been published on OpenELIS in CI detailing best practices in planning, implementation and utility (30).

To answer these questions, the study employs a qualitative design using in-depth interviews (IDIs) with users, implementers, and stakeholders at clinical and reference laboratories across CI. The Dynamic Sustainability Framework (DSF) (41) will be applied to guide analysis and identify both enablers and challenges to sustained implementation.

This study will result in a set of actionable recommendations for software developers, implementing partners, donors, and the Ivorian Ministry of Health. These findings can inform the sustainability of similar public health digital systems in CI and other LMICs, while demonstrating the value of implementation science in global health practice.

Specific Aims

1. To identify the adaptations laboratories have made to adopt and sustain OpenELIS over time.
2. To explore laboratory personnel's knowledge and perceptions regarding the institutionalization of OpenELIS in the absence of donor support.
3. To develop concrete, evidence-informed recommendations for the Ivorian government and relevant stakeholders (e.g., CDC, USAID, MOH) to support the long-term sustainability of OpenELIS.

Methods

Study Design and Frameworks

This study employed a qualitative exploratory design to generate in-depth insights into the implementation and sustainability potential of OpenELIS in Côte d'Ivoire. Individual in-depth interviews (IDIs) were conducted in French by two Ivorian research associates. Data were analyzed using a hybrid deductive-inductive approach in collaboration with a PhD candidate.

The study was guided by two implementation science frameworks: the Consolidated Framework for Implementation Research (CFIR) (42) and the Dynamic Sustainability Framework (DSF) (41). CFIR provides a structured lens to evaluate complex interventions across five key domains: intervention characteristics, outer setting, inner setting, characteristics of individuals, and implementation process. DSF, on the other hand, emphasizes the dynamic, ongoing adaptation of interventions to ensure long-term sustainability across three nested levels: the innovation itself, the practice setting (e.g., workflows, staff, infrastructure), and the broader ecological system (e.g., national policy, donor environment).

These frameworks jointly informed the design of the interview guide, coding structure, and thematic analysis. Figure 1 presents the conceptual model guiding the evaluation. By integrating CFIR and DSF, the study captures a multi-level view of how OpenELIS is being implemented, adapted, and perceived in Côte d'Ivoire, with the aim of identifying the contextual conditions that support or hinder its sustained use in complex health system settings.

The study design was further guided by the Consolidated criteria for reporting qualitative research (COREQ) checklist (43) to ensure adherence to qualitative research standards across sampling, data collection, and reporting

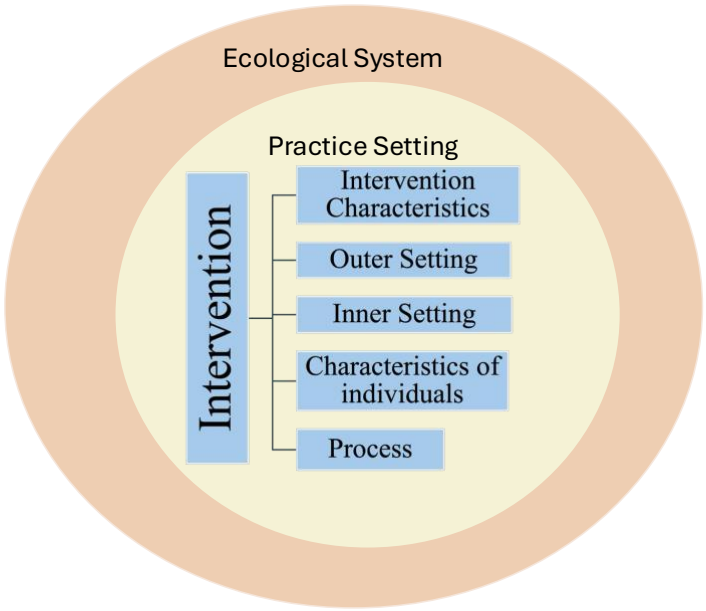

Fig 1: Conceptual Framework Guiding the Evaluation of OpenELIS Implementation and Sustainability Potential in Côte d'Ivoire

Study Population

The primary unit of analysis was laboratory personnel involved in OpenELIS implementation at 37 public laboratories across Cote D'Ivoire. These facilities were purposefully selected to reflect diversity in laboratory level, ownership, and geographic distribution. The sample included national reference laboratories, laboratories based in regional and general hospitals, and district-level laboratories, spanning urban, peri-urban, and rural areas. Eligible participants were laboratory managers, deputy managers, and technicians with current or prior experience using OpenELIS who consented to participate. No minimum threshold for duration of system use was required.

Sampling Strategy

As of the evaluation period, OpenELIS had been implemented in 108 laboratories in Côte d'Ivoire, including 68 sites that use the system for HIV-related data. A purposive sample of 37 sites was selected for this study, representing different geographic regions and facility levels (**Table 1**). Each site had actively implemented OpenELIS, and selected respondents had received prior training on the system. Sites were contacted by telephone one week and again 48 hours prior to the scheduled visits.

Within each facility, purposive sampling was used to identify staff members knowledgeable about OpenELIS. This approach ensured inclusion of respondents with relevant experience in using the system.

***Table 1: Characteristics and OpenELIS Start Dates of the Study Sites**

#	Site Name	Region	OE Start Date
1.	CHU Bouake	Gbeke	02-01-2015
2.	IPCI Adiopodoume	Abidjan I – Grands Ponts	07-01-2017
3.	CIRBA	Abidjan II	09-01-2018
4.	CHU Angre	Abidjan II	02-01-2020
5.	CEPREF	Abidjan I - Grands Ponts	11-01-2014
6.	INSP	Abidjan I - Grands Ponts	06-01-2016
7.	CHR San Pedro	Gbokle-Nawa-San Pedro	10-01-2014
8.	CHR Abengourou	Indenie-Djuablin	10-01-2013
9.	CHR Korhogo	Poro Tchologo-Bagoue	10-01-2013
10.	HG Gagnoa	Goh	07-01-2017
11.	HG Soubre	Gbokle-Nawa-San Pedro	07-01-2017
12.	CHR Man	Tonkpi	07-01-2015
13.	CHR Gagnoa	Goh	09-01-2018
14.	CHR Daloa	Haut Sassandra	08-01-2017
15.	CHR Guiglo	Cavally-Guemon	09-01-2018
16.	CHR Katiola	Hambol	08-01-2017
17.	CHR Divo	Loh Djiboua	08-01-2017
18.	CHR Bouafle	Marahoue	08-01-2017

19.	CHR Seguela	Worodougou-Bere	08-01-2017
20.	CSU Guiberoua	Goh	07-01-2019
21.	HG Bingerville	Abidjan I – Grands Ponts	08-01-2018
22.	HG Bongouanou	N'zi	09-01-2018
23.	HG Bocanda	N'zi	09-01-2018
24.	HG Adzope	La Me	08-01-2018
25.	HG Bangolo	Cavally-Guemon	09-01-2018
26.	HG Tabou	San Pedro	08-01-2018
27.	HG Daoukro	Iffou	09-01-2018
28.	HG Duekoue	Cavally-Guemon	09-01-2018
29.	HG Abobo Nord	Abidjan II	02-01-2020
30.	CMS el Rapha	Abidjan II	02-01-2020

*This table lists the 30 health facilities from the purposive sample for which complete demographic and implementation data were available. It includes each site's name, region, the date OpenELIS was introduced. Seven sites from the original sample were excluded due to missing or unmatched records in the source dataset. Dates are formatted as MM-DD-YYYY.

Study Team and Roles

The project's study team consisted primararily of four members, however working in the context of a multinational project team based both in Abidjan and Seattle under the direction of the UW based Principle Investigator (Perrone) and ITECH Cote d'Ivoire Country Director (Abiola):

- The lead author, a public health graduate candidate at the University of Washington, contributed to protocol development, data coding, and analysis. She brought prior experience in qualitative research and donor-funded health projects.
- A PhD candidate (at the time), who is a doctoral-level implementation researcher served as a mentor, providing methodological guidance and oversight. She also led a parallel impact evaluation of OpenELIS in Cote d'Ivoire.
- Two Cote d'Ivoire-based data collectors, one with expertise in health information systems and the other with a background in monitoring and evaluation and statistics, conducted all in-country interviews and contributed to interpretation of findings.
- *The graduate candidate (myself) and the PhD candidate will be then referred to as the analysis team.

The two Ivorian team members (data collectors) had previously interacted with many of the laboratory staff through training sessions or collaborative work on OpenELIS implementation, which facilitated rapport-building during data collection.

Tool Development and Validation

Semi-structured interview guides were developed using CFIR constructs relevant to the intervention, the implementation context, and evaluation goals (42). The guide was initially drafted in English (**Appendix 1**) and reviewed by two public health experts and two social scientists experienced in qualitative research. Revisions were made based on their feedback. For

example, the guide included questions such as: “How well does OpenELIS fit into your existing laboratory workflows?”, “What kind of changes or adaptations have you made to make OE useful in your setting?”, “Who led the implementation of OE and how were they selected?”, “How does OE compare to other laboratory data tools in use?”, and “What is the probability that OE will continue to be used in public health laboratories in Côte d’Ivoire?”

The guide was then translated into French (**Appendix 2**) and reviewed by the Ivorian team, who conducted a pilot test at two laboratories in January 2021. The pilot helped assess the clarity, cultural relevance, and utility of the questions. Minor revisions were made following the pilot.

Data Collection Procedures

Semi-structured in-depth interviews (IDIs) were conducted with laboratory staff to explore their knowledge, attitudes, experiences, and perceptions related to OpenELIS sustainability. The interviews aimed to identify facilitators and barriers to system use and long-term institutionalization.

Participants were briefed on the study objectives and process and provided written informed consent. They were informed of their right to skip questions, maintain confidentiality, and withdraw at any time without consequence. Data were collected between January and March 2021.

