

The Case for a National Health Information System Architecture; a Missing Link to Guiding National Development and Implementation

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Abstract

Developing countries and the global network of donors, programs and nongovernmental organizations (NGOs) have agreed that health systems need to become stronger if gains in health are to be achieved and sustained. Existing data collection and use is fragmented, disease specific, inconsistent and often of poor quality. A major factor contributing to this current situation is that the burden of data collection falls to health workers and that this burden is excessive. What is needed is a national health information system that is capable of supporting day-to-day management, long-term planning, and policy development for the entire national health system. Front line health workers who bear the burden of data collection should benefit from the availability of information for decision making in a well designed health information system. A health information system is comprised of multiple and diverse functions and applying what has been learned from other sectors is valuable. One such practice developed over the past 20 years to guide planning, development and management of complex systems in all sectors including, government, commercial, and NGOs is the development of enterprise architecture. The enterprise architecture is the next level of elaboration of the HMN Framework where general lessons, standards, and processes can be aggregated and documented for knowledge sharing. A well thought-out and collaboratively supported architecture enables systems to be built and implemented using consistent standards for data collection, management, reporting and use. The components of the enterprise architecture will be adapted from or collaboratively generated with the global disease programs whose buy in and endorsement is crucial to its success. Investments in health information systems can be aligned and leveraged around such an architecture to build stronger core health information systems supporting better local health services management, health policy and ultimately stronger health systems.

Key words

Health information systems, public health informatics, HIS, health systems, enterprise architecture, global health, health informatics, integrated data systems

Introduction

A national health information system (HIS) plays an important role in ensuring that reliable and timely health information is available for operational and strategic decision making that saves lives and enhances health. Despite its importance for evidence-based decisions, health information systems in many developing countries are weak, fragmented and often focused exclusively on disease-specific program areas.¹ There is a broad consensus in the literature that strengthening of national HIS is desirable.² An integrated HIS will provide the basis for public health professionals to look at the health system from broader more comprehensive points of view³.

To have sustainable public health development and improved health outcomes, strengthening health systems, including health information systems, is essential. A common vision of a national HIS allows for

leveraging the gains in tools and methods achieved in vertical disease-specific programs and maintaining the effectiveness of those systems to build a stronger integrated foundation addressing the entire health system. Introducing a well described and coherent set of best practices for promoting data integration and use is a step in this direction. In a typical health system in low resource settings vertical programs often implement their own information system to meet their specific needs without consideration of how this information is integrated with the overall health information system⁴. Absence of integrated information and use effectively ensures duplication and places a heavy burden on health workers caused by redundant, fragmented and inconsistent methods and instruments for data collection, aggregation and reporting⁵. It is the peripheral health workers that often collect routine data and prepare reports. There are many examples of information and communication technology being introduced that show great promise in strengthening health information systems but these efforts too often are fragmented in design and implementation are typically not systematic or scalable⁶. It is envisioned that stakeholder groups when engaged in a collaborative process see that many current program specific systems have common components and building towards a common architecture within the HIS leverage the impact of these investments and development resources. It also helps identify areas where interoperability between the components of the system is required or desirable, and can help classify the potential approaches for such interoperability points.

Health Metrics Network

Health Metrics Network (HMN) was launched in 2005 to help Ministries of Health, stakeholders and partners improve global health by improving the availability and use of health information to advance evidence-based decision-making. HMN is the first global health partnership that focuses on two core requirements of health system strengthening in low and low-middle income countries: first, to address a vision of an information system that embraces the health system and its component parts as a whole, moving beyond specific diseases and programs and secondly, draw attention to and invest in country leadership and ownership in strengthening health information management and use. In order to meet these requirements and advance global health, it has become clear that there is an urgent need to develop a common view and align partners around a common plan to develop country health information systems⁷.

