

[The Health Information System in Sudan]

*[The Disease and outbreaks Surveillance System at the National Level
and the State Capital: A Descriptive Study]*

By

[Said Salah Eldin Al-Said]



Supervisor:

Professor Gunnar Aksel Bjune

Co-supervisor: Zufan Abera Damtew

Faculty of Medicine

Institute of Health and Society

Department of General Practice and Community Medicine

UNIVERSITETET I OSLO

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Abstract

This thesis aimed at exploring means of integrating surveillance systems for disease and outbreak in Sudan; visiting both the national and the capital state, with emphasis on both the facility based statistics or Health Information system (HIS) and the program for communicable disease surveillance.

A qualitative descriptive approach is adopted and main tools employed were document analysis and interviews with the staff of the Ministry of Health (MOH) both at the national and state, as well as informants at the locality and facilities levels. Quotations from findings were used to validate results, and the study received ethical approval from both the Norwegian and the Sudanese research ethical authorities.

Main findings indicate **fragmentation** within the disease and outbreaks surveillance system. This is in particular evident when looking at the recent developments in disease surveillance. The Epidemiological Department (later called the program of communicable disease surveillance) emerged from HIS and created its own surveillance system. The establishment of disease-focused programs with own surveillance systems further added to the fragmentation. In spite of the fact that disease-focused programs took responsibilities for surveillance and control of some of the diseases, the communicable disease program is still collecting data and monitoring the situation as whole leading to data duplication. Several of these vertical programs share the same sentinel sites. In addition data for all programs are aggregated by the Department of Preventive Health at the level of the locality before being sent to the respective program at the state level.

The program for communicable disease surveillance is using mobile phones for surveillance, coordination of intervention activities and feedback systems. A computer software program is under designing for the program to serve the purpose of surveillance and interaction with users. The health information system, on the other hand, is functioning through paper forms before entered into excel program at the state and national level. The capital State of Khartoum is an exception using a computerized software program for data collection from the locality level. With regard to technology in HIS and disease surveillance, the era is lacking cohesion and common vision for a collective approach for implementation within the organization. There's a need for a common structure with modular capacity rather than the current piecemeal initiatives to build the whole. The feasibility study for a central data ware house together with the recently launched evidence-based practices plan, paved the path for information use and organizational restructuring.

The 2009 influenza pandemic has added to the capacity of the program of communicable disease surveillance and widened its scope and partnerships both within the MOH and

otherwise to meet challenges. It was a trial to meet emerging challenges in addition to its routine activities.

Introducing technology to the organization seems to promote re-integration of health information system and the disease surveillance programs. It promotes organizational restructuring, decentralization and stakeholder's participation in implementation of integrated surveillance and HIS. The District Health Information System (DHIS) has been presented as a vision for unifying use of technology and realization of evidence-based practices.

Dedication

To my dear **PARENTS**, you have been so supportive, encouraging and caring unlimited,

To the soul my dear **MOTHER**, I dedicate this to all of your love...

To you my dear **WIFE**, without you this won't have come true.

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List of acronyms and abbreviations

BHU	Basic Health Unit
DHIS	District Health Information System
EPI	Expanded Program for Immunization
FMOH	Federal Ministry of Health
HC	Health Center
HCIS	Health Computerized Information System
HIS	Health Information System
HMN	Health Metrics Network
IDS	Integrated Disease Surveillance
IDPs	Internally displaced People
IHR	International Health Regulations
IMCI	Integrated Mother and Childhood Initiative
MOH	Ministry of Health
NHIC	National Health Information Centre
PHC	Primary Health Care
RHIS	Routine Health information System
SHIC	State Health Information Center
SHIS	State Health Information System
SMOH	State Ministry of Health
WHO	World Health Organization

1. Introduction

Public Health information is needed by all levels of the community; information is needed at the level of individuals and communities for effective clinical management and for assessing the extent to which services are meeting the needs and demands of communities. Information is needed at the district level to enable health planners and managers to take decisions regarding effective functioning of health facilities and of the health system as a whole. At higher levels, health information is needed for strategic policy-making and resource allocation [1]. Furthermore, adequate health information is crucial for the measurement of health status – an important determinant of need [2].

Information is defined as *“any stimulus that reduces uncertainty in a decision-making process” and an information need as both the recognition of what information can reduce this uncertainty as well as unrecognized or potential information needs* [3] cited [4] Universal access to information for health professionals is a prerequisite for meeting the Millennium Development Goals and achieving Health for All, and *“Achieving the goal of the WHO of Universal access to essential health-care information by 2015”* as an achievement by itself is possible [5]. However, there are others doubting it due to the fact that developing countries, where the priorities are often survival and improved environmental conditions, computers and the internet are still considered innovations [6]. An ideal surveillance system is nevertheless is portrait by Kukafka and Yasnuf *“Imagine a public health system where all reportable disease and laboratory information is available within 24 hours of collection, analysis of the data for anomalies is ongoing and automatic, and alerts are distributed in an automated fashion to relevant members of both the public health and clinical community. Furthermore, a steady stream of electronic information from a wide variety of sources regarding the health status of every community would be collected, analyzed, and disseminated continuously”* [7]. Surveillance system for communicable disease and outbreaks in Sudan is a functional unit at the national level with its representative and sentinel sites at both the national, state and district levels. The surveillance system is incorporation of all epidemiological efforts to enables health personnel to make evidence-based decisions for public health actions. Policy makers and planners are very important key players in defining the specific indicators and information collected by surveillance information systems. They also utilize the surveillance system information in adapting policies and plans to meet the local needs. Evidence based decisions are mandatory for surveillance to mobilize and allocate resources and predict or provide early detection of outbreaks. However, as many other developing countries the surveillance information of Sudan has faced different problems, including fragmentation of the system. This study seeks the reasons for fragmentation of the system and possible mechanisms for integration of HIS. Thus, the results of the study will help decision-makers and health workers to understand the conditions and challenges of integrating HIS, with more focus on surveillance system.

1.1. Background for the study

The whole journey started in the summer of 2008 with an implementation type of research for the DHIS in Sudan starting with the FMOH for the design and customization. The initial suggestion from the Department of Planning and Policies was to start with a pilot of the program of communicable disease surveillance since they were mature for that with a genuine wish for computerization and even on a process of developing one. However, this initial assumption shown to be counterproductive in the sense that further steps the program in collaboration with the IT Department has already undergone were not to revert and substitute with a new program.

As a hosting for the whole endeavour, the Department of Planning and Policies was a natural level to investigate and discuss information need and use in decision making, evidence based planning and evaluations. From the beginning, this made sense of it all that the start was with this department because of overall responsibility as well as relevance from the view point of information culture as whole. Luckily, the department was in a process of revision for sectors' indicators and a consensus building exercise with regard to M and E system design, a process supported by international funding and involvement of international consultants for the purpose.

The National Health Information Centre (NHIC) was inevitably a fundamental stay with regard to information and data operation in the FMOH. Representatives participated since earlier meeting and were interest since then. A series of meeting held with them showed their engagement in software designed by the IT department for the purpose of collecting routine data from the states. Though it was in a piloting phase, there was no consensus or willingness to discuss about implementation of the DHIS.

The Department of Disasters and Humanitarian Assistance was in a search for a program (software) that systematically assists them in monitoring situations with regard to flood seasons and measures of water rise in different states of Sudan.

The decentralization project in 4 states which are less developed due to the effects internal conflict was the next round. The project suffered from lack of data and poor reporting from the areas concerned. Reporting is under 50 % in most reporting localities, apart from the great number of those were not reporting at all.

As from the above, the era was flourishing with search and visions for computerized system to serve the purpose of information management for effectiveness and evidence based practice. There are a number of initiatives and efforts on the direction of using technology in the daily function and improvements, however, scattered and not coordinated.

A study was then designed to investigate the fragmented HIS and disease surveillance system of the FMOH in a search for potentials for integration and computerization. This was achieved on the premises of plans and priorities of the Department of Planning and Policies. A research was designated as an effort to describe the system and give an over view of the health information system as whole.

1.2. Problems Statement and Research Questions

Disease surveillance is the process of watching for health problems and their determinants with the intention to be prepared to take actions that will control and prevent disease, and thus improve or maintain the health of the population. Specific disease surveillance systems and intervention programs of the health care system at all institutional levels are essential for identifying problems and acting to resolve them.

Sudan's health information systems, like many other countries in the region, appear to be fragmented and striated, of poor quality of data, seem to be like vertical programmes meeting towards the end of their baths as summaries in the statistical annual report prepared by the national health information centre at the federal ministry of health [8]. There is a huge variation between states as to the extent data compilation and quality. Another important dimension is the lack of communication between statisticians who are the specialists and responsible for data and information, and medical personnel who are the decision maker and planners. Decisions seem to be taken in any other grounds than information available, and information tend to be made from anything else but systemic data collected. The failings of health information systems have been thought into sharp focus the Millennium Development Goals (MDGs) which have a strong health component. Although (MDGs) have been widely endorsed as a framework for measuring development progress, in practice few countries have sufficiently developed health information systems to permit regular monitoring [1]. In these situations timeliness is a key concern as decisions cannot be delayed, and practitioners must be as well informed as possible [9]. That's the reality in times where it became not doubted that information is essential for health planning, decision making and identification of priorities [1, 10]. Therefore, sound information is crucial for prioritization of health problems and appropriate utilization of the scarce resources, and as a tool which will also bring the private sector into the system. The later will promote evidence-based decision-making and enhance the capacity of managers to effectively analyse and utilize statistics [11, 12].

Improvement RHIS is widely discussed as the strategy to integrate and unify fragmented HISs in developing countries rather than abandoning it. It is of the strategic plan of the National Health information Centre NHIC, and other stakeholders' such as the WHO in Sudan to facilitate the incorporation of the existing different surveillance activities into a comprehensive national surveillance system that support the establishment of an early warning system and rapid response for outbreaks. The later is a measurement to support Government at federal and state levels in the early preparedness and response to emergencies and humanitarian needs [9, 11]. Further a clear understanding of the unique information needs of public health professionals is vital to the design process for a digital knowledge management system which is also widely experienced as empowering [4]. The situation is complicated by the fact that public health includes many disciplines; its

workforce is diverse; and public health job functions are variable and often overlapping. This diversity of backgrounds and roles presents a challenge to those studying public health information needs, ways to improve access and reduce barriers to needed information and public health information sources of most importance for meeting information needs.

The following research questions were formulated on the basis of the problem statement:

1. What are the challenges facing integration of surveillance health information systems for disease and outbreaks?
2. What are the prospects of stakeholders' participation of these concurrent health information systems on relation to information use and decision – making?
3. Is the surveillance system for disease and outbreaks prepared to meet challenges of disease outbreaks and epidemics?

1.3. Objectives of the Study

General: The overall goal for the study is to describe the surveillance system for disease and outbreaks and the relations and interactions between the existing health information systems in order to identify potential integration and cooperation between them.

Specific:

- ✍ To describe the surveillance system for Disease and Outbreaks in Sudan, and its connections to other existing health information systems.
- ✍ To explore challenges and opportunities facing integration of the health information systems involved in the surveillance for disease and outbreaks.
- ✍ To identify the need for standardization of health data and to initiate technical solutions that may help to improve the existing HIS.
- ✍ To assess coping of the existing surveillance system with challenges of epidemics.

Themes of the Study

- Organizational aspects of HIS resources including policies and design.
 - Data collection, analysis and dissemination procedures in the health sector.
 - Dissemination and share of information with other stakeholders.
 - Use of information in management and decision making.
- Impacts of absence of unified HIS in the disease and outbreaks surveillance.
- Health workers' perception about integration of information system.

1.4. Research setting and context

Sudan is a large country of one million square miles and a population of 39.2 million (2008). The country is divided administratively into 25 states governed by a federation system. The study is carried out at the Federal Ministry of Health and the state capital of Khartoum Ministry of Health and its peripheral system. Khartoum state is the capital of Sudan and occupies the centre of the country with a total area of 28.000 km² and a population of 4.625.000 (census 93), estimated in 2004 to over 6.000.000 including the IDPs. Khartoum state Ministry of Health (SMOH) leads the health activities in the state, except for 12 teaching hospitals, which are administered by the Federal Ministry of Health (FMOH).

Oil is the main source of income, substituting old agricultural products where industry and tourism play a minor role.