The Ivorian team conducted all interviews in French using the validated guide. They visited each selected site and first met with facility leadership to explain the study and secure permission. Interviews were conducted in private, safe spaces within the facilities and were audio-recorded with participant consent. Written notes were also taken.

Interviewers used follow-up questions and non-verbal cues to elicit deeper responses. At the end of each interview, participants were invited to share any additional thoughts not covered by the interview guide.

Interviews continued until data saturation was achieved, defined as the point at which no new information or themes emerged during three consecutive interviews (44). A total of 37 interviews were conducted, each lasting an average of 29.5 minutes.

Transcription and Translation

Audio recordings, written notes, and scanned consent forms were uploaded to a secure, restricted-access Google Drive folder hosted by the University of Washington. The PhD candidate and two data consultants transcribed the notes and audio recordings into Word documents.

The analysis team members, both with intermediate French language proficiency, used Google Translate as a starting tool to translate transcripts into English. They listened to the recordings for contextual understanding and manually verified the accuracy of translations. Each transcript

was transcribed to capture respondent meaning precisely. Transcripts were cross-checked between the analysis team to ensure fidelity and consistency.

Rigor & Triangulation during coding

The analysis team started to individually code different patches of 5-6 transcripts and then they revised each other's coding, provided comments and highlighted changes made. They met regularly to discuss and resolve iterations and disagreements of the codes. The team documented reflections, positionality statements, and biases throughout the coding process using memos in Atlas.ti.

The analysis team acknowledges that being non-Ivorian, having limited proficiency in French, and the lack of previous experience working in LIS are crucial challenges and limitations. Therefore, I chose a well experienced committee member who has valuable experiences in LIS, CI, and conducting qualitative research. Additionally, the team is still in close contact with the Ivorian team who will be asked to review and provide feedback on the themes and results.

Data Analysis

A hybrid approach combining **deductive** and **inductive** thematic analysis was used. Deductive codes were drawn from the CFIR and DSF frameworks, allowing the analysis to be grounded in established implementation science constructs. At the same time, inductive coding enabled the identification of emergent patterns that reflected the lived experiences of interviewees. This dual strategy allowed for both theoretical alignment and contextual responsivness, an approach well supported in qualitative research literature (45,46).The analysis team collaboratively developed a preliminary codebook, which included code definitions grouped by framework domains.

In the first phase, both coders independently applied the codebook to 11 transcripts, followed by three consensus meetings to reconcile differences and refine the codebook. Inductive codes that emerged during analysis were integrated into the final version (**Appendix 3**).

Thematic Development and Synthesis

Coded data were summarized into key themes, each supported by representative quotes. Thematic patterns were compared across facility levels and regions. Areas of convergence and divergence across CFIR and DSF domains were analyzed and summarized in framework-based matrices.

All coding and thematic analysis were conducted using **ATLAS.ti version 8 (Windows)** through remote access via the University of Washington's Center for Studies in Demography and Ecology.

Ethical Considerations

Qualitative research studies impose ongoing ethical challenges as they highly involve human interactions, observations, interpretations, and biases (47). Therefore, the research team has

followed the University of Washington IRB guidelines to ensure the confidentiality and safety of participants at all stages of the research. All participants signed consent forms to participate in this study and agreed to use the information they have provided during the interviews for research and publication purposes. Identities (i.e., names) and contact information of the study participants were anonymous through all research stages and were kept confidential. Moreover, the authors' positionalities and reflections will be documented, revisited, and iterated through the analysis process to eliminate biases and ensure the rigor of the qualitative findings.

In addition, colleagues from CI will take part in reviewing, editing, and authoring the manuscript(s) to enrich the understanding of the context and setting and to collaborate with them to formulate recommendations to enhance the laboratory information system in CI and to inform any future projects that will take place in CI. Ivorian colleagues had an essential role in the data collection process, and their involvement in later stages of the research will ensure that they will receive proper retribution for the time, effort, and knowledge they contributed to the project.

Results

The findings address the study's three aims: (1) to identify how laboratories have adapted OpenELIS over time; (2) to explore stakeholder perceptions regarding the institutionalization of OpenELIS in the absence of donor support; and (3) to generate evidence-informed recommendations for the Ministry of Health (MSHP), CDC, USAID, and other relevant stakeholders.

Through thematic analysis, four interrelated themes were developed that reflect the technical, organizational, and contextual factors shaping the implementation and sustainability of OpenELIS. These include 1)System readiness and infrastructure, 2) Leadership and workforce capacity, 3) System adaptation and workflow fit, and 3) Perceptions of sustainability and donor dependency. Each theme is presented below and supported by illustrative quotes to highlight key insights from the interviews.

1. *System Readiness & Infrastructure*

System readiness and infrastructural capacity emerged as foundational conditions influencing the early implementation of OpenELIS across laboratories in Côte d'Ivoire. During analysis, these were consistently identified as critical contextual barriers to sustainability, particularly in facilities operating under significant resource constraints.

These findings align with the Outer Setting domain of the CFIR (42), which captures the role of external policies, funding structures, and systemic support, as well as the Ecological System layer of the DSF (41), which emphasizes how macro-level environmental factors influence long-term adaptability and sustainability.

As documented in the global digital health literature, challenges such as unstable electricity, unreliable internet connectivity, and lack of on-site technical support frequently compromise the uptake and continued use of health information systems in LMICs (44,48). These vulnerabilities

are especially acute in health systems with decentralized infrastructure and uneven levels of digital maturity.

The following interviewees responses illustrate the misalignment between national-level implementation mandates and site-level preparedness, exposing significant gaps in coordination, consultation, and infrastructure development across Côte d'Ivoire's laboratory network. These quotes are drawn directly from participants' answers to the questions: "*Were there financial or other incentives that influenced the decision to use OpenELIS? If so, what were they?*" and "*What performance measures, policies, regulations, or guidelines influenced the decision to use OpenELIS in your lab?*" respectively.

"*No, we have not received anything since it is public management, and we cannot oppose the decision of the ministry.*"
(**Transcript_Local_CS**)

"*No knowledge of any other document other than the mandate of the MSHP*."
(**Transcript_Local_H**)

This disconnect between policy and practice highlights systemic challenges in implementation planning. Laboratories were expected to adopt and operationalize OpenELIS without the necessary technical foundation, such as internet connectivity, computer hardware, and stable electricity. These constraints created a fragile baseline for sustainability, especially in rural and peri-urban settings where digital readiness was highly variable. The theme highlights the importance of aligning national digital health initiatives with localized capacity assessments and phased rollouts, as emphasized in both DSF and CFIR frameworks.

2. *Leadership & Workforce Capacity*

Leadership dynamics and workforce capacity played a central role in shaping how OpenELIS was adopted, operationalized, and maintained across laboratories. The analysis revealed wide variability in how leadership roles were defined, ranging from formal appointments to voluntary, informal responsibilities, and how staff turnover undermined institutional knowledge and operational continuity.

This theme aligns with CFIR's **Inner Setting** domain, particularly constructs such as *leadership engagement*, *implementation climate,* and *available resources*. It also reflects the **Practice Setting** layer of DSF, which highlights how sustainability is influenced by the adaptability of institutional routines and the individuals embedded within them.

Prior research emphasizes that digital health interventions are often less effective without clearly designated leadership roles and structured capacity-building systems (49). In LMIC contexts, reliance on informal champions may support early implementation but cannot ensure sustainability and scalability when those individuals leave or lose authority. These challenges are not only operational but strategic, as they affect whether digital tools like OpenELIS can remain effective beyond the donor funding cycle.

Across interview sites, interviewees described differing leadership structures. Some reported formal appointments to implementation roles, while others noted that responsibilities were assumed voluntarily. This inconsistency affected both the level of influence held by individuals and the clarity of their responsibilities. The absence of standardized Terms of Reference (TORs) and Standard Operating Procedures (SOPs) further contributed to varied leadership practices across facilities. When asked, *"How did this person come into this role? Appointed? Volunteered?"*, one interviewee explained:

"*There is no written note for this, so it is voluntary... I follow up on all technical activities.*" ***(Transcript_Local_G)***

In contrast, another interviewee, when asked, *"Who led the implementation of OE at your lab?"*, responded:

"*I was appointed by management... I don't have much authority because it depends a lot on the direction."*
(Transcript_Local_C*)*

Beyond leadership, several facilities reported persistent workforce challenges. Interviewees highlighted staff turnover, insufficient onboarding, and a lack of structured refresher training, leading to reliance on informal mentorship. These human resource gaps raise concerns about the system's long-term sustainability in the absence of continued donor support and investment in capacity strengthening.

3. System Fit & Iterative Adaptation

The extent to which OpenELIS was adapted to fit existing workflows played a critical role in its perceived value and usability across sites. Interviewees described the system's evolution, from the initial OE Basic version to the more advanced OE Classic, as a meaningful improvement that addressed earlier design and functionality challenges. These experiences align with CFIR's **Intervention Characteristics** domain, particularly the construct of *adaptability*, and with DSF's emphasis on *continuous fit* between the innovation, the practice setting, and the broader ecological environment.

Adaptability is widely recognized in digital health literature as a determinant of sustained system use. Studies have shown that iterative improvements, especially those responsive to user feedback, enhance both adoption and long-term integration into routine workflows (50,51). Interviewees indicated that OE Classic resolved many limitations of its predecessor, particularly those related to result formatting and data entry accuracy. However, they also noted that some features from OE Basic, such as specific age categorization fields, were lost in the transition, highlighting the importance of inclusive, user-informed upgrade processes.

