AUTHOR ACCEPTED MANUSCRIPT

FINAL PUBLICATION INFORMATION

Developing an HMIS Architecture Framework to Support a National Health Care eHealth Strategy Reform
A Case Study from Morocco

The definitive version of the text was subsequently published in

Health Systems & Reform, 3(1), 2017-01-31

Published by Taylor and Francis and found at http://dx.doi.org/10.1080/23288604.2017.1265041

THE FINAL PUBLISHED VERSION OF THIS MANUSCRIPT IS AVAILABLE ON THE PUBLISHER'S PLATFORM

Developing a HMIS Architecture Framework to Support a National Health care eHealth Strategy Reform: A Case Study from Morocco

Marc A. Le Pape[1], Juan Carlos Núñez Suárez[2], Abdelkader Mhayi[3], Dominic Haazen[4] ,Emre Özaltin[5]

[1]Tropical Medicine, University of Hawaii at Mānoa, John A. Burns School of Medicine, School of Medicine, 651 Ilalo Street, BSB 320, Honolulu, Hawaii, United States, 96813

[2]e-health consultant, Av. de Bruselas, Madrid, Spain

[3]Ministère de la Santé, Division de l'Informatique et des Méthodes, 335 Avenue Mohammed V, Rabat, Rabat, Morocco

[4]The World Bank, 1818 H st, Washington, DC, United States

[5]World Bank, 1818 H st, NW, Washington, DC, United StatAes, 20433

Corresponding author Email: eozaltin@worldbank.org

Abstract

An increasing number of low- and middle-income countries are receiving significant investments to implement health reform strategies featuring Health Management Information System (HMIS) as a fundamental eHealth intervention. We present the case of Morocco's first step towards the implementation of a national HMIS: the "*Urbanisation*" of its health information systems – an information architecture methodology designed to leverage existing capacity while ensuring sustainability of the new HMIS. We report on this process and share lessons learned, applicable to similar countries involved in HMIS interventions, including involving all stakeholders from

inception to rollout, encouraging local ownership of the new HMIS, fostering active data usage among users, and leveraging existing personnel rotation policies when developing adoption strategies and facilitating capacity building efforts.

Introduction

Deemed the single-most important revolution in healthcare since the advent of modern medicine,[1] eHealth has then been steadily growing in importance on the international public health policy agenda since 2000[2] and refers in very general terms to the use of information and communication technologies (ICT) to support the delivery of health services.[3] A national HMIS refers specifically to a comprehensive set of integrated software solutions for data collection, compilation, analysis, synthesis, and communication across health facilities and organizations to generate relevant, accurate, and timely information for decision making.[4] Its purpose, as the backbone of a national health system, is to create information and intelligence to monitor in real time the health status and services of a nation, support optimal decision making, and improve public health outcomes.

HMIS are characterized by their wide scope of application domain, their complexity, and their high cost. While there is a broad consensus on the importance of strengthening health information systems to improving health outcomes[5] the metrics for measuring the cost-effectiveness of these long-term infrastructure investments, with indirect impact on outcomes, is challenging.[6,7] While some have taken a pessimistic view,[8] others have formulated compelling customizable investment models for proactive financial risk management.[9] Nevertheless, effective information systems support is increasingly being seen as integral to high quality health care delivery through improved information availability, relevance and accuracy, and through improved efficiency of clinical and administrative processes. Furthermore, as a component of the 'Organization' control knob of health systems reform,[10] a national HMIS reform should not be viewed only as a technological solution: it entails a reform of governance as a key enabler of

3

health system reforms, and as a potential driver of structural reforms emanating from the review and reorganization of roles it necessitates.

Health sector context and Health Information Systems in Morocco

Morocco is moving towards Universal Health Coverage (UHC) with the ambition to cover the majority of its population. Currently, two prepaid fund systems provide health insurance coverage in Morocco, as provided by law 65-00.[11] The Mandatory Health Insurance (AMO) covers private and public employees insured by the National Social Security Fund (CNSS) while the National Fund for Social Welfare Agencies *(*CNOPS) functions as a mandatory, payroll-based, health insurance plan. The Medical Assistance Scheme (RAMED) guarantees access to basic health services to the poorest and most vulnerable.

Despite recent progress, health indicators in Morocco remain well behind the levels of comparable countries in the region and are highly inequitable, particularly between urban and rural areas. These inequities in health outcomes reflect inequities in access to and quality of health care providers and in the allocation of resources. Overall, the organization and delivery of health care is fragmented and faces severe resource constraints. There is no continuum of care between ambulatory and inpatient hospital care, and the system suffers from chronic drug inventory shortages, and a scarcity of human resources across all health personnel categories, a problem exacerbated by chronic absenteeism, dual practice, and inadequate skills. While the public sector continues to provide the bulk of health care services, the private sector is expanding rapidly, with little regulation and scant available data related to its activities.

The lack of an integrated, reliable, and accessible national HMIS makes it difficult for the Ministry of Health (MoH) to address such problems and to improve quality and accountability.

