ADDIS ABABA UNIVERSITY
SCHOOL OF GRADUATE STUDIES
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Architectural Framework for Information Integration: Case of Organizations Working on Water, Hygiene and Sanitation in Ethiopia

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DECLARATION

I declare that this thesis is my original work and it has not been presented for a degree in any other university. All the material sources used in this work are duly acknowledged.

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Wondwossen Mulualem

May 2013

This thesis has been submitted for examination with our approval as university advisors.

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Ato Workshet Lamenew

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Dr. Fikre Enquselassie

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ACRONYMS

CSA – Central Statistical Agency

EDHS – Ethiopian Demographic and Health Survey

EMIS- Education Management Information System

FDRE- Federal Democratic Republic of Ethiopia

FMOH- Federal Ministry of Health

GOE- Government of Ethiopia

GTP- Growth and Transformation Plan

HEW- Health Extension Worker

HIS – Health Information System

HH – Household

HMIS – Health Management Information System

HMN—Health Metrics Network

HC- Health Center

HP- Health Post

HSDP – Health Sector Development Program

IA- Information Architecture

IS – Information Systems

KAP – Knowledge, Attitude and Practice

M&E- Monitoring and Evaluation

MDG – Millennium Development Goals

MOE – Ministry of Education

MOH – Ministry of Health

MOWE- Ministry of Water and Energy

SAP- Strategic Action Plan

UNHCR- United Nations Higher Commission for Refugees.

WASH – Water, Hygiene and Sanitation

WHO- World Health Organization

WorHO- Woreda Health Office

ABSTRACT

Water, Hygiene and Sanitation (WASH) is a subject of intersectoral interest that engages different governmental and non-governmental organizations. As it happens in the other areas of public health, existence of parallel WASH activities makes the sector prone to the problems of fragmentation, lack of consistency and other problems that plagued the sector. Such problems were felt at the national level by the Ethiopian government and, as the result, movement towards integrating all WASH activities in the nation was started by drafting a WASH implementation Framework (WIF) and Memorandum of Understanding which eventually was signed by four governmental organizations. The WIF aims at integrating all aspects of WASH activities, including the information system, under one umbrella and the interest of this research lies on exploring the possibility for creating a framework for an integrated WASH information system that can be shared by all stakeholders. The main objective of this research was to study the current status of WASH data creation, management and sharing practices among organizations working in the sector and propose an architectural framework that can be considered as a guide to setup an Integrated WASH information system. To this end, this research focused on the use of indicators as primary tools for data integration and attempted to study types of WASH activities performed and indicators used by target organizations, types of data they collect under each indicator, formats for data collection including the data attributes being used, standards being used for formulation of indicators and practice of sharing between organization working in the sector. Relevant data was collected mainly through semi-structured interviews and analysis of relevant documentations provided by the respondents. The result was eventually used to propose an architectural framework that can be considered as a starting point for practitioners working in the area. The framework was discussed with selected respondents for checking its validity and the overall reaction of the respondents was found to be positive.

Keywords: *Health Information Architecture, Health Information Architectural Framework, Water, Hygiene and Sanitation information System, Water, hygiene and Sanitation information Integration, Public Health Information System, Indicator-data Linkage. Indicator definition, Indicator standardization, standardized data definition*

CHAPTER ONE
INTRODUCTION

Water, Hygiene and Sanitation (WASH) is an area of multi-sectoral interest where different governmental and non-governmental organizations take part by running independent programs which mostly would have similar targets. This has resulted in fragmentation and duplication of efforts which was felt as a problem at the national level and which has led to the drafting of a WASH Implementation Framework (WIF) on which memorandum of understanding was signed in November 2012 by three governmental organizations. The WIF aims at incorporating all WASH related activities in Ethiopia under one umbrella so that planning, budgeting and monitoring and evaluation activities can be undertaken in an integrated fashion (MOWE, 2011). In addition to that, the WIF also foresees an integrated WASH information system.

The need for integration and harmonization was found to be more pressing due to the challenging targets set by the Growth and Transformation Plan (GTP) the country has recently held as its roadmap for development. Thus, a memorandum of understanding over the WIF has been signed by the Ministry of Water and Energy (MOWE), Ministry of Health (MOH), Ministry of Education (MOE) and Ministry of Finance and Economic Development (MOFED) while representatives of donor organizations were present as witnesses. The document is now owned by the federal government.

The need for integration would also be expanded to include non governmental entities as required in the WIF and as the result of international developments, such as the Paris Declaration for Aid Effectiveness (2005), which calls for increased harmonization, alignment and management of aid for coordination and optimization of efforts particularly in the health sector.

This research was inspired by the expressed need for having an integrated WASH information system as described in the WIF document. Therefore it has sought to see the matter from the side of WASH indicators and make them a basis for studying the possibility of realizing such type of information system and, at the end, introducing an architectural

framework that could be considered as a starting point for a future Integrated WASH information system.

According to Morville and Rosenfeld (2007), Information architecture can be defined as "The structural design of shared information environments". In the same book, it is also defined as "the combination of organization, labeling, search, and navigation systems within websites and intranets". Information Architecture is also considered as an art and science of organizing information so that it is findable, meaningful and useful and also includes aspects such as data architecture, metadata management and knowledge management (Downey and Banerjee, 2011; Resimini and Rosati, 2012). Chen et al (2012) split it into two categories where the fist category , classified as Type 1 architectures , are more technical that focus on the design of systems and the second category , known as Type 2 architectures, are considered framework approaches as they aim at structuring concepts and activities necessary to build or design a system. Den Haan (2007) see the latter category, i.e., architectural framework as "structured list of issues" important for building information architecture which, according to Chen et al (2012) is categorized as Type 2 architecture. The approach this thesis attempted to follow can fall under the Type 2 category.

The emphasis of this research is on WASH data integration and, to this end, it has aimed at identifying indicators being used by the organizations, discovering categories of WASH activities and types of information they collect on the indicators, studying the formats they use to collect and store information, identifying their sources of information and their technology choices for data storage and retrieval.

As explained by Godinez et al (2010), data is no more constrained in rows and columns. It comes from within or outside of an enterprise from structured sources as well us unstructured sources such as Radio Frequency Identification (RFID)tags, GPS logs, blogs, social media, images, e-mails, videos, podcasts and tweets. For this reason, the term "data" is used here in such generic sense.

1.1. Background and Statement of the Problem

The Health Sector Development Program (HSDP IV) drafted by the Ethiopian government gives emphasis for inter-sectoral collaboration in crosscutting areas including water and

sanitation and also calls for partnership and networking between governmental organizations , NGOs and civil society working in health related activities (MOH, 2010). One of the undertakings that can be taken as a part contributing for the realization of this goal is the "One WASH" program that is discussed in the above section.

The one WASH implementation framework (MOWE, 2011) explains that goals for safe water, improved hygiene and sanitation consist part of the ambitious goals laid out in the Growth and Transformation Plan and the new WASH program is designed to support that plan. The framework also underlines the need for coordination of efforts between governmental agencies, civil society organizations and the private sector so that the targets could be achieved. It anticipates key sectors and the NGOs to be integrated in planning, implementing and reporting to one WASH Program. Moreover, it recognizes the need of information for making annual WASH inventory control and the need of ensuring information flow among stakeholders and for advocacy and promotion of WASH. But it doesn't say in detail about other aspects such as standardization of Indicators that can be used to measure the success of the program, types of information that should be collected on the indicators, data formats and types, policies, etc that are really important for framing data from various sources for integrated access and also important in conceiving a single evaluation and monitory system for all WASH activities in the country.

A report sponsored by the United Nations Department of Economic and Social Affairs (2011) also reminds that the responsibility of collecting water sector data and information in Ethiopia is distributed among different ministries and other institutions. The report acknowledges that this approach risks duplication of efforts and lack of harmonization hence underlines the need of developing a framework for monitoring and evaluation information system for the water sector.

As shown in the report mentioned above, there is a strong need for a platform of networking water sector institutions and organizations for data management, standardization of procedures, quality control, etc. Therefore, enhanced participation is recommended from stakeholders to establish the networking and to realize integrated WASH information management system. Moreover, legislative support for such kind of management system is

so crucial that requires all governmental and non-governmental organizations to sign a protocol on water sector data collection and information sharing (UN-DESA, 2011).

The two papers referred above and all the explanations given so far point the direction of the country towards WASH data integration. This can be considered as a call for an information system that collects data from various stakeholders, integrates or harmonizes the data and presents it for shared access. Such endeavor can be framed by information architecture right from its inception. According to Chen et al (2010), Information Architecture is instrumental to structure information as well as concepts. In the words of Martin et al (2010), Information architecture serves the requirement for greater integration and coordination across multiple channels and business processes addressing strategic shaping of today's Information technology systems which are increasingly getting heterogeneous, isolated and distributed. To put it in a nutshell, producing the information architecture should be the first step towards designing a new information system as it guides the input, processing and output requirements. This research was designed with this in mind and was driven by the following main research questions:

- Is there a foundation (in terms of standardized indicators and data definitions) to create an integrated WASH information system in Ethiopia which can be shared by governmental as well as nongovernmental organizations?
- If so/not so, how can we approach introducing an architectural framework that can help to realize it?

The UN-DESA report mentioned above recommends examination of the internal processes of the organizations regarding their process of knowledge creation, storage and dissemination. Therefore, this research has attempted to examine WASH data management practices and aligned organizational structures of the target organizations.

Initial investigation made on couple of NGOs prior to the design of this research showed that these organizations conduct KAP surveys, baseline surveys and carryout follow-ups depending almost entirely on the data collected by themselves. They collect and organize data in forms of excel sheets, Microsoft word documents, pictures, maps, etc. and report summarized data to their donors according to the format specified by the donors. They also

send reports to different administrative bodies of the government depending on the nature of their project. Considering the time they might have invested and the effort they might have exerted in collecting and processing the data, it was the interest of the researcher to find out whether they share such invaluable resource to others working in the same area and to see how they can contribute to the WASH information system as required by the WIF. To find answers to the above questions and to investigate the possibility of sharing data under a certain framework, this research was framed with the objectives listed in the following section.

1. 2. Objectives of the Study

1.2.1. General Objective

The main purpose of this research was to study current WASH data creation and management practices in Ethiopia and propose an architectural framework that can be considered for integrating the data produced by governmental as well as nongovernmental organizations.

1.2.2. Specific Objectives:

This research had the following specific objectives:

- Understand the strategic direction of the nation towards integrated WASH information system
- Identify WASH indicators being used by governmental as well as nongovernmental organizations, collate and categorize indicators
- compare indicators, indicator definitions and data collection formats used by organizations running similar WASH programs
- study the information sharing practices of target organization and identify their targeted information users
- Study the status of technology use for information management
- propose architectural framework that would help realize integrated WASH information system

1.3. Scope and Limitation of the Study

The research was limited to organizations in Addis Ababa Such as the Ministry of Water and Energy, Ministry of Health, Ministry of Education and couple of NGOs in Addis Ababa which are active and better experienced in WASH related Activities.

This research was undertaken with the understanding that information systems evolve as the number and scope of organizations working in the WASH sector increases through time. Therefore, the main issue was not the number of organization to include in the study. It was rather the adequacy of information obtained from the contacted organizations to propose a workable solution or a startup for a future scalable integrated WASH information system.

Obviously, the study could have been more comprehensive if it included regional, zonal or woreda level offices working on WASH related activities or more NGOs working in the area. But, the chosen data collection method, i.e., the semi structured interview method, and the arrangement it required in scheduling interviews with the targeted interviewees has made it difficult given the time frame of the research. Moreover as shown in the objectives section, the research objectives can be met through other means such as review of relevant documentations and onsite observations. For these reasons, the research was limited to the organizations mentioned above. In addition to the geographical scope explained above, the research has limited its focus mainly on the use of indicators to set a framework or foundation for an integrated information system.

One major problem faced in the course of the study in relation to time was the time it took to identify organizations (especially NGOs) which are active in WASH activities. It was not possible to find a kind of register/organizational profile of all organizations working in the WASH sector. The other difficulty was in finding the right people to interview in the chosen organizations and finding a convenient time for the interviews. This was the problem especially in the governmental organizations because, first it was time taking to know the persons that would have the right answers and second , scheduling appointments with them was not easy as they were busy with field works and other engagements.

1.4. Significance of the Study

The main significance of the study arises from its timeliness of the topic as it followed the signing of the WIF memorandum of understanding in November 2012 by four governmental organizations including MOFED and when the need for integration of WASH activities is felt at the national level. The WIF was considered as a startup for a unified system and this research was done with the belief that its output would provide timely inputs for one part of the initiative: Implementation of integrated WASH information system in the country.

Researches show that one of the main reasons for common problems such as data duplication and lack of quality in most information systems is the inability of their managers to devise an information architecture that would be a guide for organizing their information resources and also enhancing their ability to manage information by mapping it to the right person or the right business process (Evernden & Evernden, 2003). Therefore, this research encourages any initiative in management information system to start from producing the blue print of the system, which is the information architecture. The analogy can be taken from the way buildings are constructed. As the first step, an architect would produce a blue print of the building, according to the demand and need or vision of the owners as to what the building should accommodate. In a similar fashion, an information architect need to assess the needs of his or her organization for information and information system and provide a framework/blueprint/architecture that would guide the design and implementation of the information system.

Due to the time constraint, the framework proposed here would not have all technical and non technical requirements laid out. But it would serve as a starting point.

Lots of researches in IS, more specifically in IA are technical in nature and the volume of researches done from organizational or managerial perspective are minimum. The review of literature made in this paper shows that IT by itself cannot be a recipe for creating efficient health information systems. This research will encourage organizations to have a renewed look at their information systems and approach them from organizational or strategic point of view.

1.5. Organization of the Research

This research is organized into six chapters. The first chapter provides introduction to the research explaining motivation for the study and explaining statement of the problem, goal and objectives of the research, scopes and limitation of the research and significance of the study.

The second chapter reviews literature made in relation to public health information systems, problems of health information management as observed in developing countries, steps taken by some countries towards integrating health data and finally presents conceptual review on information architecture on how it can help in structuring health data for integration.

Chapter three dwells on explanation of the methodologies and selected organizations for the research providing justifications for their appropriateness in this study.

Chapter four presents the finding of the research as obtained through interviews and analysis of relevant documents. Attempt is made to categorize the findings by the research questions they tried to answer. Chapter five discusses and analyses the findings in chapter four in order to propose architectural framework for a possible integrated WASH information management system.

Finally chapter six concludes the research providing conclusions and recommendations.

CHAPTER TWO
LITERATURE REVIEW

2.1. Public Health Information

Understanding the public health discipline would be imperative to understand the nature of public health information. As explained by Tulchinsky, et.al. (2009), the public health discipline relates to or encompasses all community and individual activities directed toward improving the environment for health, reducing factors that contribute to the burden of disease, and fostering factors that relate directly to improved health. Its programs range broadly from immunization, health promotion, and child care, to food labeling and fortification, as well as to the assurance of well-managed, accessible health care services (Tulchinsky, et al, 2009).