When asked, *"What kinds of changes or alterations have you and other lab staff made so OE worked effectively in your lab?"*, one interviewee shared:

"*Yes, at the beginning of the first OpenELIS Basic phase we complained… there is information that was missing on the printing of the results, but when they came to install OE Classic it was fixed. In the Classic there are things that are missing, there are things that were in the Basic that were important that are missing in the Classic, e.g. the age groups.*"
(Transcript_Local_S)

While detailed narratives of data use were limited, a few interviewees noted that OpenELIS now includes dashboards and performance indicators, suggesting early signs of enhanced data visibility and potential for supporting clinical decision-making. These developments, though still emerging, indicate a shift toward more functional integration of digital systems into laboratory operations, provided that ongoing adaptations remain responsive to user needs and system constraints.

4. *Sustainability Planning & Transition Risks*

Perceptions of OpenELIS's sustainability varied across interviewees, shaped by their facility's level of integration, available support, and expectations for the future. While some laboratories had adopted OE into routine workflows, others raised serious concerns about what would happen after donor support—particularly from PEPFAR—wanes. These perceptions highlight a critical tension between routine system use and its long-term **sustainment within a dynamic implementation environment**.

While laboratories may successfully integrate OpenELIS into daily operations, true sustainability—as defined by the **DSF,** requires that the system continues to align with evolving contextual factors such as policy shifts, resource availability, and user needs. Similarly, the **CFIR** emphasizes that without adequate **readiness**, **leadership engagement**, and **ongoing organizational support**, a system's use may stagnate once external support is withdrawn.

When interviewees were asked:
"How likely do you think the labs in Côte d'Ivoire will continue using OE if I-TECH could no longer support the system?",
one responded:

"*It became a daily step, we adopted it*."
(Transcript_Local_T)

Despite these signs of normalization, interviewees frequently expressed uncertainty about post-PEPFAR sustainability, particularly in relation to technical support, government ownership, and the training of new staff. These concerns are consistent with broader literature on digital health in LMICs, which emphasizes that sustainability depends not only on technology and workflows but also on institutional commitment and national stewardship (52,53).

The lack of a clear transition plan for continued support and internal capacity-building has left many laboratories in an ambiguous position, functionally dependent on a system whose long-term integration into national health infrastructure remains uncertain.

Discussion

This study explored interviewee perceptions and experiences of OpenELIS (OE) implementation in Côte d'Ivoire, using the Dynamic Sustainability Framework (DSF) and Consolidated Framework for Implementation Research (CFIR) as guiding lenses. The analysis focused on four core themes derived from participant interviews: system readiness and infrastructure, leadership and workforce capacity, system adaptation, and perceptions of sustainability. These themes highlight both contextual barriers and opportunities to strengthen the long-term viability of OE and similar digital health platforms in low- and middle-income countries (LMICs).

System Readiness and Infrastructure Constraints

The results underscore how digital infrastructure gaps, such as unstable electricity, weak internet connectivity, and lack of IT support, undermined OE implementation and usability at facility level. These findings mirror broader evidence from LMICs where insufficient foundational infrastructure has led to delays or underutilization of digital health systems (54). They align with CFIR's Outer Setting domain and DSF's ecological layer, where contextual realities must inform technology rollouts.

Leadership and Workforce Capacity

The reliance on informal champions and inconsistencies in leadership roles observed in this study resonate with existing literature on digital health implementation. Studies from Kenya and Zambia found that when leadership is not formalized, systems risk collapse due to turnover or disengagement (55). These findings reinforce CFIR's emphasis on implementation climate and leadership engagement, and DSF's recognition of the human element as a pillar of system sustainability.

System Adaptation and Workflow Alignment

The evolution from OE Basic to OE Classic reflects the role of user-centered system adaptation in fostering uptake and relevance. Rather than diminishing fidelity, adaptations addressed user needs and improved print functionality, consistent with DSF's principle that sustainability is a dynamic process requiring continuous alignment. This also echoes CFIR's Process construct, emphasizing iterative refinement and responsiveness to feedback (56).

Perceptions of Sustainability and Donor Dependency

Interviewees expressed confidence in OE's integration into daily workflows but also voiced concerns about its future once external funding ends. Such tensions are well-documented in donor-dependent digital health programs, where inadequate national transition planning can jeopardize long-term continuity (53,57). These findings align with DSF's emphasis on sustainability through institutional ownership and integration, and CFIR's focus on organizational readiness.

While Côte d'Ivoire's OE scale-up is promising, its sustainability will depend on deliberate and coordinated actions in three critical areas:

- Institutionalization within Ministry of Health (MOH) planning and budgeting
- Development of in-country technical support and software maintenance capacity
- Creation of a sustainability roadmap jointly owned by MOH and implementation partners

Taken together, these findings underscore the complex interplay between technical infrastructure, workforce capacity, and institutional ownership in shaping the ongoing implementation of digital health systems like OpenELIS. By applying DSF and CFIR, this study provides a nuanced understanding of how OE is functioning in real-world settings and what conditions are necessary to support its future sustainability. As implementation continues, integrating sustainability planning, through capacity building, system adaptation, and national governance, will be essential to ensure that OE can transition from a donor-supported tool to a fully embedded component of Côte d'Ivoire's health information ecosystem.

Limitations

This study has several limitations that warrant consideration when interpreting the findings.

First, although initial code saturation appeared to be reached after the first three interviews, continued data collection was necessary due to the diversity of facility types and geographic regions across Côte d'Ivoire. Saturation was therefore confirmed iteratively to ensure diverse perspectives were captured. Nonetheless, as is common in qualitative research, the prioritization of depth over breadth means that some context-specific nuances may have been missed—particularly from facility types or regions that were underrepresented.

Second, demographic characteristics of interviewees (such as professional role, years of experience, or gender) were not systematically collected. This omission limited the ability to explore how personal or professional background may have shaped responses and constrained opportunities for subgroup comparisons.

Third, metadata describing facility characteristics was unavailable for 7 out of the 37 total sites, making it difficult to fully assess variation across levels of the health system or regional settings.

Fourth, while all interviews were conducted in person, several interviewees provided very brief responses, limiting the depth of insight and contextual richness. This affected the development of more detailed narrative accounts and contributed to the inclusion of shorter, less descriptive quotes during analysis.

Fifth, the interview transcripts were translated from French to English using Google Translate and then reviewed by team members with intermediate French proficiency. Although this approach allowed for timely and resource-conscious analysis, it introduces a risk of minor mistranslations or loss of linguistic nuance—an important consideration in qualitative research, where meaning can be embedded in phrasing.

Sixth, the study was carried out by a lead researcher returning to academic work after a prolonged pause in research activity. Although reflexive practices, such as analytic memoing, document triangulation, and consultation with local collaborators, were used to support rigor, this gap in recent field engagement may have subtly influenced the analytical process.

Finally, the research was conducted in collaboration with implementing and donor agencies, which may have influenced how freely interviewees expressed critical views. Despite efforts to ensure confidentiality and a neutral interview environment, the possibility of social desirability bias remains.

Despite these limitations, the study offers meaningful insights into the long-term sustainability of OpenELIS and contributes to the growing evidence base around digital health implementation in francophone African contexts. The use of implementation science frameworks (DSF and CFIR), the inclusion of perspectives from a wide range of laboratories, and a focus on sustainability-oriented themes strengthen the relevance and practical value of the findings.

Recommendations

Based on the findings of this study, several actionable recommendations are proposed to enhance the sustainability of OpenELIS in Côte d'Ivoire. These are organized by stakeholder level and grounded in implementation science frameworks:

1. Ministry of Health (MOH)

- **Institutionalize OpenELIS** within national health policy, digital health strategy, and budgetary frameworks to reduce reliance on external donors.
- **Develop a national training curriculum and on-going training model** to maintain institutional memory and ensure consistent onboarding of newly-hired employees.
- **Assign technical focal points** at regional or district levels to serve as intermediaries for local troubleshooting and support.
- **Implement a top-down monitoring system** to proactively identify gaps, needs, and emerging challenges at the facility level.
- **Develop and enforce standardized SOPs and TORs** to ensure role clarity and consistent implementation across sites.
- **Conduct regular reevaluations of OpenELIS** to assess alignment with evolving workflows and facility needs.

These recommendations align with implementation science principles emphasizing integration into health system governance, routine training, and continuous quality improvement (58–60).

2. Health Facilities

- **Appoint and empower local OpenELIS "champions"** with formal roles and responsibilities to lead system use and serve as peer trainers.

- **Create feedback loops** through regular review of dashboards and OpenELIS-generated reports to inform local decision-making and improve data ownership.
- **Establish a clear, multi-tiered reporting mechanism** that enables structured information flow from frontline users to facility administrators, through peripheral directorates, and up to central Ministry of Health (MOH) leadership. This will enhance oversight, accountability, and responsiveness in system implementation and sustainability efforts.

These facility-level actions reflect best practices from the literature on system sustainability, highlighting the importance of local ownership, peer leadership, and internal feedback mechanisms (32,61)

3. Technical Partners & Donors (e.g., CDC, I-TECH, Global Fund)

- Work with MOH to conduct a thorough preliminary needs and preparedness assessment at all facility levels.
- **Support long-term capacity development** by shifting focus from short-term troubleshooting to institutional systems-building.
- **Fund localized technical assistance ecosystems** that include francophone software developers and health informatics experts.
- **Facilitate joint planning** with MOH and facilities to co-develop sustainability plans, clearly outlining roles, transition timelines, and accountability mechanisms.

These recommendations reflect the global evidence base on donor-supported digital health programs, where sustainability depends on co-ownership, technical capacity transfer, and early transition planning (62,63).

References:

1. Gouda HN, Charlson F, Sorsdahl K, Ahmadzada S, Ferrari AJ, Erskine H, et al. Burden of non-communicable diseases in sub-Saharan Africa, 1990–2017: results from the Global Burden of Disease Study 2017. The Lancet Global Health. 2019 Oct 1;7(10):e1375–87.