The society is almost populated by complex ethnic groups with socio-cultural and linguistic pluralisms and some have specific administrative boundaries such as southern Sudan. Ethnicity and cultural identification has been a serious political and military issue. The past civil wars in the Southern and the eastern Sudan, and the ongoing one in Darfur has affected the health situation seriously through widespread displacement of people and resettlement difficulties, exposure to war violent experiences, loss of social resources, systematic dismantling of the infrastructures including public health facilities etc. Also 1.1 million foreigners have taken refugees in Sudan due to wars and famine in their own countries e.g. Ethiopia, Eritrea, Chad, Uganda etc.

Sudan has a well defined 5 years strategic plan for the years 2007 2011, designed for the purpose of promoting health and development. The plan is designated to detect and control emerging endemic health problems; monitor progress towards health goals and promote equity. Empowerment of individuals and communities with timely and understandable health related information is also emphasised centrally in the plan. The health information system is visioned to mind the gap in information need for policy makers, managers and health personnel in general and evidence based practice and innovation and monitor of scale up efforts [9].

The health system in Sudan is decentralized. The FMOH is responsible for formulating national policies, ensuring supervision, development and management of human resources, and managing international relations. The financial and management of tertiary-level institutions is also remit of the FMOH. The SMOH is responsible for planning, administration, and financing of primary health care and first referral (secondary) services within the frame work of the national policies.

1.5. Motivations

Information has always been an issue and a deficient area in the Health sector and other sectors in Sudan. Since early engagement in the field as a student, lack of information and true over view of services, figures on disease and health was a challenge. My search for a field for research work was long; seeking a topic that satisfies my urge to contribute to development and health.

Then trigger for this research was the course in Health Information System Programs (HISP) at the Institute for Informatics. The course has awakened the importance and complexity of Health Information Systems (HISs), at the same time was enlightening for the horizon; that there's a lot that could be done to improve. In addition to this, it has been my old interested in surveillance of epidemics in connection to disasters from before. Therefore, I have decided to carry out this type of research when a possibility came about.

The response from my primary contact at the FMOH was overwhelmingly positive and encouraging, as from my supervisor.

This is the era of information, and health informatics is a growing and developing field of great audience and interest worldwide. As a medical professional, I have been most of my career closer to that as an important tool for improvement in the field at all.

1.6. Target audiences

This study: describing the health information system in Sudan, and the interactions between its subsystems, in a search for potentials and promoters for integration, might be beneficiary for several groups of audiences, among others

- ✓ Officials at the MOH in Sudan in the different levels of the hierarchy; national, state or local levels. The study is directed mainly for health planners and health information officials, as well as IT personnel.
- ✓ Student and researchers both from medical and technical institutions who are interested in particular in Health Informatics.
- ✓ Others from both the health sector and other disciplines with interest on the topic.

1.7. Aims and expected contributions

The study aims at giving a comprehensive over view of the HIS and disease surveillance in the MOH system of Sudan. Reform and revitalization of HIS is a complex field and a dynamic process that involves several disciplines. Therefore issues of both ownership and responsibility became conflicting. A classical conflict that's documented in the literature between managers, public health experts and experts from the IT domain [13]. A holly approach is needed in order to achieve goals in this field. Both structural as well as process dimensions of implementation for a HIS are to be considered and secured to safeguard success.

The outcome from this study is hopefully to enlighten the path for health planner to inform changes processes and implementation efforts in the field of computerization and integration of HIS.

1.8. Structure of the Thesis

The thesis is organized in seven sections; starting with an introduction and background for the study, research questions and objectives in first one. A literature review and state of knowledge on the topic together with a theoretical approach are presented in the second section. The third section introduces the study area and location. The fourth section deals with the methodological approach to the study. Findings and analysis are presented in section five, and then discussion and summary in the sixth section. In the last section conclusions are formulated.

2. Literature Review

2.1. Health information systems HISs in developing countries

Fragmentation of HIS

Health information systems in most countries are centrally planned and managed. Indicators, data collection instruments, and reporting forms usually have been designed by centrally located epidemiologists, statisticians, and administrators (called data people), with minimal involvement of lower-level line managers and providers of the health services (called action people) [10]. This centralized information management results in fragmentation of the HIS. Further he described that as

National vertical programs in many countries have created separate 'program information systems' that tend to focus on one specific disease (e.g. malaria, TB), a specialized service (e.g., family planning information systems), or a management subsystem (e.g., drug management information system) instead of addressing management functions in a comprehensive way [10].

Azubike calling it the piecemeal mode of development of HIS [1], in addition to “*donors effect supporting of international organizations causing a dichotomy between information system professionals (data people) and health systems managers (action people) who could not understand each other's role and responsibilities, and the need to work together*” described by Anna Lind in [14] in the Prizm by Agil, Lippeveld and Huzmi [15].

Health reform and the deficient decentralization

The term 'decentralization' is used to describe a wide variety of power transfer arrangements and accountability systems aiming at transferring power and resources to the peripheries [16]. Policies range from the transfer of limited powers to lower management levels within current health management structures and financing mechanisms to extensive sectoral reform efforts which reconfigure the provision of even the most basic services [17, 18]. However, decentralization without measures and steps of monitoring could lead to even to more inequities in countries [19, 20]. Mouzinho amended that “*A shift towards decentralization in many low-income countries has meant more skills are demanded of primary health care managers, including data and information handling at all levels of the health care system where it is not disputed the crucial need for information in critical times for making decisions*” [19]. In the context of a decentralized health system, some government functions and responsibilities are devolved to lower levels of government (provincial, regional, or district levels). In such a context, it is needed to determine whether the HIS is structured to satisfy the information needs of those levels. Data that flows to the central level and are analyzed there may be needed most at the regional or district level

where important resource allocation decisions are made. *"You will need to determine whether the level of decentralization of the health system is consistent with that of the HIS. Otherwise, the utility of the HIS as a management tool is likely to be severely limited"*, as Bossert has titled it as *"the ignored political prospective of decentralization of services, democratization and local leadership dimensions"* [17, 21, 22].

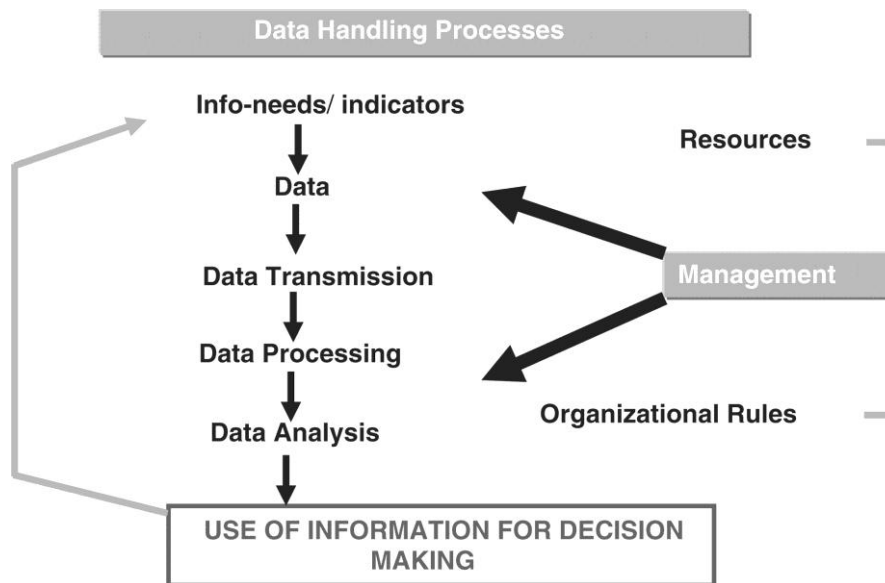
Irrelevancy and poor quality of data

Health information systems (HISs) in developing countries are characterized of data on individual healthcare activities that is irrelevant and of poor quality with the information produced not linking to a reference population [10, 23]. Chambers states that *"(Most data) remains unprocessed, or, if processed, unanalyzed, or, if analyzed, not read, or, if read, not used or acted upon"* [24] cited [10]. In addition to this, those 'data people' at the central level may not use the data because of lack of trust to the data sent. The result of this is that, data collection staff tends to be less motivated and hence produce poorer quality data, in addition to limited of training and feedback that leads consequently to low motivation and thus commitment and incentive to ensure quality of the collected data and comply with reporting requirements, not mentioning harm that could be done due to lack of education in clinical epidemiology [6, 10, 23, 25]. As Azubike expressed that saying *"Recent changes in health policy and practice have added to the capacity shortfall. Health sector reform generally comprises decentralization of decision-making and resource allocation to the district level, yet neither the tools nor the capacities for information generation and analysis at this level have been sufficiently developed"* [26].

RHIS performance

Where data quality is further described by Lippeveld in four dimensions: relevance, completeness, timeliness and accuracy [27]. PRISM authors proposed that *"RHIS performance is defined as improved data quality and continuous use of information. Relevance is assessed by comparing data collected against management information needs. Completeness is measured not only as filling in all data elements in the facility report form, but also as the proportion of facilities reporting in an administrative area (e.g. province or district). Timeliness is assessed as submission of the reports by an accepted deadline. Accuracy is measured by comparing data between facility records and reports, and between facility reports and administrative area databases, respectively"*.

The diagram below from the PRISM by Agil and other displays the data handling process



Aqil, A. et al. Health Policy Plan. 2009 24:217-228; doi:10.1093/heapol/czp010

Figure 1: Health Information System (HIS) components diagram

Poor information use for evidence-based practices

The role of health information systems is to generate, analyze and disseminate such data. In practice, health information systems rarely function systematically [19, 28]. Routine Health Information Systems (HISs) being not adequate to provide necessary information for neither to individual not to public health systems is evident in most countries [29]. Use of information provided by RHIS to make decisions, coming from valuing information and information quality as a critical component for decision-making, demand for additional information to fill in gaps and regular use of information in strategic and operational management with an overall goal to improve health [15, 19, 30]. With the availability of all this, decision makers as well as all managers undertake decisions motivated by situation they are met with depending both on formal information systems as well as other types of information available [31-34].

HMIS and Organizational Structure

Developers of HMIS are not usually taking in consideration the organizational changes that have to take place in health organizational system while developing and designing a HIS. Therefore, consequent failure and shortcomings may appear later in the process of implementation [32]. Introduction of a HIS underestimated its organizational development potential rather than simply fulfilling reporting requirements. Here, user involvement, the choice of a standardized terminology, a pre-existing culture of data collection and leadership remain crucial issues for RHIS financial and technical sustainability [19, 35, 36]. In addition there is a critical need for public health digital knowledge management systems designed to

reflect the diversity of public health activities, to enable human communications, and to provide multiple access points to critical information resources. Besides a clear understanding of the unique information needs of public health professionals that is vital to the design process for a digital knowledge management system [4].

2.2. Integration of HIS

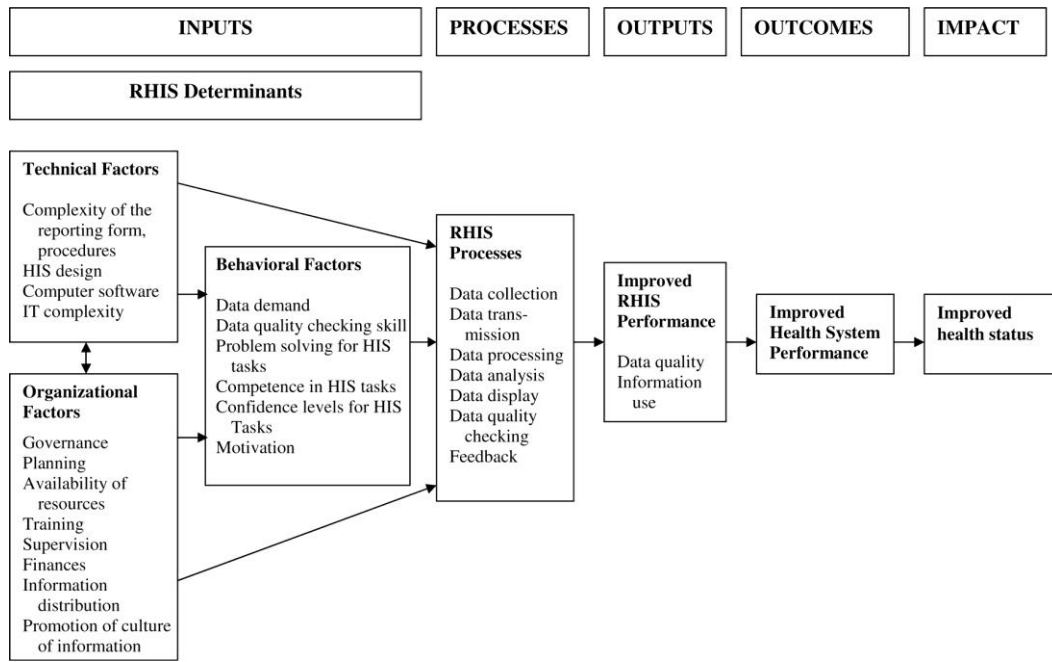
In this part issues around organization and data quality will be presented. Here will be presentation of the PRIS Framework which's a rationalization of information use framework; information cycle, Essential Data Set ESD and the information pyramid as are models to improve the quality of data as well as flow.

