

Leveraging a DHIS2 Based Ecosystem to Improve Health Data Management and Reporting: Innovations from the Monitoring, Reporting, and Evaluation (MORE-ZM) System in Zambia

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Leveraging a DHIS2 Based Ecosystem to Improve Health Data Management and Reporting: Innovations from the Monitoring, Reporting, and Evaluation (MORE-ZM) System in Zambia

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Abstract

Background

Digital health information systems (HIS) are essential for strengthening health system performance in low and middle-income countries (LMICs). In Zambia, before October 2020, HIS in programs supported by the U.S. Centers for Disease Control and Prevention (CDC) were fragmented, with limited harmonization and reliance on manual reporting, impacting timeliness and data use. With support from CDC, the monitoring, reporting and evaluation – Zambia (MORE-ZM) system was built to address these gaps using an open source district health information software 2 (DHIS2)–based ecosystem. This paper presents its implementation process and outcomes. MORE-ZM streamlined implementing partners systems into a multi-instance DHIS2 setup with centrally managed metadata. Rollout followed a collaborative process across 1,584 facilities in five provinces. Three innovations were introduced: the monitoring,

evaluation and reporting (MER) parser for automated transformation of electronic health record (EHR) outputs into DHIS2 imports, the automation tool for donor reporting which is referred to as the monthly BOB report, and DHIS2–Power BI connectors for dashboards. Training included 1,575 staff.

Results

The multi-instance system architecture provided stability during routine operational interruptions. Although no formal data were collected, it was observed that manual MER reporting took several days while the automated MER parser took few minutes and monthly donor reports were generated within half an hour. Integration of DHIS2 with Power BI enabled near real-time visualization. Training supported system use and adoption.

Conclusions

MORE-ZM demonstrates that harmonizing systems with DHIS2 and applying automation can transform reporting into timely information flow. These solutions strengthened data use in CDC-supported programs, offering scalable lessons for other LMICs.

Keywords: Automation, Interoperability, Data quality, PEPFAR, DHIS2, Open-source software

Background

Health information systems (HIS) are fundamental to the development of resilient, efficient, and responsive health systems [1]. In the context of low and middle-income countries (LMICs), the capacity to collect, manage, analyse, and use health data remains a significant determinant of progress toward universal health coverage (UHC) and Sustainable Development Goals (SDGs)

[2]. Timely and accurate data are required for monitoring service delivery, tracking health outcomes, allocating resources, and shaping public health policy [3, 4]. As countries continue scaling up health programs, particularly those targeting people living with HIV/AIDS, tuberculosis, and malaria, the demand for real-time data has grown, placing pressure on existing HIS infrastructures [5].

Although digital tools have become increasingly prevalent, many LMICs continue to experience significant gaps in HIS infrastructure, including fragmented data sources, poor interoperability between platforms, inconsistent indicator definitions, duplicated reporting efforts, and underutilization of data for decision-making [6]. These issues are particularly problematic in settings where programmatic reporting is donor-driven, necessitating integration of international standards for data quality, completeness, and timeliness [7].

The adoption of digital health platforms has created new opportunities to transform HIS design and operation. Among these platforms, the district health information software 2 (DHIS2) [8] has emerged as one of the most widely implemented open source HIS platforms globally. As of 2023, DHIS2 is used in over 80 countries, supporting national data systems that serve more than 2 billion people [9]. The modular and highly configurable architecture of DHIS2 allows ministries of health and implementing partners to customize the platform to local settings. However, widespread adoption alone does not equate to effective use. While DHIS2 improves data availability, challenges remain. These include ensuring data quality, achieving standardization among implementing partners, and effectively using data for strategic planning [10]. Without mechanisms for automation, harmonization, and visualization, the full potential of DHIS2 to strengthen HIS remains unrealized in many contexts.

Over the past decade, Zambia has made strides in digitizing its health sector, including the national rollout of the SmartCare electronic health record (EHR) system, expansion of mobile health applications, and widespread use of DHIS2 for routine reporting and program monitoring [11]. Despite these investments, the health information ecosystem remained fragmented with vertical programs and implementing partners operating parallel systems that created duplicated reporting requirements, delayed data collection and donor reporting submissions and limited timely use of data for decision-making [12]. These persistent inefficiencies underscored the need for a harmonized, automated solution. To address these challenges, the monitoring, reporting and evaluation – Zambia (MORE-ZM) system was launched 1 October 2020 with funding and technical support from the U.S. Centers for Disease Control and Prevention (CDC) through the President’s Emergency Plan for AIDS Relief (PEPFAR). MORE-ZM replaced fragmented implementing partners’ data management tools with a standardized open source DHIS2-based ecosystem that harmonized and automated reporting workflows, embedded data quality checks, and streamlined visualization across CDC-supported programs. By documenting both the technical innovations (automation, harmonization, real-time analytics) and the governance processes (implementing partners alignment, capacity building, etc.), this paper contributes applied lessons to global efforts advancing digital transformation, system interoperability, and HIS resilience [4, 13].