2. Roth GA, Abate D, Abate KH, Abay SM, Abbafati C, Abbasi N, et al. Global, regional, and national age-sex-specific mortality for 282 causes of death in 195 countries and territories, 1980–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet. 2018 Nov 10;392(10159):1736–88.

3. UNAIDS-Côte d'Ivoire [Internet]. 2020 [cited 2022 Mar 7]. Available from: https://www.unaids.org/en/regionscountries/countries/ctedivoire

4. Incidence of tuberculosis (per 100,000 people) - Cote d'Ivoire | Data [Internet]. [cited 2022 Mar 7]. Available from: https://data.worldbank.org/indicator/SH.TBS.INCD?locations=CI

5. Azevedo MJ. The State of Health System(s) in Africa: Challenges and Opportunities. Historical Perspectives on the State of Health and Health Systems in Africa, Volume II. 2017 Feb 3;1–73.

6. BÉDIA FRANÇOIS AKA KOFFI, CHRISTIAN N'DA ARTHUR OUATTARA, NADJAMAN OUATTARA. The impact of the military-political crisis of 2002 on inequalities in Côte d'Ivoire [Internet]. [cited 2022 Nov 13]. Available from: https://www.afd.fr/en/ressources/impact-military-political-crisis-2002-inequalities-cote-divoire

7. Kerouedan D. Health in Africa: what can France and Europe do about it? Field Actions Science Reports The journal of field actions [Internet]. 2012 Mar 6 [cited 2022 Nov 13];(Special Issue 4). Available from: https://journals.openedition.org/factsreports/1564

8. Médecins Sans Frontières (MSF) International [Internet]. [cited 2022 Nov 13]. Côte d'Ivoire | MSF medical and humanitarian aid. Available from: https://www.msf.org/c%C3%B4te-divoire

9. Oxford Business Group [Internet]. 2020 [cited 2022 Nov 13]. How can Côte d'Ivoire improve the education of its citizens? Available from: https://oxfordbusinessgroup.com/overview/class-investment-national-development-plans-seek-prepare-large-young-population-labour-market

10. Population growth (annual %) - Cote d'Ivoire | Data [Internet]. [cited 2022 Nov 15]. Available from: https://data.worldbank.org/indicator/SP.POP.GROW?end=2021&locations=CI&start=1961&view=chart

11. Cote d'Ivoire | Institute for Health Metrics and Evaluation [Internet]. [cited 2025 May 25]. Available from: https://www.healthdata.org/research-analysis/health-by-location/profiles/cote-divoire

12. Boniol M, Kunjumen T, Nair TS, Siyam A, Campbell J, Diallo K. The global health workforce stock and distribution in 2020 and 2030: a threat to equity and 'universal' health coverage? BMJ Global Health. 2022 Jun 1;7(6):e009316.

13. Debes JD, Quadri NS, Sultan A, Yousif M, Ali SI, Kayandabila J, et al. Risk of Healthcare Worker Burnout in Africa during the COVID-19 Pandemic. Ann Glob Health. 2021 Jan 5;87(1):5.

14. Szabo S, Nove A, Matthews Z, Bajracharya A, Dhillon I, Singh DR, et al. Health workforce demography: a framework to improve understanding of the health workforce and support achievement of the Sustainable Development Goals. Human Resources for Health. 2020 Jan 29;18(1):7.

15. Perrott GSJ, Holland DF. Population Trends and Problems of Public Health. Milbank Q. 2005 Dec;83(4):569–608.

16. Duran D, Sieleunou I, Ozaltin E. Health Systems Assessment for Cote d'Ivoire: Accelerating Reforms Toward Universal Health Coverage [Internet]. Washington, DC: World Bank; 2020 May [cited 2022 Nov 15]. Available from: https://openknowledge.worldbank.org/handle/10986/33763

17. Bekelynck A, Larmarange J, Group for the A 12323 DCS. Pepfar 3.0's HIV testing policy in Côte d'Ivoire (2014 to 2018): fragmentation, acceleration and disconnection. Journal of the International AIDS Society. 2019;22(12):e25424.

18. cdi-cop22-sds.pdf [Internet]. [cited 2025 Jun 1]. Available from: https://hivpreventioncoalition.unaids.org/sites/default/files/attachments/cdi-cop22-sds.pdf

19. CDC. Global HIV and TB. 2025 [cited 2025 May 25]. Tracking PEPFAR Impact Toward Global Targets. Available from: https://www.cdc.gov/global-hiv-tb/php/data/phia.html

20. Frescura L, Godfrey-Faussett P, Feizzadeh A A, El-Sadr W, Syarif O, Ghys PD, et al. Achieving the 95 95 95 targets for all: A pathway to ending AIDS. PLoS One. 2022;17(8):e0272405.

21. Drain PK, Dorward J, Bender A, Lillis L, Marinucci F, Sacks J, et al. Point-of-Care HIV Viral Load Testing: an Essential Tool for a Sustainable Global HIV/AIDS Response. Clin Microbiol Rev. 2019 May 15;32(3):e00097-18.

22. Flowers J, Sutton P, Boncy J, J W, C A, J S, et al. OpenELIS: Open-source laboratory information system for clinical and reference laboratories: Implementations in Haiti and Cote d'Ivoire. In 2010.

23. Bates I, Maitland K. Are laboratory services coming of age in sub-Saharan Africa? Clin Infect Dis. 2006 Feb 1;42(3):383–4.

24. Drain PK, Hyle EP, Noubary F, Freedberg KA, Wilson D, Bishai WR, et al. Diagnostic point-of-care tests in resource-limited settings. Lancet Infect Dis. 2014 Mar;14(3):239–49.

25. Hoover R. Benefits of using an electronic health record. Nursing2020 Critical Care. 2017 Jan;12(1):9–10.

26. World Health Organization - Regional Office for the Eastern Mediterranean [Internet]. [cited 2022 Jun 21]. WHO EMRO | Laboratory information management system | Health topics. Available from: http://www.emro.who.int/health-topics/laboratory-information/index.html

27. Khubone T, Tlou B, Mashamba-Thompson TP. Electronic Health Information Systems to Improve Disease Diagnosis and Management at Point-of-Care in Low and Middle Income Countries: A Narrative Review. Diagnostics. 2020 May;10(5):327.

28. Mathews A, Marc D. Usability Evaluation of Laboratory Information Systems. Journal of Pathology Informatics. 2017 Jan 1;8(1):40.

29. Ondoa P, van der Broek A, Jansen C, de Bruijn H, Schultsz C. National laboratory policies and plans in sub-Saharan African countries: gaps and opportunities. Afr J Lab Med. 2017 Jul 31;6(1):578.

30. He Y, Iiams-Hauser C, Henri Assoa P, Kouabenan YR, Komena P, Pongathie A, et al. Development and national scale implementation of an open-source electronic laboratory information system (OpenELIS) in Côte d'Ivoire: Sustainability lessons from the first 13 years. International Journal of Medical Informatics. 2023 Feb 1;170:104977.

31. Walugembe DR, Sibbald S, Le Ber MJ, Kothari A. Sustainability of public health interventions: where are the gaps? Health Research Policy and Systems. 2019 Jan 15;17(1):8.

32. Mary Ann Scheirer, James W Dearing. An Agenda for Research on the Sustainability of Public Health Programs [Internet]. [cited 2022 Mar 9]. Available from: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3222409/

33. World Bank [Internet]. [cited 2022 Jun 21]. Case studies of project sustainability : implications for policy and operations from Asian experience. Available from: https://documents.worldbank.org/en/publication/documents-reports/documentdetail/601151468760543920/Case-studies-of-project-sustainability-implications-for-policy-and-operations-from-Asian-experience

34. Yin RK, Heald KA, Vogel ME. Tinkering with the system: technological innovations in state and local services. Lexington, Mass: D.C. Heath; 1977.

35. Nwaozuru U, Murphy P, Richard A, Obiezu-Umeh C, Shato T, Obionu I, et al. The sustainability of health interventions implemented in Africa: an updated systematic review on evidence and future research perspectives. Implementation Science Communications. 2025 Apr 8;6(1):39.

36. Landgraf KM, Kakkar R, Meigs M, Jankauskas PT, Phan TTH, Nguyen VN, et al. Open-source LIMS in Vietnam: The path toward sustainability and host country ownership. Int J Med Inform. 2016 Sep;93:92–102.

37. Shelton RC, Cooper BR, Stirman SW. The Sustainability of Evidence-Based Interventions and Practices in Public Health and Health Care. Annual Review of Public Health. 2018;39(1):55–76.

38. Shediac-Rizkallah MC, Bone LR. Planning for the sustainability of community-based health programs: conceptual frameworks and future directions for research, practice and policy. Health Educ Res. 1998 Mar;13(1):87–108.

39. Labrique AB, Wadhwani C, Williams KA, Lamptey P, Hesp C, Luk R, et al. Best practices in scaling digital health in low and middle income countries. Globalization and Health. 2018 Nov 3;14(1):103.

40. Fast-Track - Ending the AIDS epidemic by 2030 | UNAIDS [Internet]. [cited 2022 Mar 10]. Available from: https://www.unaids.org/en/resources/documents/2014/JC2686_WAD2014report

41. Chambers DA, Glasgow RE, Stange KC. The dynamic sustainability framework: addressing the paradox of sustainment amid ongoing change. Implement Sci. 2013 Oct 2;8:117.

42. Helga E. Breimaier, Birgit Heckemann, Ruud J. G. Halfens, Christa Lohrmann. The Consolidated Framework for Implementation Research (CFIR): a useful theoretical framework for guiding and evaluating a guideline implementation process in a hospital-based nursing practice | SpringerLink [Internet]. 2015 [cited 2022 Mar 10]. Available from: https://link.springer.com/article/10.1186/s12912-015-0088-4

43. Tong A, Sainsbury P, Craig J. Consolidated criteria for reporting qualitative research (COREQ): a 32-item checklist for interviews and focus groups. International Journal for Quality in Health Care. 2007 Dec 1;19(6):349–57.