RHIS Potential for Integration and Improvement

The word "System" implies a connected whole or organized process. In practice, as AbouZahr and Boerm stated that *"most country health information systems lacks such cohesion, having developed in a piecemeal way, fashioned by administrative, economic, legal or donor pressure and are invariably high complex"* [1]. In the 1990th Lippeveld and others introduced the idea of the routine health information system (RHIS), data, routine reporting system in health care facilities are the building blocks for health information systems (HISs) and management system in the public health sector of developing countries [10, 37]. Readily available data collected using standardized procedures, such as the data that are routinely recorded on hospital discharge records, are extremely important, in that they can provide useful indications of the health situation in a given area and can be obtained at a low cost and in a long-term, sustainable manner. Moreover, researchers like Agil argued that:

"health system managers have no substitute for routine information in terms of monitoring progress towards achieving service coverage objectives and managing associated support services (e.g. logistics, human resources, finance) for their local target populations [15]."

On the other hand Lippeveld argued that *"RHIS will remain the major source of information and platform to achieve MDGs and informed decisions in and thus prosperity. RHISs have the potential to play a major role in facilitating integration between individual health and public health interventions"* [29]. Further, Agil and Lippeveld promoted the idea that the focus of debate and reform should shift from abandoning RHIS over other sources of data to showing how to improve RHIS [15]. They have The PRISM framework brings a paradigm shift in RHIS design and evaluation by considering RHIS to be a system with a defined performance and by describing the organizational, technical and behavioural determinants and processes that influence its performance. This is shown in the diagram below



Aqil, A. et al. Health Policy Plan. 2009 24:217-228; doi:10.1093/heapol/czp010

Figure 2: PRISM (Performance of Routine Information System Management) framework

Authors of the PRIS continue that *“The framework implies continuous improvement of RHIS performance by analysing the role of each of these determinants and by identifying appropriate interventions to address determinants that negatively influence RHIS performance. Through broader analysis of organizational information needs, it also hinders fragmentation of the existing RHIS and promotes a more integrated approach to information system development”*. So the idea of the PRISM is illustrated by the figure from the article

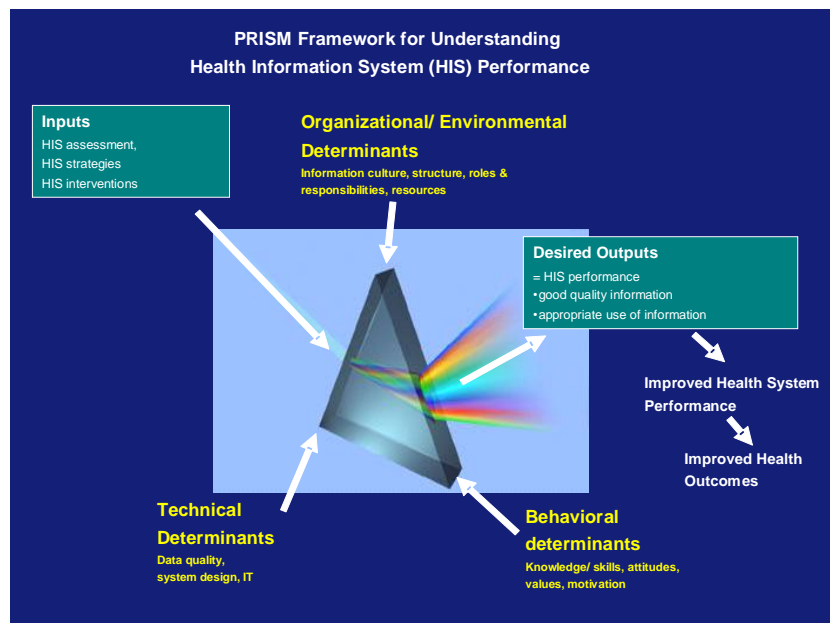


Figure 3: The PRISM Framework for understanding HIS Performance

Seen as a valuable and enviable development, the emergence of information systems for vertical programs has added a new value in terms of competencies in the field, which might be for the best for the vision integration of efforts [14, 15]. This vision is supported by the fact that while statistics and information systems have been the business of only statisticians and epidemiologists until not long time ago, experience has shown from later work that medical personnel and managers have gotten involved and been targeted with the training as well [1].

The information cycle

The Information Cycle is a diagrammatic way of looking at information and enables you to see the links between the different phases of collecting, processing, analyzing, presenting, interpreting and using information [38]. Whereas **data** that's what we collect, which is the observations and measurements about the world, e.g. Representation of observations or concepts suitable for communication, interpretation, and processing by humans or machines that may or may be not useful to a particular task. **Information** on the other hand is the transformed facts extracted from a set of data (interpreted data), giving meaning and usefulness to data which is return useful to a particular task.

Talking about **data transmission**; the process should address the main flows of information within health care services; within individual health care system promoting continuity of care and permitting follow up by individual patients and clients (horizontal transmission), as Heywood described it in the Equity Project from South Africa. Secondly, it should ensure effective data flow between health unit and system management (vertical transmission) [39]. **Data processing and analysis**, on the other hand, range from simple manual computations to sophisticated computerized processing and analysis that transforms the data into useful variables. The challenges in the coming years will be to achieve the right mix of computer and manual systems [29].

Data presentation and communication (feedback) should be customized to users at to all levels and their functions in order to promote use. Good feedback is based on meaningful comparisons; time comparisons, geographical comparisons, or comparisons of actual versus mean or planned performance [29, 40]. Neame and Boelen stated that "it is only when those providing the data being to receive meaningful and useful feedback that they will begin to appreciate the value of data and will therefore take appropriate steps to improve the quality, timeliness and quality if the data they provide" [41].

How do we use it? Planners and managers face deadlines and time constraints in their daily decision making. Outdated information, even of high quality, is of low value to them. In real worlds situation, decision makers as well as all managers undertake decisions motivated by situation they are met with depending both on formal information systems as well as other types of information available [31].

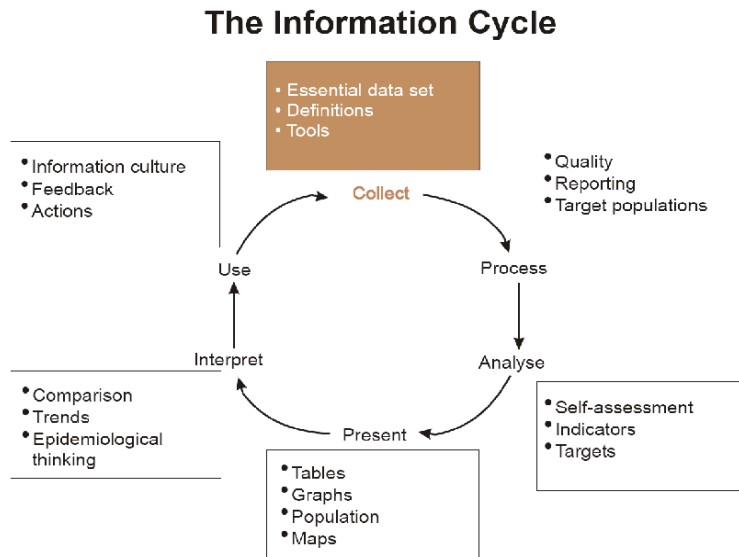


Figure 4: The Information Cycle from the Equity Project

Essential Data set and information pyramid

The Minimum Data Set, or also named Essential Data Set (**EDS**), is “a collection of data which is based on indicators reflecting the health status of the community. The basic characteristics of the Minimum Data Set are the following ; can provide useful information, which affects the management decisions, cannot be obtained elsewhere, are easy to collect, do not require much work or time, and can be collected relatively accurately. The **later** is one of the key elements in a health information system, and involving indicators which reflects the health status of a district/ community” [38]. So the big question is which indicators should be collected? One challenging task is to limit the data collection to the minimum. Not everything must be collected for the reason that the complexity in the collection process will increase. There are information that one must know, information that is useful to know, information that is nice to know and information that is dangerous to know. The later is information that is too much to handle and can contribute to complicate the data collection process, which may result in poor data quality and messy information infrastructure consequently. To develop a minimum data set, or more often called essential data set for the health information system in development countries, may perform a number of challenges. According to Shaw “Developing an essential data set provides managers with a clearly defined set of indicators for monitoring and evaluating services. The development of an essential data set both requires and can contribute to a process that allows the reporting requirements to be adjusted over time in response to changing circumstances” [42].

The information pyramid

The **Information Pyramid** is a schematic way of looking at the number of data items to be collected at each level of the health system, allowing each level to gather data of importance and relevance to their daily work while avoiding excessive data where no action is taken. In this model the community is the foundation: it is where all information originates and where most health service action takes place. Most data collected in the community and at health facilities is of an operational nature and is not needed at district level. Therefore, “filters” are put in place in the form of reports which send only the “essential data sets” to the next level. Each of these data sets contains only the essential data of the next level, which get smaller and smaller as one gets further from patients and the community [38].

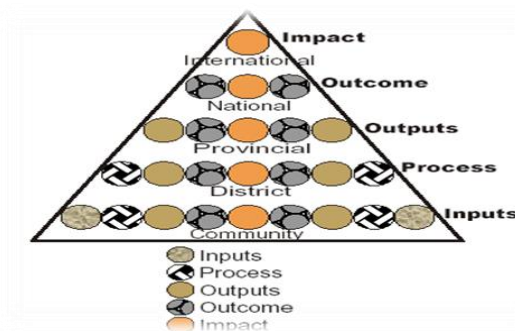


Figure 5: The information Pyramid of the Equity Project

2.3. Computerization and HIS transfer

The HIS system is a very costly intervention usually involving an international vendor; hence failure to deliver the anticipated benefits is a big loss. Studies report incidences of under usage of the system by the users as the case in Zambia [43]. The greater the change-gap between current realities and the design conceptions (i.e. requirements and assumptions) of a new health care information system, the greater the risk of failure. Heeks summarized that further [44]

Three archetypal large design-reality gaps affect the HCIS domain and are associated with an increased risk of failure; rationality-reality gaps: that arise from the formal, rational way in which many HCIS are conceived, which mismatches the behavioral realities of some health care organizations, Private-public sector gaps: that arise from application in public sector contexts of HCIS developed for the private sector, and country gaps: that arise from application in one country of HCIS developed in a different country.

Taking the example of the ambitious hospital project in South Africa in 1994 that aimed at scale up of administrative, managerial and clinical processes. Problems due to inadequate

infrastructure as well as functionalities and implementation of the system, main network was delayed to priorities and competitions in the region, difficulties to use the software, poor organization of the management team, and insufficient training was offered to the staff of the hospital to run the demanding system [43, 45, 46]. Understanding the reasons of implementation from the outset and underestimating the complexity of health care tasks [46]. It is as Heeks summary on failures and success: *Failures and success of health information systems could be attributed to a vast structural reason; resources both human and materials, technology, country of implementation, leadership ...etc [45]*. Besides, the *technology itself* referred to as the “design–reality gap” represent a challenge, gap between “current realities” and “design conceptions of the HIS” add up to the situation as Heek explained it in his model.

The project failed to take account for healthcare culture [43] contributing to weakening of the motivation, and thus their commitment to the new system by less involved stakeholders [46]. Further the **underestimation for the complexity of the healthcare processes** which have their own peculiarity, where each patient has a unique pathway to complete a round inside the health system. IT professionals dominate the design process, allowing a technology-based worldview to dominate design inscriptions. In addition the relationships between the three classically groups around such systems; technical people, managerial and medical experts with their varying expectations for the system ought to be balanced in order to prevent dominance of one of the groups on the others [47]. The later shows importance of consensus building among **commissioner, developer and users not the least, to share expectations** and values with regard to the change to be implemented would have empowering for the process.