Water, Hygiene and Sanitation (WASH) can also be taken as part of public health practice since access to water and safe sanitation is the least expensive and most effective means for improving public health and saving lives (Montgomery and Elimelech, 2007)protecting the public from the following categories of diseases:

Categories	Description (Disease)
Waterborne	Caused by the ingestion of water contaminated by human or animal excreta or urine containing pathogenic bacteria or viruses; includes cholera, typhoid, amoebic and bacillary dysentery, and other diarrheal diseases.
Water-based	Caused by parasites found in intermediate organisms living in water; includes dracunculiasis, chistosomiasis, and some other helminths.
Water-related	Caused by microorganisms with life cycles associated with insects that live or breed in water; includes dengue fever, lymphatic filariasis, malaria, onchocerciasis, and yellow fever.
Excreta-related	Caused by direct or indirect contact with pathogens associated with excreta and/or vectors breeding in excreta; includes trachoma and most waterborne diseases.
Water collection and storage	Caused by contamination that occurs during or after collection, often because of poorly designed, open containers and improper hygiene and handling.
Toxin-related	Caused by toxic bacteria, such as cyanobacteria, which arelinked to eutrophication of surface-water bodies; causes gastrointestinal and hepatic illnesses.

Table 2.1. Categories of water-, sanitation-, and hygiene-related diseases (Source: Montgomery & Elimelech, 2007, page 1)

The literature reviewed under this chapter refer to the general context of health information systems and they are presented with the understanding that, in the sense discussed above, would apply to WASH as an integral part of the public health practice.

Information is both a critical currency and a product of public health practices that can be collected and used by hospitals, health centers, clinics, health departments, statisticians, research organizations and others who have stakes in the sector (O' Carroll, et.al 2003). It can also be found from censuses and surveys which are sources for mortality, morbidity, demographic data and data on the utilization and supply of health services (Stephen, 2010).

The growing magnitude of data available from multiple public and private sources, advances in information technology and the growing awareness of information as an important public health tool for decision making has increased the importance of health information systems (Studnicki et al, 2008.). But the multiplicity of data sources resulting from parallel and similar public health practices has created serious problems faced by health information systems : duplication and fragmentation of data (Stansfield et al, 2008) This problem is in part attributed to donor influences favoring vertical programs (Latifov & Sahay, 2012), their failure to integrate their activities with other entities and also the nature of funding that emphasizes specific parts of public health while ignoring others (AbouZahr and Boerma, 2005; Stansfield et al, 2008). Beside this, technical reasons such as the use of rigid and proprietary software that makes it hard to change the system whenever there is a need, for instance, the challenge it poses for adding new indicators and linking data elements whenever needed, are mentioned as contributing factors (Latifov & Sahay, 2012).

This section discusses these and other challenges faced in the health information systems of the developing world in general and presents experiences of other countries towards integrating health data. It also discusses information architecture which is instrumental in providing guiding blueprints for information integration and finally returns to the main issue of this paper, WASH information, to explain the situation in Ethiopia.

2.2. Health Information in Developing Countries

Health Information Systems have been identified as one of the six pillars of the health system (WHO, 2007) being crucial elements in monitoring progress, adjusting policies and

funding priorities , and making evidence based decisions for spending resources where they make the most impact (Kossi et al, 2010).

As the research conducted by Vital Wave Consulting (2009) describes, the regions, nations, and communities that comprise the developing world face a wide variety of health-related challenges and the health systems that address those challenges are struggling with limited resources and capability. Explaining trends affecting health information in the developing world, the research listed the following:

- There is significant fragmentation and duplication in data collection, because governments, donors and implementing partners have little incentive to collaborate on data collection, data sharing, or leveraging common infrastructure.

- The health information system is not used by those providing or managing health services at the local level, as these individuals are often presumed to not need health information of this nature

- Various independent systems are seldom integrated, which impedes the ability to share data, increase the efficiency of operations or enhance the sophistication of analysis and decision making.

Macfarlane (2005) adds to what is discussed above showing that the sector is plagued by costly duplications, inefficiencies and inconsistencies between institutions in the collection, reporting, storage and analysis of data, and a ubiquitous shortage of the human resources needed to design and manage information systems. A research by Selamawit and Birknesh (2005) confirmed the existence of such problems in the Ethiopian context and detailed existing problems such as incompleteness and un-timeliness of data and reports, ambiguity of data elements in the reporting formats, Inaccuracy of data, Inconsistent data collection procedures, poor infrastructure, Inadequate HII resources (data collection instruments, human resources and computers), Fragmentation of the paper-based reporting system, fragmentation of the technical system and weak information use culture. Lack of standardization and fragmentation of health data in different partly overlapping sub-systems run by different vertical health programs cause unreliability and inefficiency of health

information creating obstacles for reaching the Millennium Development Goals (Kossi et al, 2010).

Stansfield et.al (2008) add that those health information systems are often focused exclusively on disease specific program areas and as a solution, they recommended the sector to learn from other sectors and adopt the idea of enterprise architecture, which can be a solution to guide planning and development of complex systems in all sectors including, government, commercial, and NGOs. Gordon and Hilson (2007) mentioned 'sustainability' as another challenge to health information systems. They also added inappropriate donor policies and strategies as other sources of problem. Donors help developing countries directly by implementing the programs themselves or by funding other implementers. The problem is that the funds are project-driven that makes them unsustainable. Moreover, the funds are directed to specific disease areas or projects rather than following the integrated approach to develop the health systems of host countries (Gordon and Hilson, 2007).

The problem of developing countries in relation to health data is not limited to those mentioned above. Latifov and Sahay (2012) add two more problems to the mix: *"One, excessive data is collected; and, two, the data that is collected is not adequately Utilized"* (Page 1). One other problem they indicated in health information systems in developing counties is poor data-indicator linkage. Explaining this, they took the example of multi-level organizations where sub-units are distributed across different geographical locations. Each unit might have its own specific needs of information with its own set of primary data collection procedures and formats. Such diversity might create a problem of data quality. Moreover, there might be different population estimates of a catchment area depending on who is the data collecting agency. As indicators are abstracted knowledge of a health situation calculated out of these data sets (e.g. numerator over denominator; the numerator being data collected by health workers and the denominator being population estimates of the catchment area), they might be erroneous. The other problem discussed by the authors was that, since health workers are given targets to achieve, there might be a tendency to manipulate data to show that their performance is in line with the targets (Latifov & Sahay, 2012).

The analysis provided by Braa et al (2007) and Kossi et al (2010) could be used to summarize the situation in developing countries. According to them, the following are typical to the HIS of those countries:

1) there is a national HIS run by the Ministry of Health aiming at covering data from across the various health services and disease specific health programs (e.g. HIV/AIDS, Tuberculosis, Maternal & Child Health, Disease Surveillance, Vaccination Program);

2) the health services generally and the national HIS are relatively weak with insufficient resources;

3) While the vertical programs are comparatively rich as they are funded from international sources (e.g. HIV/AIDS), they need to provide their funders with quality information on their activities and achievement in order to maintain their funding. As a consequence,

4) not being satisfied with the data from the national HIS, the vertical programs develop their own sub-HIS with international funding, funding which is difficult to achieve for national HIS, and further fragmentation is generated

Despite all those shortcomings explained so far, there are also commendable efforts being made in the health information management system of developing countries. For instance as mentioned by The Vital Web Consulting (2009), there is a growing trend in not only improvements of technology, but also in the commitment to the use of health system information in evidence-based management decision making which in turn requires effective leadership and comprehensive training at all levels of the health system. Braa et al (2010) recommends poor countries like those in Africa to adopt HIS which is scalable (vertically down to administrative hierarchies and horizontally in scope) and interoperable explaining the importance of standardization in data collection formats and benefits of integrating data to overcome persistent problems in HIS : Fragmentation, duplication and all others discussed so far. The following section presents ways of integrating health data and experiences of other countries as explored from literature.

2.3. Health Data Sharing and Integration

The need for data integration rises out of all problems of health information systems discussed above. The list of benefits includes reduced duplication of data, more coordinated efforts, efficiency, active public participation, transparency, cost savings, policy effectiveness and service quality (Gli-Garcia, 2012).

Health/public health is a vast area where different independent organizations operate. Moreover, it is a sector that may depend on data generated by other sectors. For example, planning of public health interventions on the basis of environmental indicators, prediction of epidemics on the basis of climate data, monitoring of chronic diseases through risk factor surveillance (Macfarlane, 2005) are just few examples for the interdependence.

There are also bigger national and international developments that encourage intersectoral collaboration in data sharing. For instance, the Paris Declaration for Aid Effectiveness (2005) which calls for increased harmonization, alignment and management of aid for coordination and optimization of efforts particularly in the health sector, can be seen as one pushing factor. Agenda 21[1] (UN 1993), stresses the need for intersectoral efforts for the linkage of health environmental and socioeconomic improvements and underlines the importance of "bridging the data gap" by increasing the relevance and availability of data, improving the cost-effectiveness of data collection and developing capacities for data management and analysis across all sectors.

The term "Integration" refers to the concepts of coordination, coherence and uniformization and , depending on the degree of coupling, it can either mean "tightly coupled" where components are interdependent and inseparable or "loosely coupled" which would mean that components exchange services while continuing their independence (Chen et al, 2008). The concept of integration also has political aspects as it involves negotiating actors who have been working independently and who primarily have been the causes of fragmentation (Kossi et al, 2010).

[1] Agenda 21 is a non-binding, voluntarily implemented action plan of the United Nations with regard to sustainable development

Integration can be done using different approaches. The approaches categorized as Enterprise Application Integration (EAI) solution models are explained by Mykkänen et al (2008) as follows:

- *The Information-oriented* integration approaches integration problems through information exchange, and databases and APIs that produce information
- *The process-oriented* integration produces a layer of defined and centrally managed processes on top of existing processes
- *The service-oriented* integration allows applications to share common business logic or methods
- *The User-oriented* integration (portal oriented) allows the user to gain a consistent view of multitude of systems.

The authors mentioned that one of the approaches is the most evident in one integration solution but also added that combination of the approaches could be used to solve one integration problem.

Gli-Garcia (2012) explains that data integration will have social/political nature and technical aspects when applied across different government organizations. The social aspects of information sharing and integration would refer concepts such as information sharing, inter-organizational collaboration, and coordination mechanisms whereas the technical aspects would focus on interoperability and the integration of data by means of various technologies, such as standards-based document sharing, middleware applications, data warehouses, and consolidated information systems (Gli-Garcia, 2012).

There have been recommendations put forward to enable institutions share health information. Ying et al (2010) recommend standardization in schemas (for example, XML schemas) and messaging protocols to achieve interoperability between distributed health systems. They also noted that semantics of the relationship should be added to avoid confusion while interpreting data. For instance, a date might be transferred through multiple systems and confusions might arise if there is no understanding on whether the date refers to a date of birth or date when a document was created (Ying et al, 2010).

As the most referred problems of health information systems are data fragmentation, data redundancy and lack of data standards, there have been different approaches made by different researchers for solving these problems. The examples given on this paper mostly adopted what is called the "Data Warehouse Approach". A data warehouse is defined as a repository storing integrated information (collected from heterogeneous sources) for efficient querying and analysis (Kossi et al, 2010; Stanford University, 2008)

In their research analyzing Tajikistan's health information system, Latifov and Sahay (2012) explained the importance of the data warehouse approach to strengthen the data-indicator linkage. They understood data warehouse as a data repository that can accommodate data from different sources, transform them into common representation, and help the viewer to use various presentation tools such as graphs, maps, charts, etc to visualize the data in the manner they want in order to make informed decision making (p. 5). However, they mentioned that this is a technical as well as a social exercise that requires actors to agree to share data to the common store and allow the visibility of data to users. Moreover, they added that it requires a "durable structure" where it becomes an integral part of the organizational health information system (Latifov & Sahay, 2012).

Presenting experiences of countries in integrating health information, Kossi et al (2010) presented the case of four African countries such as South Africa, Zanzibar, Sierra Leone and Botswana. The authors mentioned that those countries adopted the "Data Warehouse Approach" but the ways of implementation were different. Explaining the case of Botswana, the researchers noted that there were several ministries involved in the collection, compilation and use of health data. Then there was a centralized initiative to integrate the health information systems through the Health Statistics Unit (HSU) to collect essential data from a range of health programs. The main reason was for the compilation of an annual book on health statistics, not for supporting local health information use. But the publication of the year book was delayed for two years that made various health programs to rely on their own individual systems. Then DHIS[2] version 1.4 was deployed with the bid of demonstrating the use of computerization and data warehousing for integrating health data. This was done without standardizing the data collection formats, literally by direct mapping

[2] The **District Health Information System** (**DHIS**) is a highly flexible, open-source health management information system and data warehouse developed in global collaboration between students, researchers and experienced developers in Norway, India, South Africa, Ethiopia, Vietnam and Nigeria)

of paper based data collection formats into the software. This approach was chosen because, according to the authors, the capacity to negotiate integration was not available at that time. As the result, duplication and fragmentation of data persisted to be problems but the authors believe that this has helped in quick computerization of data storage process. This project was managed by the Ministry of Science, Technology and Communication and from the very beginning it was distant from the heath domain. Therefore, it was considered as a "computer project" by several health affiliated stakeholders. The authors mentioned that this failure to create a link between health, IT and local actors has created complications in the implementation of this project.

Presenting the case of Zanzibar, Kossi et al (2010) explained that the project of data warehousing was started from revising all existing data collection formats to avoid overlaps between forms and data elements. This was made possible because of the agreement secured from all stakeholders to revise and coordinate their data collection forms so as to solve problem of overlaps. The forms were updated annually. Finally this has helped in improving data quality and by the time of the research it was adopted as a national standard (Kossi et al, 2010).

Presenting the case of Sierra Leone , Braa et al (2010) described that a data warehouse project DHIS v2 (District Health Information Systems) was initiated in 2007 to integrate the various data reporting structures at district level. At that time, there was no agreed standard across the various health programs and the data collection method was extremely fragmented. Each facility had to report on 17 separate but overlapping forms which resulted in very poor quality data. But as they start the new project, they piloted several stakeholders and convinced them to standardize and share their health information. This was done by providing them with data collection forms and harmonizing all data elements being collected inside the database. This made all stakeholders to have their own data and other data integrated in one database. The pilot was seen as a success and was scaled up later to include all 13 districts of the country which enabled Sierra Leone's ministry of health to make comprehensive analysis of all public health data being collected in the country for the first time . It was claimed that the comprehensiveness of the data has enabled donor organizations to use the data from the shared repository (Braa, 2010). Kossi et al (2009)

mentioned that memory sticks have been used to export data from each district's DHIS to the national DHIS.