A Framework for Health Information System Strengthening

The HMN Framework draws on a set of guiding operating principles that have evolved through the active participation of over 65 countries and numerous partners to date. The principles which provide the direction for the development of the Framework are as follows:

1. Routine use of better information is associated with better health outcomes and a strengthened national HIS is one essential mechanism for delivering capacity.
2. Fostering country leadership and ownership is necessary for sustaining gains in health, strengthening health systems and the enabling health information system.
3. Country requirements and implementation challenges must be thoroughly understood and directly addressed for a national HIS to be effective.
4. Improving health, health policy and health system performance requires national, broad-based stakeholder consensus and stakeholder commitment.
5. Health information system strengthening requires a long term strategic plan with short term pragmatic action plans that build on successive coordinated incremental steps.

An Architectural Approach to Health Information System Strengthening

Ministries of Health and their stakeholders have begun to voice the need for a more detailed technical elaboration of the HMN Framework to support focused investments and the mobilization of a wider pool of leaders and advocates of health information. Building on its global acceptance as an organizing framework for health information systems the application of enterprise architecture principles appear to serve the purpose of describing and documenting the requirements and characteristics of a national HIS. It will help to communicate its benefits as a national HIS inclusive of all public health and disease programs to accelerate adoption. It will also serve to create a platform for purposeful investments that will ultimately improve health outcomes and promote greater health system efficiency and effectiveness.

Enterprise architecture (EA) is a comprehensive description of all of the key elements and relationships that make up an organization⁸. It is used to define the alignment of an organization's mission, goals and objectives with information systems⁹. EA can be used to describe the methods for designing health information systems in terms of a well defined set of building blocks, and showing how the building blocks fit together and how the communication between the building blocks can be achieved. Since its development in 1984 the EA approach has been applied by many companies, governments and other institutions worldwide in order to improve their business process, e.g. US Department of Defense, Massachusetts Institute of Technology, commercial firms like BP (British Petroleum), Intel and Volkswagen. Global organizations like The World Bank are viewing EA as an enabler to broad reforms in the public sector¹⁰.

An EA approach to health information systems development allows for important interrelationships to be identified, including which components need to be aligned to which parts and in so doing reduce the risks and incentives of fragmentation, and duplication, and lack of interoperability. Furthermore, insights from governments and commercial entities have shown that well-developed enterprise architectures reduce the risk of costly mistakes from applying diverse information and communication technologies in an unplanned and unstructured manner, while they accelerate the evaluation and adoption of emergent technologies in a way that benefit the whole system. Beyond the focus on the public health sector the general government sector has emerged as the area of largest implementation of enterprise architecture¹¹.

The HMN Framework provides a sound basis to design an EA for a national health information system that will guide development of health information systems better able to meet immediate country requirements and support continuous improvement in health systems. The EA will also serve as a global repository for lessons learned, standards and tools that any country, donors, developers, and partners worldwide can apply to strengthen health information systems. In addition, the EA will help describe the current state of a country's HIS, and provide a roadmap of maturity levels and steps for growth over time that countries can use to inform their plans for HIS investments. The EA architecture for national health information systems will be most powerful if widely disseminated as a public good and is co-developed by experts, practitioners and users from across the globe. Ultimately the EA process will produce a Reference National HIS Enterprise Architecture that will serve as a foundation for a national implementation and as a foundation for the development of multinational tools. An EA is not a static documentation of the system rather it allows for a long term aspiration vision while enabling practical stepwise progress that is informed by continuous experience and feedback.

The Role of the Enterprise Architecture in Alignment and Consensus Building

The EA for a national HIS will describe the fundamental organization of the system embodied in its components, standards and the principles governing its design and evolution¹². It will provide a unifying and coherent structure that leads to a common understanding and provides guidance for conceptualizing, building or contributing to a national health information system. It should provide a description of key actors, their primary information needs and the logical data management processes; what existing processes could be improved and what new processes could be supported, how it would work in the operational environment; and what technologies would be required. The process for developing the EA will out of necessity involve the many stakeholders within countries and the network of partners. This the process of creating the EA will bring together for the purposes of aligning and inspiring a shared vision for national health information systems.