44. “Are We There Yet? Data Saturation in Qualitative Research” by Patricia I. Fusch and Lawrence R. Ness [Internet]. [cited 2022 Nov 24]. Available from: https://nsuworks.nova.edu/tqr/vol20/iss9/3/

45. Roberts K, Dowell A, Nie JB. Attempting rigour and replicability in thematic analysis of qualitative research data; a case study of codebook development. BMC Medical Research Methodology. 2019 Mar 28;19(1):66.

46. Fereday J, Muir-Cochrane E. Demonstrating Rigor Using Thematic Analysis: A Hybrid Approach of Inductive and Deductive Coding and Theme Development. International Journal of Qualitative Methods. 2006 Mar 1;5(1):80–92.

47. Guillemin M, Gillam L. Ethics, Reflexivity, and “Ethically Important Moments” in Research. Qualitative Inquiry. 2004 Apr 1;10:261–80.

48. Ali SK, Khan H, Shah J, Nadeem Ahmed K. An electronic health record system implementation in a resource limited country-lessons learned. Digit Health. 2023;9:20552076231203660.

49. O'Brien M, Duerr R, Taitingfong R, Martinez A, Vera L, Jennings LL, et al. Earth Science Data Repositories: Implementing the CARE Principles. Data Science Journal. 2024 Jul 3;23:37.

50. Kruk ME, Gage AD, Arsenault C, Jordan K, Leslie HH, Roder-DeWan S, et al. High-quality health systems in the Sustainable Development Goals era: time for a revolution. The Lancet Global Health. 2018 Nov 1;6(11):e1196–252.

51. DePasse JW, Caldwell A, Santorino D, Bailey E, Gudapakkam S, Bangsberg D, et al. Affordable medical technologies: bringing Value-Based Design into global health. BMJ Innovations [Internet]. 2016 Jan 1 [cited 2025 Jun 10];2(1). Available from: https://innovations.bmj.com/content/2/1/4

52. Scott RE, Mars M. Principles and Framework for eHealth Strategy Development. Journal of Medical Internet Research. 2013 Jul 30;15(7):e2250.

53. Ilesanmi OS, Afolabi AA. Sustainability of Donor-Funded Health-Related Programs Beyond the Funding Lifecycle in Africa: A Systematic Review. Cureus. 2022 May;14(5):e24643.

54. The case study approach | BMC Medical Research Methodology | Full Text [Internet]. [cited 2022 Nov 24]. Available from: https://bmcmedresmethodol.biomedcentral.com/articles/10.1186/1471-2288-11-100

55. Moucheraud C, Schwitters A, Boudreaux C, Giles D, Kilmarx PH, Ntolo N, et al. Sustainability of health information systems: a three-country qualitative study in southern Africa. BMC Health Serv Res. 2017 Jan 10;17:23.

56. Means AR, Kemp CG, Gwayi-Chore MC, Gimbel S, Soi C, Sherr K, et al. Evaluating and optimizing the consolidated framework for implementation research (CFIR) for use in low- and middle-income countries: a systematic review. Implementation Science. 2020 Mar 12;15(1):17.

57. Huffstetler HE, Bandara S, Bharali I, Kennedy Mcdade K, Mao W, Guo F, et al. The impacts of donor transitions on health systems in middle-income countries: a scoping review. Health Policy Plan. 2022 Jul 29;37(9):1188–202.

58. Fixsen D, Blase K, Naoom S, Wallace F. Core Implementation Components. Research on Social Work Practice - RES SOCIAL WORK PRAC. 2009 Aug 19;19:531–40.

59. World Health Organization. Global diffusion of eHealth: making universal health coverage achievable: report of the third global survey on eHealth [Internet]. Geneva: World Health Organization; 2016 [cited 2025 Jun 11]. 156 p. Available from: https://iris.who.int/handle/10665/252529

60. Peters DH, Adam T, Alonge O, Agyepong IA, Tran N. Implementation research: what it is and how to do it. BMJ. 2013 Nov 20;347:f6753.

61. The sustainability of health interventions implemented in Africa: an updated systematic review on evidence and future research perspectives | Implementation Science Communications | Full Text [Internet]. [cited 2025 Jun 11]. Available from: https://implementationsciencecomms.biomedcentral.com/articles/10.1186/s43058-025-00716-x?utm_source=chatgpt.com

62. Huffstetler HE, Bandara S, Bharali I, Kennedy Mcdade K, Mao W, Guo F, et al. The impacts of donor transitions on health systems in middle-income countries: a scoping review. Health Policy Plan. 2022 Jul 29;37(9):1188–202.

63. OECD. Development Co-operation Report 2019: A Fairer, Greener, Safer Tomorrow [Internet]. OECD; 2019 [cited 2025 Jun 11]. (Development Co-operation Report). Available from: https://www.oecd.org/en/publications/development-co-operation-report-2019_9a58c83f-en.html

Appendicies

Appendix 1: Interviews Guide (English)

Overview

This interview will provide valuable information for the impact evaluation of the OpenELIS laboratory information system in Côte d'Ivoire. The questions are about the adoption and implementation process of OpenELIS at your laboratory. The information that you provide and the findings of the evaluation project will help improve the OpenELIS program implementation.

The interview will take approximately one hour. The audio of the interview will be recorded to help project members provide detailed information afterwards. The recordings and interview notes will be strictly confidential. We may remove anything that might identify you and your laboratory from the information that we present in reports and presentations. You can refuse to participate or withdraw from the project at any time before October 1, 2021. Details will be available in the informed consent form.

If you have any questions, please contact Mr. Yves-Rolland Kouabenan (M&E Specialist/Lead, I-TECH Côte d'Ivoire) at rkouabenan@itech-cotedivoire.org.

Thank you for your collaboration!

1. When was OpenELIS (OE) installed in your lab? When did you start using OE? What lab tests do you use OE to record data for?
2. Why is OE being installed and used in your lab? [Intervention Characteristics – intervention source]
    1. How was the decision made to start using OE? [Process - engaging]
3. Who are the key influential individuals to get on board with implementing OE? [Engaging – opinion leaders]
4. What are influential individuals saying about OE? [Process – engaging – opinion leaders]
    1. To what extent have they influenced others' use of OE?
5. Who led the implementation of OE at your lab? [Process – engaging – formally appointed internal implementation leaders]
    1. How did this person come into this role? Appointed? Volunteered?
    2. Does this person have sufficient authority to do what is necessary to implement OE?
6. Who else is involved with leading the implementation? In or outside your lab. [Process – engaging – champion; external change agents]
7. What performance measures, policies, regulations, or guidelines influenced the decision to use OE in your lab? (Prompt: Aside from the mandate from MSHP to use OE for viral load and EID data, what other policies, regulations, performance measures, etc. that made you and your lab think that it would be better to use OE?) [Outer Setting – external policies & incentives]
8. Were there financial or other incentives that influenced the decision to use OE? If so, what were they? [Outer Setting – external policies & incentives]
    1. How would using OE affect your lab's ability to receive these incentives?
    2. How would using OE affect payment or revenue for your lab?

What kinds of changes or alterations have you and other lab staff made so OE worked effectively in your lab? [Intervention Characteristics – adaptability]

1. Do you think the changes were successfully carried out? Why or why not?

10. How do you think the infrastructure/characteristics of your lab (its level in the health system, number of years in operation, number of staff, size, or physical layout) affects the use of OE in your lab? [Inner Setting – structural characteristics]

1. How did the infrastructure/characteristics facilitate/hinder the use of OE?
2. How have you worked around structural challenges?

11. How well has OE fit within existing work processes and practices in your lab? [Inner Setting – implementation climate - compatibility]

12. Can you describe how OE was first integrated into the workflow of the lab? [Inner Setting – implementation climate - compatibility]

1. How did that integration go? Well or did it severely conflict with existing processes?
2. What issues or complications arose in the process of integration?

Do you think the use of OE has been effective in your lab? [Characteristics of Individuals – knowledge & beliefs about the intervention]

1. Why or why not?

14. How have you <u>felt</u> about OE being used in your lab? [Characteristics of Individuals – knowledge & beliefs about the intervention]

1. How do you feel about the process of implementing OE in your lab?
2. Did you have any feelings of anticipation? Stress? Enthusiasm? Why?

15. What is the general level of receptivity by staff in your lab to using OE? [Inner Setting – implementation climate]

1. The staff in my lab are generally _____ towards using OE.
    1. Strongly receptive
    2. Receptive
    3. Indifferent
    4. Resistant
    5. Strongly resistant
2. Why?

16. What stage of OE implementation is your lab at? [Characteristics of Individuals – knowledge & beliefs about the intervention & maturity] (***<u>Prompt</u>***: a) still very new, a lot to learn; b) we know the basics, but we still need a lot of help with specific issues; c) using OE is part of the routine now, although we still have issues sometimes, we can troubleshoot some issues on our own or we know how to get help.)

17. Have you received feedback reports about using OE? [Process – reflecting & evaluating]

1. What do they look like? Content, mode, form?
2. How helpful do you think they have been?
3. How could they be improved?