Discussing the case of South Africa, Kossi et al(2010) explained that the health services were extremely fragmented due to the legacy left behind by the old apartheid system. Health services were inequitable separated by race, color and other factors. Therefore there was a need to reconstruct the entire health system. This fresh start created opportunity to introduce district based health information systems. Three districts in the Western Cape region were selected as pilots and agreement was made with them to adopt a common standard for data reporting. This yielded quality data and the experience was gradually expanded adding more data sets and being adapted by other provinces.

The review of researches presented above shows that standardization is key in creating an efficient health data warehouse. However this is not an easy process as donors of health programs would have their own requirements and reporting formats and organizations would choose to comply with them for funding purposes (Kossi et al, 2010). This shows that IT by itself cannot be a solution. Identification of different actors and stakeholders then negotiating and forging relationships with them is important. In other words, technical, social and organizational inputs need to be laid out before starting to design an integrated data warehouse. The next step towards implementing the data warehouse or the information system would be to prepare the blue print that would help to visualize all requirements and provide a structure on how to store and retrieve the data. We call that information architecture and the following few sections are dedicated for discussing it.

2.4. Understanding Information Architecture

The modern information environment is characterized by exponential growth, increasing speed with unprecedented rates, and varied formats which creates tremendous opportunities but makes using information a daunting task (Godinez et al, 2010).

Considering the importance information has in decision making and looking at the challenges associated with its exponential growth, speed of production and varied formats, it becomes

differentiator between those who can't cope with this information challenge and those who are able to harness it and make the best out of it (Godinez et al, 2010).

Information architecture enables us to harness information. It facilitates labeling and organizing information resources and making them easily accessible for users (Morville & Rosenfield, 2007). It enables us to minimize data and process redundancy and to define and plan incremental delivery of solutions in the context of a roadmap (Godinez, et al, 2010). The choice of information architecture can have far reaching implications on the performance of health information systems (Lapisa et al, 2012).

According to ANSI/IEEE, Architecture is defined as:

> *"The fundamental organization of a system, embodied in its components, their relationships to each other and the environment, and the principles governing its design and evolution"*

And, according to Resmini and Rosati (2012):

> *"Information architecture (IA) is a professional practice and field of studies focused on solving the basic problems of accessing, and using, the vast amounts of information available today."(P. 33)*

Roger and Elaine Evernden (2003) described information architecture as:

> *"A foundation discipline describing the theory, principles, guidelines, standards, conventions and factors for managing information as a resource"(P. 1)*

The above explanations show us that we can not merely equate information architecture with website development. It incorporates wider organizational issues. It is a broad area concerned with structuring of all enterprise-wide information assets which can be called "enterprise IA" and with the design of information for websites, portals or application UIs which we call "user experience IA" or "Web IA" (Remini and Rosati, 2012). Stansfield et al (2008) explain the enterprise architecture is the next level of elaboration of the HMN Framework where general lessons, standards, and processes can be accumulated and documented for knowledge sharing helping to identify interrelationships between components and also to help in reducing the risks of fragmentation, duplication and lack of

interoperability. Martin et al (2010) add that IA needs to cross organizational boundaries and for that reason it requires an integrated enterprise approach.

In designing architecture for health information systems (HIS), trends such as the shift from the institution-centered HIS to regional or global HIS, the shift from focusing mainly on technical HIS problems to those of change management as well as strategic information management, the shift from mainly alpha-numeric data in HIS to images and to data on the molecular level, ubiquitous computing environments etc should be taken under consideration (Haux, 2006).

The aspects that need to be taken into account while designing information architecture include guidelines and principles for implementation, operations, administration and maintenance, and also description of the architecture, i.e. how it is structured and described in a formal way, often by providing generic and detailed diagrams (Godinez et al, 2010).

There are layers or domains of architecture that are subsets of the overall enterprise architecture. The four common ones in the HIS are presented by Stansfield et al (2008) as shown in the following table

HIS Enterprise Architecture		
Architecture Domain	**Deliverables**	**Representative Questions Addressed**
1. Organizational Architecture	➢ Business domains ➢ Business functions ➢ Business processes ➢ Governance, Policy, Resources	➢ 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 development and implementation of a national HIS? ➢ 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	➢ Data model ➢ Metadata dictionary ➢ Classification standards and systems	➢ 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 program M&E?

Architecture Domain	Deliverables	Representative Questions Addressed
3. Applications Architecture	➢ Software applications ➢ Interfaces between applications ➢ User interfaces	➢ 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	➢ Hardware platforms ➢ Local and wide area networks ➢ Operating system ➢ Interoperability	➢ 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?

Table 2.2. HIS Enterprise Architecture (Source: Stansfield et al, 2008)

2.5. Why Information Architecture?

The modern information environment is facing different internal and external challenges (Godinez et al, 2010). The increasing volume of information and the increasing capacity of computers to store large volumes of data, the increasing amount of information coming from structured (e.g. , database management systems) and unstructured (e.g. blogs, GPS logs, Radio Frequency Identification tags, etc) resources and the increasing velocity of information production constitute the external challenges. Lack of central planning in developing information environments, inability to access timely information for decision making, technology and data redundancy, inability of business leaders and IT leaders to be at loggerheads with each other, lack of data quality, cost and other challenges associated with systems integration are examples of internal challenges organizations face in leveraging information for quality decision making (Godinez et al, 2010).

One of the main mistakes made by organizations is rushing to have a quick fix for the problems by purchasing or developing technology based information systems without first understanding information needs of their users, or, by focusing on knowledge creation disregarding the need of a formal structure for capturing personal knowledge as a corporate

information asset (Evernden & Evernden, 2003). That means, when they pursue technological solutions, they tend to forget architecture which is the human side of information management (Evernden & Evernden, 2003).

Therefore, information architecture can be the way forward for overcoming challenges like those discussed above (and the first sections of this chapter) because it can be used as a guiding framework for the management and effective utilization of information (Martin et al, 2009). As the shape and functions of a building are determined by its architecture, information architecture provides "simple shared structures that are used by everyone in the organization to investigate and assess how things are going, to improve use of information, and to plan, monitor and implement change programs and projects" for coordinating efforts and leveraging the use of information (Evernden & Evernden, 2003, P. 4).

In the area of health, the concept of information architecture provides guiding plan across development projects, promotes component orientation to the development process so that larger components of a system are built from the smaller ones, decreases data redundancy by providing a coherent approach for data storage, backup and security, promotes interoperability and efficiency through the adoption of standards, promotes planning and clarifies business process and most importantly, takes the locus of decision making away from the information technology community and provides the executive level with the basis for business control over the distributed development of information systems (Stansfield et al, 2008).

However, we need to take into account that health is a combination of many uncertain inputs and such systems are not analogous to their counterparts in business or manufacturing industries since health is a combination of inputs ranging from unique biological or behavioral characteristics of individual patient or population under study simple (Studnicki et al, 2008). Moreover as explained by Studnicki et al (2008) development of health information systems that support public health institutions is more complex and costly than those practiced in other industries and professions . The expertise needed to design health information systems needs to be drawn from computer science, electrical engineering, medicine, nursing , health management, finance and accounting, economics , sociology, survey design, epidemiology and statistics (Studnicki et al, 2008).

Ownership of information is another issue that needs to be addressed when institutes share information. We need to ask important questions like the one presented by Tsiknasis et al (2005): "*should access to information determine competitive advantage or should information be made available among stakeholders so that market advantage is based on creative use of information rather than access to information? "* (p. , 316). Legislations, rules and guidelines need to be created to govern information sharing (Tsiknasis, 2005).

The notion of describing information as a resource takes it beyond technological departments and makes it everyone's responsibility where it can provide practical tools for improving effectiveness, efficiency and productivity. Information architecture helps in structuring and organizing information thus playing the key part in managing corporate information (Evernden & Evernden, 2003).

2.6. Distributed vs. Centralized Information Architecture

Most of the health information exchange efforts are said to have been taking place in the distributed fashion (Lapisa et al, 2009). In distributed model (also known as institution-centric model), each organization will have total institutional autonomy over the data it generates. This would help to relieve fears and concerns associated with privacy, confidentiality, proprietary interests and other related organizational issues (Lapisa et al, 2009). Though this model is good to serve institutional interests, the research by Lapisa et al (2012) shows that questions remain on its effectiveness in the actual practice. Some of the problems noted on this model are fragmentation of data sources, lack of accuracy and completeness of data, and complications related to real time availability of data whenever it is needed. Moreover, when compared with the centralized model, retrieving complete information on an item might require multiple queries. For instance, a patient's records might reside on different nodes or computers if the distributed model is adopted for the file management. For example, if complete information is sought on a patient, then the searcher has to perform several queries on all nodes that host the patient's records. But if the centralized model is adopted, one query would be enough to get all information stored on the patient (Lapisa et al, 2012). Tsiknakis et al (2005) also elaborated such shortcomings of the distributed architecture citing the problems they observed on HYGEIAnet, a distributed information system for eHealth and mHealth services in Crete, saying: *" many pieces of*

information, in many formats, on many platforms, in many stakeholder environments, to many geographic locations."(p. 20). Moreover, they mentioned organization changes as other forces affecting such information environment.

On the other hand, there are recurring themes of "seamless integration" of health information systems along the needs of collaboration and coordination of institutions across geographical, institutional, disciplinary and professional boundaries overcoming factors such as the differences in software products institutions may use and the difference in architecture that may exist between the systems (Ellingsen and Montiero, 2006; Mykkänen, 2003). As explained by Ying et al (2010), isolated islands of information exist due to the lack of standards and coordination between different health information systems. However, there have been approaches and strategies such as federated database systems, World Wide Web, ERP systems, components and Internet portals have been suggested to integrate information systems (Ellingsen and Montiero, 2006). Beside the talk from the technological standpoint , it is important to take into account the organizational factors that dictate which information resources can be shared, who can have access to the resources and also what conditions should be satisfied for the information to be shared (Tsiknakis et al, 2005).

The choice between distributed and centralized systems requires identification of their strong and weak sides as well as their suitability to the organization's policy regarding information management. From the technological view, there are those who say the centralized architecture is better than the distributed architectures for the reasons like those mentioned above. On the other side, we can see the likes of Tsiknasis et al (2005) who say that federation of autonomous health information systems with services facilitating the seamless integration and unified access to the distributed data are most promising approach for establishing efficient and dynamic sharing relationship among any potential participants.

2.7. WASH information in Ethiopia

Having discussed about issues such as information integration and information architecture for health information systems, this section attempts to provide the context of WASH information in Ethiopia so as to review the status and study approaches that can be followed for creating an integrated WASH information system in the country.

Ethiopia has a 20 years comprehensive health sector development program which attempts to "strengthen the health management information system [HMIS]" in Ethiopia, which, in general terms, represents a combination of health services-based data sources. The Ministry of health owns the country's health information management system, while the Central Statistics Agency manages "population –based health information sources" - censuses, ad hoc surveys, and registering vital events(Vital web Consulting, 2009). The HMIS was established to "support informed strategic decision-making by providing quality data that help managers and health workers plan and manage the health service system." The HIMS included 108 health related indicators in which two of them are WASH related.

The Health Sector Development Plan (HSDP) IV has set 100 percent of coverage of basic sanitation and 84 percent of access to improved sanitation by 2015 as its goal (MOH, 2010). As information obtained from the Federal Ministry of Health[3] indicates, Ethiopia has a Five-Year Hygiene and Sanitation Strategic Action Plan (SAP) that focuses on rural and urban, domestic and institutional on site sanitation, hand washing and safe drinking water handling in the home. There is also another strategy under development to address large-scale and communal (off site) sanitation needs in urban areas in Ethiopia. As the construction and development of water supply is the responsibility of the ministry of Water and Energy, another strategic plan on water will be developed and implemented together with the National Hygiene and Sanitation Strategic Plan. The need for accurate data is acknowledged as a high priority by the government to support evidence based planning. Therefore, as found out in the course of this research, a "National WASH inventory" was made with the purpose of supporting the SAP will be used to inform the SAP.

The above example shows the inter-sectoral nature of WASH and the recognition given to information as enabler of effective decision making. Therefore the importance of having information architecture for standardization of information exchange lies on the fact that it is an issue that involves different ministries and also private and nongovernmental organizations.

The WASH symposium report of 2010 (Butterworth et.al, 2011) highlighted the need for inventory on water, hygiene and sanitation sector and also demonstrated the value

[3] National Hygiene and Sanitation Action Plan for Rural, Per-Urban & informal Settlements in Ethiopia (2011). FMOH.

information had for the sector mentioning the huge amount of money (200 Million Birr) that was anticipated to make the three-phase inventory of the sector in the country.

But there are some challenges the sector faces. Lack to reliable data, which was exemplified by the variation observed between official GOE figures and figures by internationally accepted joint monitoring program (WHO and UNICEF) was mentioned as one of the main challenges (WaterAid Ethiopia, 2010; Butterworth et al, 2011). One possible reason raised for the disparity was the difference in approaches both entities follow in estimating figures for the purpose of WASH monitoring. The problem of disparity is also reflected on other health related information produced by government entities. For instance, CSA conducts the Ethiopia Demographic and Health Survey (EDHS) every five years and a Welfare Monitoring Survey (WMS) every 2-3 years. But the results of these surveys may sometimes appear different from the HMIS and even from each other (MoH HMIS, 2008). The reconciliation of the results of different surveys is also difficult as it requires better understanding of why the results vary, knowledge of common data definitions, and understanding of the methods to interpret the results (Butterworth et al, 2011; MoH HMIS, 2008). This can be used to demonstrate the lack and need of standardization in methodology regarding data collection since such disparity would affect the quality of information required for effective decision making. The other problems of the sector include weak intra-sectoral coordination in planning, monitoring and low level of capacity (human power) at local levels (WaterAid Ethiopia, 2010).

CHAPTER THREE
METHODOLOGY

This chapter explains the methodologies employed to collect data relevant to the research questions listed under chapter one. The research followed the qualitative research methodology because, as explained by Hewit-Taylor (2001) it was found to be suitable for collecting as much information as possible from targeted organizations as well as from variety of resources so as to enhance thorough understanding of the situation.

3.1. Sampling

There are governmental organizations in Ethiopia such as the Ministry of Water and Energy, Environmental Protection Authority, National Metrological Services Agency, Ministry of Mines- Geological Survey of Ethiopia, Ethiopian Mapping Authority, Central Statistical Agency, Ministry of Agriculture and Rural Development, and Ministry of Health that work with water data (UN-DESA, 2011). There are also non-governmental institutions engaged in WASH activities but it was not possible to get a complete list of them during the time of the study. Tracking such NGOs is complicated because, depending on the nature of their projects and source of funding, their WASH activities can be long term or short term. Therefore the preferred selection (sampling) method was Judgmental.