National governments are addressing development of many functions of government that are advancing in their use of ICT, including transportation, finance, statistics, education, defense, agriculture, and natural resources. An important consideration in an EA for health is the degree to which a national function or enterprise architecture has been established and to what extent the national HIS is expected to relate to such architecture. The national HIS EA can be instrumental in defining the relationship to other ministries as well as reflecting standards and principles of a national strategy or EA to the extent it exists.

National HIS Enterprise Architecture Domains

There are a range of alternatives for developing an EA including The Zachman Framework, The Open Group Architecture Framework (TOGAF), the Federal Enterprise Architecture and the Gartner Methodology¹³. Each of these methods has strengths and weaknesses and none are really complete as they exist today. This white paper does not attempt to decide which methodology is the best fit for addressing national health information systems in resource constrained settings. Rather, we will present the common elements that serve to introduce the core elements of EA. In the practice of developing an EA the most common approach is often a blend of existing methods that address the specific challenges of the enterprise setting. This blended approach holds promise for developing the Reference National HIS Enterprise Architecture¹⁴.

Commonly there are layers or domains of an architecture that are subsets of an overall enterprise architecture¹⁵. Four layers are commonly defined in a general model of an enterprise architecture. For developers and implementing partners to have sufficient guidance these four domains provide distinct granularity. Together these four domains make up our initial enterprise architecture for a national HIS.

HIS Enterprise Architecture		
Architecture Domain	Deliverables	Representative Questions Addressed
1. Organizational Architecture	<ul style="list-style-type: none"> • Business domains • Business functions • Business processes • Governance, Policy, Resources 	<ul style="list-style-type: none"> • Who are key decision makers, what are their roles and behaviors insofar as decision making is concerned? • What are the essential questions that as users must be able to answer for strategic and day to day decision making? • What core business processes, i.e. health services delivery, laboratory, pharmacy, are necessary to support decision making? • What policies and laws are necessary to support the initial

		<p>development and implementation of a national HIS?</p> <ul style="list-style-type: none"> • What resources are necessary to establish the minimum capacity for a sustainable HIS? • Who will be responsible for the maintenance of the integrity of the national HIS?
2. Data Architecture	<ul style="list-style-type: none"> • Data model • Metadata dictionary • Classification standards and systems 	<ul style="list-style-type: none"> • What are the essential core and common data necessary to support information and evidence for decision makers? • What data sources contain these data and what can be linked for use from existing operational systems? For example the national census, vital registration or surveillance systems? • What is the link between essential minimum data sets and global programme M&E?
3. Applications Architecture	<ul style="list-style-type: none"> • Software applications • Interfaces between applications • User interfaces 	<ul style="list-style-type: none"> • What are the initial key applications a minimal national HIS must be able to deliver? Examples include standard data collection instruments, data communication services, data analysis and modeling, report generator, GIS. • What applications are best included within a single platform design versus those applications that are best maintained as separate operational systems? • How will applications that have a requirement to be linked be able to do so? • How should the user interface work?
4. Technical Architecture	<ul style="list-style-type: none"> • Hardware platforms • Local and wide area networks • Operating system • Interoperability 	<ul style="list-style-type: none"> • What are the requirements for information to be captured, data entered, tagged, communicated, managed and disseminated? • What is the minimum information and communication technology capacity needed across the country to support access to the applications and dissemination of information? • How will new classes of electronic devices, communication networks and related ICT be leveraged over the next 5 to 7 years?