Implementation

Legacy Systems and Manual Workflows

PEPFAR implementing partners conducted both monthly and quarterly reporting as part of the required data processing obligations. Monthly reporting was done through what is referred to as the BOB report. The BOB is a Microsoft Excel-based template that has more granular facility-level program performance details in one sheet and a consolidated summary of all supported facilities on another. The quarterly reporting involved populating data to the DHIS2-based Data for Accountability, Transparency and Impact Monitoring (DATIM), a U.S government centralized, web-based platform built on a DHIS2 platform. DATIM also served as the source for facility-level performance targets by indicator, which implementing partners used for planning and tracking progress toward targets.

Each implementing partner maintained independent Excel-based and custom electronic tools for data collection, storage, and reporting. Data-collection tools and reporting templates were developed according to implementing partner program requirements. During this period, CDC's implementing partners included Western, Lusaka, Southern, and Eastern Provincial Health Offices (PHO), together with Centre for International Health, Education, and Biosecurity (CIHEB), Development Aid from People to People (DAPP), University Teaching Hospital (UTH), International Center for AIDS Prevention (ICAP) at Columbia University, Family Health International (FHI360), Chreso Ministries, Coptic Hospital, Circle of Hope Zambia (CoH) and Centre for Infectious Disease Research in Zambia (CIDRZ).

Under the national monthly reporting schedule followed by CDC–PEPFAR implementing partners, a ten-day period starting at the end of the month of interest is used to complete data collection. This is followed by five-day period where data from all facilities and implementing partners is compiled and populated into the BOB report template. This would be necessitated by the need to meet the deadline usually set to be on the third Monday of that month. During these intervals, responsible personnel would export data from electronic tools, transcribe data from paper registers, and populate aggregated indicator values into the BOB report template and, for quarterly reporting, DATIM (see Figure 1).

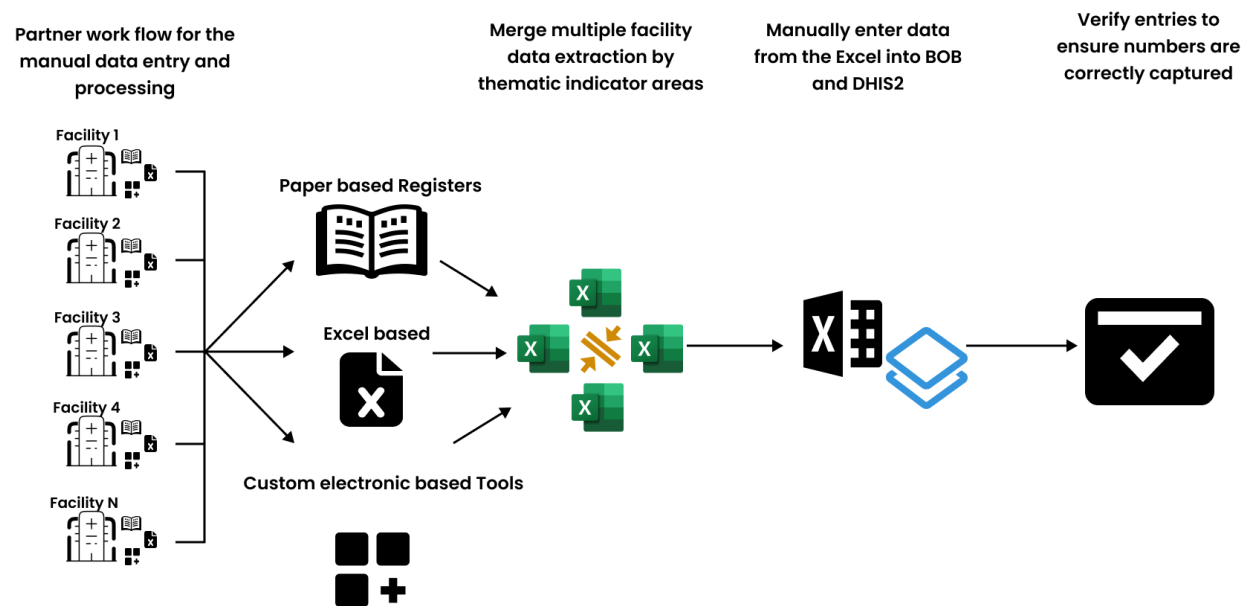


Figure 1. Manual data-entry and reporting workflows.

Program managers and analysts used Excel to combine data from implementing partner systems with DATIM targets and then create visualizations and summaries, both for ad hoc analysis and routine reporting.

Overview of the MORE-ZM Implementation Strategy

The MORE-ZM system adopted a phased, modular implementation strategy centred around the DHIS2 platform. The phases of the implementation were as follows: the metadata harmonization, multi-instance configuration, deployment to initial provinces, scale-up across all implementing partners and integration of automation tools. The separate modules of the system are the DHIS2 architectural components, the monitoring, evaluation and reporting (MER) parser, the BOB automation tool and DHIS2-Power BI connectors. DHIS2 is a web-based system designed with three layers; a database for data storage, an application server for processing, and a web interface for user access where configuration details (called metadata) can be easily updated and shared. Implementation was supported through structured capacity-building and training of program staff, instituting governance mechanisms, and alignment with donor reporting requirements. This framework provided the basis for the system design, integration, and monitoring processes described in the subsequent sections. The ecosystem was scaled through a phased rollout beginning 1 October 2020. System expansion continued to include 1,584 health facilities across five CDC-supported provinces — Eastern, Lusaka, North-Western, Southern, and Western by 30 September 2025.