Stakeholders’ participation and information culture

Being not involved in the process of design and management of information system, health care providers and managers at district and lower level are left dissatisfied and little engaged and committed to the system. The level of motivation in this category is directly related to the degree of involvement and understanding for the task they are achieving. Not the least the issue of disorganization of information systems and the doubling up of work by the demanding donors programs for information and results outside the routine health information flow exhaust the cadre and weakened quality of data and information [1, 25]

Measures that proved effectiveness and usefulness in successful development and implementation of HIS among others were stakeholders’ participation and decentralization of information management towards the district level. Participation and involvement of all main stakeholders in the process is one of the safeguards for successful implementation as well as reform of health system. Decentralized Routine Health Information system in countries allow health program managers at both peripheral (district and regional) and central (national) levels to better monitor and evaluate the health programs by making available at all levels the data necessary for decision making [48].

Touching on a conflicting zone, researchers like Sandiford discussed the relationship and the power questions between the classical groups; IT experts, health care managers and the public health specialists with regard to expectations for a system. With the objectives of getting rid of the paper work, increased efficiency, and effectiveness and equity, these groups respectively, might mean resistance from other groups [47]. Lippeveld expressed that in his article Routine Health Information system as the Glue:

“Attributed mainly to the management-culture, internal resistance within the system from vertical programs or others might be another type of obstacle to deal with. In reality most care providers feel threatened by a new system that lead to objective decision making and are suspicious of automations. Leadership and consensus building between the different groups involved therefore is valuable and empowering in these terms and bridging during the implementation process [29]”.

Furthermore, the process of developing and implementing a HIS could be an empowerment in the case of developing countries as Helfenbein stated *“Changing the way information is gathered, processed, and used for decision making implies changes in the way an organization operates. Producing and utilizing information more effectively will affect the behavior and motivation of all personnel. It is therefore important for those in charge of HIS restructuring to have a full understanding of what is at stake for each of the actors involved in the projected changes.”*[13]

2.4. District Health Information System (DHIS)

The District Health Information Software – Version 2 (DHIS 2) is Free and Open Source Software (FOSS) HMIS designed and developed under a global research and development initiative (called Health Information Systems Project – HISP) originating from the Department of Informatics, University of Oslo, Norway. DHIS 2 is built on Java based frameworks after several years of development and modification. It is platform independent, can run on both on-line and offline modes, is multi language enabled and integrated with various other applications such as Geographic Information Systems and Excel. The WHO and HMN (Health Metrics Network) are currently using DHIS 2 for implementing an integrated solution in the first HMN country – Sierra Leone. While DHIS 2 will be used for the aggregated statistics component of the HMIS, it will be integrated with a free software application called Open MRS for patient based management, and the WHO created Open Health for GIS and Web pivot tables.

Security concerns for aggregated data are not as crucial as for patient data, as there are no ways of relating it to a person. However, data can still be misused and misinterpreted by others, and should not be distributed uncritically. A data policy needs to be established by

the managers about who gets access to what data. A module can be seen as an independent component of application that is capable of both processing inputs as well as outputs, that is used to communicate with other modules. The modules are flexible enough to allow changes in one module without having any effect on other modules. The program and its implementation have values in terms of decentralization and integration of HIS where data at every level are immediately available if the whole system is web-based. The data is easy to report also off-line. Quick feedback from first data-entry point to facility will show if there are entry errors. When the data is in the system – higher levels will not be subject to new data-entry errors. (But of course, there might be other types of data errors). The program has capacity to integrate vertical programs and remote districts are linked to a bigger system.

Advantages of computerization in the context of developing countries[49, 50]

Improved patient care: Computerized HIS can make patient information from other hospitals available where the patient is currently being treated. This might be especially valuable during acute emergencies and in areas where there is “shopping” of health care services or high level of migration, improved accessibility of patient related information to healthcare professionals through improved handling of medical records, and results of investigations that require analysis and interpreting from other parts of the health care facility or system will come more quickly.

Improved public health management: With computers there is much easier to aggregate and process information that comes out as valuable for public health. Different databases can be tapped and data combined to get out population data, indicators and surveillance information.

Improve management decision making: Through the availability of integrated management information, there is possible to make hypothesis of possible reasons for epidemiological traits, actions to take in order to improve quality of care or new services that has to be started.

2.5. Epidemics and Pandemics preparedness

The starting block in health information systems and promotion of information use is undoable the quality of data. Not arguing that good data could necessarily mean good decision making, but that can be a convincing and encouraging factor to the process. Quality of training for personnel involved in the process needed also to be maintained and upgraded [51]. Surveillance defined by Noah as *“is the ongoing and systematic collection of routine data which are then analyzed, interpreted, and acted upon”* [52]. It is undoubtedly an essential – indeed critical – ingredient of any disease control program. It is used to monitor the impact of an infection, the effect of an intervention or health promotion strategy, health

policy, planning, and delivery. Surveillance methods are ranging from target disease, the surveillance system, community based surveillance, and hospital based surveillance, and passive or active surveillance. Syndromic surveillance mentioned by Buckeridge in automated surveillance, is yet a new advancement that these systems may be effective usually to detect disease outbreaks rapidly [53].

In the early twentieth century, information gathering on infectious diseases and other hazards to humans was developed in parallel with the development of microbiological technology and epidemiology. The data thus collected were analyzed and the results were distributed to systems and individuals responsible for control actions, as reported by Arita [54]. Epidemiological surveillance was the beginning of a new era of infectious disease control. In recent years, surveillance activities have been expanded from infectious diseases to chronic diseases and automobile accidents and other injuries. In addition, long-term data collection of such as vital statistics and surveillance of health-related social or economic activities have been surveyed systematically. Frerichs in the article on epidemiological surveillance in developing countries continued that stated that [55]:

Most countries attempt to gather surveillance data on cholera, yellow fever, and plague, the three diseases subject to International Health Regulations. Other conditions typically included are those under active surveillance by WHO, such as AIDS, dracunculiasis (guinea worm), poliomyelitis, influenza, and malaria. It also included are those conditions that are required to be reported at the national level by most countries, such as various forms of encephalitis and hepatitis, measles, typhoid and paratyphoid, tuberculosis, leprosy, diphtheria, pertussis, human rabies, and tetanus. Other problems occasionally reported are accidents, low weight-for-age or weight-for-height, dog bites, and snake bites.

Taking the example Influenza as a viral disease of global dimension, presenting with high morbidity and mortality in annual epidemics, and in pandemics which are of infrequent occurrence but which have very high attack rates [56]. Azubike argued in his article that “Health managers have often been caught unprepared by fairly predictable epidemics with thousands of people dying from situations that could have been prevented if there was adequate planning and monitoring of trends” [26]. The WHO Global Agenda defines 17 priority activities that are critical to reducing the morbidity and mortality from annual influenza epidemics and preparing for the next pandemic. The Global Agenda will provide the foundation for global and national intervention plans, facilitate international coordination of prevention and control activities and contribute to renewed interest in epidemic influenza prevention and pandemic preparedness [57].

Enhancing global surveillance for influenza is crucial because an early warning of an impending pandemic might save thousands of lives. A very practical consequence of these limited supplies is that each country will have to identify the population groups that should

have received the first doses of vaccine and antiviral once they become available. Successful implementation of a pandemic response will require a clear chain of command and a strategy and structure for effective communications at both the national and local levels. The best defense against the next pandemic will be to strengthen the global capacity to respond to yearly epidemics of influenza. By building this capacity we will not only be better prepared for the next pandemic, we will also save thousands of lives before it arrives [58]. Cox continues in his article saying that:

*Information processed through a **disease surveillance system** should be able to provide guidance during inter epidemic phases as well as epidemic and pandemic phases likewise. **Information** about the different phases of the situation, infrastructure, and population to serve and achieve preparedness for are all equally important as the And here is the role of information and a systemic approach to detect, intervene and evaluate developments [58].*

2.6. The information system in Sudan

In Sudan as in many countries of the region, health information systems are designed and managed by experts in the centre, including to varying degrees personnel from lower levels [10]. The 5-year Health system strategy of the FMOH [59] described the HMIS as

“The HMIS performance is weak, unreliable and fragmented. This was a result of poor administrations of the systems, under funding and inharmonious actions of different players in the health arena. Recognizing these facts, the FMOH has developed a plan to strengthen the Health Management Information System which will be financed through the Health Metrics Network (HMN). The strategy will further expand on this work and provide a Framework for future development.”

In addition to the routine health information system that exists in this district, health care providers are collecting data to a variety of programs that exist in the area. Fragmentation for the information system was the result of this pattern of satisfying program needs, and overload and meaningless tasks for care providers and managers at lower levels [8]. In addition, information use is weakest at the district level, where the main public health interventions are planned, implemented, and monitored, and at the health unit level, where individual health decisions are made.

Disease surveillance and control after flood in Khartoum

An article by Bradly [60] describes the emergency disease surveillance implementation in Khartoum following the 1988 flood, a surveillance system that stood on symptom-oriented case definitions for diarrhea disease, measles, respiratory tract disease, malaria and jaundice. Samples were collected from both permanent and temporal sides, and diarrhea

shoed to be the most prominent from the sentinel cites. Data were collected on morbidity and mortality surveillance from 30 temporary outreach clinics, 12 sentinel cites, and mainly was the major teaching hospitals for pre – and post disaster data for evaluation of the effects of floods on the situation. In addition special surveys were conducted to collect information that is unattained from facilities on malaria, nutritional status.

Disease surveillance provided useful data in identifying public health problems, setting priorities, targeting interventions and controlling rumors. The MOH carried out interventions; provision of potable water, standardization of medical care, distribution of immunization, ORS and Vitamins.

Post-disaster surveillance should ideally, be an extension for routine disease surveillance, based on representative sampling rather than total count, and including null report. Post-intervention evaluation was a failure due to lack of measures for before and after the disaster, besides when considering resources; usefulness of a surveillance system is a capacity to respond to the information collected. Other issues were training and dependency as not been part of the existing system.

2.7. Theoretical Approach

Fragmentation of the communicable disease surveillance systems

AbouZahr and Boerma argue that many countries are unable to generate the data needed to monitor progress towards the (MDGs), which is the bigger goal towards better health, *“It is not because countries are too poor that they cannot afford good health information systems; it is because they are poor that they cannot afford be without it”* [1]. Individual health interventions and public health interventions are complementary and interdependent in improving the health status of individuals and populations. Information needed by one system is available at another system and vice versa. There’s evidence duplication, poor quality data and the whole set of consequences of fragmentation and running vertical [29]. There is an emerging power question on the traditionally centrally designed Information systems and the restructuring process of services through decentralization processes. Computerization is yet another threatening aspect on this conflicting issue [61, 62]. Sudan has gone further steps in introducing computer infrastructure in the health sector as well as other sectors of administration and services. For the routine data a computer based program has been introduced both at the national and the state level. The communicable disease program is introducing and piloting a computer based system to collect and manage data from the wide spread sentinel cites to integrate surveillance activities for disease and outbreaks.

Potential for integration and improvement

Health information system (HIS) is deemed to be producing good quality data if the users of the information system are confident that the data it produces reflect the actual status of the health system of which the surveillance system is part. Generally speaking, relevance, appropriateness, accuracy, timeliness, and completeness are all factors that contribute to the quality of HIS data [38, 63]. Relevance and appropriateness pertain to the design of the HIS, whereas accuracy, timeliness, and completeness relate to implementation(1).

Case definitions and quality control systems can be useful to improve accuracy[52]. Information generated by Routine Data Systems (Federal and State HISs) are used basically for annual reports and archive, or any other purpose but not the daily operation of services providing [8]. However, RHIS will remain the major source of information and platform to achieve MDGs and informed decisions in and thus prosperity. Furthermore, routine health information systems have the potential to play a major role in facilitating integration between individual health and public health interventions [29] calling for *“shift from abandoning RHIS over other sources of data to showing how to improve RHIS”* [15]. Not forgetting the added value of existence of competencies within *“vertical programs”* in the field of health information as promoters for integration and development [14, 15]. Statistics and medical statistics is not longer the business for only statisticians and epidemiologist, experience has shown from later work that medical personnel and managers have gotten involved and been targeted with the training as well [1].