4

Morocco is coping with a siloed and fragmented HMIS, characterized by poor integration of central data, and disparate, redundant data collection mechanisms that impose a significant reporting burden at the service delivery level. National statistics are published with a two year delay and reliable data are rarely available to policy makers. Data collection is mostly paper-based, and is gleaned primarily for administrative purposes without feedback to health facilities, limited dissemination to citizens, and scant subsequent analysis. The Human Resource Information System (HRIS) and Pharmacy Information Systems (PIS) are not functioning, there is neither integration nor interoperability across systems or between Health Insurance Information Systems (HIIS) and RAMED, and the private sector is not taken into account. Notwithstanding these shortcomings, several important strategic health initiatives have been implemented, echoing the World Health Organization (WHO) suggestion that "*the most favorable approach to the implementation of eHealth at the national level is to have a framework of strategic plans and policies which lay the foundations for development*".[12,13] Morocco instituted in 2011 a new Constitution ratifying health care as a fundamental right of the Moroccan people, MoH introduced a 2012-2016 health strategy,[14] and the 2013 Morocco's National Conference on Health helped ensure among stakeholders a broad recognition of the importance of a national HMIS in improving quality and access to health services, while fostering transparency and governance.

Objectives

In line with this framework of strategic plans and reforms, the Government of Morocco requested that the World Bank add a HMIS sub-component to its program-for-results lending operation directed at improving primary health in rural areas in Morocco.[15] The World Bank responded by allocating 30 million USD to this subtask; independently, it also included

Technical Assistance to support the Ministry of Health (MoH) in carrying out all preparatory HMIS activities. As part of these preparatory activities, MoH requested carrying out the "*Urbanisation*" of its information systems – a French approach to Enterprise Architecture (EA) emphasizing the strategic alignment of information systems to a pre-defined strategy.[16] While EA methodologies vary in focus and details, at the highest level of abstraction EA consists of a set of methods for planning and documenting information systems architectures. A merit of the "*Urbanisation*" approach lies in anticipating the problem of sustainability in legacy information systems, which typically result from ad-hoc, incremental development efforts marred by redundancies, lack of integration, and scant attention to systems interoperability.[17]

The purpose of the "*Urbanisation*" effort was to provide MoH's leadership with "*signature-ready*" recommendations for the optimal implementation of the proposed HMIS, and to guide decision-making in its implementation. This paper describes the methodology and its outcomes, with a focus on recurring themes, and potential lessons for policy makers engaged in similar reforms in the region and globally.

Materials & Methods

To ensure the strategic planning of a national HMIS is fully in line with MoH's strategic objectives, the project team followed the "*Urbanisation*" methodology[16] with particular attention paid to process reengineering and optimization of the overall design. The work was carried out by experts at the World Bank, experts at Indra,[18] and an independent consultant. The effort was overseen by a Steering Committee, chaired by MoH Secretary General, composed of all concerned departments' heads, and charged with implementing the national HMIS strategy. A Technical Committee, chaired by MoH Division of Informatics and Methods (DIM) Director,

composed of the heads of all concerned MoH IT departments, was responsible for overseeing and guiding the day-to-day and technical aspects.

The existing HMIS was evaluated in terms of three layers:

- The Business Layer, i.e., funding of Morocco's health system, legislative framework, reforms at the planning stage, regulations, main processes, roles and responsibilities, chief internal and external processes, data management and data exchange – internally and across all involved public, or private, health organizations.

- The Applications Layer, i.e., current applications map, current software development technologies and methodologies, information governance and organization of IT units, budgets and personnel.

- The Technical Layer, i.e., IT management organization, end-user equipment and servers, data centers, cabling, communication networks and all other relevant IT infrastructure.

The "*Urbanisation*" itself involved four distinct phases:

- In the first phase, in order to understand the current policies and practices at MoH and the current status of its IT organization, 56 interviews were conducted with the General Directorates ("*Directions Générales*") in Rabat, and with the Regional Directorates ("*Direction Régionales*") in Agadir and Meknes. Twenty primary and secondary care facilities including hospitals, community health centers, and dispensaries were surveyed in Souss-Massa-Drâa region's remote rural areas, and the proposed target pilot region of Meknès-Tafilalet.

- In the second phase, the modeling of the strategy was carried out. This involved an analysis of the strategic objectives of MoH, to determine the national HMIS objectives and the relative priorities of these objectives. Key documents were analyzed: (1) the recommendations of the Second National Health Conference, (2) the white paper "Health Sector Strategy 2012 to 2016", (3) the World Bank relevant financing instrument, i.e., the Program for Results for Improvement of Primary Health Care in Rural Areas; and (4) the European Union supported Program to Support Health Reform ("Health II"). Thereafter, various *"Urbanisation"* scenarios were developed and analyzed. Alternatives for patient identification, type of medical records and collaboration modalities with external health care providers were systematically evaluated. From this preliminary work, a vision for Morocco's national HMIS emerged, and guidelines for its implementation were established.

- In the third phase, new business processes were defined, components and functionalities of the proposed HMIS established, a new IT organizational structure tailored to the requirements and specifications of the HMIS was proposed, recommendations pertaining to data dictionaries were made, and advice with regard to more technical issues (e.g., communications' bandwidth, and architecture scenarios) provided.

- In the fourth phase, the action plan, comprising the implementation strategy and an assessment of needed human and financial resources was developed.