Multi-Instance DHIS2 Architecture and Design

MORE-ZM utilized a multi-instance DHIS2 architecture that reflects the decentralized nature of Zambia's health system, and PEPFAR's implementing partners. In this model, each participating PHO or implementing partner operates its own DHIS2 instance. These instances are deployed independently to allow for localized data entry, analysis, and ownership. They are hosted on separate virtual machines with distinct Tomcat application servers and PostgreSQL databases. As

illustrated in Figure 2, the architecture includes instances each representing a separate deployment aligned with provincial or implementing partner’s needs. These deployments are anchored in a common hosting environment, with consistent technical configurations and security standards. End users at the facility level access these instances through secure web interfaces to enter, validate, and view programmatic data. An example of a live deployment within the multi-instance setup, the Lusaka Provincial Health Office (LPHO) instance, is accessible online [14].

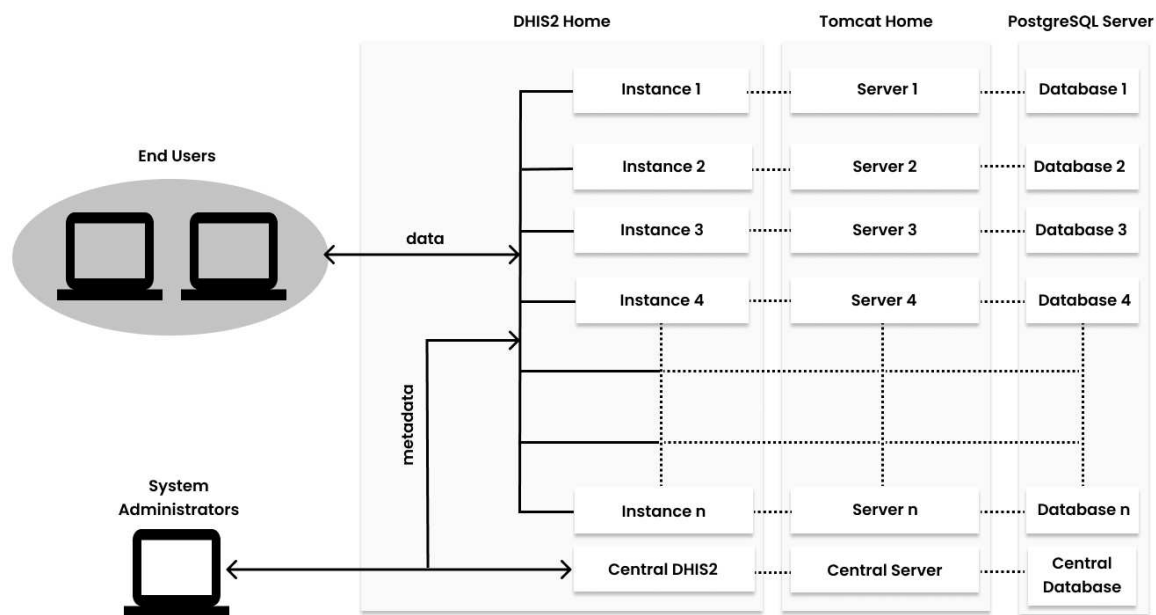


Figure 2. Multi-instance DHIS2 architecture and centralized metadata coordination in the MORE-ZM ecosystem

Central Metadata Harmonization

MORE-ZM implemented a centralized metadata management strategy, wherein a central metadata server acts as the authoritative source for all system configurations, including data elements, indicators, datasets, organisation units, and reporting templates. Metadata from the

central instance is exported and imported across all provincial and implementing partners instances, periodically and as changes arise, to maintain uniformity. This is done through version-controlled metadata packages shared via Git repositories and periodically synced using DHIS2 import/export tools. As shown in Figure 2, metadata flows from the central instance outward to individual deployments, while data flows in the opposite direction for aggregation and analysis.

System Integration and Automated Data Flow

A coordinated suite of automation tools was designed to extend the functionality of DHIS2 and support data management and reporting among participating implementing partners. In the sections below, we describe the various tools included in this suite.

The Monitoring, Evaluation and Reporting (MER) Parser

The MER parser was implemented in the MORE-ZM ecosystem to automate and standardise the transformation of EHR outputs into DHIS2-importable formats. The parser converted the manual data entry steps of EHR files, by validating the files against a standard format, mapped their values to DHIS2 data elements, and produced a DHIS2-ready comma-separated values (CSV) file for direct import, as illustrated in Figure 3. The MER parser was developed in Python using the Flask web framework and is accessible through a web interface [15].