Scoping the Enterprise Architecture Program of Work

An important step in developing the enterprise architecture is to establish the initial scope. A scope allows for the careful consideration and definition of what is appropriate and of the highest priority. Again there are various approaches to creating an EA. TOGAF like other approaches provides a methodology for developing an EA. The Architecture Development Method (ADM) is useful in the discussion of the importance of scope and how one might blend different models.¹⁶ There are four main dimensions in which scope may be defined and limited:

- Enterprise scope or focus: what is the full extent of the enterprise and how much of that enterprise should the architecture focus on?
- Architectural domains: a complete enterprise architecture description should contain all four architecture domains (business, data, applications and infrastructure) but resource constraints will impact the extent of the architecture even if the full enterprise is limited.
- Vertical scope or level of detail: how much of architecture is enough before implementation activities including system design, system engineering and system development can begin?
- Time horizon: what is the time horizon for a complete architecture and do resource constraints require intermediate *Target Architectures* to be defined that enable implementation activities to begin?

Establishing the initial priorities as informed through collaboration with Ministries of Health and their stakeholders will serve as a context to understand the dimensions of EA. Business domains are another critical element in scoping the EA. Business domains are clusters of coherent business functions, over which meaningful responsibility can be taken in business processes, i.e. pharmacy, laboratory or facility operations. Below is an example of an initial set of business domains that might serve as a starting point for the scoping process. It is important to reinforce the principle that the enterprise architecture is intended to enable a foundation platform capacity what might be called “core and common” across the health system. It is the foundation upon which continuous improvement will be based and expanded capabilities created. It is a starting point for what we hope is a long, dynamic and innovative future.

Business Domain	Business Processes	Archetypical Users
Health Services	Patient registry Individual health record Registration of death Registration of birth Classification of disease Classification of symptoms Classification of procedures Notification of reportable diseases	Patient/guardian/parent Chief health officer Physician Community health worker Trained birth attendant MCH worker District health manager Director of primary health care
Laboratory	Collect and register specimen Determination of results Associate result to patient Notification of reportable diseases Classification of disease	Chief health officer Physician Surveillance officer Laboratory technician
Pharmacy	Central stock registration Facility stock registration Supply chain & distribution Patient registry Classification of disease Treatment plan and prescription	Chief health officer Physician District health manager Provincial health manager Pharmacist Central Stores manager
Human Resources in Health	Taxonomy of health workforce Recruitment, credentialing, hiring of health workers Monitoring deployed workforce Reporting priorities for recruitment & training	National health manager National finance manager Provincial health manager District health manager Facility health manager
Environmental monitoring	Water quality and access mapping Sanitation resources and access Environmental conditions & history of natural disasters & events Classification of monitoring procedures Routine environmental monitoring	Chief health officer Physician District health manager Provincial health manager National surveillance officer
Decision Support	Family of International Classifications Access to health protocols & research Aggregation of routine data Linking of routine and population data	Chief health officer Physician District medical officer Provincial medical officer

	Budget & expenditure reporting Analysis and representation of data Monitoring of urgent health events MDG and M&E reporting ¹⁷	Global M&E officer Community health worker
Finance	Patient services fee for service collection Health insurance enrollment Health services insurance settlement National and sub-national budgeting National and sub-national expenditure tracking National and sub-national revenue tracking	Chief health officer District health manager Provincial health manager National health finance officer National treasury finance officer

Conclusion

This paper presents the case for an enterprise architecture for guiding the development and evolution of an integrated national health information system. The incredible surge in health funding has created a plethora of tools, methods and practices for data collection and analysis that have placed a counterproductive and unsustainable burden on front line health workers. There is a growing consensus that this burden not only causes poor data quality it also diverts critical health resources from patient care responsibilities. The challenge of how to improve the current situation is one that an enterprise architecture can help address. By providing an architecture that is scalable, flexible and resilient donors, governments, NGOs and commercial suppliers can contribute to the development of tools and methods that reuse components and leverage core and common data and standards that reduce not add to the burden of data collection. A model architecture of a national HIS will provide a foundation for countries that are developing their own national health information system as well as for developers of tools used in many countries. The enterprise architecture provides the missing link to guide development and implementation of national health information systems. Improving health system performance through the consistent use of an EA will be the blue print for better health outcomes resulting from the routine use of better information from stronger national health information systems.

End Notes

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