As a whole, the results of this analysis describe the current state of Morocco's HMIS, clarify the integration, interoperability and standardization requirements of MoH operating model, explain

8

how the proposed HMIS' services requirements are aligned with MoH's Health Strategy,[14] and offer an integrated perspective on the recommended strategy.

Results

The *"Urbanisation"* was a stated prerequisite to, and a first step toward, the implementation of the national HMIS; given that Morocco has just completed this preliminary step, a limitation of this paper is that we can neither report on the implementation of the HMIS nor its effects. The chief end-results of the *"Urbanisation"* were the definition of the proposed national HMIS (including business processes and functionalities), and the action plan for the HMIS' implementation. Intermediate products, such as the landscape analysis and the modeling of the information systems strategy[19] were instrumental in attaining these results.

Landscape Analysis

Currently, the information systems map comprises a number of separate applications, mainly designed for the reporting of facilities' health care production from health centers and hospitals, up to MoH central divisions. Intermediate levels such as the provincial and regional levels, merely compile, consolidate, and forward data to the next level, adding little intelligence to the data.

Regarding the organization of Information Technology (IT) services, although the DIM, the division in charge of IT at MoH, employs most of the IT personnel, nearly all divisions at MoH have their own technical staff and administer their own budget. This system undermines

9

planning, coordination, and the application of common management policies to IT management while fostering siloed approaches and redundancy.

Handwritten at the source in health care facilities, data are occasionally transmitted up the information chain through applications addressing very specific purposes. Over its life cycle, data may be transmitted again either in paper or electronic format, but since applications are not interfaced users need to re-enter data at every level of the information chain, leading to unwarranted delays and overloading of the administrative staff.

Central units require overlapping data from lower levels in the information chain. However since data follows different paths from capture at the facility level to retrieval at the central unit, data integrity is compromised[20] and indicators may yield different values depending on the path followed, leading to lack of reliability. Overall, users complain of poor or no information for decision-making, and lack of feedback, particularly for practitioners and facility managers. Change management and capacity training are common requests (**Figure 1**).

MoH allocates most of its IT budget (about 89%) to the purchase of hardware and software licenses, which is consistent with an early information system adoption stage. Maintenance and user support expenses are low at 11%. Regarding software applications lifecycle, 51% are in full production stage while 49% are still under development. Furthermore, since applications serve very specific purposes, they support only a tiny fraction (0%-5%) of MoH's divisions and health care facilities' functions.

Legislative frameworks are critical to national HMIS to ensure sustainability and facilitate users' uptake.[21,22] Morocco has passed personal data protection legislation of electronic formats, the basis for the regulation of telemedicine, the exchange of electronic data, and digital signatures

usage. However, further legislation is needed with regard to legal title and control of medical records, to foster clinical data sharing for improved care coordination and continuity of care. Indeed, under current hospital regulations, the medical record is hospital property, while a widely preferred approach is for health care facilities to store and maintain the medical records owned by the patients. Currently, the medical code of ethics requires the handwritten signature of clinical documents, a requirement that prevents the exclusive usage of electronic formats.

Modeling of the strategy

The modeling of the strategy stems from MoH's strategic objectives, the detailed objectives of the national HMIS, and the vision for its implementation. Not surprisingly, most of the national HMIS objectives fall within the division and facility levels of MoH, as these organizational units use and generate most of the information. In order to prioritize HMIS objectives, a matrix classifying objectives according to priority level and complexity was used. This matrix, along with the internal relationships among components led to the formulation of the tactical implementation.

The work of the Technical Committee resulted in a commonly shared vision for the new system. Overall, this vision would require the national HMIS to be patient and user centric, responsive and flexible, integrated and interoperable, and operational at all levels of the health system. Additionally, the HMIS would provide quality information, echo MoH's strategic guidelines, and become a tool for health system management and optimal decision-making.

The Proposed System

The aim of the proposed national HMIS is to support the activity of Morocco's health system at all levels of the organizational structure. In terms of user needs, the HMIS addresses all stated

requirements. The architecture design enforces throughout principles of abstraction and modularity, so the HMIS may readily address future requirements and user needs as the health system evolves. Likewise, the architecture design leverages principles of systems integration and interoperability, so the HMIS may exchange data with the private health care sector and other organizations. Furthermore, the proposed HMIS is comprehensive in its scope of application, which includes provision of health care (**Figure 2**), public health (**Figure 3**), and the management of health care facilities (**Figure 4**).

From the clinical perspective, the system was designed as a patient centric Electronic Health Record (EHR), an approach designed to breaks data silos, and to facilitate the integration of all patient data. To expedite identification at the point of care, a personal health card independent of patient age or insurance coverage was proposed, as a unique patient identifier (UPI) is a key requirement to guarantee unique medical records and to avoid duplicates. Again, the medical record holds central stage in this approach, as it should follow patients from primary to secondary care and across referrals on the clinical pathway. The goal was to build a comprehensive medical record of patients that facilitates continuity and coordination of care. Two options were considered: individual versus household records. Notwithstanding Morocco's current development of household records, the individual record stands to contribute significantly to the implementation and sustainability of a lifelong UPI considering that household records instantiate several patient identifiers as a patient matures from childhood to adulthood.