18. How have you assessed progress towards implementation goals? [Process – reflecting & evaluating]

1. How have results of the evaluation been distributed to stakeholders?

What is your opinion of the software development and technical work done on OpenELIS (OE)? [Intervention Characteristics – intervention source]

19. How complicated is the OE system? Please consider the following aspects of OE: [Intervention Characteristics – complexity]
    1. The amount of time spent learning to use OE
    2. How different OE was from previous tools of collecting and reporting lab data
    3. How difficult it has been to use OE? How many steps are usually involved?
20. Other than OE, what are the main tools for data collection and recording in your lab? (*Prompt*: paper registries, paper forms, notebooks; other electronic data collection tools such as Excel spreadsheets, online data reporting platforms) [Intervention Characteristics – relative advantage]
21. How does OE compare to other lab data tools in your lab? [Intervention Characteristics – relative advantage]
    1. What advantages does OE have compared to existing tools?
    2. What disadvantages does OE have compared to existing tools?
23. How likely do you think the labs in Cote d'Ivoire will continue using OE if I-TECH could no longer support the system? [Intervention Characteristics – perceived sustainability]
    1. Under what circumstances would the lab system continue or stop using OE? E.g., changes in government policy/requirement, funding availability.
24. How likely do you think the usage of OE can be expanded in the health system in Cote d'Ivoire? [Intervention Characteristics – perceived scalability]
    1. Expanded to collect and report data on more types of lab tests?
    2. Expanded to more labs? What kind of labs?
25. How do you think OE could be modified or optimized? [Intervention Characteristics – perceived scalability]
26. What are your expectations for the MSHP in terms of coaching and assistance for using OE in the future?

27. Have you heard of the HIV viral load and early infant diagnosis dashboards? _____
    a) Yes. (Go to Question 28.)

b) No. (Please briefly explain what the dashboards are to the participant or show them the website of the dashboards. Then go to Question 36.)

28. Where or how have you heard of them? _____
29. Have you ever visited or used them?
    a) Yes. (Go to Question 30.)

b) No. (Go to Question 36.)

30. Did anyone suggest you use them?
    a) Yes. Who? _____
    b) No.
31. What do you use the dashboards for?
32. Do you think they are useful? Why or why not?
33. What is your perception of the appearance and quality of the dashboards?

34. What changes would you like to suggest for improving the dashboards? In terms of functions, appearance, quality, etc.
35. Have you used similar data visualization tools?

35.1. If so, what are those tools? How do the dashboards compare with the other tools that you have used?
36. What features are necessary to make the dashboards useful for you and your laboratory?
37. Do you know any other laboratories that use these dashboards?
37.1. How does knowing that there are some laboratories or no laboratories that use the dashboards influence your decision to use the dashboards?
38. Do you think a policy, guideline, or program is necessary to promote the use of the dashboards?
38.1. If so, what kind of policies, guidelines, or programs?
38.2. If not, why not?

Appendix 2: Interview Guide (French)

Aperçu

Cet entretien fournira des informations précieuses pour l'évaluation d'impact du système d'information du laboratoire OpenELIS en Côte d'Ivoire. Les questions portent sur le processus d'adoption et de mise en œuvre d'OpenELIS dans votre laboratoire. Les informations que vous fournissez et les conclusions du projet d'évaluation aideront à améliorer la mise en œuvre du programme OpenELIS.
L'entrevue durera environ une heure. L'audio de l'entretien sera enregistré pour aider les membres du projet à fournir des informations détaillées par la suite. Les enregistrements et les notes d'entretien seront strictement confidentiels. Nous pouvons supprimer tout ce qui pourrait vous identifier, vous et votre laboratoire, des informations que nous présentons dans les rapports et présentations. Vous pouvez refuser de participer ou vous retirer du projet à tout moment avant le 1er octobre 2021. Les détails seront disponibles dans le formulaire de consentement éclairé. Si vous avez des questions, veuillez contacter M. Kouabenan Yves-Rolland (Spécialiste S&E / Responsable, I-TECH Côte d'Ivoire) à rkouabenan@itech-cotedivoire.org.
Merci pour votre collaboration !

1. Quand est-ce qu'OpenELIS (OE) a été installé dans votre laboratoire ? Quand est-ce que vous-avez commencé à utiliser OE ? Pour quels tests de laboratoire est-ce que vous utilisez OE pour enregistrer des données ?
2. Pourquoi est-ce qu'OE est installé et utilisé dans votre laboratoire ? [Caractéristiques de l'intervention – source d'intervention]
    1. Comment est-ce que la décision de commencer à utiliser OE a été prise au sein du laboratoire ?
3. Quelles sont les personnes influentes pour participer à la mise en œuvre d'OE ? Par exemple, quelqu'un du ministère, ou du PMO, ou vous-même ? [Processus – engageant – leaders d'opinion]
4. Que disent les personnes influentes à propos d'OE ? Par exemple, est-ce que quelqu'un a dit qu'OE allait être vraiment utile ou pas très utile, etc. ? [Processus – engageant – leaders d'opinion]
    1. Dans quelle mesure est-ce qu'ils ont influencé l'utilisation des OE par d'autres ?
5. Qui a dirigé la mise en œuvre d'OE dans votre laboratoire ? [Processus – engageant – responsables internes de la mise en œuvre officiellement nommés]
    1. Comment est-ce que cette personne est entrée dans ce rôle ? Nommé ? Bénévole ?
    2. Est-ce que cette personne a suffisamment d'autorité pour faire ce qui est nécessaire pour mettre en œuvre OE ?
6. Qui d'autre est impliqué dans la direction de la mise en œuvre ? Dans ou dehors de votre labo. Par exemple, le directeur de l'hôpital, ou quelqu'un de l'équipe régionale de gestion de la santé ou du PMO? [Processus – engageant – responsables internes de la mise en œuvre officiellement nommés]
7. Quel type de mesures de performance, de politiques ou de lignes directrices au niveau du district, de la région ou du pays a influencé la décision d'utiliser OE ? (*Réplique* : mis à part le mandat du MSHP d'utiliser OE pour les données de charge virale et d'EID, quelles autres politiques, mesures de performance, etc. qui vous ont amené à penser qu'il serait préférable d'utiliser OE ?) [Environnement extérieur – politiques et incitations externes]

8. Quel type d'incitation financière ou autre a influencé la décision d'utiliser OE ? [Environnement extérieur – politiques et incitations externes]
    1. Comment est-ce que l'utilisation d'OE affecterait la capacité de votre laboratoire à recevoir ces incitations ?
    2. Comment est-ce que l'utilisation d'OE affecterait le paiement ou les revenus de votre laboratoire ?

9. Quels types de changements ou de modifications est-ce que vous aviez effectués pour que OE soit un logiciel complet et utile dans votre laboratoire ? Par exemple, les changements dans l'organisation du personnel, le flux de travail, la configuration de l'équipement, l'ajout ou le retrait d'équipement, etc. [Caractéristiques de l'intervention – adaptabilité]
    1. Est-ce que vous pensez que les changements ont été effectués avec succès ? Pourquoi ou pourquoi pas ?

10. Comment est-ce que les caractéristiques de votre laboratoire (niveau du système de santé, âge, nombre d'employés, taille ou disposition physique, les bâtiments) ont affecté l'utilisation d'OE ? [Environnement intérieur – caractéristiques structurelles]
    1. Comment est-ce que les caractéristiques ont facilité / empêché l'utilisation d'OE ?
    2. Comment est-ce que vous avez contourné les défis structurels ?

11. Dans quelle mesure est-ce qu'OE s'intègre bien aux processus et pratiques de travail existants dans votre laboratoire ? [Environnement intérieur – climat de mise en œuvre – compatibilité]

12. Est-ce que vous décririez comment OE a été intégré aux processus existants ? [Environnement intérieur – climat de mise en œuvre – compatibilité]
    1. Comment est-ce qu'OE a interagi ou est-ce qu'il est en conflit avec les processus existants ?
    2. Quels problèmes ou complications sont survenus au cours du processus d'intégration ?

13. Est-ce que vous pensez que l'utilisation d'OE a été efficace dans votre laboratoire ? [Caractéristiques des individus – connaissances et croyances sur l'intervention]
    1. Pourquoi et pourquoi pas ?

14. Qu'est-ce que vous pensez de l'utilisation d'OE dans votre laboratoire ? [Caractéristiques des individus – connaissances et croyances sur l'intervention]
    1. Qu'est-ce que vous pensez du processus de mise en œuvre d'OE dans votre laboratoire ?
    2. Est-ce que vous avez eu des sentiments d'anticipation ? Stress ? Enthousiasme ? Pourquoi ?

15. Quel est le niveau général de réceptivité de votre laboratoire à l'utilisation d'OE ? [Environnement intérieur – climat de mise en œuvre]
    1. Le personnel de mon laboratoire est généralement _____ pour utiliser OE : a) très réceptif ; b) réceptif ; c) indifférent ; d) résistant ; e) très résistant
    2. Pourquoi ?

16. À quelle étape de la mise en œuvre d'OE se trouve votre laboratoire ? [Caractéristiques des individus – connaissances et croyances sur l'intervention]

Choisissiez : a) encore très nouveau, beaucoup à apprendre

b) nous connaissons les bases, mais nous avons encore besoin de beaucoup d'aide pour des problèmes spécifiques

c) l'utilisation d'OE fait maintenant partie de la routine, même si nous avons encore des problèmes parfois

d) autre : expliquez

17. Est-ce que vous avez reçu des rapports de commentaires sur l'utilisation d'OE ? [Processus – réflexion et évaluation]
    1. À quoi est-ce qu'ils ressemblent ? Contenu, mode, forme ?
    2. Dans quelle mesure est-ce que vous pensez qu'ils ont été utiles ?
    3. Comment est-ce qu'ils pourraient être améliorés ?

18. Comment est-ce que vous avez évalué les progrès vers les objectifs de mise en œuvre ? [Processus – réflexion et évaluation]
    1. Comment est-ce que les résultats de l'évaluation ont été diffusés aux parties prenantes ?