Therefore, the study limited itself to the three government ministries namely the Ministry of Water and Energy, the Ministry of Health and the Ministry of Education who are signatories of “one WASH” Implementation Framework. Moreover, two NGOs which relatively have more established WASH activity were chosen for the research. The following explanation was adding with the purpose of explaining why those organizations were chosen.

3.2. Description of Targeted Organizations

3.2.1. Ministry of Water and Energy

The Ministry of Water and Energy of Ethiopia (MOWE) is a federal organization tasked with the management of water and energy resources in Ethiopia including development, planning and management of water and energy resources, development of polices, strategies and

programs, development and implementation of water and energy sector laws and regulations, conduct study and research activities, provide technical support to regional water and energy bureaus and offices and sign international agreements[4]. It has a Water Supply and Sanitation directorate that is responsible for overseeing WASH related matters including reports and data collection. It is also a place for WASH coordination office that is tasked with the formulation and implementation of the one WASH program.

As per the information obtained from respondents in the WASH directorate, the ministry has undertaken WASH inventory in 2011 and hired a consultant for organizing the data in a database. The database utilizes Microsoft SQL technology and it is hosted by a server in the prime minister's office with an effort of utilizing the existing WoredaNet so that it can be accessible to stakeholders in the rural areas which already have access to the network. (WoredaNet is Ethiopian government network that connects more than 611 Woredas, regional and federal government offices across the nation and it is a terrestrial and satellite-based network designed with the primary objective of providing ICT services such as video conferencing, directory, messaging and Voice Over IP, and Internet connectivity to the Federal, Regional and Woreda Level government entities)[5]. But this database is not yet made accessible to other partners as it was revealed during the course of the research.

MOWE also has Geo-Information and Information Technology Directorate for processing, storage and dissemination of information collected from all directorates in the ministry. Recent information obtained from this directorate shows that they don't yet have complete and up to date data from the WASH directorate.

3.2.2. The Federal Ministry of Health

The federal ministry of health is a federal entity tasked with the overall management of health and healthcare related issues of the nation. it is organized under directorates such as Finance and Procurement Directorate , Policy Analysis and Planning directorate, Gender Mainstreaming and Women's Empowering Directorate, Health Sector Reform Directorate , Public Relations and Health Communication Directorate ,Financial Resource Mobilization Directorate ,General Service Directorate ,Human Resource Development Directorate , Public

[4] MOWE. http://www.mowr.gov.et/
[5] UNPAN, http://unpan1.un.org/intradoc/groups/public/documents/un-dpadm/unpan034887.pdf

Health Infrastructure Directorate ,Medical Service Directorate ,Plan, Policy and Finance General Directorate ,Health Promotion and Disease Prevention General Directorate and ,Quality and Compliance Directorate[6].

There is no separate directorate for WASH as we have seen in the case of MOWE. But, Hygiene and Sanitation related activities are undertaken under the Health Promotion and Disease Prevention Directorate through promotion of the Health Extension Program and mobilization of community movements such as open-defection-free movements.

The Plan, Policy and Finance directorate includes the monitoring and Evaluation case team which is responsible for undertaking data collection activities and management of the HMIS. Some details about the HMIS is presented under section 2.8.

3.2.3. Ministry of Education

The ministry of education, the country's top organ in leading the education sector of the country is organized under directorates such as, Communication affairs Directorate, Planning, Resource Mobilization and Education Management Information Systems Directorate, Procurement & Material Management Directorate, Finance Administration Directorate, Gender Directorate and HRDA Directorate. As presented under section 4.3., the MOE also has a stake in WASH as it seeks to expand access to water and sanitation facilities across schools in Ethiopia. There is a WASH focal person under the directorate of Planning, Resource Mobilization and Education Management Systems. The same directorate also is responsible for running the Education Information Management System (EMIS) which includes data about WASH in schools.

3.2.4. WaterAid Ethiopia.

WaterAid Ethiopia was chosen in this research considering its long resume in the field of Water, Health and Sanitation. According to the organization's website[7], WaterAid is an international nongovernmental organization having more than 30 years of experience in the WASH sector. According to the information on their website, they have funded more than 50

[6] www.fmoh.gov.et
[7] http://www.wateraid.org/

WASH projects in Ethiopia[8]. Moreover, they work with local partners who understand local issues and coordinate a country-wide water, sanitation and hygiene coalition uniting government organizations, donors, the media and private sector to help promote the right to water and sanitation throughout Ethiopia[9]. They have no as such grown information system at their office in Ethiopia. But they do have a Monitoring and Evaluation unit that works on formulation of indicators for M&E and also data collection.

3.2.5. International Rescue Committee (IRC)

International Rescue Committee (IRC) is an international humanitarian nongovernmental organization working in 40 countries and 22 US cities[10]. According to the organization's website, it was founded in 1933 by recommendation of Albert Einstein and it has a long history of working on primary care, environmental health, reproductive health, epidemiology, child survival, and emergency medicine among refugees, displaced people, distressed communities and disaster stricken areas. Through its environmental health programs, the organizations provide access to clean water and sanitation. In Ethiopia, it is active especially in the northern and eastern parts of the country. Individual units in the organization are responsible for collecting data pertinent to their activities and they use a Microsoft Excel template that is used to send WASH report to UNHCR's Health Information System (see section 4.6 for details).

3.3. Data Focus

After recognizing the need of integrated WASH information system in the country, the methodology favored in this research was to approach the issue mainly through the use of indicators.

Why indicators were so important in this research? They were important because they represent the starting and the end points in HIS design[11] . Their importance lies in the fact that they are the objects that determine what data should be collected, define the layout and format of the information sources, and govern how the data will be handled,

[8] ibid
[9] ibid
[10] http://www.rescue.org/about
[11] UNHCR, Health Information System, available at http://www.unhcr.org/461e51702.html

interpreted and used to direct public health practice[12.] In other words, they determine and guide the generation, collection, analysis and storage of information that is key for measuring the success of an organization in the accomplishment of its mission. Most researches reviewed (see chapter two) imply the prime importance of indicators in designing integrated heath data warehouses. Therefore, the belief taken in this research was that identification of indicators should be the first step towards conceptualizing an integrated WASH information system. Thus, effort was made to collate indicators from target organizations and the result is presented in the following sections and it was done through interviews and analysis of relevant documents as discussed above.

3.4. Method of Data Collection

3.4.1. The Interview Method

Semi-structured Interview questions were used to get as much first hand information as possible from those concerned with the collection and management of WASH information produced by each institution. The Interview questions were also designed to get as much information as possible over types of WASH activities and types of indicators being used for M&E, data collection methods, datasets and datasets definition, information management and others as sown under Appendix I. the selection of interviewees was also judgmental which was made by following the recommendations of personnel working in the respective organizations. The following table lists the respondents interviewed.

	Organizations included	**Respondents Interviewed**
1	MOWE	"One WASH" program coordinator Deputy head of the MIS WASH information expert
2	MOH	A personnel from the WASH team A personnel from the HMIS team
3	MOE	Focal person for WASH A Member of EMIS team
4	WaterAid	Planning, Monitoring and Evaluation and Reporting coordinator
5	IRC	Environmental Health Assistant Program Coordinator

Table 3.1. List of Respondents

[12] Meadows, D. (1998). Indicators and Information Systems for Sustainable Development, Sustainability Institute

3.4. 2. Document Analysis

There have been important documentations provided (recommended) by the interviewees and those documents were reviewed as they contained information that was important to answer the research questions. The following table provides their list.

	Respondents	Documentations provided (recommended)
1	MOWE	• List of WASH indicators, data collection formats • one WASH implementation framework (WIF) • MOWE website
2	MOH	• list of indicators • EDHS 2011 preliminary report • documentation on HSDP IV in line with GTP • Strategic plan for HMIS & M&E • National Hygiene and Sanitation Plan for Urban, Per-urban and Informal settlements in Ethiopia • Memorandum of understanding on WIF signed by three government ministries
3	MOE	• Data collection and entry format for School wash • WIF summary • website
4	WaterAid	• List of indicators used by WaterAid • document showing linkage between government and WaterAid indicators
5	IRC	• list of indicators • sample logframe • the WASH reporting card designed with Microsoft Excel • Website

Table 3.2. List of documents analyzed

3.5. Development of the Framework

The approach this research followed in proposing information architecture can be termed as Type 2 or framework approach as discussed under section 1.2. Moreover, it has adopted information- oriented integration approach in the sense of the explanation given under section 2.3. Revision of related literature as well as analysis of the findings has resulted in the development of architectural framework which is presented under chapter five.

3.6. Validating the Framework

After the framework was developed, the chosen method for validating the framework was formulation of discussion points/questions (see Appendix II) and going back to the respondents to get their feedbacks on the proposed framework. The diagrams were sent via

e-mail to the respondents and onsite visitation and interviewing techniques were also employed. Though it was not possible to find all of the original respondents due to different reasons, it was possible to secure satisfactory feedbacks which were eventually used to validate the framework.

3.7. Summary

This research employed the qualitative type of research that involved semi-structured interviews and analysis of relevant documents to answer the research questions listed under chapter one. Three governmental and two nongovernmental organizations were chosen on the basis of judgmental sampling technique. The reason for choosing the governmental organizations was that they signed the WIF that requires creation of integrated WASH information system and the reason for choosing the nongovernmental organization was based on their relatively bold resume on WASH activities in Ethiopia and with the purpose of examining how they fare in joining the integrated information system as envisioned by the WIF. It was believed that limiting the respondent organization to this size is enough to get answers to the research questions. Indicators were the main objects in this research and they were collated from target organizations to analyze them as per the objectives listed under chapter one. In addition to the documentations provided by the respondents, relevant literature showing experiences of other countries were also consulted to get further inputs for the formulation of WASH architectural framework, which was the main objective of this research. finally interview methods were used again to validate the framework.

CHAPTER FOUR
FINDINGS

This chapter presents answers to the research questions as listed as specific objectives under section 1.2.2.

4. 1. Strategic Direction Regarding WASH

The health sector development program IV (HSDP VI) of the Ethiopian government gives emphasis for inter-sectoral collaboration in cross cutting areas such as water supply and sanitation. It also stresses the need for partnership and networking between the government, NGOs and civil society engaged in health related activities (MOH, 2010). There is also the Health Information Management System/Monitoring and Evaluation (HMIS/M&E) strategy designed to fit with the objectives and strategies set by the HSDPIII plan that aims at establishing a single, shared monitoring and evaluation system in Ethiopia (MoH, 2008). Adding the new WASH WIF to the picture, we can see the trend suitable for the creation of an integrated WASH information system.

4.2. WASH Indicators

4.3.1 Indicators used by Governmental Organizations

According to the interview made at the MOH and as per the publication on Health and Health Related Indicators in Ethiopia[13], MOH uses the two basic WASH indicators (which they say MDG indicators) namely “improved toilet facility” and “safe water coverage”. The respondents were asked on how the indicators are defined. The documentation they provided defines the indicators respectively as shown in the following tables:

[13] Health and Health Related Indicators, Federal Demorcatic Republic of Ethiopia, Ministry of Health, 2011

definition	The proportion of households using latrines.
interpretation	Use of latrines is known to reduce the morbidity of communicable diseases, particularly those transmitted by the fecal oral route, such as diarrhea, hepatitis, etc. Access to a latrine must be accompanied by appropriate utilization and availability of hand washing facilities after use. This is usually assessed by survey; in Ethiopia, routine visits to each household by Health Extension Workers (HEWs) offer an alternative method to surveys.
formula	The number of households using a latrine divided by the total number of households. The indicator is reported as a proportion of all households visited and as a proportion of all households in the catchment area. When each household is assessed each year, the calculation based on the number of households assessed can be dropped.
numerator denominator	$\text{latrine coverage of households assessed} = \frac{\text{Number of HHs using a latrine}}{\text{Total number of households assessed}} x100$ $\text{latrine coverage} = \frac{\text{Number of HHs using a latrine}}{\text{Total number of households}} x100$
sources	When HEWs visit households, assessment of the household's latrine use is recorded in the HEW's household logbook. At the end of the year, the number of households recorded as using a latrine at the last visit in the year is reported as the number of HHs using a latrine.

frequency of collection and reporting

	HP	HC	Hospital	WorHO / Subcity	Region / Zone	FMOH
collected	household register / tally			annual report	annual report	annual report
reported	annually			annually	annually	annually

Table 4.1. Indicator Definition: "Improved toilet coverage"

definition	The proportion of households using an improved water source as their main source of drinking water.
interpretation	Using a safe water source is known to reduce the morbidity of communicable diseases, particularly those transmitted by water or the fecal oral route, such as diarrhea, hepatitis, etc. The safe water source must be protected to avoid contamination. This is usually assessed by survey; in Ethiopia, routine visits to each household by Health Extension Workers (HEWs) offer an alternative method to surveys.
formula	The number of households using a safe water source as their main source of drinking water divided by the total number of households. The indicator is reported as a proportion of all households visited and as a proportion of all households in the catchment area. When each household is assessed each year, the calculation based on the number of households assessed can be dropped.
numerator denominator	$\text{safe water coverage of households assessed} = \frac{\text{Number of HHs using a safe water source}}{\text{Total number of households assessed}} x100$ $\text{safe water coverage} = \frac{\text{Number of HHs using a safe water source}}{\text{Total number of households}} x100$
sources	When HEWs visit households, assessment of the household's use of an improved drinking water source is recorded in the HEW's household logbook. At the end of the year, the number of households recorded as using an improved drinking water source at the last visit in the year is reported as the number of HHs using an improved drinking water source.

frequency of collection and reporting

	HP	HC	Hospital	WorHO / Subcity	Region / Zone	FMOH
collected	household register / tally			annual report	annual report	annual report
reported	annually			annually	annually	annually

Table 4.2. Indicator Definition: "Safe Water Coverage"

The Ministry of Water and Energy (MOWE) has longer list of indicators categorized as Rural WASH, Urban WASH, School WASH, Health Facilities WASH and Household Water Treatment and Storage. A documentation found from them presents the indicators with their definitions in the following manner:

Category		Key Performance indicators	Input elements for computation
1. Rural	1.1.	% of rural population accesses to latrine facility (TPL) with hand washing and soap /alternatives	1.1 No. HH with Traditional pit Latrine Facilities
			1.2 Total No. of Population in required area
			1.3 Average no. of people per HH
	1.2	% of rural population access to improved latrine facility (ILF) with hand washing facility and soap/alternative	1.1 No. of HH with improved latrine Facilities
			1.2 Total No. of HH in the required area
			1.3 Average No. of people per HH
	1.3	% of rural population accesses to latrine facility without hand washing	1.1 No. HH with any type of latrine Facilities
			1.2 Total No. of HH in required area
			1.3 Average no. of people per HH
	1.4	Proportion of Open Defecation Free (ODF) Villages	1.1 No. of ODF villages in the Kebele
			1.2 No. of Total villages in the Kebele
2.Urban	2.1	% of urban population access to latrine facilities with hand washing and soap/alternative	1.1 No. HH with Latrine Facilities
			1.2 Total No. of HH in required area
			1.3 Average no. of people per HH
	2.2	% of urban population access to latrine facilities without hand washing	1.1 No. HH with any type of latrine Facilities
			1.2 Total No. of HH in required area
			1.3 Average no. of people per HH
School WaSH	3.1	%. of schools access to any type latrine facilities	1.1 Number of schools who have any type of latrines
			1.2 Total number of schools in required area
	3.2	% of schools with improved latrine facilities	1.1 Number of schools with improved latrine facilities
			1.2 Total number of schools in the required area
	3.3	% of schools with drinking water supply	1.1 No. of schools with Water Supply
			1.2 Total number of schools
4. Health facilities WaSH	4.1	% of Health Facilities access to latrine facilities with hand washing	1.1 Number of Health Facilities access to latrine facilities with hand washing in the required areas
			1.2 Total number of Health Facilities in the required areas
	4.2	% of health facilities with access to water supply	1.1 Number of Health Facilities with Water Supply
			1.2 Total number of Health Facilities in the required areas
5. Household WASH	5.1	% of households practicing water treatment and safe storage (HWTSS) at household levels	1.1 Number of households practicing HWTSS
			1.2 Total number of households in the required area

Table 4.3 WASH Indicators (MOWE)

During the interview made at the Ministry of Education, it was found out that they too also have two indicators such as “toilet coverage in schools” and “access to clean water in

schools". It was not possible to know how they define the indicators but, as shown in the following table, it was possible to get the list of data items (attributes) they used for collecting data for each indicator:

School water supply (Attributes)
• Tap water • water wells • River/stream • Collected water • Pumps • Others

Table 4.4. Attributes for School WASH indicators (Access to clean water in Schools) at MOE

School Toilet Coverage (Attributes)	
• Cemented	
• Not cemented	
• Number of pits	o For male students only
	o For female students only
	o For both male and female students
	o For teachers only
	o For teachers and students
• Distance between male and female toilet facilities	
• Hand washing facility?	