Particular attention was paid to undeserved communities in rural and remote areas, whose needs are typically met by medical caravans and mobile units. To better serve these areas, clinical stations preloaded with the patient population's clinical records were suggested and designed to

be used either synchronously or asynchronously with the capability to upload data to synchronize servers' databases. Fingerprints were also proposed as a means to identify individuals, such as nomads or migrants, who may not have personal health cards or any other means of identification.

Health services demand management is improved in the proposed national HMIS, due to the generalized implementation of the appointments and referral system. Critically, it addresses the disparity between demand and supply, responsible for overcrowding at some facilities and underuse at others. This functionality is intended to serve a wide range of providers, from ambulatory care, primary care, and outpatient consultations, to laboratory testing and imaging facilities.

To build the target system, the following supporting sub-systems were identified: unique patient identifier, personal health card, patients database, health system organizational chart (i.e., "*filière des soins*"), users database, shared data dictionaries, and coding systems for diagnostics, pharmaceutics, procedures, etc. The health system organizational chart consists of a series of pre-defined relationships among facilities, services, and resources, mirroring intended clinical pathways within the health system (e.g., from primary care to a specialty consultation or test facility in secondary care).

Once these supporting sub-systems are implemented, the implementation of the administrative modules is to be initiated: appointments and referrals, admission, transfer and discharge, bed management, and surgical waiting list.

In order to validate the target system, a pilot implementation within the target pilot region approach was proposed. As such, pilot facilities representative of all health care levels will test

the target system before rollout to all remaining facilities in the pilot region. Once the administrative modules are in place, the clinical modules will be implemented.

The action plan

The HMIS scale-up in Morocco is to take place over an 11-year span (**Figure 5**). In phase 1, foundational structures will be developed, with initial implementation in one pilot region; in phase 2, gradual scale-up to all public health facilities is to take place in all regions, with potential inclusion of the private sector at that time or shortly thereafter. Phase 1 will address administrative modules; phase 2 will address clinical modules. However, standalone radiology and laboratory systems may be developed in phase 1, and linked to the medical record in phase 2 once clinical modules are in place. In phase 1, public health surveillance modules autonomous from the medical record (e.g., environmental health) will be implemented.

To facilitate the management of the demand of services and promote patient satisfaction,[23] all HMIS foundational elements, including datacenter and call center, will be implemented prior to rollout to health facilities. Personal health cards will be distributed to patients incrementally during rollout. To secure revenue for hospitals and all other health care facilities checkout and invoicing will be implemented in the first phase. Information for decision-making will be captured and accessible as the various components are deployed.

For budgeting purposes, several alternatives were analyzed to leave options open to policy makers between conservative and ambitious rollout scenarios. For example, two scenarios considered were (1) a minimal rollout involving patient health cards for a pilot region, a project management office (PMO), rollout of primary care modules, regional datacenter, health centers' infrastructure, cost of communication lines, and 2 years support; versus (2) a more ambitious

14

approach involving organizational type projects including process reengineering, onsite implementation support, larger field implementation, change management, appointment via call center, and backup datacenter. **Table 1** shows the breakdown of projects' costs for the scenario chosen by MoH. For purposes of homogeneity, costs are assessed as third party costs. Considering MoH may subcontract projects or implement them with its own resources (at the time of the action plan's submission MoH had not made a decision in this regard) projects' costs have been assessed as third party costs in order to present a consistent view of budget requirements. Project Management Office costs (a large sum if subcontracted) are not included as MoH expressed the desire to keep this in-house. Similarly, costs of software development and licenses are not included considering their great variability in terms of vendor and client type; however, to secure better rates, we recommended that MoH favor corporate agreements.

Discussion

National HMIS interventions worldwide are quickly reshaping the way knowledge is created, used, and shared, spurring changes spanning from clinical insights to global health. At the same time, these reforms have profound implications for health care culture and organizational processes, from clinical practice to health financing and health policies. Acting as a catalyst for public health on the one hand, and a reorganizational force on the other, national HMIS interventions are compelling in their merits and disruptive in their institutionalization. The disruptive and complex nature of the reforms means that often institutional and cultural factors constitute barriers to national HMIS reform,[7] and sustainable improvements in HMIS at scale often do not follow initial small-scale advances.[8] To resolve this innovator's dilemma, strong political will within MoH leadership is needed to reconcile individual and institutional priorities, the predominance of long terms objectives over short term objectives, and a resource

15

allocation mechanism consistent with the recommended strategy stemming from the *"Urbanisation"*. At the national level, implementation requires at a minimum committed leadership and governance,[8,24] and a deliberate effort to leverage existing capacity.[25]

The action plan was designed to produce quick returns, and to keep momentum going among key stakeholders: MoH leadership, providers, patients, and payers. To achieve these goals, the following issues were taken into account: the implementation of individual health cards to address patient identification issues, scheduling systems to improve service demand management and patient satisfaction, hospitals administrative capabilities to increase revenue, and data analysis tools to improve decision making and planning. The deployment strategy has been devised to accommodate an incremental approach, from selected pilot facilities within a pilot region, to full parallel rollout to all regions. While the 11-year time frame for full HMIS rollout across 7 regions was deemed to be realistic, the team recognized the need to balance developing a realistic plan with the risks to assuring long-term stable financing as well as leadership focus and political support for reforms. Another key issue considered was the need to develop flexible systems capable of integrating new technologies that will progressively become available over this period and beyond.