Lessons learnt from other countries confirm the importance of stakeholders' participation and embedment of introduction and improvement of HIS into the context of the organization it's to serve. The later has a direct effect on Strengthen the culture of information use during project implementation [29, 36]. *“A cooperative achievement in this field would be the acknowledgement of for the existence of other information forms outside the formal HMIS in the district health system”* [18]. Organizational development is a continuous process to get better and stronger, and indeed appreciated in the sector as relevant actor (relating, positioning). Through improvements of the procedures and capacity of people (being) [36].

There is a critical need to understand local information flows, but to what end? Partly, so that established information sources can provide better information, but also so that we can focus more directly on how information is created and used locally [5]. This process could have a greater impact on the empowerment of local management, health workers, and communities [32, 64, 65]. It is a consensus building exercise on agreeing on essential data set is a crucial stage in the process where also attainment of stockholder's participation is another block stone on the process and a safeguard for success [10].

3. Study context of Sudan

3.1. Geography and Demography

Sudan is a large country of one million square miles (2.505.810 km²). The country has borders with 9 countries; Egypt in the northern border, then Libya, Chad, Congo, Uganda, Kenya, Ethiopia and Eritria. Although the economy of Sudan has been depending mainly on agricultural products; cotton, seasam, wheat, gum Arabica and others, the main source of governmental revenues has recently come from oil revenues. Industry and tourism play a minor role. Being a highly indebted poor country and given its extensive area.

This vast area, with difficult terrain and poor infrastructure, affect coverage of health services and increases cost. Different contrasting ecological and climatic conditions of Sudan contribute to population exposure to serious communicable diseases and humanitarian crisis and emergencies related to spells of drought, famine and flooding [11, 12].

The country's total population was estimated to be 39.2 (2008) with annual growth rate of 2.6% and total fertility rate of 5.9 % and 54 years life expectancy at birth. 63 % of the population is in the rural areas with a further 11 % being nomadic. 46% of the population is below age of 15 years while 4% are above 65 years. This means that more of half of the population is not economically active and dependent.

The society is almost populated by complex ethnic groups with socio-cultural and linguistic pluralisms and some have specific administrative boundaries such as southern Sudan. Ethnicity and cultural identification has been a serious political and military issue. The past civil wars in the Southern and the eastern Sudan, and the ongoing one in Darfur has affected the health situation seriously through widespread displacement of people and resettlement difficulties, exposure to war violent experiences, loss of social resources, systematic dismantling of the infrastructures including public health facilities etc. Also 1.1 million foreigners have taken refugees in Sudan due to wars and famine in their own countries e.g. Ethiopia, Eritrea, Chad, Uganda etc.

Politically, the country is a republic chosen a federation as governmental structure. The first presidential election in the recent time, has been in April 2010 demarcating a progress in the political transformation in the country in the post-war time. The later is one of the corners of the Comprehensive Peace Agreement of January 2005 that ends the North-South 20 years' civil war. The agreement has also given the Southern part autonomy during the interim period until February 2011 where a referendum will decide on the future of the country as one or independence of the Southern part as a country of t own.



Map of the Sudan: from [right maps](http://www.RightMaps.com)

3.2.Epidemiological Context

The country's overall health panorama is dominated by infectious diseases, problem of malnutrition, maternal and childhood diseases. In northern Sudan the infant mortality rate is

68/1000; maternal mortality rate is 509/100 000 while under 5 year's mortality is estimated to be 105/ 1000. The health indicators may be much worse in war affected areas¹.

Coverage with basic health services is low across the country and extremely scant in some areas of the southern Sudan and Darfur. The federal system in place and decentralization provides another window of opportunity. Greater availability of resources complemented with authority for decision-making at state and locality level will enhance efficiency and better utilization of resources according to local needs [11]. The system is characterized by:

Significant regional disparities in health service distribution, being mainly concentrated in the better off north central states. Also there are urban/rural disparities the available facilities, even in the north, are far below the required numbers. There is shortage of health human resources and professional misdistribution. The health infrastructures are generally weak with insufficient capacity. Free of charge services are offered at the primary level and at hospitals to emergencies and children less than 5 years. Service user fees are pre-requisite for service provision at hospitals and outpatient referral departments. The health insurance covers about 24 % of the total population.

3.3. Health System Organization

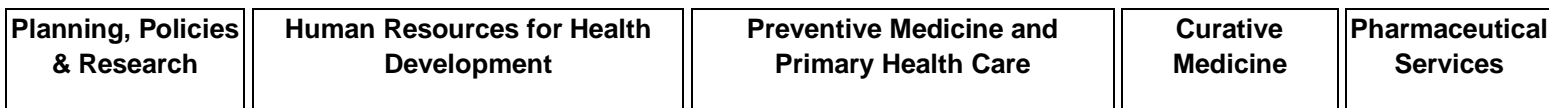
The 25-years strategic plan for health sector describes the health system in Sudan with its 26 State Ministries of Health (SMOH), one in each State, that's a three-tiered network, federal, state and locality. The Federal Ministry of Health (FMOH) is responsible for the development of national health policies, strategic plans, monitoring and evaluation of health systems activities. The SMOH are mainly responsible for policy implementation, detailed health programming and project formulation. The implementation of the national health policy is undertaken through the district health system based on the primary health care concept. At the lower level, the first line services (PHC units, health centers, dressing stations and dispensaries) are administratively under the responsibility of the local council, and technically under the SMOH, while rural hospitals are under the management responsibility of SMOH.

¹ Statistical annual report of 2007 of the FMOH, Sudan

Federal Minister

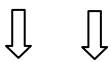
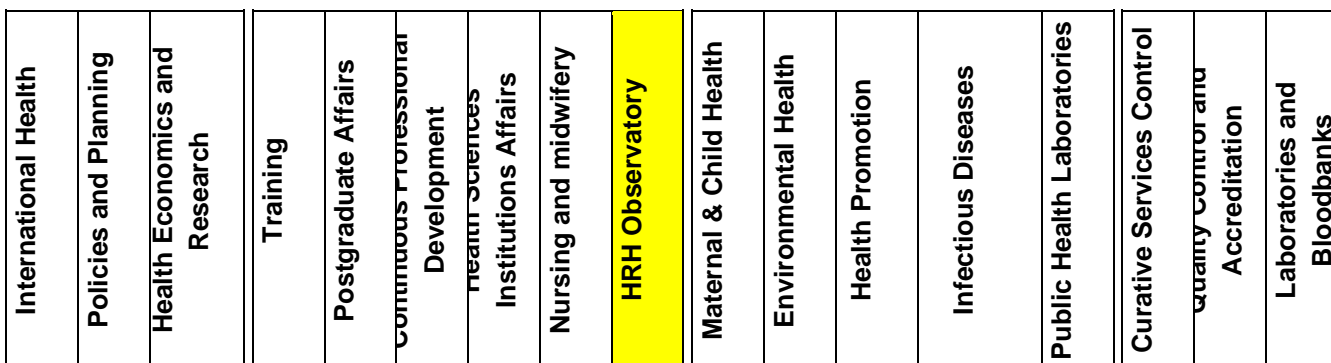
Undersecretary

Directorates, headed by Undersecretary Assistants

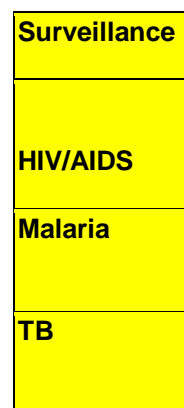


SHHS

Departments, headed by Directors



Sections, headed by a Section Head



Dr. Samah M. Awad, 2008

Adapted by Maria Paalman

Figure 6: FMOH Organization cart

The federal ministry of Health experienced marked reforms in its general directorates during 2002. Even though, its systems are still immature to withstand integration of programs between different directorates. Both evidence based decision-making and collaboration needs to be promoted. PHC was adopted as a main strategy for health care provision in Sudan and new strategies were introduced during the past years, include:

- Health area system in 1989.
- Polio eradication in 1988.
- The Integrated Mother and Childhood Initiative (IMCI).
- Rollback Malaria strategy 2001-2010.
- Basic developmental needs approach in 1997 (15 models in 8 states).
- Safe Motherhood, making pregnancy safer initiative, eradication of harmful traditional practices and emergency obstetrics care program.

Health information system in Sudan

Sudan has a well defined 5 years strategic plan for the years 2007 2011, designed for the purpose of promoting health and development. The plan is designated to detect and control emerging endemic health problems; monitor progress towards health goals and promote equity. Empowerment of individuals and communities with timely and understandable health related information is also emphasised centrally in the plan. The health information system is visioned to mind the gap in information need for policy makers, managers and health personnel in general and evidence based practice and innovation and monitor of scale up efforts [9].

3.4. Local Health System in Sudan

Sudan has undergone several trials for decentralization of health services since 1956; however, little attention was paid to decentralization of health sector. FMOH has introduced the health area policy in 1989 to enhance and promote local leadership among local communities.

Health Areas

The health area system as a policy was adopted by the FMOH since the beginning of the nineties to promote primary health service delivery in all parts of the country, and as the best and most effective system that solves the problems of the health services.

However its application in Sudan was not accompanied by the necessary regulatory laws and rules and the weakness in the applied areas was attributed to:

- *Lack of committed trained leadership and lack of job description and responsibility borders.*

- *Weakness of monitoring and supervision from the federal ministry of health and lack of continuous supervision by the states*
- *Lack of a clear vision regarding the objectives of the health system which resulted in reduction of the administrative and financial support*
- *Community mobilization in some areas was not enough to support this system; it was limited to some isolated PHC activities such as immunization.*
- *In general the weak performance is due to lack of feelings of ownership by the state authorities in addition to weak supervision, monitoring and poor local capacity and the high turnover of the trained staff in the health areas.*

Decentralization

The adoption of the decentralized system in Sudan was faced with many problems arising from the abrupt implementation without prior effective training programs. The qualifications of many of the senior staff at state ministries of health are irrelevant to the assigned jobs. The federal rules, although comprehensive, are not equally understood at the state level, moreover, lack of mechanisms to identify, analyze and solve problems has led to accumulation of many unsolved problems, and there is no system for experience exchange between different states. The main problems with the organizational structures in the governmental health services at different levels are:

- *Rigidity of the organizational structure.*
- *Poor coordination between departments.*

According to Local Government Law (LGL 2003) the locality gained broader political, administrative, administrative and financial authorities and responsibilities. With regard to health, the locality became fully responsible for primary health care facilities and activities leaving the responsibility for rural hospitals for the state ministry of health. The locality became an autonomous administrative level. The responsibility for basic health service provision was decentralized to state and local levels, but the necessary funding transfers from the central government have remained insufficient: basic health services have deteriorated over the past decade, particularly in poorer States and rural areas. The FMOH has adopted a district health system policy, with the goal of promoting, through community participation, the delivery of health services at local level. The initiative was introduced in certain localities in the northern states follows the PHC approach to health care provision. The implementation of the policy has, however, suffered from lack of inputs.

Work is organized across the division of curative/ preventive services; where PHC components and surveillance activities are under the preventive part, HCs and other unit's management and organization is under the curative department.

3.5.Human resources

"The number of nurses and general practitioners has declined in relation to population growth. Evidence indicates that staffing in rural areas is much weaker compared with urban areas. The main reasons are the substantially lower incentives and employment conditions for health care professionals working in rural areas compared to urban areas. Again, rural areas are less well served than urban areas. Recently a marked increase in higher medical education has occurred. The following table is from the WHO webpage on Sudan ([Work force](#)) indicating numbers of the different medical categories in the country

Table 1: Work force in the health sector (WHO)

Indicator	Value (year)
Community and traditional health workers density (per 10 000 population)	2.00 (2004)
Dentistry personnel density (per 10 000 population)	<1 (2006)
Number of community and traditional health workers	5,797 (2004)
Number of dentistry personnel	944 (2006)
Number of nursing and midwifery personnel	33,354 (2006)
Number of other health service providers	21,723 (2006)
Number of Pharmaceutical personnel	1,531 (2006)
Number of Physicians	11,083 (2006)
Nursing and midwifery personnel density (per 10 000 population)	9.00 (2006)
Other health service providers density (per 10 000 population)	6.00 (2006)
Pharmaceutical personnel density (per 10 000 population)	<1 (2006)
Physicians density (per 10 000 population)	3.00 (2006)

The private sector

Government policies in the recent years have encouraged the growth of the private sector. Doctors in Sudan are allowed to have a private practice besides to their work in the public sector. In addition the huge number of doctors produced by the country is among actors helped in this direction. There are 350 general clinics, 300 specialized and 83 operational hospitals.