Table 4.5 Attributes of School WASH indicators (Toilet Coverage)-MOE

Attempt was made to know what data elements are being used to collect data on indicators being used by MOH and MOWE. At the MOH, they said they depend on MOWE for WASH related data and they are not so advanced regarding WASH data collection, as their HMIS is heavily biased towards healthcare and other aspects of health. One of the documentations obtained from them, i.e. the 2011 DHS survey[14], however presents list of attributes for data to be collected in monitoring household access to improved water and sanitation facilities. The following table lists them categorized under their respective indicators

[14] Housing characteristics and household population, DHS survey, Ethiopia (2011), chapter 2.

Safe Water Coverage	Toilet Facility
Source of Drinking Water • **Improved Source** o Piped into dwelling o Piped to yard/plot o Public tap/standpipe o Borehole o Protected Well o Protected Spring o Rain Water o Bottled Water • **Non Improved Source** o Unprotected well o Unprotected spring o Tanker truck/cart with small tank o Surface water (river/lake/pond/stream dam) • **Other Sources**	**Improved , Not Shared Facility** • Flush/pour flush to piped sewer system • Flush/pour flush to septic tank • Flush/pour flush to pit latrine • Ventilated improved pit (VIP) latrine • Pit latrine with slab • Compositing toilet
Time to obtain drinking water (round trip) • Water on premises • Less than 30 minutes • 30 minutes or longer • Don't know/missing	**Shared Facility** • Flush/pour flush to piped sewer system • Flush/pour flush to septic tank • Flush/pour flush to pit latrine • Ventilated improved pit (VIP) latrine • Pit latrine with slab • Compositing toilet
Person who Usually Collects Drinking Water • Adult Woman • Adult Man • Female child under 15 years old • Male child under 15 years old • Other • Water on premises • missing	**Non-improved facility** • flush/pour flush not to sewer/septic tank/pit latrine • pit latrine without slap/open pit • hanging toilet/hanging latrine • no facility/bush/field • other • missing
Water Treatment Prior to Drinking • boiled • Bleach/chlorine added • Stained through cloth • Bio-sand, composite, ceramic pot fitter • Let it stand and settle • Other	

Table 4.6. Attributes of household WASH indicators (DHS &MOH)

Documentation found from the MOWE shows the data elements used to collect data under three WASH categories as shown in the following table:

Indicators Category	**Data Elements**
Health institutions Facilities WASH	• Village Name • Name of the health facility • Type of the health facility • GPS location • Type of water supply in health facility premises • Functionality (Y/N) • Reasons for non functionality • Type of latrine • Physically separated facilities for male/female/parents? Y/N • Number of latrine rooms • Remarks
Schools WASH	• Village name • Name of the school • Type of school • GPS location • Total number of students (M,F) • Type of safe water supply • Functionality • Reason for non-functionality • Type of latrine • Physically separated facilities for girls and boys? Y/N • number of latrine rooms • remarks
Household WASH	• Name of the household head • Gender of the HH head • Number of residents per HH (M |F) • Type of toilet of the HH (Improved/unimproved) • Evidence of use of toilet facility? (Y/N) • Toilet facility have hand washing water nearby with soap/ash available within 3 meters? (Y/N) • Household have safe water management at home? (Y/N) • remarks

Table 4.7 data elements per WASH category (MOWE)

It was possible to see a space for entering area information and CSA codes at the top of each form. The area identification includes attributes such as Region, Zone, Woreda, Town, Sub city, Kebele and Village. Moreover, a type of data dictionary that explains what the attributes stand for is also attached with the data collection form.

4.3.2. Indicators Used by Non Governmental Organizations:

As observed from the interview made with NGOs engaged in WASH activities, their indicators understandably vary according to the nature of their projects in and the references they draw their indicators from. For Instance, International Rescue Committee works in Rural, Emergency and Refugee WASH. It drew indicators for its Emergency WASH from Sphere[19] and its rural WASH indicators from WHO. As an example, the indicators they use with respect to Refugee WASH are presented in the following table:

Objectives	Indicators	Sources
Objective 1: To maintain adequate environmental health conditions in Sherkole Refugee Camp by providing refugees access to water that meets international standards.	**Impact** Number of liters of safe water[15] utilized by refugees per person per day	Follow up KAP Survey report
	Output Number of liters of water available per person per day Number of persons per functional tap	Water consumption survey
	Water quality meets Sphere standards	Water quality test report
	Number of Operation and Maintenance team members who receive quarterly refresher training.	Training report
Objective 2: To maintain adequate environmental health conditions in Shimelba Refugee Camp by providing refugees with access to sanitation facilities and hygiene promotion that meets international standards.	**Impact** Percentage of households who practice safe drinking water management[16]	Follow up KAP Survey report
	Percentage of respondents who can identify 3 of the 5 critical times for hand-washing[17]	Follow up KAP Survey report
	Percentage of respondents report that they utilize a latrine for defecation[18]	Follow up KAP Survey report
	Output Ratio of people per waste pit	Project records, Monthly reports
	Ratio of people per public latrine stance	Project records, Monthly reports

Table 4.8. WASH Indicators (IRC)

WaterAid Ethiopia has attempted to create linkages between indicators used by the Ethiopian government and those formulated by WaterAid Ethiopia. They listed fifteen

[15] "Safe water" is defined as water meeting Sphere standards for quality.
[16] "Safe drinking water management" is defined as ensuring that drinking water is from a safe source (tap stand or hand-dug well) or treated at point-of-use with treatment chemicals; stored in a narrow-necked, closed container separate from the fetching container; separately from water used for purposes other than drinking.

[19] Sphare is sets of standards formulated by humanitarian agencies for setting minimum standard of quality for humanitarian actions

national WASH indicators and specified which of those they can work on. The following table shows the link that relates the two sets of indicators as specified by WaterAid Ethiopia:

	National WASH Indicators	**WaterAid Ethiopia Indicators**
	% of rural and small town population using improved water sources by type	• Number of people (Rural) using improved water sources • % increase in water coverage • Number of water facilities with inclusive designs
	% of urban population using improved water sources by type	• Number of people (urban) using improved water sources • Number of water facilities with inclusive designs
	% of new, expanded or rehabilitated schemes completed according to plan	• Number of constructed and rehabilitated WASH schemes
	% of functional rural projected public water supply scheme	• % increase in functionality of schemes
	Number and % of towns that cover operating costs/full cost recovery	• % of increase in covering operation and maintenance cost of schemes by users
	No and % of schools with functioning Projected Public Water Supply Scheme and minimum standards latrines	• Number of schools with inclusive WASH facilities
	% of households with a functioning latrine meeting minimum standards	• % increase in sanitation coverage • Number of households using appropriate latrine facility • Number of sanitation facilities with inclusive designs
	% of households with a functioning hand washing facility	• Number of households using appropriate hand washing facility
	% of people with washing hands after defection	• % of people washing hands during critical times
	% of Kebeles with WASH action plans	• Number of Kebele's developing WASH action plan • Number of HIV /AIDS, disability organizations promoting WASH in an appropriate way in their programs

Table 4.9.: Government vs WaterAid Ethiopia Indicators Linkage

4.4. References for Indicators

Knowing the references used in the sector would have an importance to find commonalities that can be very important to understand the relationship between different organizations

working on WASH. In the process of this research, it was able to know that Governmental organizations drew their indicators mainly government strategic plans such as the Growth and Transformation Plan and also from the MDG. Those non-governmental organizations included in this research have also their own references. For instance, WaterAid Ethiopia uses indicators formulated by WaterAid Global. But they are also tried to create links between their indicators and government indicators specifying which government indicators they can work on and which they can't (see the above section). IRC uses WHO as reference for its Rural WASH indicators and Sphere for its Refugee WASH.

4.5. Categories of WASH Activities (and also Indicators)

Understanding categories of WASH activities would be important to categorize indicators and also categorize information resources for better management. The respondents of this research were asked to tell how they classify their activities (and also indicators). The following table shows the categories

Respondent	**WASH categories**
MOWE	Urban WASH Rural WASH School WASH Health Facilities WASH Household WASH
MOH	Health Facilities WASH
MOE	School WASH
WaterAid	Rural WASH, Urban WASH
IRC	Rural WASH Refugee WASH Emergency WASH

Table 4.10. Categories of WASH (and also Indicators)

4.6. Sources of Information and Reporting Relationship

From the interviews made with the respondents, all of them mentioned baseline surveys or KAP surveys and periodic reports as their main sources of information. All of them said they choose to conduct surveys themselves and then as a second step, they may have a need to refer to the already available statistics compiled by the Central Statistics Agency. When asked whether they attempted to share information with other partner organizations, the

main ways of sharing information used by the governmental organizations were found to be annual abstracts that are published by the ministries and also via their websites. The non-governmental organizations report to government organizations periodically (quarterly and yearly). But the nature of their project determines to which governmental body they communicate their data. For instance, IRC said they have projects that need to report to Woredas and Projects like Refugee WASH that requires them to report to the federal office that deals with immigration.

The other way of sharing information is through the WASH Committee which is composed of government and non-governmental organizations that are working on WASH. For instance, if a matter of emergency that requires a WASH intervention happens at some part of the country, then organizations working in that area will be called for meeting so that they can exchange information that can be used in the intervention.

Beside the above ways of communicating and sharing information, all respondents said that they would entertain requests whenever there is a need for more detailed information. But as reflected from two respondents, that doesn't seem so easy. For instance, both of them have indicated that they made requests to MOWE for data out of the WASH inventory made in 2011 but they couldn't get access to it.

4.7. Use of Information Technology

After asking the respondents about their indicators, what type of information they collect on their indicators and how frequent they update their data, the next question was on how they use technology in storing and communicating information/data. In the governmental organizations, most of the data is available at lower administrative levels such as Woredas information is communicated up in the hierarchy in form of consolidated reports. Then the respective federal ministries compile reports collected from regions and produce it in form of annual abstracts to distribute them to stakeholder and decision makers that might need the information.

At the Ministry of Education, they have database applications distributed to regional education bureaus. Microsoft Access was the technology chosen to serve as a backend application while PHP was used at the front end. The reason they chose Microsoft Access, as

they said, was due to the fact that it is relatively simpler to use by those responsible to compile and encode data at the regional bureaus. The EMIS office at the ministry of Education merges the copies of those individual databases to maintain the EMIS at the ministry. Moreover, the respondents there said there is a plan to use the GPS technology in the future mentioning that UNESCO has started using the technology on some project sites.

At the Ministry of Water and Energy, they said that the consultant that helped organizing the 2011 national WASH inventory has utilized Microsoft SQL Server to be the backend application. In addition to that, they said that they keep different WASH related data in their computers using Microsoft Access and Excel. The reason given to use especially Access in offices was that the simplicity it offers to migrate data to Microsoft SQL Server. Moreover, MOWE utilizes ArcGIS application for creating maps.

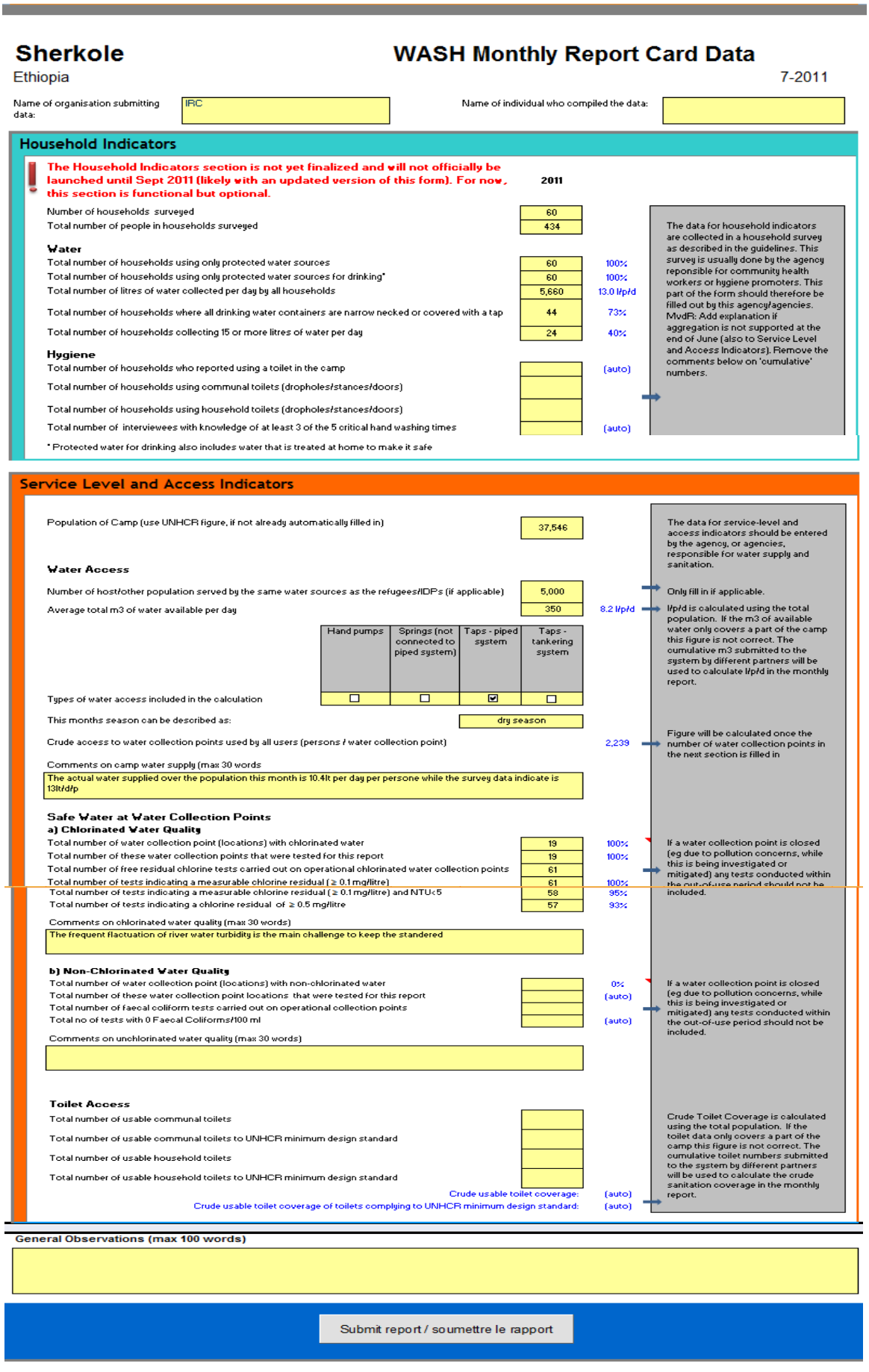
At the Ministry of Health, they said that they have deployed database applications with Microsoft SQL server at the backend and C# at the front end. The system is supposed to work in the regions but it is not yet fully utilized by all regional bureaus. Therefore, paper is yet the main way of communicating information up to the ministry.