Several challenges however, remain to be addressed. Health IT in Morocco is in its infancy; primary care is not computerized and, out of the 140+ hospitals of the country only 9 are implementing some kind of hospital information system and none has achieved full implementation. Few vendors have tangible field implementation experience in the country. Few IT employees are knowledgeable of health care processes and adapting experience gained abroad to local culture norms is a key proposition.

A large portion of MoH IT budget dedicated to the acquisition of hardware and software licenses is consistent with an early information system adoption stage. However, getting out of the adoption stage towards further IT development will require inversing this allocation, and investments in people and organizations to ensure expected return on hardware investment. Indeed, the budget projected for implementation was designed to support capacity building efforts, as simply rolling out software components is unlikely to ensure users' uptake. Hardware and software are to be purchased and deployed in parallel to system implementation, to preclude premature hardware and software purchases. In the Moroccan context, legislation and regulation are important prerequisites to implementation; accordingly, regulation is proposed as a key leverage to facilitate user's uptake.

Information systems architecture planning in any form, including *"Urbanisation"*, is an obligatory step towards the implementation of large information systems. Incorporating process reengineering into overall HMIS reform design is critical, as stakeholders are all too often resistant to change and simply wish for the automation of familiar workflows, which inevitably leads to the automation of poorly designed processes[26]. The *"Urbanisation"* of a national HMIS, while a heavy and complex process, allows for the re-engineering of workflows across health organizations, to systematically revise processes that perpetuate inefficiency and contribute to rising costs.

National HMIS implementations call for long term vision, commitment and stability, which may not be reached if not supported by long term plans.[27] An advantage of the *"Urbanisation"* methodology lies in instantiating the organization's strategic objectives in the HMIS' requirements set, ensuring that the proposed system contributes to the realization of the organization's mission. At a lower level of abstraction, the methodology is comprehensive as it

17

tackles business, application and technical layers, while allowing the evaluation of various implementation scenarios.

Since the proposed information system is intended for a nationwide rollout, particular attention was paid to systems and sub-systems architectures. Indeed, several alternatives were analyzed: centralized, distributed and mixed models. The volume of data to be exchanged was also considered in light of telecommunication alternatives in Morocco. All these factors converged in recommending the distributed model. This approach favors an incremental implementation, and sequential investments as the system is built. Compared to the centralized model, this approach is admittedly more costly in terms of human resources and licenses, but it is less demanding in terms of communications load.

The next step in this process is the development of the HMIS Master Plan, derived from the *"Urbanisation"*. This document will be validated and adopted by key stakeholders, including civil society, NGOs, patient groups, health insurance groups, the private sector, and all concerned MoH departments.

Lessons learned

Involving all stakeholders, particularly health care professionals, in all phases of the implementation of large and complex HMIS from inception to full rollout, is a key success factor in developed countries.[7,28] This includes encouraging local ownership of the new HMIS to sustain their integration and deter the perception that such systems belong to "others", [29] fostering active data usage among staff responsible for data collection to improving data integrity and timeliness, and proper attention to "power distance", the degree to which the less powerful members of a society accept and expect that power is distributed unequally. In multilateral

18

government programs, countries where national culture imposes a high power distance in the workplace,[30] should endeavor acculturating to methods from countries where power distance is lower, to facilitate decision making and move projects forward. Indeed, streamlining the decision process impacting HMIS implementation alternatives is a key success factor in optimizing implementation schedule and curtailing drag. Hierarchical structures can hinder decision making, particularly when senior officials must be implicated. Case in point: while objectives prioritization is a key success factor, and should be entrusted to senior members of the organization, as it directly impacts the timely implementation of national HMIS components, in Morocco members of key committees did not feel entitled to list, let alone prioritize objectives, and relegated the responsibility of doing so to the expert team. Such issues can compromise HMIS ownership. Furthermore, organizations in short-term oriented societies may find it difficult to commit themselves to the long-term health strategies essential to the successful implementation of a national HMIS.[21,28]

Focus on rural and remote areas is both a national priority[31] and a priority of the World Bank supported Program for Results for Improvement of Primary Health Care in Rural Areas,[32] with 25% of the Moroccan population living more than 10 km away from a basic health facility. Yet in the field, the team was met with strong skepticism as to the usefulness and feasibility of surveying health facilities in rural areas. However, during the visits that eventually did take place, health practitioners in these areas expressed a substantial interest in a national HMIS – in contrast to health practitioners in urban areas. This appeared largely due to the MoH personnel assignment system, that systematically assign young nurses and physicians to remote or rural areas, and the marked interest in HMIS reforms manifested by these health workers. Young health practitioners are well versed in computer technology and the Internet and aware of the

19

benefits ICTs could bring to their patients and practice. To ensure the successful implementation of a national HMIS in Morocco, MoH was encouraged to leverage its personnel rotation system by adopting a strategy that prioritizes HMIS implementation in health facilities in remote rural areas, and its gradual adoption over time from the periphery to the center, i.e., from remote rural areas to key urban centers. Overtime, this strategy may mitigate a substantial risk to the successful implementation of health reforms: the resistance to change among older MoH staff in urban and central units. It may also greatly facilitate capacity building efforts, since personnel in remote and rural areas are already well versed with computational technology, and eager to receive associated foundational and supplemental training.