3.6. Finance of the health services

As overall government expenditure has increased largely due to growth in oil revenues, allocation to health sector in absolute terms have also increased. The main resources for states health budget come from the ministry of finance. It is noted that at best the expenditure of the allocated budgets never exceed 70% (62 % for 2007) and most of it comprise the salaries component. Part of the budget comes from household's direct contribution through user fees or through health insurance premium. The following table is from the WHO [webpage](#) on Sudan

Table 2: Health finance in Sudan, from the WHO webpage on Sudan,

Indicator	Value (year)
External resources for health as percentage of total expenditure on health	6.8 (2005)
General government expenditure on health as percentage of total expenditure on health	37.6 (2005)
General government expenditure on health as percentage of total government expenditure	7.0 (2005)
Out-of-pocket expenditure as percentage of private expenditure on health	98.30 (2005)
Per capita government expenditure on health at average exchange rate (US\$)	11.0 (2005)
Per capita government expenditure on health(PPP int. \$)	20.0 (2005)
Per capita total expenditure on health (PPP int. \$)	54.0 (2005)
Per capita total expenditure on health at average exchange rate (US\$)	29.0 (2005)
Private expenditure on health as percentage of total expenditure on health	62.4 (2005)
Social security expenditure on health as percentage of general government expenditure on health	11.3 (2005)
Total expenditure on health as percentage of gross domestic product	

National Health Insurance Fund (NHIF)

As an insurance institution, it provides potential source of information that shouldn't be forgotten. It was established in 1994 as a social health insurance, now responsible to the Ministry of Social Welfare, Women and Child Affairs. The unit in the system is the household; employee pays 10 % of his/ her net salary to cover their whole household. The formal sector pays a flat rate.

For PHC service, NHIF contracted 530 centers, in addition to the 240 its runs itself. Secondary services are contracted from other providers. This service covers 24 % for all of Sudan.

3.7. The national health information center

The Sudan HIS started as data collection in 1902 serving the invading troops, then documented annual reports in 1921. The NHIC was developed as an end point for the bottom up facility based system in 1955. The NHIC and the Khartoum SHIC, to a relative degree Gezira SHIC, has an adequate infrastructure compared to the rest of the country. The system is financed by both the government and external donors.

There are 1461 health statisticians in the country, where 48.1 % of the health statisticians are employed in facilities in Khartoum state. 84.4 % (266 out of 315) of the country's hospitals are staffed with statistics cadre.

The Health Statistics Technicians training Centre (HSTTC)

The centre was established in 1979 in collaboration with the WHO. The aim is to provide qualified cadre to meet the need in the health system. A course varying between 4-5 month is offered for a class of 35 a year, for both the governmental and the private sector. However, over 60 cadres are graduated from the center; the remaining number of cadre in the country is minimal due to drainage both inside and outside the country. Subjects covered in the course are health, hospital and population statistics, in addition to computer science, epidemiology and medical records, medical terminology. A minimum criterion for admission is secondary school certificate.

Health services provision (NHIC)

Health system organization and management

The country has a three-layered health system: Federal Ministry of Health (FMOH), State Ministries of Health (SMOH) and Locality Health Management Authorities.

Health Facilities Services Provision specifications

Basic Health Units: It's the first point of contact to the society and the health services; it provides comprehensive basic health services. The basic Health unit serves 5000 population Within 5 Km radius or 30 mins walking time.

Rural Health Center: It's the first point of contact to the society and the health services including referral first point. The Rural Health Center serves 20000 population surrounded by basic health units and administratively responsible for supervising it.

Rural Hospital: Defined with a capacity of 40 beds Hospital, and covers a population of 100000 -250000.

General Urban Hospital (Locality Hospital): A secondary care delivery level 200-250 beds Hospital, and covers 500000 populations.

States Specialized Hospital: It provides distinguished specialized services for one of the medical fields. It's a state Referral and teaching Hospital with 100 Beds and more depending on the need to the service and national policy. It covers national as well as population at the catchments area around it.

Urban Health Center: It's the first point of contact to the urban society and the health services including referral first point for rural health centers. It serves 50000 population surrounded by rural health centers and basic health units.

General State Hospital: The State referral hospital has a capacity of 300 beds, and covers state Population.

Federal specialized Hospital: It provides distinguished specialized services for one of the medical fields. It's a national Referral and teaching Hospital with 150-200 Beds serving both the national as well as population at the catchments area around it.

Federal General Hospital: A General referral hospital with 300 beds capacity, and serves the state population.

4. Methodology in Health and HIS research

4.1. Rationale for the choice of qualitative methods

Development and organisation of services, and here health services, demands a continuous inquiry and investigations both at the micro as well as the macro levels to inform policies and practices in the field. It requires dialogue between individuals and groups in order to mind gaps and manage bottlenecks. Taking in consideration users' perspective in Murphy:

Qualitative methods are usually promoted on the basis of their ability to provide deeper understanding of the rationalities (why), process (how) and content (when) shaping patients' interactions with health care services [66].

Where both qualitative and quantities methods has a role and contribution here, qualitative methods are powerful to bring together pieces of the puzzle to reform and improve services. Qualitative health inquiry is powerful in such a way that it achieves both the purpose of exploring depth of phenomena as well as mobilises individuals and communities to participate actively in research programs as a key issue in services' delivery and organization. Lillemor in her book about qualitative methods in public health stated that *"the term "qualitative "has its roots in "qualia", the pleural term of "quale" which means: "the subjective qualities of experiences, here meant human experience, opposite to "qualitative" which has its roots in "quanta" which refers to things that has mass, weight, volume that can be described in form of numbers, and can be localized in space and time"*. The main arguments for distinction between qualitative and quantitative methods can be summarized as follows. Researchers and scientists who follow the scientific paradigm or tradition defended by Aristotle (484-322 B.C) or Dilthey (1822-1911), that is, who classify science either in three different categories or classes (natural science, social science and humanities), or two categories (Natural science and the Humanities), must, by logical necessity, distinguish between quantitative and qualitative methods [67].

Randomization is the essence of quantitative research through selection of a sample from the study population and the random assignment of the sample to the various study groups. Qualitative research by nature is an in-depth study, and for its data analysis, a small selected sample is required. Here the researcher biased by predisposition may affect the generaliseability of results to a big sample of the population. However, when a sample is well defined in this type of research, results could get a momentum of generalization.

The goal of research in HIS should be to establish knowledge about which we can be reasonably confident, and to provide findings that are relevant to policy makers and practitioners. Therefore, decisions about whether qualitative or quantitative methods (or a combination of both) are most appropriate to a particular research problem should be made

on the basis of which approach is likely to answer the question most effectively and efficiently. Malterud wrote that *“Qualitative research methods could help us to improve our understanding of medicine rather than thinking of qualitative and quantitative strategies as incompatible, they should be seen as complementary”* [68].

Qualitative methods are therefore useful in the exploratory stages of a research project, where they will often help to clarify or even set the research question, aid conceptualization and generate hypotheses for later research. Qualitative methods may also be used to interpret, qualify or illuminate the findings of quantitative research and to test hypotheses. Qualitative research is particularly useful to policy makers and planners by providing descriptive information and understanding of the context in which policies will be implemented, such as in the case of integration of HIS, which is the theme of this study.

4.2. Research approaches and methods

A descriptive qualitative study aiming at exploring the fragmented disease and outbreaks system and identify potentials for integration. As explained by Hallberg that *“Descriptive approaches aim at pure description of experiences, uncovering what is revealed in the lived experience, unlike the interpretive approach which aims at understanding of those lived experiences”* [67].

Following the donabedian care framework for organizational and health systems research [2], the following stages will be visited with regard the system; **Structure/ Input:** the attributes of settings where care is delivered, **Process:** whether or not good practices are followed, and **Output.** Here a delicate balance between standardization, procedures and IT technologies in one hand, and the continuous dialogue between care deliverers, management and beneficiaries is decisive for any progress.

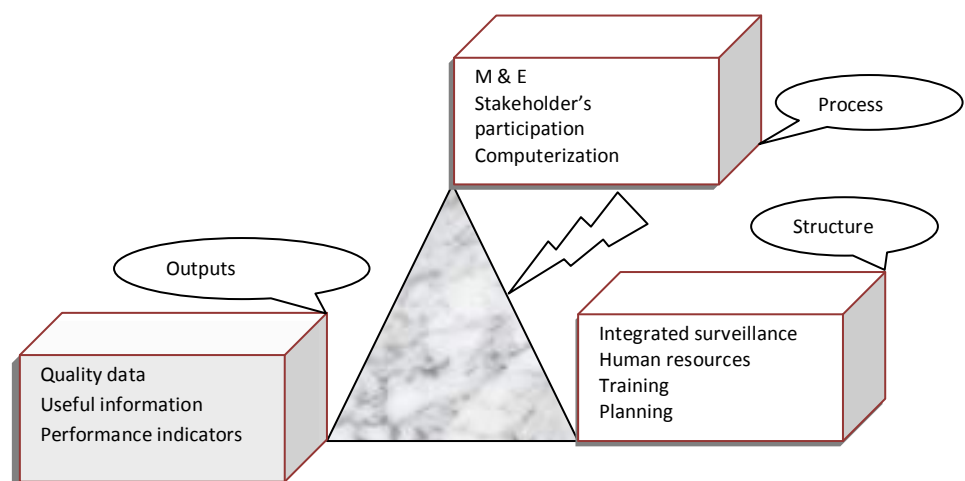


Figure 7: The Donabedian framework and HIS

4.3.Data Collection and analysis

The various methods of qualitative research could have a function to empower this investigation, from observation to participatory methods. Participant observation enables reaching out to difficult groups, and gives textual to observed phenomena [69, 70]. Participatory methods on the other hand are powerful tools to mobilize and empower individuals and groups to engage and learn, about oneself first and about surroundings in the second place. Qualitative approaches, therefore, allows data collection to describe social dynamics and organizational culture. As Gubrium said *"It is by asking people to talk about themselves we generate empirical data about the social world involved in HIS in general and surveillance systems in particular"* [71]. It also provides a range of methods and approaches to empower involvement to formulate and inform a process of describing an organization and hence inform a change processes. Several approaches could be used to complement each other in order to explore challenges meeting surveillance system for disease and outbreaks. Mixed methods merge to describe the challenge of employing different techniques to complement methods in research. Quated in Elske from Greene [72] that *"Triangulation in evaluation in general means the multiple employment of sources of data, observers, methods, or theories, in investigations of the same phenomenon"*.

Therefore, methodological **triangulation** involves a complex process of playing each method off against the other to maximize the validity of field efforts and enables greater accuracy of measurements by using more than one reference [73]. In this study, I tried to make triangulation of data by recruiting participants from different levels of the health care system hierarchy, using the interview guide, with modifications for each level, in order to view the issue in their respective levels. I also did document analysis, group discussions and participated in ----meetings.

Document analysis

Reviewing existing documents and previous assessments is a valuable moment in any type of investigation. It served as an essential part of preparations, but also important in terms of validating findings along the way. As stated by Murphy that analysis of written records has an important contribution to make to our understanding of the processes and consequences associated with new technologies. In addition, documents such as health diaries may provide important data on the implementation of health technologies [66]. One of the tools for this methods is **Rapid Assessment** [74]: Collecting data to describe a situation. Of it principles to conducting a review of secondary data before going into the field, once in the field, the advice is to observe, converse and record. Interviewees/ informants have assisted this task by recommending document to read and analyze.

From the above mentioned a need for a deeper investigation and collaborative visioning for improvements requires a carefully designed research approach to empower and bring about informed changes and improvements. The participation of different professionals' categories is crucial in this process and a safeguard to success. This approach helped me to substantiate my finding that I found from other sources.

Key informants Interviews

The start was through purposive interviews with key informants within Directorate of planning and Health Information Center in order to proceed. Qualitative interview techniques are used particularly in exploratory research, to study the range and complexity of ideas and definitions employed by individuals and groups involved. Following recommendation of Kvale [75] cited in [67] that

A qualitative interview is theme centered, interpersonal, based on assumption on shared meaning, qualitative in nature, descriptive, particular in content, presumption less, supported by minimal ambiguity, able to be altered, sensitive to each person, focused in the phenomenon and a positive experience for all people [67].