19. Quelle est votre opinion sur le développement logiciel et le travail technique effectué sur OpenELIS (OE) ? [Caractéristiques de l'intervention – source d'intervention]

20. Quelle est la complexité du système OE ? <u>Veuillez considérer les aspects suivants :</u> [Caractéristiques de l'intervention – complexité]
    1. Le temps passé à apprendre à utiliser OE
    2. La différence entre OE et les outils précédents de collecte et de rapport des données de laboratoire
    3. Le nombre d'étapes impliquées lors de l'utilisation d'OE.

21. À part OE, quels sont les principaux outils de collecte et d'enregistrement des données dans votre labo ? (***<u>Réplique</u>*** : registres papier, cahiers ; autres outils électroniques tels que des feuilles de calcul Excel, des plateformes en ligne) [Caractéristiques de l'intervention – avantage relatif]

22. Comment est-ce qu'OE se compare aux autres outils de données de labo dans votre labo ? [Caractéristiques de l'intervention – avantage relatif]
    1. Quels sont les avantages d'OE par rapport aux outils existants ?
    2. Quels sont les inconvénients d'OE par rapport aux outils existants ?

23. Selon vous, quelle est la probabilité pour que les laboratoires de santé publique de Côte d'Ivoire <u>continuent</u> à utiliser OE ? [Caractéristiques de l'intervention – durabilité perçue]
    1. Dans quelles circonstances est-ce que le système de laboratoire continuerait ou cesserait d'utiliser OE ? Par exemple, changements dans la politique / les exigences du gouvernement, disponibilité du financement, etc.

24. Selon vous, quelle est la probabilité pour que OE puisse être <u>étendue dans tout le système de santé</u> en Côte d'Ivoire ? [Caractéristiques de l'intervention – évolutivité perçue]
    1. Étendu pour collecter des données sur plus de types de tests de labo ?
    2. Étendu à plus de laboratoires ? Quels types de laboratoires ?

25. Comment est-ce qu'OE doit être modifié ou optimisé pour contribuer à son expansion potentielle ? [Caractéristiques de l'intervention – évolutivité perçue]

26. Quelles sont vos attentes pour le MSHP en termes de coaching et d'assistance pour l'utilisation d'OE à l'avenir ?

27. Avez-vous entendu parler des tableaux de bord de la charge virale VIH et de diagnostic précoce chez le nourrisson (EID) ? _____
    a) Oui. (Passez à la question 28.)
    b) Non (Veuillez expliquer brièvement ce que sont les tableaux de bord au participant ou montrez-leur le site Web des tableaux de bord. Passez ensuite à la question 36.)

28. Où et comment en avez-vous entendu parler ?

29. Les avez-vous déjà visités ou utilisés ?
    a) Oui. (Passez à la question 30.)
    b) Non. (Passez à la question 36.)

30. Quelqu'un vous a-t-il suggéré de les utiliser ?
    a) Oui. Qui ? _____
    b) Non.
31. Pourquoi utilisez-vous les tableaux de bord ?
32. Pensez-vous qu'ils sont utiles ? Pourquoi ou pourquoi pas ?
33. Quelle est votre perception de l'apparence et de la qualité des tableaux de bord ?
34. Quels changements souhaitez-vous suggérer pour améliorer les tableaux de bord ? En termes de fonctions, d'apparence, de qualité, etc.
35. Avez-vous utilisé des outils de visualisation de données similaires ?
35.1. Si oui, quels sont ces outils ? Comment les tableaux de bord se comparent-ils aux autres outils que vous avez utilisés ?
36. Quelles fonctionnalités sont nécessaires pour rendre les tableaux de bord utiles pour vous et votre laboratoire ?
37. Connaissez-vous d'autres laboratoires qui utilisent ces tableaux de bord ?
37.1. Comment le fait de savoir qu'il existe des laboratoires ou pas de laboratoires qui utilisent les tableaux de bord influence votre décision d'utiliser les tableaux de bord ?
38. Pensez-vous qu'une politique, une ligne directrice ou un programme soit nécessaire pour promouvoir l'utilisation des tableaux de bord ?
    38.1. Si oui, quel genre de politiques, de directives ou de programmes ?
    38.2. Sinon, pourquoi pas ?

Appendix 3: Codebook

Code	Comment	Code Group
01.A intervention source	Definition: Perception of key stakeholders about whether the decision to start using OpenELIS is externally or internally developed. Inclusion Criteria: Include statements about the source of the OpenELIS project and the extent to which interviewees view the change as internal to their lab/hospital, e.g., an internally developed program, or external to the lab/hospital, e.g., a program coming from the outside. Exclusion Criteria: Exclude or double code statements related to who participated in the decision process to implement the innovation to **Engaging**, as an indication of early (or late) engagement. Participation in decision-making is an effective engagement strategy to help people feel ownership of the intervention.	intervention characteristics
01.A.1 reason for installation	For answers to question 2	intervention characteristics
01.B relative advantage	when there's actually a relative advantage of OpenELIS compared to other tools in terms of the characteristics and technicalities. Must be double coded with **Facilitator** Inclusion Criteria: Include statements that demonstrate OpenELIS is better than existing programs. Exclusion Criteria: Exclude statements that demonstrate a strong need for OpenELIS and/or that the situation without OpenELIS is untenable. Exclude statements that discuss the need to change anything in the environment to accommodate OpenELIS.	intervention characteristics
01.B relative disadvantage	when there's actually a disadvantage/flaw/issue of OpenELIS in terms of the characteristics and technicalities. Must be double coded with **Barrier**. Inclusion Criteria: Include statements that demonstrate OpenELIS is worse than existing tools.	intervention characteristics
Disadvantage	Include statements about a disadvantage/flaw/issue of OpenELIS software, technology, or program implementation when there is **no explicit comparison** to other tools.	intervention characteristics
01.C adaptability	Definition: The degree to which OpenELIS can be adapted, tailored, refined, or reinvented to meet local needs. Inclusion Criteria: Include statements regarding the (in)ability to adapt OpenELIS to their context, e.g., complaints about the rigidity of the protocol and/or software. Suggestions for improvement can be captured in this code but should not be included in the rating process, unless it is clear that the participant feels the change is needed but that the program cannot be adapted. However, it may be possible to infer that a large number of suggestions for improvement demonstrates lack of compatibility, see exclusion criteria below. Exclusion Criteria: Exclude or double code statements that OpenELIS did or did not need to be adapted to **Compatibility**.	intervention characteristics
01.D complexity	Definition: Perceived difficulty of OpenELIS, reflected by duration, scope, radicalness, disruptiveness, centrality, and	intervention characteristics

	intricacy and number of steps required to implement. Inclusion Criteria: Code statements regarding the complexity of OpenELIS itself. Exclusion Criteria: Exclude statements regarding the complexity of implementation process (rather than using the software itself) and code to the appropriate CFIR code, e.g., difficulties related to space are coded to Available Resources and difficulties related to engaging participants in a new program are coded to Engaging: Innovation Participants.	
01.E perceived sustainability	Definition: The perceived likelihood of continued use of OpenELIS program components and activities for the continued achievement of dessirable program outcomes. Inclusion criteria: Include statements that capture perceptions of sustainability of OpenELIS at a **health systems level** throughout and after implementation. Exclusion criteria: Exclude statements that capture current or potential sustained behavior at an **individual level**.	intervention characteristics
01.F perceived scalability	Definition: The perceived potential of OpenELIS implementation expansion so that OpenELIS is available across wider geographic or practice settings. Inclusion criteria: Include statements that capture perceptions regarding why OpenELIS could or could not scale, and how implementation could be modified or optimized to enhance replicability of core intervention components.	intervention characteristics
01.G design quality	Definition: Perceived excellence in how OpenELIS software is bundled, presented, and assembled. Inclusion Criteria: Include statements regarding the quality of the materials and packaging. Exclusion Criteria: Exclude statements regarding the receipt of materials/computers as an engagement strategy and code to Engaging.	intervention characteristics
02.A external policy & incentives	Definition: A broad construct that includes external strategies to spread OpenELIS including policy and regulations (governmental or other central entity), external mandates, recommendations and guidelines, pay-for-performance, collaboratives, and public or benchmark reporting. Inclusion Criteria: Include descriptions of external performance measures from the system.	outer setting
03.A structural characteristics	Definition: The social architecture (level in the health system, service capacity [VL/EID/reference,hub lab/routine local lab]), age, maturity (duration of lab services, OpenELIS use), and size (# staff, # rooms/buildings) of an organization. Also use this code to code the name of the health facility/lab at the very top of each transcript.	inner setting
03.B implementation climate	Definition: The absorptive capacity for change, shared receptivity of involved individuals to OpenELIS, and the extent to which use of OpenELIS will be rewarded, supported, and expected within their lab/hospital. Inclusion Criteria: Include statements regarding the general level of receptivity to implementing OpenELIS.	inner setting