With regard to the action plan, several scenarios were analyzed, from minimal to ideal implementation. These scenarios analyzed alternatives for the implementation of key components, such as patient identification using existing health cards versus individual health cards, household records versus individual records, alternate collaboration modalities with other health care providers. In terms of type of medical record, Morocco's tradition relies heavily on the household institution and the household medical record had emerged as a means for the MoH to obtain a comprehensive view of a household demographics and medical components. However, for the purpose of the "*Urbanisation*", the individual record emerged as a better approach since it supports the entire lifespan of a patient's medical record. A household medical record would have been much harder to implement since patients may belong to several households throughout their lives. For a national HMIS based on individual records to capture household information, it needs to contain links between individuals of the household and

20

household's demographic information such as revenue, housing type, and level of education of household members.

With a poorly developed health ICT infrastructure and substantial capacity constraints in terms of budget, equipment, and human resources, Morocco tended to favor budget reduction, potentially compromising success. However conservative approaches are preferable to unrealistic or insufficiently funded objectives. This is particularly the case with regards to infrastructure and communications, which need to be reliable and sufficient, and onsite training and support to health care professionals. When addressing infrastructure issues, governments need to keep in mind that implementation timelines will probably be longer than anticipated; therefore, they should select proven, reliable, and sustainable technologies comparable to those chosen for similar large-scale projects. When selecting products, crucial components should originate from leading vendors committed to reliability and sustainability. Crucially, system architecture ought to be scalable in order to facilitate incremental implementation of the target system over a long period of time. Also, advanced capabilities should be postponed in order to ease implementations. In terms of software acquisition Morocco should consider several alternatives, including open source components, tailor-made applications, and equipment from vendors experienced in the field. The "*Urbanisation*" further revealed the urgent need for Morocco to leverage software internationalization and localization,[33] i.e., the addition of locale-specific components required to comply with local languages, regulations, organizational processes, and technical requirements, without software re-engineering.[34]

A national HMIS reform requires from the get go qualified project management structures[35] to ensure proper change management.[36] In Morocco, the Steering and Technical committees attempted to address this issue, with mixed results. As has been noted elsewhere,[37] Morocco had

many supporters of reform, but also met strong resistance from others, particularly those who may perceive themselves to be somehow penalized by the implementation of some components of the HMIS.

As public health systems in low- and middle-income countries in MENA, and globally, continue to address significant challenges in the provision of health care, HMIS interventions are quickly reshaping the way clinical knowledge is created, shared and applied in these countries.[38] As such, stakeholders must keep working together to ensure that national HMIS implementations meet tangible and measurable goals of eHealth: access, equity, efficacy and quality. Time is of the essence, as it is no exaggeration to claim that the health sector is twenty years behind in the computerized management of health; one only needs to look at the significant progresses achieved in other sectors (e.g., banking services, transport services, etc.) in leveraging the transforming power of ICTs, to take the full measure of the lag impacting the health sector in this domain. Governance and leadership are clearly of utmost importance in ensuring the success of far ranging initiatives such as the planning and implementation of a national HMIS.[8,24] Critical to success is a governmental drive that recognizes the value of health informatics interventions, and appreciates the risk that the incentive may be lost along the way to bring them to a tipping point where sustainable large-scale benefits accrue beyond initial small-scale accomplishments.

References

[1] Silber D. The case for eHealth. Maastricht: European Institute of Public Administration; 2003.

[2] World Health Organization. Building foundations for eHealth. Geneva: 2006.

[3] World Health Organization, International Telecommunication Union. National eHealth Strategy Toolkit. Geneva: 2012.

[4] Lippeveld T, Sauerborn R, Bodart C. Design and implementation of health information systems. Geneva: World Health Organization; 2000.

[5] Health Metrics Network, Framework and standards for country health information systems. 2008, World Health Organization: Geneva.

[6] Schweitzer T, Synowiec C. The economics of eHealth and mHealth. J Health Commun 2012; 17(Suppl)

[7] Shortliffe EH. Strategic action in health information technology: why the obvious has taken so long. Health Aff 2005; 24(5): 1222−1233.

[8] Lucas H. Information and communications technology for future health systems in developing countries. Soc Sci Med 2008; 66(10): 2122−2132.

[9] Bartlett C, Boehncke K, Johnstone-Burt A, Wallace V. Optimising eHealth value: Using an investment model to build a foundation for program success. Booz & Company; 2010.

[10] Roberts M, Hsaio W, Berman P, Reich M. Getting health reform right: a guide to improving performance and equity. New York: Oxford University Press; 2008.

[11] Kingdom of Morocco. Dahir 1-02-296 of Rejeb 25, 1423 promulgating law 65-00 on the basic medical coverage. 2002.

[12] Kay M, Van Andel M, Klint K, Tristram C. Building foundations for eHealth, in Report of the WHO Global Observatory for E-Health. Geneva: World Health Organization; 2006.

[13] Scott R, Mars M. Principles and framework for eHealth strategy development. J Med Internet Res 2013; 15(7):

[14] Ministry of Health. Sectoral Strategy for Health for 2012-2016. Rabat: Kingdom of Morocco; 2012.