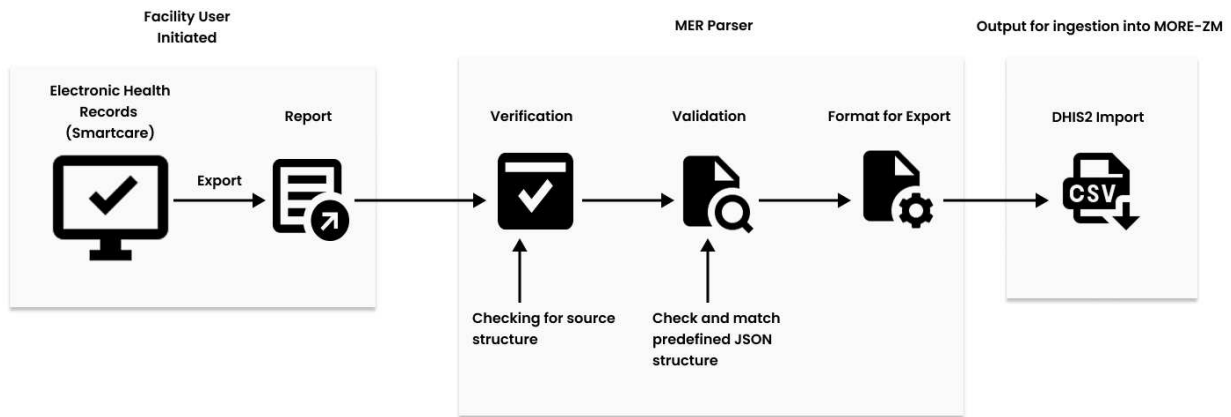


Figure 3. Data extraction and transformation workflow in the MER parser: From EHR reports to DHIS2-importable CSV files.

The CSV files are uploaded via the DHIS2 import/export app as illustrated in Figure 4, where standard validation rules check for consistency in data elements, category combinations, and organizational units.

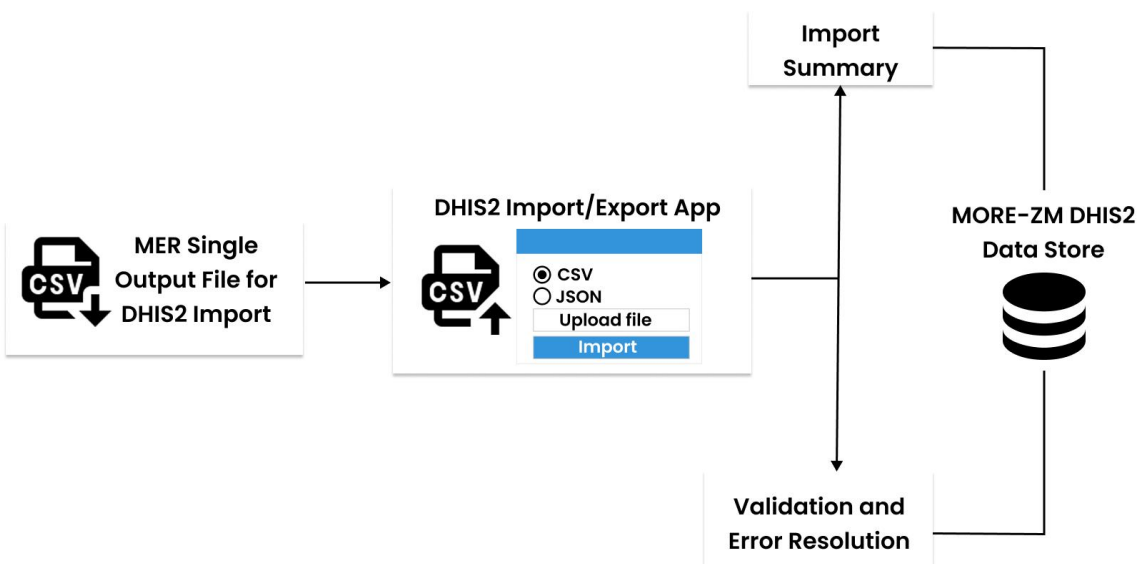


Figure 4. DHIS2 import and validation workflow for transformed EHR data via the MER parser

The BOB Reporting Automation Tool

The BOB reporting automation tool was developed to streamline preparation of monthly PEPFAR reports. The automated BOB tool re-engineered the manual preparation steps into a fully integrated workflow. The tool queries the PostgreSQL database underlying the DHIS2 instance to extract programmatic data, including HIV testing services (HTS), antiretroviral therapy (ART), tuberculosis (TB), prevention of mother-to-child transmission (PMTCT), and viral load (VL) indicators. As illustrated in Figure 5, the process begins with a user-initiated request to generate a report. The system retrieves the required indicators and aligns them to mappings stored in an external configuration file. Like the MER parser, the BOB reporting automation tool was developed in Python using the Flask web framework and is accessible through the same web interface [15].

Using predefined logic, the automation populates the standardized Excel template required for PEPFAR BOB reporting by placing each data value into the correct worksheet cell.