Here to start with a round of interviews was the first stage which enabled me to draw the broad picture of the situation and issues of concerns for the different groups and individuals. Alternating, I have started with group discussions in some stages prior to interviews with member of the group.

Here is a summary of interviews and discussion groups I did in the field

Tabell 3: Interviews and group discussions at the different levels

Level	Number	Group discussions	Remarks
National	18	4	
State	12	2	
Locality and health teams	6	1	
Health facilities	6		
Total	42	7	

Group Discussions

As a natural mean of collecting data, group discussion is an instrument that allows free share of views and feeling about a topic of interest, yet in a structural process. I have used this technique on the closing rounds mainly following individuals interviews, me as "moderator" to facilitate, guide and structure the flow of interaction to address the issue of concern, or

issues of concern around the topic under discussion. This technique is not by all means pushing consensus or conformity as thought by many researchers, it enables sharing and opening for change. Minkler concluded in his articles (Participatory Action Research to build health communities), that qualitative methods like group discussion and visionary exercises have great value to promote participation of communities involvement onto research activities [76].

Most of my informants have been part of a discussion group whereby issues were discussed in a bigger audience. This has been useful confirming findings and clarifying complexities.

4.4.Sampling

The investigation started with purposive interviews with key informants from the Department of Planning and Policies and the National Information Centre as the main destination for the research. Then through **snowballing** as a powerful technique I proceeded to locate other informants was employed at all levels of the investigation. Informants were willing to introduce me to others and advice names and positions other times [63].

4.5.Data analysis

Categories are formed from analysis of data abstracted from interviews and analysed documents. Then the four steps of analysis of descriptive qualitative research were followed; from becoming familiar with the data and gaining an overall impression, noting similarities and differences in the statements, determining descriptive categories of conceptions, and then examining the underlying structure of system of categorization.

The primary outcome of both document analysis and interviews, portrayed both in form of quotations, text and statements, as well tables and schemes. Categories carry all characteristics of qualitative research described by Hallberg; showing intentional or subject-object relation, experiential, content oriented focussing on researched issue, and descriptive [67].

4.6.Ethical issues

Here to mention the dilemmas around consent: different from quantitative approach, qualitative search suggests the complexity of getting the consent of participant on an issue yet to explore. However, consent was renewed the whole way under the process of exploration and interviewing into different part of investigations. Among other issues could be the researcher's bias and definition of position on the continuum between observation

and participation along the way in addition to binding to high ethical research conduct defined by research ethics.

Accordingly, a letter of ethical clearance has been obtained from FMOH of Sudan and University of Oslo. Participants were informed about the study. In addition, the responses of the survey were kept anonymous and confidentiality was maintained.

4.7.Limitations

Triangulation of informants from the different levels was employed in order to come closer to a comprehensive picture of the studied situation. However, several factors plays in to compromise findings, among others is limited disclosure from participants from lower levels i.e. localities and facilities as hierarchical power questions. Both qualitative and quantitative interviewing share the same fundamental problem, that they rely upon interviewees' reports and such reports are necessarily constrained by the context in which they are collected [66].

Not always been well informed about the groups for discussion or even interviewees beforehand could also minimize the interaction and thus reduce disclosure and discussion.

Influenza pandemic has been the topic of most of interviews to start with, both as a real time event and as a big happening that explore much of potentials the program investigated has. However, it could act limiting of other sides of the dynamics and activities of the program.

5. Findings and analysis

The findings section is divided into two main parts; document analysis and interviews. The first part is presenting regional documents that influence and shape national plans, review of national plans and strategies in the area of HIS and disease surveillance, and then description of both disease surveillance programs and the facility-based surveillance as main sources of information. The second part include finding from interviews, also starting with a background section of description of sections and functions with FMOH and SMOH Departments.

5.1. Document analysis: Background information

5.1.1. Integrated disease surveillance (IDS) in the African region

A Regional Strategy for Communicable Diseases 1999-2003

Communicable diseases are the most important health problem in Africa and the commonest cause of death in the region. Respiratory tract infections, malaria, diarrheal diseases, tuberculosis, HIV/AIDS and vaccine preventable diseases, and meningitis and viral fevers remain a great threat. However, surveillance and information system in the content are falling short behind providing a measurement of health impacts and make difficulty in evaluation of current disease control programs. Although Sudan is administratively under the regional office of the eastern Mediterranean WHO office, I have chosen to present the African region strategic plan which has been the base for the evolution of surveillance systems in the country. In addition both informants and program documents at the FMOH has pointed the direction of this document as a source of guidance for country plans and strategies.

Summary problems with surveillance systems in the regions that calls for the strategy [77]

- Vertical surveillance systems those were established for each disease control program.
- Failure of health care providers to provide timely report on first case of epidemic prone disease.
- Inadequacy of collection, analysis and dissemination of data at the district level.
- Limited attention that has been given to integrating activities between the different programs and efforts serving the purpose.
- Inadequate attention to evaluation of programs.
- Lack of or limited laboratory surveillance
- Quality of data and reports are compromised.

Strengthening disease surveillance system: an integrated approach

The approach encourages integration of surveillance activities (collection, analysis, interpretation, use and dissemination of surveillance data) at the district level, and ensures both technical and material support for implementation. The strategy assigned the central level; and in particular the surveillance unit to coordinate the implementation of the integrated strategy for disease surveillance. Here meant that analysis of routine data, whereas specialized analysis could be undertaken in collaboration with the concerned intervention program.

The IDS strategy called for the WHO aims to provide national basis for decision making and implementing public health interventions that responds to communicable diseases in an efficient way. The notion is to look at surveillance as a service activity, as a network that improves with collaborative efforts to strengthen each other in; data management, training and supplies. WHO is viewing it as

“Integrated disease surveillance envisages all surveillance activities in a country as a common public service that carry out many functions using similar structures, processes and personnel. The surveillance activities that are well developed in one area may act as driving forces for strengthening other surveillance activities, offering possible synergies and common resources.”

Goal of the strategy

The goal of integrated disease surveillance is to ensure that each Member State has the capacity to define, detect and respond to communicable public health threats. To this end, an integrated disease surveillance program aims to provide:

- Timely, complete, regular and high quality information
- Early detection and prediction of epidemics (early warning systems)
- Objective assessment of interventions during epidemics; and
- Efficient monitoring of intervention programs.

As preparation member states were encouraged to prepare list of priority diseases, minimum data set consensus, and introduction of case definitions.

5.1.2. Guiding principles

- Data collection for action was the basis of the integrated disease surveillance system, implying that only data necessary for action is collected. *This can be achieved and sustained by complying with the overall guiding principles of usefulness, simplicity and flexibility of the system, orientation to specific action, and integration.*
- *Other attributed of surveillance system included acceptability and reliability of data, completeness and timeliness of reporting and specificity and sensitivity of the system.*

- Intensifying in-service training, establishing focal points at the national level for integration, placing computerization system at the central and users interphase at the state and periphery, intersectoral collaboration, community networks and lab capacity in surveillance.
- The frame work strategy places responsibilities to each level in the system, and encourages cooperation and mobilization of resources. Special emphasis was put on commitment of policy makers and all partners to deliver their share of specialty to contribute significantly to success of the strategy.

5.1.3. The International Health Regulations IHR 2005

In recent years has the IDS strategy became a reality in 43 countries out of 46, in addition came the endorsement of the IHR [78], which calls for broadening of the scope of surveillance beyond disease situation and trends, to event-based surveillance at all levels and moving away from pre-set to adapted control measures. During the time of my field work, the communicable disease surveillance program of the FMOH was collecting data for the country assessment with regard to the IHR. The IHR is *"The IHR (2005) implies a paradigm shift, calling for the broadening of the scope of surveillance beyond disease situation and trends; it also calls for event-based surveillance at all levels and moving away from pre-set to adapted control measures.*

Responding to new challenges and increase travel and international trade, the WHO and its 194 member nations agrees to implement the International Health Regulations (IHR), which has the stated purpose and scope to:

"To prevent, protect against, control and provide a public health response to the international spread of disease in ways that are commensurate with and restricted to public health risks, and which avoid unnecessary interference with international traffic and trade." Because the IHR are not limited to specific diseases, but are applicable to health risks, irrespective of their origin or source, they will follow the evolution of diseases and the factors affecting their emergence and transmission. The IHR also require States to strengthen core surveillance and response capacities at the primary, intermediate and national level, as well as at designated international ports, airports and ground crossings. They further introduce a series of health documents, including ship sanitation certificates and an international certificate of vaccination or prophylaxis for travelers.

The IHR faces similar challenges as the IDS strategy of lacking community surveillance, laboratory surveillance, in-service training and improved capacities of cadre among others.

The WHO Country Strategy 2008 – 2013

The strategy described the HIS *“The routine health information system does not cover a large population, leaving substantial gaps, especially for mortality and related indices. The private sector is not covered, and other groups such as the army, police etc. are not linked to the public sector health information system. Only 58% of births were recorded and there is no death registration system. These conditions hinder proper assessment of Sudan’s achievements and progress towards the MDGs and highlight the need for developing a comprehensive health management information system”*.

Strengthen health information system

- Assess the current status of information collection production and dissemination at all levels.
- Develop a proposal for integrated health information systems at various levels in an incremental and phased manner.
- Develop procedures and train staff for developing information as basis of planning and policy development.
- Computerize the information system in a phased approach Improve the registration of vital Information.

Biannum 2006 – 2007

Integrated communicable disease surveillance and control US\$ 948 000 (21.1 %) as compared to US\$ 1.5 million (34.3%) in 2008–2009.

Reduce the high maternal and the under-five mortality rates

- Assist in strengthening existing national surveillance systems to assess mortality and morbidity trends among mothers and newborn babies for formulation of evidenced-based policies and plans to improve conditions.

Develop a consolidated disease surveillance and early warning system

- Develop a consolidated disease surveillance and early warning system.
- Support accelerated implementation of the International Health Regulations (2005).
- Strengthen the existing epidemiological surveillance system, and support the establishment of an early warning system and rapid response system for outbreaks and other emergencies.
- Facilitate the incorporation of the existing different surveillance activities into a comprehensive national surveillance system strengthen the public health laboratory network as part of the communicable diseases surveillance and control system at federal and state level.

5.1.4. Health sector strategic plans and policy

A situation analysis with regard monitoring and evaluation was achieved in the context of the DHSDP in October 2008 at the Federal level with regard to policies, sources of information and capacities. In May/ April 2009 states of Kassala and South kordofan were visited to assess the situation at the state level.

The DHSDP is a project which seeks to immediately improve access to basic health services in South Kordofan, Blue Nile, Kassala, and Red Sea, which have a total population of approximately 5.1 million, by rehabilitation of infrastructure, provision of equipment and drugs etc., while at the same time providing technical assistance in the areas of planning, financing, human resources and monitoring and evaluation, thereby preparing these post-conflict states for further development and reform of their health system [79].

The document gave context for both FMOH strategy and policies documents with regard to both information systems and HMIS and M and E.

The 25-Year Strategic Plan for the Health Sector

The Federal Ministry of Health (FMOH) has produced a 25-year strategic plan for the health sector (2003-2027). The Strategy has eight goals, with sub-objectives, targets and indicators. The Strategic Plan does not contain any objectives for improving M and E as such, nor does it have a chapter on M and E explaining how the 25-year Strategic Plan will be monitored and evaluated.

The National Health Policy

The National Health Policy was approved in 2007 formulates the vision for the future and the mission of the FMOH. It states that *“Reform will be based on solid policies, scientific evidence and a critical analysis of the situation”*.

As statistics play an important role in measuring and monitoring the progress of a country on the road to development, including its achievement toward reaching the targets of the MDGs, the National Health *“Policy envisages designing and implementing a comprehensive health information system; revamping the existing disease surveillance system; conducting household surveys; performing registration of vital events; maintaining patient and service records; and conducting programme-specific monitoring and evaluation. Such a tool, which will also bring the private sector into the system, will promote evidence-based decision-making and enhance the capacity of managers to effectively analyse and utilize statistics”* [11, 12].