[15] The World Bank. Improving Primary Health in Rural Areas Program-for-Results Project for Morocco. 2015. Available at: http://www.worldbank.org/projects/P148017?lang=en (accessed August 15 2016)

[16] Longépé C. Le projet d'urbanisation du S.I. Cas concret d'architecture d'entreprise. Paris: Dunod; 2009.

[17] Hjort-Madsen K. Enterprise architecture implementation and management: a case study on interoperability. In: Proceedings of the 39th Annual Hawaii International Conference on System Sciences. Hawaii; 2006.

[18] Indra SA. Indra Systems. 2016. Available at: http://www.indracompany.com/en/ (accessed 9/18/2016)

[19] World Health Organization. Landscape analysis of barriers to developing or adapting technologies for global health purposes. Geneva: WHO; 2010.

[20] Barchard KA, Pace LA. Preventing human error: The impact of data entry methods on data accuracy and statistical results. Comput Human Behav 2009; 27(5): 1834–1839.

[21] Deutsch E, Duftschmid G, Dorda W. Critical areas of national electronic health record programs - Is our focus correct? Int J Med Inform 2010; 79(3): 211–222.

[22] Haazen DS, Slote A, Al-Shorbaji N, D'Adamo P. eHealth Technical Paper. In: Measurement and Accountability for Results in Health Summit. Washington, DC: World Bank; 2015.

[23] Andalucía Health Service. Innovación. 2012. Available at: http://www.calidadsaludandalucia.es/es/innovacion_9_5.html (accessed 21 August 2016)

[24] Morquin D, Ologeanu Taddei R. Professional facing coercive work formalization-Vicious circle of the Electronic Medical Record (EMR) implementation and appropriation. in Conference: 32nd Colloquium of the European Group for Organization Studies (EGOS). Naples, Italy; 2016.

[25] Riazi H, Jafarpour M, Bitaraf E. Towards national eHealth implementation: a comparative study on WHO/ITU National eHealth Strategy Toolkit in Iran. Stud Health Technol Inform 2014; 205: 246–250.

[26] Militello L, Arbuckle N, Saleem J, Patterson E, Flanagan M, Haggstrom D, Doebbeling B. Sources of variation in primary care clinical workflow: implications for the design of cognitive support. Health Informatics J 2014; 20(1): 35–49.

[27] Chaudry Z, Koehler M. Lessons Learnt On Electronic Health Record Systems' Implementation. 2014. Available at: https://www2.health.vic.gov.au/api/downloadmedia/%7b10c45dcc-acda-4ab2-bc21-5ef18df41f36%7d (accessed August 21 2016)

[28] Stroetmann KA, Jones T, Dobrev A, Stroetmann VN. e-Health is Worth it: The economic benefits of implemented eHealth solutions at ten European sites. 2006. Available at: http://www.ehealth-impact.org/download/documents/ehealthimpactsept2006.pdf (accessed 9 February 2016)

[29] U.S. Agency for International Development (USAID). Participatory Development for a Sustainable Health Management Information System. Measure Evaluation; 2016.

[30] Geert Hofstede, Geert Jan Hofstede, Minkov M. Cultures and organizations: software of the mind: intercultural cooperation and its importance for survival. New York: McGraw Hill; 2010.

[31] World Health Organization. Country Cooperation Strategy Brief Morocco. Geneva: WHO; 2013.

[32] World Bank. Morocco - Improving Primary Health in Rural Areas Program-for-Results Project. 2015. Available at: http://documents.worldbank.org/curated/en/716821468274482723/Morocco-Improving-Primary-Health-in-Rural-Areas-Program-for-Results-Project (accessed September 25 2016)

[33] Aykin N. Usability and internationalization of information technology. Mahwah, N.J.: Lawrence Erlbaum; 2005.

[34] Hall P, Hudson R. Software without frontiers : a multi-platform, multi-cultural, multi-nation approach. New York: Wiley; 1997.

[35] Siles   R. Project management organizational structures: a methodology to manage development projects for international humanitarian assistance and relief organizations. 2007.

[36] Pinto J, Millet I. Successful information system implementation: the human side. Newtown Square, PA: Project Management Institute; 1999.

[37] Asangansi I Understanding HMIS Implementation in a Developing Country Ministry of Health Context - an Institutional Logics Perspective. Online J Public Health Inform 2012; 4(3):

[38] Lewis T, Synowiec C, Lagomarsino G, Schweitzer J. E-health in low- and middle-income countries: findings from the Center for Health Market Innovations. Bulletin of the World Health Organization 2012; 90: 332–340.