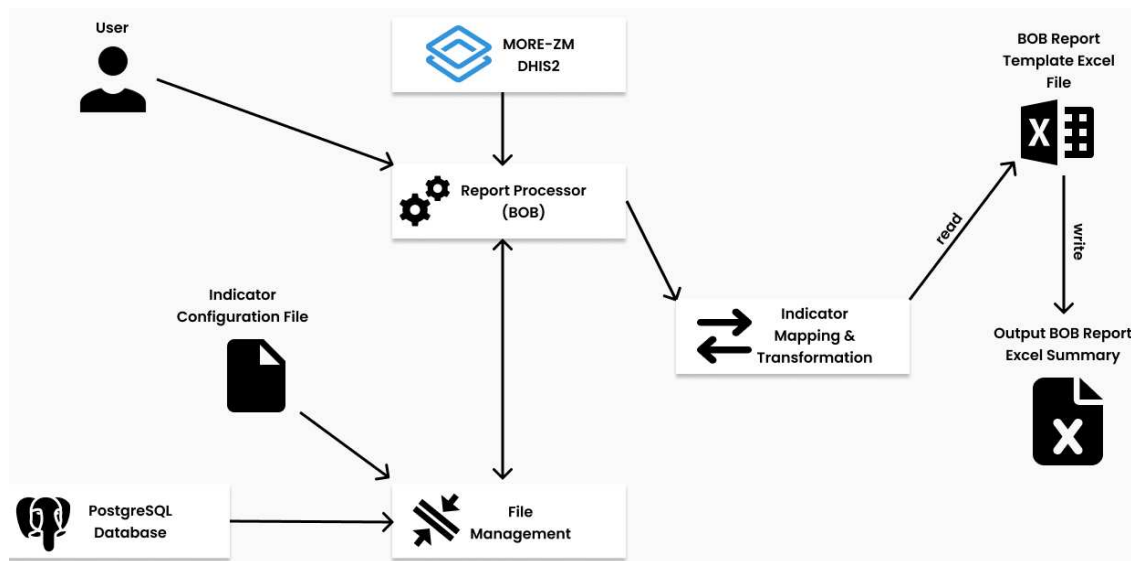


Figure 5. BOB Reporting Automation workflow: PostgreSQL queries and auto-mapping to PEPFAR-compliant excel templates.

DHIS2 - Power BI Integration for Aggregate and Tracker Data

Custom DHIS2–Power BI connectors were developed within the MORE-ZM ecosystem to enable integration with the DHIS2 instances. The connectors were built using Microsoft’s M-language and interfaced directly with the DHIS2 web application programming interface (API). The connectors retrieved aggregate data from the DHIS2 analytics data value set endpoint and access longitudinal (tracker) data through the tracked entity instances, enrolments, and events endpoints. Users are authenticated through a secure login form, after which the connectors fetch the specified data, applied optional filters (such as organizational unit or program), and structured the outputs into a Power BI compatible data model. Implementation followed published configuration guidelines described in the DHIS2 Power BI connector user guide and the DHIS2 community release documentation [16]. Figure 6 illustrates the technical data flow from DHIS2 API endpoints into Power BI. The two compiled connector extension packages, for

aggregate data and for tracker data, including their Power Query M source code, are provided with this article as Additional files 1 and 2.

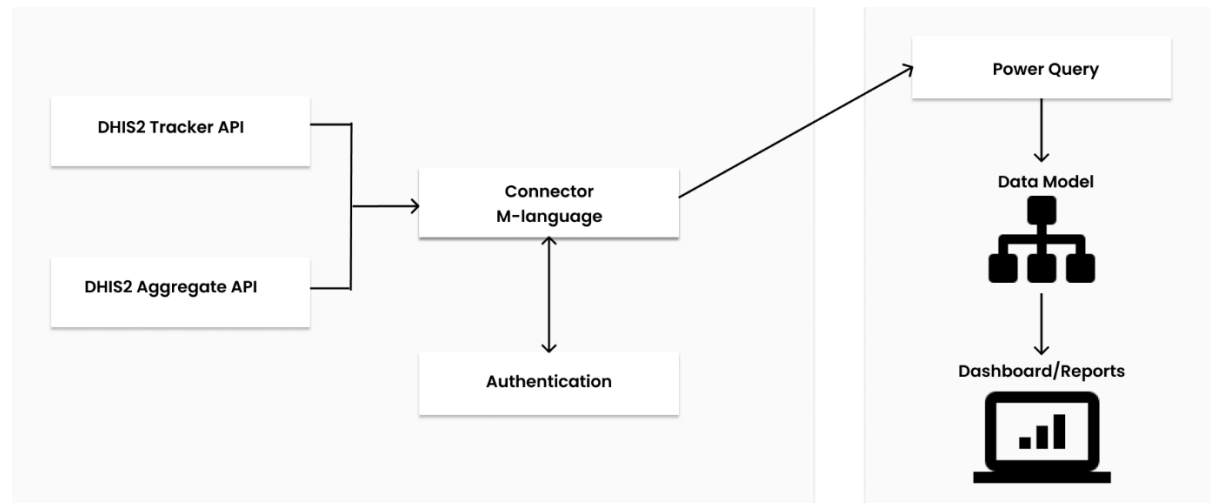


Figure 6. DHIS2-Power BI connector data flow: from DHIS2 API endpoints to interactive dashboards and advanced analytics in Power BI.