	Exclusion Criteria: Exclude statements regarding the general level of receptivity that are captured in the sub-code **Compatibility**	
03.B.1 compatibility	Definition: The degree of tangible fit between meaning and values attached to OpenELIS by involved individuals, how those align with individuals' own norms, values, and perceived risks and needs, and how OpenELIS fits with existing workflows and systems. Inclusion Criteria: Include statements that demonstrate the level of compatibility OpenELIS has with organizational values and work processes. Include statements that OpenELIS did or did not need to be adapted as evidence of compatibility or lack of compatibility.	inner setting
04.A knowledge, attitudes & beliefs about the intervention	Definition: **Individuals**' attitudes toward and value placed on the OpenELIS project, as well as familiarity with facts, truths, and principles related to OpenELIS.	characteristics of individuals
04.B self-efficacy	Individual belief in their own capabilities to execute courses of action to achieve implementation goals.	characteristics of individuals
05.A engaging	Definition: Attracting and involving appropriate individuals in the implementation and use of OpenELIS through a combined strategy of social marketing, education, role modeling, training, and other similar activities. Inclusion Criteria: Include Answers to question 2.1, if appropriate. Include statements related to engagement strategies and outcomes, i.e., if and how staff and intervention participants became engaged with the OpenELIS project and what their role is in implementation. Note: Although both strategies and outcomes are coded here, the **outcome** of engagement efforts determines the rating (= double code with **Facilitator** or **Barrier**). For example, if there are repeated attempts to engage staff, but the efforts are unsuccessful, this construct should be double coded with Barrier. Exclusion Criteria: Exclude statements related to specific sub constructs (code 5.A.1-5.A.4). Exclude or double code statements related to who participated in the decision process to implement the intervention to **Intervention Source**, as an indicator of internal or external intervention source.	process
05.A.1 opinion leaders	Definition: Individuals in the lab/hospital that have formal or informal influence on the attitudes and beliefs of their colleagues with respect to implementing OpenELIS. Inclusion Criteria: Include statements related to engagement strategies and outcomes, e.g., how the opinion leader became engaged with the OpenELIS project and what their role is in implementation. Note: Although both strategies and outcomes are coded here, the **outcome** of efforts to engage staff determines the rating (**Facilitator** or **Barrier** double code). E.g., if there are repeated attempts to engage an opinion leader that are unsuccessful, or if the opinion leader leaves the organization and this role is vacant, the construct should be double coded with Barrier.	process

05.A.2 formally appointed internal implementation leaders	Definition: Individuals from **within** the lab/hospital who have been formally appointed with responsibility for implementing OpenELIS as coordinator, project manager, team leader, or other similar role. Inclusion Criteria: Include statements related to engagement strategies and outcomes, e.g., how the formally appointed internal implementation leader became engaged with the OpenELIS project and what their role is in implementation. Note: Although both strategies and outcomes are coded here, the **outcome** of efforts to engage staff determines the rating (**Facilitator** or **Barrier** double code), i.e., if there are repeated attempts to engage an implementation leader that are unsuccessful, or if the implementation leader leaves the organization and this role is vacant, the construct receives a negative rating.	process
05.A.3 champions	Definition: "Individuals who dedicate themselves to supporting, marketing, and 'driving through' an [implementation]", overcoming indifference or resistance that the intervention may provoke in an organization.Inclusion Criteria: Include statements related to engagement strategies and outcomes, e.g., how the champion became engaged with the intervention and what their role is in implementation. Note: Although both strategies and outcomes are coded here, the outcome of efforts to engage staff determines the rating, i.e., if there are repeated attempts to engage a champion that are unsuccessful, or if the champion leaves the organization and this role is vacant, the construct receives a negative rating. In addition, you may also want to code the "quality" of the champion here - their capabilities, motivation, and skills, i.e., how good they are at their job, and this data affects the rating as well.	process
05.A.4 external change agents	Definition: Individuals who are affiliated with an **outside** entity who formally influence or facilitate OpenELIS project decisions in a desirable direction. Inclusion Criteria: Include statements related to engagement strategies and outcomes, e.g., how the external change agent (entities **outside** the lab/hospital that facilitate change) became engaged with the OpenELIS project and what their role is in implementation, e.g., how they supported implementation efforts. Note: Although both strategies and outcomes are coded here, the **outcome** of efforts to engage staff determines the rating, i.e., if there are repeated attempts to engage an external change agent that are unsuccessful, or if the external change agent leaves their organization and this role is vacant, the construct receives a negative rating (i.e., Barrier).	process
05.B reflecting & evaluating	Definition: Quantitative and qualitative feedback about the progress and quality of implementation accompanied with ~~regular~~ personal and team debriefing about progress and experience. Inclusion Criteria: Include statements that refer to the implementation team's (lack of) assessment of the progress toward and impact of implementation, as well as the	process

	interpretation of outcomes related to implementation. Reflecting and Evaluating is part of the implementation process; it likely ends when implementation activities end. It does not require goals be explicitly articulated; it can focus on descriptions of the current state with real-time judgment, though there may be an implied goal (e.g., we need to implement OpenELIS) when the implementation team discusses feedback in terms of adjustments needed to complete implementation.	
06.1.1 facilitator	Definition: Any factor/construct/subconstruct that facilitates/helps/enhances any attitude or action in the positive direction along the implementation process (from being approached to adopt to post-implementation) Can be double coded with any CFIR construct or inductively created factor codes	valence
06.1.2 barrier	Definition: Any factor that hinders/inhibits any attitude or action in the negative direction along the implementation process (from being approached to adopt to post-implementation) Can be double coded with any CFIR construct or inductively created factor codes	valence
06.1.3 present	Definition: Simply describe whether an implementation factor is present, when there really is no information for us to infer whether a factor helps or hinders implementation. Exclusion: If you can rate the factor as facilitator or barrier, do not use this code.	valence
07.1 maturity	Definition: Must be double coded with Knowledge & Beliefs about the Intervention For question 16	maturity
08 suggestions for improving OE	Suggesting new changes to improve the OpenELIS software or the program implementation/support/maintenance/monitoring Exclude: complaints/descriptions of problems in the status quo or in the past	suggestions
08 suggestions for MSHP		suggestions
08 general suggestions	Suggestions that are not related to OE software, OE program, or specifically to MSHP. E.g., labs need training support in other aspects of lab management.	suggestions
09.1 pitching	Adoption or implementation has not begun. There was just this idea of adopting OpenELIS. No concrete actions.	timeline
09.2 adoption	Concrete action/decision to adopt OpenELIS.	timeline
09.3 early implementation	After adoption, concrete actions of actually starting to use OpenELIS and to try to routinize the use in the **early/initial** period of implementation.	timeline
09.5 current implementation	Recent and current implementation	timeline
10.1 changes in OpenELIS to improve fit between OpenELIS and practice setting	The changes that were made on the intervention (OpenELIS) after the implimentation process, based on feedback and M&E to accomodate and improve the fit of OpenELIS in the practice setting (staffing, info system, org. culture/climate, training, supervision) Inclusion criteria: any change that was made after the implimentation process on one or more of the following:	

	Components, Practitioners, Outcomes, Delivery Platform with the aim of improving the practice settings mentioned above. Exclusion criteria: changes that were made on OpenELIS before the implimentation process, any change that was made to accommodate or improve the fit with anything other than the practice setting	
10.2 changes in practice setting to improve fit with OpenELIS	The changes that were made on a practice setting level (staffing, info system, org. culture/climate, training, supervision) to accommodate the implementation of OpenELIS and leverage its meaningful impact	
10.3 changes in OpenELIS to improve fit with eco system	The changes that were made on the intervention (OpenELIS) after the implimentation process, based on feedback and M&E to accomodate and improve the fit of OpenELIS in the eco system (policy, regulations, market forces, population charachtersitics) Inclusion criteria: any other practice setting other than the ones mentioned in 10.1	
10.4 changes in eco system to improve fit with OpenELIS	Any change that was made on an eco system level (policy, regulations, population charachteristics, market force) to accommodate and improve the fit of OpenELIS	
10.5 changes in practice setting that improve the fit between OpenELIS and eco system	The changes that were made on a practice setting level (staffing, info system, org. culture/climate, training, supervision) to facilitate the fitting between OpenELIS (intervention) and the eco system.	
10.6 any other changes	Capture the change over time that is not captured by any of the 10.1-10.5 codes	
Dashboard	Any question and response related to the data dashboards	
Quote	Any direct quotes (in both French and English) that convey strong meanings/emotions or are so well said that we as analysts would not be able to summarize better than the original quotes.	
Double check the translation	Inclusion criteria: For content whose translation is unclear/confusing but seems the nuance is important enough for our findings.	
Autonomy	Statements about how the lab staff feel about their autonomy/authority in the decision making or implementation process of OpenELIS.	
Functionality	Includes statements that describe any uses/functions/purposes of OpenELIS. e.g. the lab tests that people use OpenELIS for; other purposes such as data management, storage, reporting, quality control, etc.	intervention characteristics
Supervisors' role	Describe the roles/responsibilities/duties of the supervisor/leader of the OpenELIS implemenation at a lab	
Need context	For codes out of context and no clear meaning	
Perceptions of future	Statements about perceptions of the future of the OpenELIS software or program, except statements about perceptions of sustainability or scalability which are captured by 01.E and 01.F	
Q15 a. strongly receptive		
Q15 b. receptive		
Q15 c. indifferent		

Q15 d. resistant
Q15 e. strongly resistant
Q16 a. still very new, a lot to learn
Q16 b. we know the basics
Q16 c. using OE is part of routine

Appendix 4: Positionality Statement

Positionality Statement

The analysis and interpretation presented in this thesis were shaped by my background as a public health professional with over five years of experience working with donor-funded programs. This experience has provided me with a strong understanding of health systems from the perspective of funders and national-level implementation. At the same time, it may have influenced how I approached the concept of sustainability, potentially prioritizing formal structures over more localized, facility-level experiences.

I was not involved in designing the study or conducting the interviews. I joined the project during the analysis phase and worked with transcripts and materials that had already been developed. My lack of prior experience in digital health, particularly in laboratory information systems, presented a learning curve and may have shaped what I initially paid attention to. However, it also allowed me to engage with the data without rigid expectations or preexisting assumptions.

This thesis was completed after a break from formal academic work. Returning to it after time away gave me distance and perspective, but also required me to reconnect deeply with the material and context. Importantly, I finalized this manuscript during a period of significant political and funding shifts, including the dismantling of USAID programs and broader cuts to U.S. global health funding. These developments may have sensitized me to issues of donor dependency and influenced my interpretations of sustainability and local ownership.

Throughout the process, I remained aware of how my position, assumptions, and background could influence interpretation. I used memoing, revisited documentation, and consulted with colleagues to stay grounded in the original setting and maintain analytic integrity.