The NGOs included in this research do not use the database approach of storing information but they utilize Microsoft Excel for processing data. IRC utilizes ArcGIS application and it also utilizes a Health Information System, which is maintained by the UNHCR , mainly for reporting purpose. They use data reporting template (which they call Wash Reporting Card) prepared with Microsoft Excel which have macros connecting the template to the database available to the HIS server maintained by the UNHCR. A screenshot of a sample WASH reporting card is presented on the following page.

The following table summarizes the use of technology by the respondent organizations

Respondents	**Technologies Used**
Ministry of Water and Energy	Microsoft Access, Excel, Word, Microsoft SQL server, ArcGIS
Ministry of Health	Microsoft Excel, Word, C# with Microsoft SQL server (Microsoft SQL server as a back end application)
Ministry of Education	Microsoft Excel, Word, PHP and Microsoft Access (Microsoft Access at the back end)
WaterAid Ethiopia	Microsoft word and Excel
International Rescue Committee	Microsoft Word, Excel, Access, ArcGIS

Table 4.11. Technology Use of the Respondents



Sherkole — **WASH Monthly Report Card Data**

Ethiopia — 7-2011

Name of organisation submitting data: IRC

Name of individual who compiled the data:

Household Indicators

The Household Indicators section is not yet finalized and will not officially be launched until Sept 2011 (likely with an updated version of this form). For now, this section is functional but optional.

	2011	
Number of households surveyed	60	
Total number of people in households surveyed	434	
Water		
Total number of households using only protected water sources	60	100%
Total number of households using only protected water sources for drinking*	60	100%
Total number of litres of water collected per day by all households	5,660	13.0 l/p/d
Total number of households where all drinking water containers are narrow necked or covered with a tap	44	73%
Total number of households collecting 15 or more litres of water per day	24	40%
Hygiene		
Total number of households who reported using a toilet in the camp		(auto)
Total number of households using communal toilets (dropholes/stances/doors)		
Total number of households using household toilets (dropholes/stances/doors)		
Total number of interviewees with knowledge of at least 3 of the 5 critical hand washing times		(auto)

* Protected water for drinking also includes water that is treated at home to make it safe

The data for household indicators are collected in a household survey as described in the guidelines. This survey is usually done by the agency reponsible for community health workers or hygiene promoters. This part of the form should therefore be filled out by this agency/agencies. MvdR: Add explanation if aggregation is not supported at the end of June (also to Service Level and Access Indicators). Remove the comments below on 'cumulative' numbers.

Service Level and Access Indicators

Population of Camp (use UNHCR figure, if not already automatically filled in)	37,546	
Water Access		
Number of host/other population served by the same water sources as the refugees/IDPs (if applicable)	5,000	
Average total m3 of water available per day	350	8.2 l/p/d

Types of water access included in the calculation	Hand pumps	Springs (not connected to piped system)	Taps - piped system	Taps - tankering system
	☐	☐	☑	☐

This months season can be described as: dry season

Crude access to water collection points used by all users (persons / water collection point): 2,239

Comments on camp water supply (max 30 words)

The actual water supplied over the population this month is 10.4lt per day per persone while the survey data indicate is 13lt/d/p

Safe Water at Water Collection Points

a) Chlorinated Water Quality

Total number of water collection point (locations) with chlorinated water	19	100%
Total number of these water collection points that were tested for this report	19	100%
Total number of free residual chlorine tests carried out on operational chlorinated water collection points	61	
Total number of tests indicating a measurable chlorine residual (≥ 0.1 mg/litre)	61	100%
Total number of tests indicating a measurable chlorine residual (≥ 0.1 mg/litre) and NTU<5	58	95%
Total number of tests indicating a chlorine residual of ≥ 0.5 mg/litre	57	93%

Comments on chlorinated water quality (max 30 words)

The frequent fluctuation of river water turbidity is the main challenge to keep the standered

If a water collection point is closed (eg due to pollution concerns, while this is being investigated or mitigated) any tests conducted within the out-of-use period should not be included.

b) Non-Chlorinated Water Quality

Total number of water collection point (locations) with non-chlorinated water		0%
Total number of these water collection point locations that were tested for this report		(auto)
Total number of faecal coliform tests carried out on operational collection points		
Total no of tests with 0 Faecal Coliforms/100 ml		(auto)

Comments on unchlorinated water quality (max 30 words)

If a water collection point is closed (eg due to pollution concerns, while this is being investigated or mitigated) any tests conducted within the out-of-use period should not be included.

Toilet Access

Total number of usable communal toilets		
Total number of usable communal toilets to UNHCR minimum design standard		
Total number of usable household toilets		
Total number of usable household toilets to UNHCR minimum design standard		
Crude usable toilet coverage:		(auto)
Crude usable toilet coverage of toilets complying to UNHCR minimum design standard:		(auto)

Crude Toilet Coverage is calculated using the total population. If the toilet data only covers a part of the camp this figure is not correct. The cumulative toilet numbers submitted to the system by different partners will be used to calculate the crude sanitation coverage in the monthly report.

The data for service-level and access indicators should be entered by the agency, or agencies, responsible for water supply and sanitation.

Only fill in if applicable.

l/p/d is calculated using the total population. If the m3 of available water only covers a part of the camp this figure is not correct. The cumulative m3 submitted to the system by different partners will be used to calculate l/p/d in the monthly report.

Figure will be calculated once the number of water collection points in the next section is filled in

General Observations (max 100 words)

Submit report / soumettre le rapport

Fig. 4.1. Microsoft Excel Template of WASH Reporting Card used by IRC

4.8. Targeted Users

One of the inevitable questions in any information system is the issue of targeted or perceived users and this was also a question presented to the respondents. For the nongovernmental organizations, the reporting relationships (with donors and relevant government bodies) was used to define their targeted users. The governmental organizations included in this research regard any interested member of the public, governmental and non-governmental organizations as their targeted users. As explained in the previous section, governmental organizations communicate information mostly via yearly abstracts (published) and their websites (noting that reports are the main ways of exchanging information up in the hierarchies). Aside from that, information is kept in the departments.

In relation to this question, the respondents were asked how a request of an organization can be handled if they ask for WASH information. The governmental organization pointed out their websites and annual abstracts (yearbook). Moreover they also said the people can come to them and ask for the information they want. The NGOs focused on their reporting relationships with government bodies and also their donors which they regard as their primary users.

CHAPTER FIVE
ANALYSIS AND DISCUSSION

This section presents analysis of the findings listed in the previous chapter picking up the main themes that stood out in the course of the research and also proposes an architectural framework that can be considered for introducing an integrated WASH information system in the country.

5.1. Inconsistency in Indicators and Data Elements

As could be recalled from the discussions made under the literature review (section 2.8), disparity appears between official GOE figures and those figures by WHO and UNICEF joint monitoring program. Disparity happens even between data collected by governmental organizations (see section 2.8) which can be evidence for the lack of standardization.

The findings in this research too show evidences that might lead to the presence of data inconsistency regarding WASH even between governmental organizations. For instance when we see data elements used for school WASH (see table 4.4.) by MOE and School WASH by MOWE (see table 4.6), we see a difference in data elements used. Comparing attributes for household WASH between MOH/DHS (see table 4.5) with those at the MOWE (see table 4.6) we can see that the there is a difference in the data elements. Adding this to the confusion observed at the MOH whether to use the data collection formats prepared by MOWE or the CSA (EDHS), as discussed under section 4.3.1., shows the presence of a problem related to the usage of standardized formats even for the same WASH category.

Taking the comparison between indicators being used by the governmental and also nongovernmental organizations, we can see evidences for inconsistency in indicator definitions. For instance taking a simple example from Table 4.8 in section 4.3.2, we can see a government WASH indicator

"Percentage of households with a functioning hand washing facility ",

and its corresponding (related) WASH indicator from WaterAid

"Number of households using appropriate hand washing facility"

How should we store the data? Should we put the calculated value (i.e. percentage) or the raw value (i.e. the numbers)? Moreover, we may ask what qualifies a “functioning hand washing facility” or what constitutes an” appropriate hand washing facility”. In other words, we need standards and detailed set of attributes that govern data collection and storage across stakeholders working in the same WASH category. It was found out that NGOs utilize standards set by their parent organizations and the governmental organizations derive them mainly out of federal policies and strategies.

5.2. Problems with the current Information Sharing System

As it is discussed in the previous chapter, annual abstracts and websites are the main means of sharing information used by governmental organizations whereas the NGOs rely on their reporting relationship. Though indicators and data elements are detailed as shown in the previous chapter, information that can be found at higher level of governmental organizations is highly summarized. For instance, the booklet published by the Policy Planning and Directorate of the ministry of health provides WASH information by regions. Data elements for the “Access to Safe Water” are “Urban%” “Rural %” and “coverage%”. For the indicator “Access to Excreta Disposal”, the data elements are “No of HHs in the Region” , “Cumulative No of HHs with Latrine”, and “% coverage”. This falls short of details for those requiring detailed information. For instance, under section 4.2 (table 4.5), we have seen that latrines can be improved and not shared, shared, and non improved and shared. So if someone needs information on the coverage of , for instance, percentage of improved and not shared toilet facilities in a certain region, it is not possible to get that information from the type of documentation mentioned above.

The other important question that can be raised in relation to the above mentioned example is on how to define “coverage”. For instance, as a personnel working in one of the NGOs included in the research said, there are water points which are functioning and there are also others which are functioning. One organization tends to report all water points (functioning and non-functioning) in reports dealing with safe water coverage and some other organization would include only the functioning ones in its reports. This also can be a source for inconsistency.

5.3. The issue of Harmonization and Integration

Despite all the problems discussed above, we can also see conditions that show the possibilities of achieving harmonization. One example is the set up of the WASH coordination office under the MOWE for coordinating WASH efforts at the three ministries. The other example is the response obtained from an official at the MOH saying they depend on WASH data collected by the MOWE and they can use the data collection formats developed by them. Such trend would lead to adoption and usage of standardized data collection formats for each category of WASH. The data dictionaries seen on the data collection formats used at the MOWE also show that such trend can lead to consistent data definition among the organizations.

Looking at the findings in chapter four, we can see that the Ministry of Water and Energy has more WASH categories than others. In addition to that we can see that the MOWE uses the GPS technology and also has a separate WASH directorate which is not available on other ministries added in this research. Therefore, we might consider MOWE as a center for an integrated WASH data warehouse. As NGOs are taken as partners in helping the country achieve its objectives, we can suggest other organizations to follow the example of WaterAid Ethiopia to see how their indicators can be mapped to the national indicators. For instance from the previous section, we can see this in the following way:

WASH Type	**Organizations involved**
Rural WASH	MOWE, MOH, WaterAid, IRC, others…
Urban WASH	MOWE, WaterAid, others…
Pastoralist WASH[20]	MOH, Ministry of Federal Affairs, MOWE, others..
School WASH	MOE, MOWE, others…
Health Facilities WASH	MOH, MOWE, others…
Household WASH	MOWE, MOH
Refugee WASH[21]	IRC, others
Emergency WASH	IRC, others

Table 5.1. Mapping WASH Indicators by organizations.

[20] Though not mentioned during the interviews with correspondents, this category of WASH was observed during the analysis of related documents.

[21] From the interview with IRC, it was found such activity is reported to a government department in Immigration Authority.

Under each category of WASH, there are list of indicators and data collection formats used to collect information over each indicator. However, it should be noted here that there should be harmonization between the standards being used by both governmental and nongovernmental organizations because that is one of the reasons for inconsistency between data collected by the two types of organizations.

As explained under section 2. 2, Harmonization is required between sets of indicators so as to smoothen integration or interoperability between data collected by different organizations. There should also be standardization between data collection formats.

In addition to data harmonization, the other area that needs focus is the existence of indicator-data linkage (see section 2. 3). Are the data being collected relevant for computing values for the indicators? This would invite another research.

5.2. Preventing Data Duplication

Data Fragmentation and Duplication are the most mentioned problems of the public health specifically in the WASH sector. Beside the above mentioned indicator harmonization and integration strategies that can be followed, one can take advantage of the existing administrative practice that prevents duplication of efforts. During the process of data collection, it was found that government regulations in Woredas protect duplication of effort. For instance, if an NGO wants to undertake a WASH intervention in a certain Woreda, the Woreda officials would investigate the proposal and inform the NGO of other related activities being undertaken in their area. If the new proposal creates duplication of effort in a certain locality, then It will not get the “go ahead”. Moreover, there was a suggestion surfaced during the course of the study on the use of CSA are codes for integrating data collected from different Woredas or administrative areas.