System Governance, Sustainability, Capacity Building, and Technical Support

MORE-ZM applied a governance and capacity-building framework to support deployment and system maintenance. Stakeholder engagement and technical coordination were structured through monthly virtual meetings and annual in-person bootcamps. Agile project management tools, including JIRA and Asana, facilitated task tracking, backlog management, and documentation. We trained clinical and monitoring and evaluation (M&E) staff in DHIS2 data entry, dashboard use, and metadata standards. Technical modules covered the MER parser, BOB automation, and DHIS2–Power BI integration. System administrators received advanced training on dataset management, validations, user roles, and SQL view configuration.

Data Quality Assurance Mechanisms

MORE-ZM implemented data quality assurance (DQA) measures comprising validation, verification, and feedback processes across the data lifecycle. Quality checks were embedded at multiple levels within the system. The MER parser performed initial structural validation through its extract-transform-load (ETL) process, enforcing metadata alignment and verifying disaggregation variables. Within DHIS2, the Validation Rules Engine applied basic and compound rules using the Validation App during data entry and cleaning. The BOB automation tool incorporated internal validation steps to detect missing data, formatting inconsistencies, and mapping errors. Cross-system consistency was verified by comparing DHIS2 outputs with Power BI visualizations and BOB reports, using key program indicators across major service areas.

Monitoring and Maintenance Processes

MORE-ZM implemented continuous monitoring and maintenance procedures to sustain system functionality and stability across all implementing partner instances. System monitoring dashboards were set up to track server uptime, disk use, API response, and database performance. Alerts for downtime or configuration errors were shared through email. Version-controlled metadata repositories ensured traceability, and synchronized updates across deployments.

Evaluation

No formal evaluations were conducted for the implemented tools. However, feedback on system functionality and user experience was routinely gathered through discussions during implementing partners meetings, review calls, and coordination sessions. User engagement and

adoption were tracked through implementing partner-initiated feature requests, which provided practical input for technical refinements. We provide descriptive observation on system coverage, reporting workflows, and how dashboards were used for data visualization and use, along with other implementation experiences.

Results

Coverage and Alignment

By September 2025, MORE-ZM was operational in 1,584 health facilities across five CDC-supported provinces which is 80% of the 1,986 health facilities in these provinces. All participating instances functioned under a common configuration and reporting framework, resulting in uniform indicator definitions and consistent reporting outputs among implementing partners. The system achieved full metadata alignment across provinces, enabling comparable and consolidated data reporting.

Reporting Duration Improvement

Automated reporting workflows reduced manual data handling during reporting. Although no formal data were collected, it was observed that manual MER reporting took several days while the automated MER parser took a few minutes and monthly donor BOB reports were generated within half an hour.

Visualization and Data Use

The integration of DHIS2 with Power BI provided near real-time dashboards that replaced reliance on manual CSV exports and pivot tables. Program managers gained immediate access to disaggregated trends in HIV testing, treatment, PMTCT, and TB. These dashboards were routinely used during provincial and district performance reviews, supporting more timely, data-driven decision-making and increasing the visibility of program progress across facilities.

Data Quality Gains

The previous manual process had no standardized way of validating data while MORE-ZM introduced validation processes that supported the consistency of reported indicators across systems. Cross-checks between EHR, DHIS2, and reporting tools showed results aligned, with only minor timing-related differences observed during data synchronization. These variations reflected routine system update intervals rather than data entry errors, confirming overall consistency of reported values.

Governance and Local Ownership

Regular coordination meetings and technical bootcamps improved alignment and collaboration among implementing partners. From documentation of trainings, at least 1,575 programme, M&E, and system administration staff received training on MORE-ZM use, though some participants may not have been fully accounted. Implementing partner adoption increased from four at initiation to all the thirteen by September 2025, reflecting broader engagement with the system over time.

System Reliability and Scalability

Dashboard system monitoring confirmed uptime and stable performance across deployments. The modular system design allowed uninterrupted operation during maintenance activities and supported expansion without service disruption. As illustrated in Figure 7, this architecture improved operational resilience, scalability and enabled seamless integration of automation and analytics tools across the ecosystem.

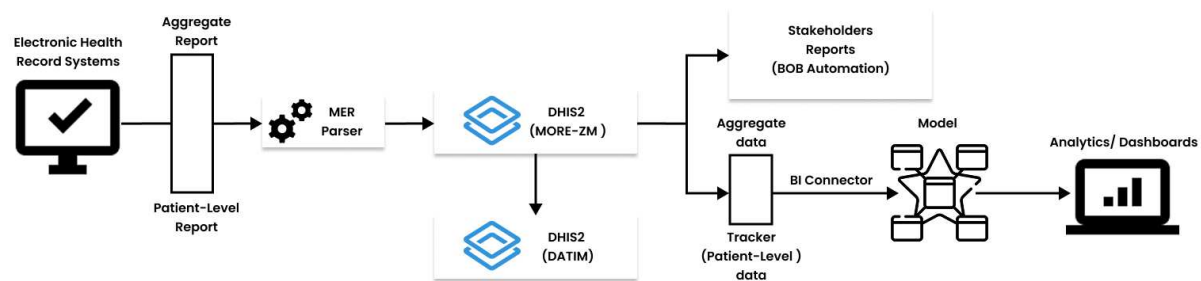


Figure 7. Modular integrated flow in the MORE-ZM DHIS2 Based ecosystem from EHRs to reporting and analytics platforms

Discussion

Automating routine MER reporting and BOB submissions shifted staff effort from repetitive compilation to review and decision support. The reduction from multi-day manual workflows to minutes of automated processing suggests that targeted ETL and templating can materially compress reporting cycles in implementing partner-led DHIS2 ecosystems. Similar effects have been reported in other DHIS2 implementations where automation reduced turnaround times and reliance on manual-based workflows [17, 18]. Importantly, manual workflows still run in some

settings; the current gains reflect an early-scale state and will likely vary by implementing partner capacity and local processes.