27

Table 1:

	Budget estimates (USD)
Creation of steering committee	62,000
Organization	
Implementation of the new IT organization	485,000
Process manual elaboration (50 processes)	515,000
Project management office (annual cost)	1,125,000
Pilot region	
Elaboration of a infrastructure plan	280,000

Implementation of the module to manage personal health card life cycle	400,000
Distribution of health cards to patients of the pilot region	650,000
Implementation of the so-called pillars of the HIMS and administrative modules of 80% of facilities	10,700,000
Implementation of the call center	1,800,000
Implementation of digital imaging in 8 hospitals of the pilot region	850,000
Implementation of LIS in 9 hospitals of the pilot region	1,800,000
Implementation of the hospital's ERP in the pilot region	8,650,000
Development of the public health modules (public health surveillance, nutrition and environmental health, death	1,850,000

register)	
Implementation of public health modules of phase I	175,000
Information for decision making of phase I	750,000
Change management for the implementation of administrative modules	1,750,000
	Budget estimates (USD)
Implementation of administrative modules in the remaining 20% of modules of the pilot region	1,800,000
Implementation of clinical modules in all facilities of the pilot region	16,800,000
Implementation of digital imaging in a regional hospital	150,000

Implementation of the LIS in a regional hospital	285,000
Implementation of the remaining management modules in the pilot region	9,390,000
Change management for the implementation of clinical modules	450,000
Development of the remaining public health modules (health prevention and promotion, research, MBDS)	3,100,000
Implementation of public health modules of phase II	285,000
Implementation of module for project management	60,000
Implementation of module for document management	1,350,000
Implementation of patient portal	1,800,000

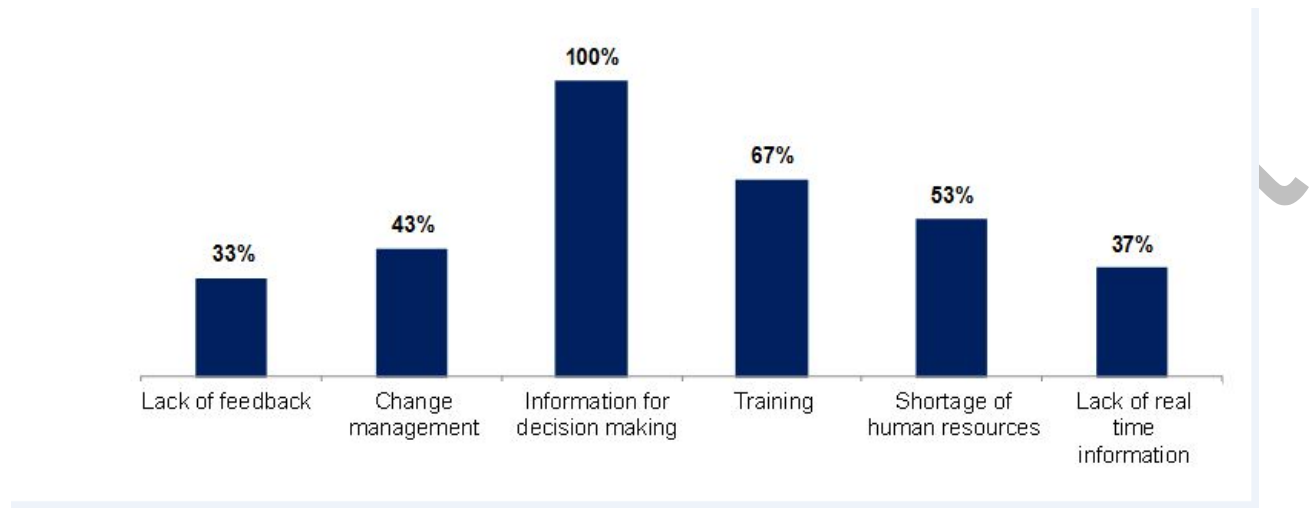|	
Implementation of health care professional portal	1,600,000
Information for decision making of phase II	900,000
Quality improvement	375,000
Total (excluding PMO)	**69,062,000**

Figure 1.Top HMIS needs as expressed by users: percentage of interviewees that raised each issue.

Figure 2. Components of the health care provision dimension.

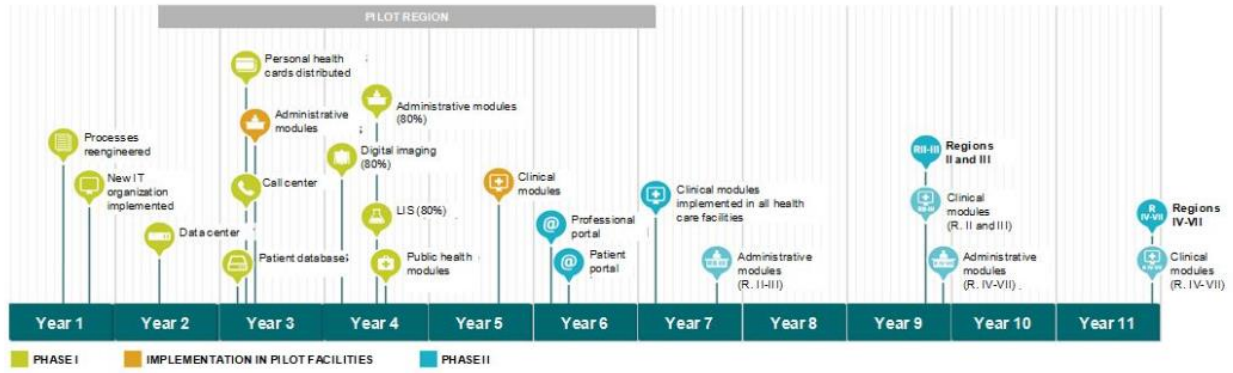Figure 3 Public health building blocks.

Figure 4 Management tools.

Figure 5. Main milestones of the implementation plan.