5.3. Use of Technology

Microsoft Access and SQL server are the database applications being used by most respondents (see section 4.6). Microsoft Access has been used by four of the respondent organizations whereas Microsoft SQL is said to have been used by two of them. The reason given for the adoption of Microsoft Access was its practicality for those at lower

administrative hierarchy considering the level of IT expertise they may have (MOE) and for the ease it provides migrating data to Microsoft SQL server (MOWE). Adding the situation at the MOH to this scenario, Microsoft SQL server is chosen to be used at higher administrative hierarchies such as regional health bureau. To start with, It would be possible to think of a centralized data warehouse supported by Microsoft SQL server at the back end. Application made with Microsoft Access to can be prepared for those situated in areas where there is no connectivity.

It was also mentioned in the Section 4.6. , the data from the 2011 National WASH inventory was stored in a server in the prime minister's office so that it can be accessed via WoredaNet. The fact that WoredaNet is the largest government network in the country and reaches to 611 administrative units in the country (see section 4.1.1) might be appealing to use such vast network to host integrated WASH data of the nation. But its suitability for this purpose and the practicality would require another investigation.

5.4. The Proposed Indicator Driven Data Integration Framework

Integration is an issue that has requires technical, social and organizational inputs as it also involves the politics of negotiation with partners in formulating standardized data collection practice (see 2.3). Therefore, before embarking on technological solutions by layering hardware and software requirements, there should be steps taken in order to make the "politics" work. Therefore, from what is presented in the above analysis and also the review of literature made under chapter 2, indicator-driven WASH information integration can be proposed in the following order:

1. Identify categories of WASH activities
2. Identify types of indicators under each category; provide standard definitions for the indicators (definitions that should be used by all partners).
3. Determine data elements (attributes) for the data collected under each indicator and provide consistent data definition (prepare data dictionary to be used by all partners)
4. standardize the data collection format, determine variables (attributes) to use in data collection formats, clearly define variables (data fields)

5. Identify which organization works on which category of WASH and reach consensus on the usage of standardized indicators, indicator definitions, data formats and data definitions.
6. Reach consensus on how each organization collect and store data to the common data warehouse.
7. Design a scalable data warehouse (thinking about the future need of integrating all public health data. hardware and software choices could be made here).
8. Check for indicator-data linkage (make sure that relevant data is collected to compute each indicator.

Putting the above recommendation in organizational context, it would be important to start from the overall goal (aim) of the organization. Then, it would be possible to see the factored out objectives where indicators are driven from to measure the success of an organization towards accomplishing its objectives. The following diagram would summarize the proposed way for standardizing indicators and data collection formats.

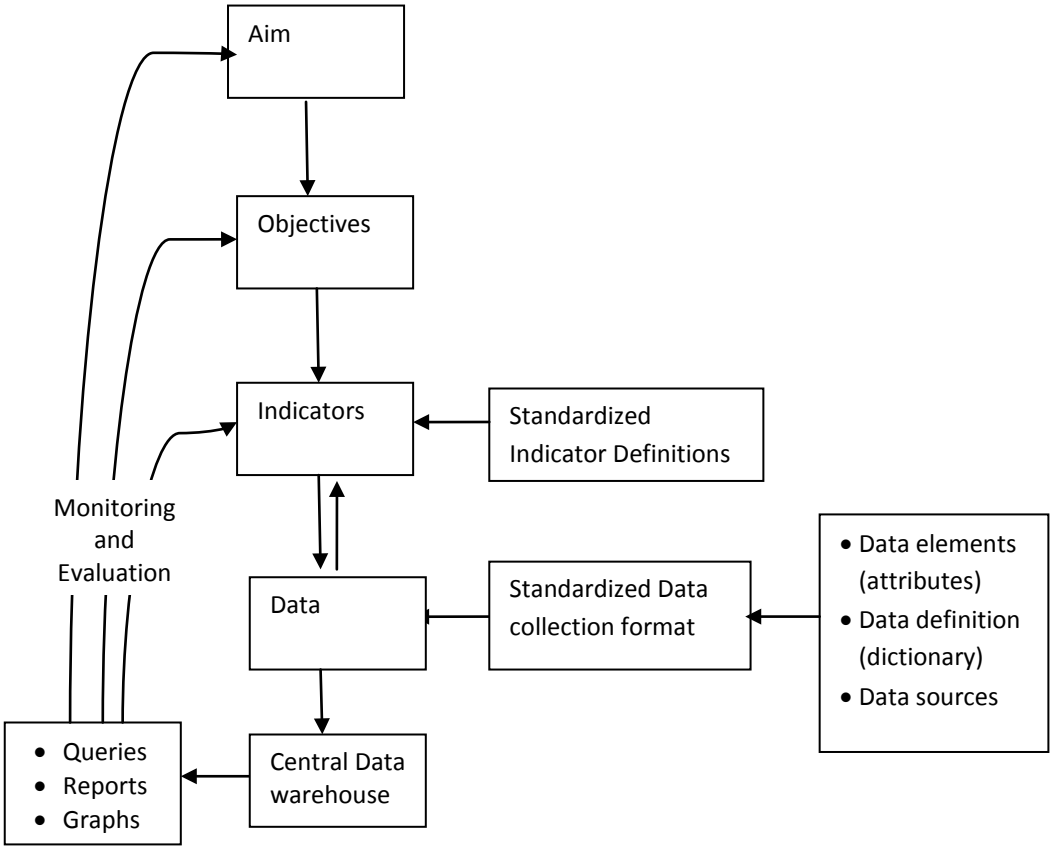


Fig 5.1. Standardization of indicators and data elements for indicator driven information system

Organizations might work on any of the WASH categories (school WASH, Health facilities WASH, household WASH, etc) as explained in the above chapter. To have an integrated information system, the harmonization should be made between the indicators they use for monitoring their activities. For instance, if two organizations work on school WASH, they need to standardize the indicators and data collection formats they use otherwise it would not be possible to integrate the information collected between the two entities.

The main challenge here might be to include NGOs in the mix as they have their way of doing things and the WIF has also given them freedom to innovative in their own right. However, as explained under the findings chapter, they can try finding links between their indicators and the indicators being used by the government .Then compromise can be reached on standardizing those sets of indicators that share similarity. Besides, they can be convinced of the benefits they would get from an integrated WASH data warehouse (See section 2.3).

As it was learned during the data collection phase, if an NGO wants to undertake a new intervention in a certain area need, they need to consult with local officials on the nature of their intervention. The local officials advise the NGO on where it can start their project and after that the NGO conducts a KAP or another type of survey. Time and resource would be wasted when the organization tries to choose the right place to do the right intervention. But if there was an integrated repository or data warehouse, that would be an instant source of information (See Sierra Leone's example under section 2.3.) saving time and resource. Therefore, the non-governmental organizations could be convinced to take part in this collaborative process because it could eventually be used for their own benefit.

Therefore, after harmonization between indicators and data elements is made, it would be possible to think of the information architecture that would be proposed to introduce an integrated WASH information system.

5.4.1. Description of the proposed Architectural Framework

In order to recommend an architectural framework, it would be imperative to look at the recommended structural arrangements of the national WASH program as shown in the following table (Table 5.1). As shown in the table, WASH coordination offices are available at national, regional and zonal levels to facilitate synergy among the sectors (water, education and health) through coordinated and collaborative planning, implementation ,

monitoring , reporting and evaluation of program results (MOWE, 2011). Taking this structure and the information management practices and technology use of the organizations, this research would recommend a scalable WASH information system that enables creation of databases at regional levels which ultimately will be aggregated into a centralized WASH data warehouse.

Level	Governance & Guidance	Oversight & Management	Program Implementation	Program Coordination
National	National WaSH **Steering Committee**	National WaSH **Technical Team**	National WaSH Management Units (WMUs)/Focal person MoFED H W E	National WaSH **Coordination Office**
Regional	Regional WaSH **Steering Committee**	Regional WaSH **Technical Team**	Regional WaSH Management Units (WMUs)/Focal Person BoFED H W E	Regional WaSH **Coordination Office**
Special Zones (or others Zones where applicable)	Zonal WaSH **Management Team**		Zonal WaSH Management Units – or Focal Persons (Water, Health, Education) H W E	Zonal WaSH **Coordination Office**
Woreda	Woreda WaSH Steering Committee (Woreda Cabinet)		Woreda WASH Team WoFED H W E Other desks	
Town/City	Town/City WaSH Steering Committee (Town Cabinet)		Town/City WaSH Technical Team Municipality Health Desk Education Desk Town Water Board Town Water Utility	
Kebele & Community	Kebele Administration (Manager) Kebele Development Committee		Kebele WaSH Team Health Extension Workers Water Extension Workers/Technicians[1] Development Agents School Teachers Other relevant Community WASHCOs	

Table 5.1. Structural Arrangements of the National WASH program(Source, WIF)

This research proposes a data warehouse at each region run by Microsoft SQL server which will have web interface that will be used by partner organizations for entering as well as querying data. the choice of Microsoft SQL was made on the basis of its suitability for large databases and also the practice of two out of three governmental organizations planning (or, in the process of) deploying Microsoft SQL server supported databases at their regional bureaus). Regarding the placement of the regional and central data warehouses, we can recommend the Regional water bureaus and also MOWE as they are responsible for managing most WASH data of the nation. Moreover, MOWE has a WASH directorate unlike other government ministries and, for that reason, we can recommend the aggregated WASH data warehouse to be maintained at the MOWE.

Adding the NGOs in this context would be complicated as they may report to Woredas, regions or federal offices as dictated by the nature of their project. The proposed architectural framework shown below attempts to accommodate this as shown on the diagram.

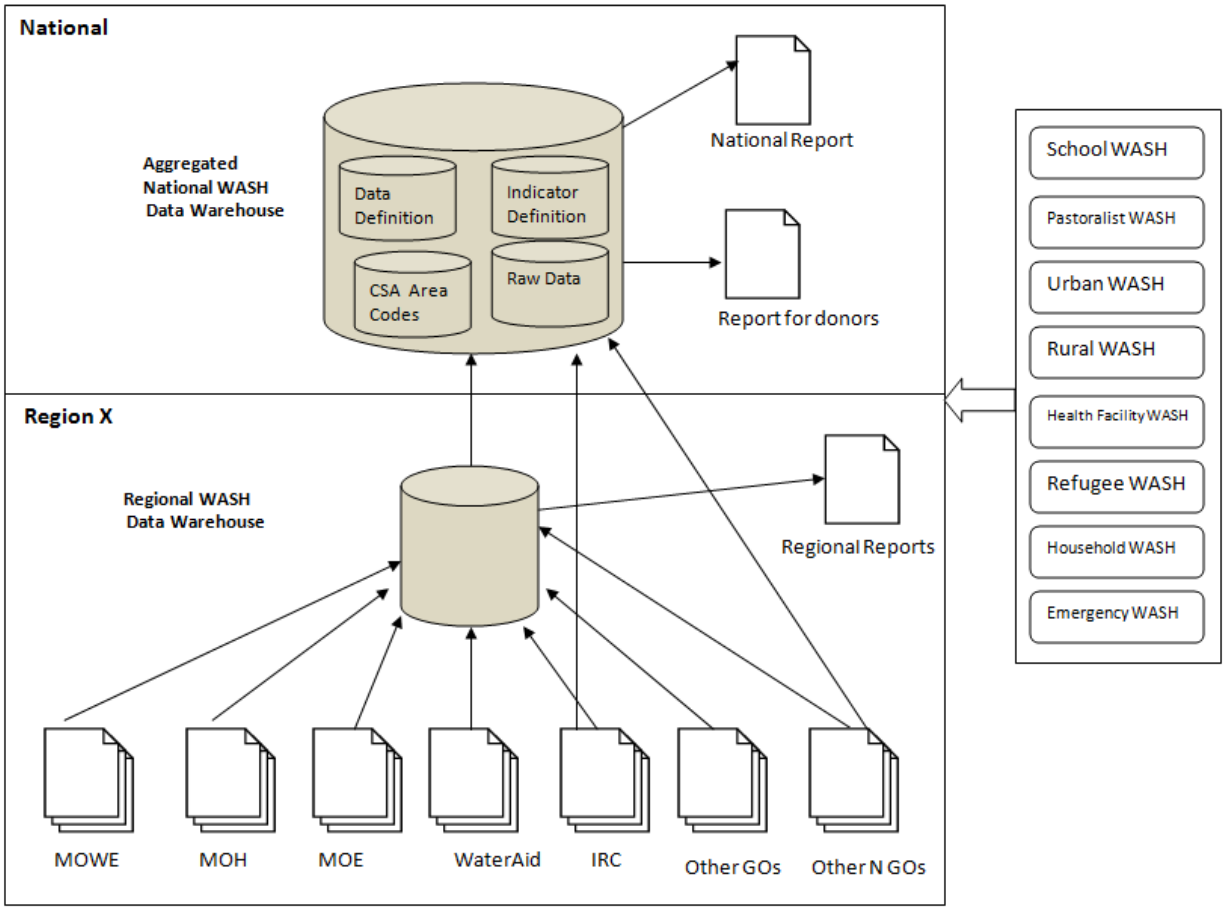


Fig 5.2. The Proposed Architectural Framework for Integrated WASH Data Management

As shown in the above diagram, the architecture proposes a system where WASH data is kept in databases in regions and a national data warehouse where all data from regions is aggregated. It enables entry of WASH data under each category as shown in Fig 5.2. and makes it possible to generate national reports, reports for donors and also regional reports .

5.5. Validating the Framework

E-mails were sent to the two respondents from the NGOs side and onsite visitations were made to three respondents at the three governmental organizations in order to get their reaction to the framework proposed in this paper. One respondent from the NGOs was not available. Therefore, with a bid of getting more comments from the NGO side, two other people working in WASH activity at a certain NGO were contacted. The overall reaction to the framework was positive from all sides.

Those from the governmental organizations said the proposed WASH information framework goes in line with the objective of the WIF and see its practicality among governmental organizations. But they have doubts whether the NGOs would cooperate as they have their own ways of collecting and reporting data. They said one of the aims of the new WASH initiative is to standardize indicators and data collection formats at the signatories. Moreover, they said that the situation is now being studied by consultants and the output of this research can serve as an input in the process. One respondent said the framework should consider civil society organizations and also donor and partner organizations that might not be involved in WASH as heavily as those chosen in this research, but which might be users of the information.

One person from the NGOs side said that he believes on the standardization of the indicators and mentioned that, as they consider local situations while formulating their indicators, there would be a possibility of harmonizing theirs with those used by the governmental organizations. He also indicated that he supports harmonization between indicators and data collection formats. However, he also noted that their donor's or headquarters requirements and the nature of their interventions (e.g. humanitarian) influence the formulation of indicators, which makes standardization difficult.

Another person working in an NGO mentioned that his organization reports quarterly and annually to the Woredas. According to him, the Woredas add the data with other data collected from other organizations and report them to the higher level as the total activities of WASH undertaken in the Woredas, without mentioning who did what. Therefore he believes that, as the Woredas are already taking care of the reporting, the NGOs may not need to be part of the information framework but still can be regarded be as suppliers and users of the information. However, when we see the case with IRC as an example, they report data on their WASH activities to the Immigration Authority which is not active in such activity. Therefore, this researcher believes it would be important to add the NGOs in the framework.