Embedding validation at multiple points—parser-level structural checks, DHIS2 validation rules performed during the 10-day entry and 5-day cleaning window, automated BOB feedback, and DHIS2–Power BI cross-checks helped operationalize proactive DQA rather than retrospective error correction. This layered approach is aligned with global HIS guidance emphasizing metadata standardization and routine validation cycles [13, 19]. While improvements were observed anecdotally by implementing partner teams, such as fewer mis-mapped indicators and earlier discrepancy detection, a formal before–after measurement of error rates was not conducted; future work should include independent audits to quantify data quality effects.

Near real-time dashboards reduced reliance on manual CSV exports and pivot-table workflows, improving the timeliness of actionable insights for provincial reviews and implementing partner performance management. Experience from other DHIS2 deployments suggests that timely, standardized dashboards increase data use, provided users receive adequate training and governance sets expectations for how data should be applied in decision-making forums [10, 20]. Risks remain, however, including dashboard fatigue and misinterpretation in the absence of data literacy support.

Governance and local ownership were strengthened through monthly implementing partner meetings, a yearly bootcamp, and the use of shared backlog tooling to coordinate metadata updates and troubleshoot issues across multiple DHIS2 instances. These mechanisms distributed operational knowledge beyond a central technical team, supporting sustainability. This is consistent with lessons from earlier DHIS2 programs where weak coordination constrained long-

term performance [21]. Continued attention to role clarity, succession planning, and documentation will be essential as implementing teams evolve.

The modular, multi-instance architecture limited the blast radius of local outages and enabled provincial ownership, while central metadata harmonization created a single authoritative source of truth for indicators and templates so that automations behaved consistently across implementing partners. Yet trade-offs remain: multi-instance models require disciplined release management to avoid version drift, and centralized metadata governance must keep pace with rapidly evolving program indicators. Future system strengthening could explore standards-based interoperability (e.g., Health Level Seven - Fast Healthcare Interoperability Resources (HL7 FHIR)) to move beyond file exports, containerized deployment for elastic scaling, and the adoption of explicit service-level objectives with embedded monitoring [22, 23].

Several limitations should be noted. First, the assessment of data-quality accuracy, particularly reduction in discrepancies across systems, was based on validations and cross checks comparisons rather than from formal evaluation methods. Second, data entry automation depended on periodic EHR exports rather than real-time exchange, constraining immediacy. Third, results derived from a donor-supported implementation in Zambia and may not generalize without similar governance and technical capacity.

Overall, the findings suggest that a combined strategy of automation, metadata harmonization, and structured governance can improve reporting cycles, data consistency and use in DHIS2-enabled HIS. As MORE-ZM scales, priorities should include formal evaluation of efficiency and data-quality outcomes, progressive adoption of interoperability standards, capacity building for

data use, and planning for sustainable financing. While context-specific, the MORE-ZM experience provides transferable lessons for others seeking to modernize HIS using DHIS2.

Conclusions

MORE-ZM demonstrates how targeted innovations in automation, data integration, and governance can transform HIS in resource-limited settings. By reducing routine and donor reporting from several days to minutes, strengthening data quality assurance, and enabling real-time analytics through DHIS2–Power BI integration, the system has improved both efficiency and reliability of programmatic reporting. The adoption of a multi-instance architecture with centralized metadata harmonization further ensured coherence across implementing partners, while proactive monitoring reinforced system scalability and resilience.

Beyond technical achievements, the initiative fostered local ownership through capacity-building and structured governance processes. Initial discussions have begun to support transition toward sustainable adoption within the Zambian Ministry of Health–managed DHIS2 system, embedding long-term sustainability within HIS. These results illustrate a shift from fragmented, labour-intensive reporting towards an integrated, adaptive ecosystem that empowers evidence-based decision-making across U.S Government/PEPFAR-supported programs in Zambia.

Future work should focus on extending these tools to additional provinces, expanding interoperability with other digital health platforms and institutionalizing automation within routine workflows.

Availability and requirements

Project name: MORE-ZM DHIS2-based ecosystem (customized DHIS2 multi-instance deployment, MER parser, BOB reporting automation tool, and DHIS2–Power BI connectors)

Project home page: MORE-ZM DHIS2 Lusaka Provincial Health Office instance (example deployment within the multi-instance architecture): <https://lpho.more-zm.org:8445> [14]; MER parser and BOB reporting automation web application: <https://reporting.more-zm.org:444> [15]

Operating system(s): Platform independent (web-based applications accessed through a modern web browser). The DHIS2–Power BI connectors require Microsoft Windows with Microsoft Power BI Desktop.

Programming language: Java (DHIS2 core platform); Python with the Flask web framework (MER parser and BOB reporting automation tool); Power Query M language (DHIS2–Power BI connectors)

Other requirements: DHIS2 version 2.39 or later; Apache Tomcat application server; PostgreSQL database; Microsoft Power BI Desktop (for the connectors)

License: BSD 3-Clause open-source license. The DHIS2 core platform is released by the University of Oslo under the BSD 3-Clause license, and the MER parser, BOB automation tool, and DHIS2–Power BI connectors are likewise released under the BSD 3-Clause open-source license.

Any restrictions to use by non-academics: None. The connector packages are freely available as Additional files 1 and 2 under the BSD 3-Clause license. Access to the live MORE-ZM instances and reporting apps (housing the mer parser and BOB automation tool) requires user

credentials because they contain routine program data; credentials for review purposes are available from the corresponding author.

List of abbreviations

API: Application Programming Interface; ART: Antiretroviral Therapy; CDC: U.S. Centers for Disease Control and Prevention; CIDRZ: Centre for Infectious Disease Research in Zambia; CIHEB: Centre for International Health, Education, and Biosecurity; CoH: Circle of Hope Zambia; CSV: Comma-Separated Values; DAPP: Development Aid from People to People; DATIM: Data for Accountability, Transparency and Impact Monitoring; DHIS2: District Health Information Software 2; DQA: Data Quality Assurance; EHR: Electronic Health Record; ETL: Extract-Transform-Load; FHI360: Family Health International; HIS: Health Information Systems; HL7 FHIR: Health Level Seven Fast Healthcare Interoperability Resources; HTS: HIV Testing Services; ICAP: International Center for AIDS Prevention; LMIC: Low and Middle-Income Country; LPHO: Lusaka Provincial Health Office; M&E: Monitoring and Evaluation; MER: Monitoring, Evaluation and Reporting; MORE-ZM: Monitoring, Reporting and Evaluation – Zambia; NHRA: National Health Research Authority; NREC: National Research Ethics Committee; PEPFAR: U.S. President’s Emergency Plan for AIDS Relief; PHO: Provincial Health Office; PMTCT: Prevention of Mother-to-Child Transmission; SDG: Sustainable Development Goal; SQL: Structured Query Language; TB: Tuberculosis; UHC: Universal Health Coverage; UTH: University Teaching Hospital; VL: Viral Load

Declarations

Ethics approval and consent to participate

This activity was reviewed in accordance with CDC human research protection procedures and was determined to be non-research, as it did not involve the collection or analysis of identifiable private information. All activities were undertaken as part of routine health system strengthening efforts under the MORE-ZM system. Ethical review and oversight were sought from the Zambia National Health Research Authority (NHRA) through the National Research Ethics Committee (NREC), in line with national guidelines and requirements for health systems research. The study used only aggregate, routinely collected program data drawn from facility-level reporting systems within the MORE-ZM DHIS2 ecosystem. Individual informed consent was not required, as no identifiable patient information was accessed or used.

Consent for publication

Not applicable. The article contains no individual person's identifiable data, images, or videos.

Availability of data and materials

The DHIS2–Power BI connector packages, including their Power Query M source code, are provided with this article as Additional files 1 and 2. The MER parser and BOB reporting automation tool are accessible at <https://reporting.more-zm.org:444> [15], and an example DHIS2 instance from the multi-instance deployment is accessible at <https://lpho.more-zm.org:8445> [14]; access credentials for review purposes are available from the corresponding author. No individual-level datasets were generated or analysed during the current study. Aggregate routine

program data referenced in this article are not publicly available because they relate to CDC/PEPFAR-supported program operations, but are available from the corresponding author on reasonable request and with permission of the relevant program authorities.

Competing interests

The authors declare that they have no competing interests.

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Authors' contributions

Conceptualization: JP, CC, MZM, KMo, TNK, MwM, LM, CeC, MaM, BM, BK, MT, JMP, ML and TS. Data curation: JP, CC and ML. Formal analysis: JP and ML. Funding acquisition: ML and TS. Investigation: ML and TS. Methodology: JP and ML. Project administration: JP, MT, ML and TS. Resources: MiM, YT, CK, MT, ML and TS. Software: JP and CC. Supervision: JP, MT, ML and TS. Validation: JP. Visualization: JP and MZM. Writing – original draft: JP, CC, MZM, KMu, KMo, TNK and ML. Writing – review and editing: all authors (JP, CC, MZM, KMu, KMo, TNK, MwM, JM, VK, JMW, ChC, KCh, KK, MMM, AM, MiM, YT, CK, KC,

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Additional files

Additional file 1. CIDRZ_DHIS2_PBI.zip – DHIS2–Power BI connector for aggregate data (Power Query M extension package, .mez, developed in Visual Studio Code).

Additional file 2. CIDRZDHIS2PBITRACKER.zip – DHIS2–Power BI connector for tracker (longitudinal, patient-level) data (Power Query M extension package, .mez, developed in Visual Studio Code).

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

- [Additionalfile1.zip](#)
- [Additionalfile2.zip](#)