One other person from the NGOs side supports the idea behind the architectural framework because he believes it promotes transparency and ease of access to data. He mentioned the 2011 WASH inventory as an example and the difficulty his organization faced in accessing that data. A person working in the Ministry of Health has also said that his office couldn't get access to the inventory. Therefore, they believe the idea of integrated information system would simplify the process of retrieving the required data at the right time. Commenting on Fig 5.1, a respondent from the NGOs side commented that the framework should include monitoring and evaluation of the data itself.

In conclusion, there is a support for such type of architectural framework to be considered for creation of an integrated WASH information system.

5.6. Strength and Weakness of the Study

The main strength of the study, as explained in section 1.4 is its timeliness as it followed the signing of the WIF in November 2012. The fact that Semi-structured interview was used in the study has given the researcher the freedom to ask broad and context-dependent questions that has given freedom to collect as much reliable data as possible. The cooperation the respondents showed in providing useful documentations that could potentially answer the research questions has simplified the process. Moreover, the fact that relevant people were interviewed constitutes the strong side of this research.

The problem was that most respondents looked to be troubled when asked questions related to technology and information system related questions. The reason as it was found out later was that in most cases external consultants were hired to conduct studies or to undertake projects related to the information system so some of the respondents had difficulties in answering some of the questions. Some of them seemed to lack the updates regarding WASH strategic direction in the country. For instance, there was a person who doesn't know about the WIF. All in all, it is possible to say that this research relied much on the documentations (some of them looked not so recent) the respondents provided than on the outputs of the interviews. This constitutes the weak side of the study.

CHAPTER SIX
CONCLUSION AND RECOMMENDATIONS

6.1. Conclusion

The findings of this research indicate that the overall trend of the nation favors creation of integrated information system for WASH. However, the findings also show that the existing situations make that difficult. Differences were observed in the indicators and indicator definitions being used even for the same categories of WASH. Differences were also observed in the data collection formats and data elements (attributes) used in the formats. The main reason for the discrepancies, as found out in the research, emanates from the variety of references being used for the formulation of the indicators. Government organizations used the MDG and GTP as their main references whereas the NGOs mentioned WHO, Sphere, their headquarters as the main references used in formulating the indicators. The NGOs pointed that they consider the local situations in formulating indicators but interpretation of those "local situation" might also have contributed for the inconsistencies. Therefore, to create an integrated information system as required by the WIF, standardization of indicators and data collection formats should be given the utmost and primary importance.

From the targeted organizations, it was found out that the WASH activities in the country can be categorized as Urban WASH, Rural WASH, Pastoralist WASH, Emergency WASH, Household WASH, Refugee WASH, Health Facilities WASH, and School WASH. For instance, MOE is engaged in School WASH, MOH works on Health Facilities WASH and Household WASH, IRC works on Rural and Refugee WASH, and MOWE works on most of the categories. All organizations studied operate in more than one WASH category yet differences exist in the indicators and data collection formats they use. Such categorization can be utilized as a tool for classifying, organizing, storing and managing the information.

The research attempted to study the information sharing practices between the organizations and found out that it was limited to sharing summarized data in form of annual abstracts, information via websites and the reporting relationships between the

organizations. All of them indicated their willingness to accommodate requests for detailed data from any interested member of the public but they also expressed the difficulties they faced in getting such information from other organizations.

In relation to the choice of technology for data storage, processing and retrieval, the research has found out that all organizations use Microsoft Excel and Access and also there are startups in using Microsoft SQL server especially at offices in the higher administrative regions (at federal level and at regions). GIS technology has also seen some usage by the likes of MOWE and IRC.

Therefore, as the main solution for the problems mentioned above and also as required by the WIF, this research has sought a way for integrating WASH data that have diverse backgrounds as explained above. As the result, an indicator based architectural framework was introduced which later was discussed with respondents so as to check its validity. The overall reaction showed that the respondents would accept integrated WASH information system as depicted by the framework though issues of standardization and harmonization of indicators remain as challenging tasks.

6.2. Recommendations

Standardization is the main issue that stood out in the course of the research as a crucial element for the successful integration of WASH data from different organizations. Therefore, before embarking on sophisticated and IT intensive solutions, governmental as well as non-governmental organizations working in the sector should negotiate on standardization of the indicators to be used for each WASH category, indicator definitions, types of data (data elements) to collect and formats for data collection. This would be a timely suggestion for organizations working in the WASH sector as the WIF creates an opportune time to work on the foundation of a future integrated information system. This research would be an important reference. It would also inspire further researches in the field that could also serve as further references to be used by practitioners.

It was easy to observe the low capacity in terms of IT expertise in organizations when this research was being conducted. It was found out that major IS tasks were outsourced to consultants. There were questions the respondents couldn't answer and at some points,

there were suggestions presented to the researcher to try contact a consulting firm for detailed information. As written here over and over again, there is a need for WASH information system. But this could be far from being materialized in the absence of organizational information system staffed with qualified manpower.

Reference

AbouZahr, C. & Boerma T. (2005). Health information systems. The foundation for public health, Bull WHO 2005: 83(8) 578-83. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2626318/

Birkinesh W and, Selamawit M. (2005). Challenges and Approaches to Scaling and Standardizing Health Information Infrastructure in Developing Countries: Case Studies from Ethiopia". Masters Thesis. University of Oslo

Braa, J. et al (2010). Comprehensive Yet Scalable Health Information Systems for Low Resource Settings: A Collaborative Effort in Sierra Leone. AMIA Annual Symposium,372-376. Retrieved from www.ncbi.nlm.nih.gov/pmc/articles/PMC3041283/

Butterworth, J. (2011). Monitoring WASH in Ethiopia: Messages from a Sector Symposium. RIPPLE Ethiopia, Addis Ababa; Retrieved from: http://www.rippleethiopia.org/documents/info/20101222-monitoring-wash-in-ethiopia

Chen, D., Guy Doumeingts, G.,& Vernadat, F. (2008). Architectures for enterprise integration and interoperability: Past, present and future. Computers in Industry 59 (2008) 647–659. Retrieved from www.sciencedirect.com/science/article/pii/S0166361508000365

Den Haan, J.(2007). Architecture, a Definition. Retrieved from www.theenterprisearchitect.eu/archive/2007/05/15/architecture-a-definition

Downey, L., & Banerjee, S. (2011). Building an Information Architecture Checklist. Journal of Information Architecture. Vol. 2, No. 2. [Available at http://journalofia.org/volume2/issue2/03-downey/

Evernden, R. & Evernden, E.(2003). Information First: Integrating Knowledge and Information Architecture for Business Advantage. Elsevier.

FMOH Health Management Information System Reform Team (2008). Health Management Information System (HMIS)/Monitoring and Evaluation (M&E). Strategic Plan for the Ethiopian Health Sector. FDRE Ministry of Health.

Gli-Garcia, R. (2012). Towards a smart State? Inter-agency collaboration, information integration, and beyond. Information Polity. vol 17, pp. 269-280

Godinez et al (2010). The Art of Enterprise Iinformation Architecture. IBM Press.

Gordon, A. & Hinson, R.(2007). Towards a sustainable framework for computer based health information systems (CHIS) for least developed countries (LDCs). Emerald .Vol. 20 No. 6, pp. 532-544.

Haux, R.(2006). Health Information Systems – Past, Present, Future. International Journal of Medical Informatics. 75, 268—281.

Hey, A. J. G., & Trefethen, A. E. (2003). The Data Deluge: An e-Science Perspective. In F. Berman, G. Fox, & T. Hey (Eds.), Management (Vol. 54, pp. 809-824). Wiley and Sons. Retrieved from http://eprints.soton.ac.uk/257648/

Hewitt-Taylor J (2001) Use of constant comparative analysis in qualitative research. Nursing Standard. 15, 42, 39-42. Date of acceptance: March 19 2001.

Khan, R. et al (2009). The Information Nation. Indianapolis. IN. Wiley Publishing

Kossi, E.K., Sæbo,J. I., Titlestad, O.H. Romain, R. T. & Braa, J (2010). Comparing Strategies to Integrate Health Information Systems Following a Data Warehouse Approach in Four Countries. *10th International Conference on Social Implications of Computers in Developing Countries*

Lapisa, V., Lamb, K. & Yasnoff, W. A.(2012). Where Should Electronic Records for Patients be Stored? International Journal of Medical Informatics, (81) 821-827

Latifov, M. A., & Sahay, S. (2012). Data Warehouse Approach to Strengthen Actionability of Health Information Systems: Experiences from Tajikistan. The Electronic Journal of Information Systems in Developing Countries, 53.

Macfarlane, S. B. (2005). Harmonizing health information systems with information systems in other social and economic sectors. Bulletin of the World Health Organization, 83(8), 590-596. World Health Organization. Retrieved from http://www.ncbi.nlm.nih.gov/pmc/articles/PMC2626316/pdf/16184278.pdf

Martin, A., Dimitriev, D., & Akeroyd, J.(2010).A Resurgence of Interest in Information Architecture. International Journal of Information Management 30 (2010) 6–12.

Ministry of Water and Energy (2011). National WaSH Implementation Framework. Draft. Retrieved from http://www.information-management.com/news/10001092-1.html

Montgomery, M & Elimielch, M.(2007). Water and Sanitation in Developing Countries: including Health in the Equation. Environmental Health and Technology.

Morville, P., & Rosenfeld, L. (2006). Information Architecture for the World Wide Web: Designing Large-Scale Web Sites (Third Edition.). O'Reilly Media.

Mykkänen, J., Porrasmaa, J., Korpela, M., Häkkinen, H., Toivanen, M., Tuomainen, M., ... & Rannanheimo, J. (2004). Integration models in health information systems: Experiences from the PlugIT project. Medinfo, 11(Pt 2), 1219-1222.

O' Carroll, Patrick W. et.al (2003).Public Health Informatics and Information Systems. Seattle, WA. Springer.

(The) Paris Declaration for Aid Effectiveness and the Accra Agenda for Action. (2005/2008).

Penuel, G.S.(2010).Designing Information Architecture for a Mobile Interface: How to Design and Integrate Information Architecture into an Information Ecology. Masters Thesis. Aalborg University

Resmini, A. & Rosati, L. (2012). A Brief History of Information Architecture. Journal of Information Architecture. Vol. 3, No. 2. [Available at http://journalofia.org/volume3/issue2/03-resmini/]. Originally published in Resmini, A. & Rosati L. (2011). Pervasive Information Architecture. Morgan Kauffman. (Edited by the authors).

Robertson, J. (2005) 10 Principles of Effective Information Management. Available at http://www.steptwo.com.au/papers/kmc_effectiveim/index.html

Stansfield, S., Orobaton, N., Lubinski, D., Uggowitzer, S., Elec, B. E., & Mwanyika, H. (2008). The Case for a National Health Information System Architecture ; a Missing Link to Guiding National Development and Implementation. *Social Science & Medicine*, 1-9. World Health Organization. Retrieved from http://www.hrhresourcecenter.org/node/2600

Stanford University. (1998). Data warehousing at Stanford. Retrieved from http://infolab.stanford.edu/warehousing/warehouse.html

Studnicki, J., Berndt, D. J., & Fisher, J. W. (2008). USING INFORMATION SYSTEMS FOR PUBLIC HEALTH ADMINISTRATION. Public Health Administration: Principles for Population-Based Management: Principles for Population-Based Management, 353. Retrieved from www.jblearning.com/samples/0763738425/38425_ch13_353_380.pdf

Tsiknakis, M., Katehakis, D. G., & Orphanoudakis, S. C. (2002). An open, component-based information infrastructure for integrated health information networks. *International Journal of Medical Informatics*, *68*(1-3), 3-26. Elsevier. Retrieved from http://www.ncbi.nlm.nih.gov/pubmed/12467787

Tulchinsky, Theodore H. et.al (2009). The New Public Health. Second Edition. Amsterdam. Academic Press .

United Nations Division for Sustainable Development (1992). Agenda 21. The Rio Declaration on Environment and Development. United Nations: New York

UN-DESA(2011). Strengthening Water Sector Monitoring and Information System in Ethiopia with GIRWI Project: Second Phase.

Vital Waves Consulting (2009). Health Information Systems in Developing Countries : A Landscape Analysis.

WaterAid (2010). Ethiopia Country Strategy: 2011-2016.WaterAid Ethiopia.

Ying , W., Wimalasiri, J.S., Ray, P.,Chattopadhayay, S., & Wilson, C.S.(2010). An Ontology Driven Multi-agent Approach to Integrated E-Health systems. International Journal of E-Health and Medical Communications, 1(1), 28-40

APPENDIX I
INTERVIEW GUIDE

The following semi-structured interview questions are aimed at getting answers that would be used in the research entitled **"Architectural Framework for Information Integration: Case of Organizations Working on Water, Hygiene and Sanitation Activities in Ethiopia".**

Questions:

1. How do you group your WASH activities? (how do you categorize them)?
2. What are the indicators you use in Water and Sanitation monitoring and evaluation?
    a. How do you define them?
    b. How were the indicators chosen? Was there a standard or reference you used while choosing those indicators?
    c. What types of information do you collect on the indicators and what attributes do you use to describe/organize them?
        i. What are the sources to collect information: primary data? Secondary data? eg. CSA data?
    d. How do you collect them? (routine? As required?)
    e. When/hHow do you update your data?
3. How do you store the information?
    a. Formats used: Database? Paper based records? GIS?
    b. What technologies do you use to present and store information?
        i. Microsoft Access
        ii. Microsoft excel, PDF,
        iii. Microsoft SQL server
        iv. MySQL/PHP
        v. Record offices on paper based format
        vi. Digital repositories?
        vii. GIS? Others?
    c. Do you use any standard for storage and retrieval of WASH information?
        i. Use metadata or labeling schemes?
4. Who are the target users and how can they get access to the information they want?
    a. Are there any users or perceived users of your WASH information outside your organizations? If so, how should they approach the organization to get the information?
    b. What types of WASH information you require from other GOs and NGOs working in the area and what is the mode of communication?
5. What guidelines /policies governing management/sharing of information?
6. Do you use a management information system (MIS) you share with other organizations? Please explain?

APPENDIX II

DISCUSSION POINTS FOR VALIDATING THE PROPOSED FRAMEWORK

The following are questions/ discussion points intended for validating architectural framework proposed in this research entitled : **"Architectural Framework for Information Integration: Case of Organizations working on Water, Health and Sanitation in Ethiopia"**

1. Do you think integration of WASH data is a good idea? Do you think it is practical?
2. If so, what benefits would it have or what problems would it solve?
3. Do you think it is possible to standardize indicators as proposed in the framework? What challenges do you see?
4. Which part of the framework do you think should be improved or corrected?
5. What is your overall opinion of the proposed architectural framework?