The 5-Year Health Sector Strategy

IN accordance with the National policy, it also emphasizes the importance of reaching the MDGs (2007 – 2011), which was not approved before 2007. On the HIS the 5-year strategy states [59]

The HMIS performance is weak, unreliable and fragmented. This was a result of poor administrations of the systems, under funding and inharmonious actions of different players in the health arena. Recognizing these facts, the FMOH has developed a plan to strengthen the Health Management Information System which will be financed through the Health Metrics Network (HMN). The strategy will further expand on this work and provide a Framework for future development.

Unlike the National Health Policy, the plan does not include any specific strategy to improve neither the M and E system nor the HIS. In the chapter of implementation, monitoring and evaluation it states that:

“...The monitoring process will depend on the regular reports of the HIS as well as the reports of the programs and departments. Part of the indicators will be assessed only at the mid-term or end-term evaluations. This will be done through surveys as well as reports.”

Overall assessment of policies and plans [79]

Generally speaking the 25- and 5-year strategic plans for the health sector as well as the national health policy are of good quality. There could have been more synergy between the 5-year health sector strategic plan and the national health policy and some improvements are needed in the internal logic of the 5-year health sector strategic plan. Most indicators of the 5-year health sector strategic plan correctly measure the outputs; have a baseline and a target, but no clear Means of verification (MoV): some sharpening up of indicators and MoV is needed.

The Health Information System Strategic Plan

The NHIC developed a strategic plan document in 2007 [80] based on the HMN assessment. It defines a well-functioning HIS would enable decision makers with multiple benefits:

- Detect and control emerging and endemic health problems and monitor progress towards health goals, and promote equity.
- Empower individuals and communities with timely and understandable health related information, and derive improvement in equality of services.
- Strengthen the evidence base for effective health policies, permit evolution of scale-up efforts, and enable innovation through research.
- Improve governance, mobilize new resources, and ensure accountability in their use.

The strategy stands firm on the rationales of better health information means better decision making, which results in better health, and strong and effective health information system is needed permit adequate monitoring of progress towards MDGs. Besides, decision makers need information to identify needs and problems, assess impact of intervention and to make evidence-based transparent decisions on policy and allocation of resources, and decentralization as a reform and shift in function between centre and peripheries demanded restructuring in information flow.

Challenges and opportunities

- The fact that the system since establishment is a facility-based one not including the community level activities and thus data and opportunities to generate information beneficiaries. In 2009 a proposal was ready for expanding to grass-root level.
- The system is described as weakness when it comes to supervision and monitoring mechanisms, with poor availability of capacities at the state and the locality levels.
- The system is paralleled by vertical programs with own HISs with poor or any coordination and integration
- As information produced by the system are to a lesser degree utilized specially at the state and locality level, the HIS is unable to produce information needed to address both health inequities and health determinants.

Opportunities

- The implementation of decentralization in the health care sector across the country and emphasis on local ownership, local needs and hence the relevancy and information use in resource allocation and management.

- The orientation of the health reform around issues of standardization and quality present a challenge for the national health authorities as how to sew all this parts of the puzzle in order to attain goals.
- Market improvements and technologies, and the availability of experience outside the health system, is an encouraging factor to upgrade and innovate.
- Control of major diseases holistic approach could only be achieved by coupling of the individual health care HIS and the public HISs.
- The increasing demand for the HIS to produce information for evidence based practice, and decision-making, extended recently to evidence-based policy, planning, management and evaluation of health services, to ensure the best used to the limited resources.

Priority areas of the NHIS

The centre and the strategic plan has an overall goal to increase availability, accessibility, quality and use of health information that is critical for decision making at federal, state and locality levels. Priority areas:

- HIS resources; mobilizing extra resources in support of the HIS through political commitment, establishment of partnership with main users, and develop human resources for HIS.
- Data management processes; via establishment of network for NHIS to cover all states, upgrade the electronic data storage, dissemination and feedback practices, capacity building of data management processes at state level, and integration with vertical programs both at national and state level.
- Improvement of capacity, practices, dissemination, integration and use in health and disease records including the vertical surveillance systems.
- Information- based policy, decision making and planning at different levels through active involvement of stakeholders in development of mechanism for information use to achieve consensus on essential health indicators.
- Vital events registration systems though improve coverage of both birth and death reporting at all levels including the community.
- Capacity building in conducting research and surveys to supplement the routine data collection system.

5.2. The Health Information system HIS

The HMN assessment report of the Sudan stated HIS *“is one of the oldest systems in the region. It started as data collection from 1902 in all health units serving the military troops during the invasion of Sudan. The documented annual reports started in 1921, but the central unit in the Federal Ministry of Health was founded in 1955 which then developed to be the national health information centre (NHIC). However it does not fulfill all the required criteria, but the system seems to be well shaped”*.

The HMN report further quantified the system describing it as the *“largest “health data/information” operation in the Sudan”*. Data is acquired through the State health directorates, primarily via periodically filled forms feeding into the National Health Statistics Data Base, after validation, and processing through few applications to produce periodic reports (e.g. with Health Indicators) and to serve Surveillance purpose. A great deal of information use from reports is used rather in research than other purposes. *“These applications are mostly programmed on Access, the Microsoft data-base management system. The resultant reports are usually shared back with the States also on CDs and diskettes”* [8].

Data source

It is a bottom up system which starts from the health centers at the bottom, those units send their reports to the State Ministry of Health (SMOH) where those reports are compiled in a single report and then sent to the Federal Ministry of health (FMOH). *“This system is neither including community based activities; neither does it cover services provided by the private sector”* [8, 9]. Currently the system is health facility based with plans for community based activity in the future. *“The system is further fragmented to by disease focused program demands which often relate to donor requirements and international initiatives directed towards specific disease areas (e.g. malaria, HIV/AIDS or Tuberculosis)”* [8-10]. These programs represent source of data for disease and outbreaks surveillance of the system and send reports to both SHIC and NHIS from respective levels to be included in monthly and annual statistical reports. These programs/ data sources are:

Table 4: Data sources for disease and outbreaks in the Health Information System of FMOH

Data source	Reports
The facility based health data collection	Monthly, quarterly and annually
Communicable diseases surveillance system in Sudan	Daily, weekly and monthly
Malaria surveillance system	Weekly data
Expanded Program for Immunization EPI Information system	Monthly to Federal
The Sudan National AIDS Control Program (SNAP) Surveillance System	Regular reports to the governmental and non-governmental HIV/AIDS main players besides the related departments of FMOH.
The National Tuberculosis Program (NTP) surveillance system	Quarterly and annual.
Epidemiological Health Surveys	

The facility based health data collection

In Sudan the National Health Information Centre NHIC is responsible for the health HIS receiving quarterly and annual reports from the SHICs who in turn receive monthly reports from the localities, who receive them from the health facilities. Even though not all health facilities are regularly reporting to the state level especially health centers, dispensaries and the PHC units. This has resulted in confinement of the reported data from the tertiary level hospitals. Hospitals use a form with ICD-10 classification for categorization of diseases of admitted patients and outpatients. At the NHIC the reports are compiled into national reports, which are sent back to the states. Once a year a meeting is held to discuss the annual reports with the SHICs and each state receives a supervisory visit at least once a year. The NHIC produces a statistical annual report. In this report also data from other sources than the HIS are included, such as demographic data from the CBS, survey data, HRH and expenditure data, vertical programs from other departments in the FMOH. A summary of that would be introduced in this section later. An annotated list of indicators included in the annual report is attached as Appendix I.

<i>Type of indicator</i>	<i>Source of data</i>
Demographic info: CBR; CDR; annual growth rate; natural increase rate; % pop<15; % pop >60; TFR; % urban pop	Census CBS/UNFPA pop data sheets
% of children vaccinated OPV, DPT, Hep B, BCG and measles (per dose)	EPI
Top 10 diseases treated in health units (outpatients)/ 1000 pop and % of total; for Sudan	Facilities statistics

Table 5: Indicators from the annual statistical report of the NHIC

All patients attending health facilities with communicable and non – communicable diseases are classified according to ICD 10, and also includes the medical investigations carried (X-rays, ECG,) and human resources. In most hospitals the statistical work is carried manually as paper based, and computers are used only in referral hospitals, states and federal levels.

The capital state statistical report is produced monthly and includes these types of indicators among others: also see Appendix II.

- Utilization of services (hospitals and HCs) in a comparison between the first halves of 2008 and 2009.
- Malaria cases, admissions and death rates, in a comparison between first halves of 2007, 2008 and 2009.
- Other epidemic diseases like measles, typhoid and meningitis; in a comparison between first halves of 2007, 2008 and 2009.

Table 2: Indicators from the monthly statistical report from the capital State

Number Statistics staff is adequate in 84% of the hospitals and urban health centers, in the remaining health facilities the information work is usually performed by auxiliary health staff. The capacity of the health statistics is moderate as about 60% of them are trained. Training of auxiliary health staff on information is very limited.

The statistics report format are standardized and distributed regularly by the NHIC.

Communication equipments are limited, which affect the timeliness of the information availability. The number of the qualified senior staff especially at the state level is limited which in turn negatively affects the quality of the information collected and managed.

Facility-based statistics as a monitoring and evaluation tool

As an important source of information for M and E activities, facility-based data has been recognized by the (situation analysis document for M and E system) as of great value in particular for intermediate indicators such as outputs and outcomes. Unlike population data provided by surveys and census sources, routine data reflects status of individuals been treated at these facilities, therefore, representativeness is jeopardized.

The analysis states that *“The extensive review of the system in 2007 by the HMN showed clearly that HIS resources, dissemination and use as well as data management are not adequate. The annual report consist of tables, but few summary data and cross-tabulations, analysis is almost absent and no relation to policy and planning. Being not user-friendly, suffering completeness and adequacy in quality usefulness of HIS is questionable particularity at the national users and among potential users”* [79]. Further the analysis explained that

- Vertical programs are having their own information systems, leading most of the time to duplication. Efforts are put during the last years to harmonize work through a common standard format and share of tasks between the NHIS and vertical programs. A manual is prepared for the purpose committed by the WHO and the HMN waiting for funds.
- 90 % of data is provided by hospitals, however, suffering reliability because of diagnosis problems since that is written by non-medicals. HCs and BHUs have a response rate of only 40 %, but still more reliable data as written by medical and treating staff.
- Data from other care providers like the military, police, private sector and NGOs are not included in the HIS.

5.3. National program for communicable diseases surveillance

The HMN assessment report describes the program as: The National program for communicable diseases surveillance is responsible for systematic collection, collation, analysis and interpretation of data and the designation of the control actions/interventions to be adopted. 22 communicable diseases are included. 7 communicable diseases for immediate reporting while 15 communicable diseases for weekly reporting. As a vertical organization, has the division developed from the national health information system to achieve purposes of timely and swift response and communication that is not available for the RHIS. This development went down the system including state and locality levels as well.

Using a sentinel total coverage surveillance system, reports are transferred weekly to the state level by phone and from there to the FMOH; reaching the Minister, the Undersecretary, Director of the Infectious Diseases Department, the NHIC and to WHO. At the national level annual reports are produced by the M and E section of the Epidemiology Department – now called the national program for communicable disease surveillance - that also conducts supervision and follows up on low response rates.

The surveillance system is composed of four levels:

1. The peripheral level with 726 clinical sentinel sites distributed in 18 states. The highest number of sentinel sites is in Khartoum State (150) and the lowest is in South Kordofan State. The number of sites will be doubled in the near future, while the objective is to reach full coverage in the years to come (5).
2. The locality level: supportive laboratory data and epidemiological link.
3. The state level: Diagnostic laboratory services for suspected cases.
4. The federal level: Professional diagnostic for confirmation of the diagnosis.

The situation analysis document for the M and E system amended that: The means of reporting includes fax, telephone, radio and hard copy. Reporting is of high completeness and quality is satisfactory. The program is developing and testing a computerized program for the time being to achieve effectiveness and better covering. In addition, a mobile telephone system has been introduced in phases to enhance coverage and timeliness of data. At other levels, trained personnel were employed in charge of the surveillance system.

Limited dissemination of the surveillance information is encountered at different levels of the health care delivery system. In addition there is no integration with the NHIS. The surveillance information is mainly used at levels of the system for epidemic detection and control.

A draft document (TORs document) of the program gives a description of goal, types of surveillance, and categories of diseases for reporting, in addition description of standard procedures of the surveillance system.

Goals of surveillance

1. Provision of quality data to support decision making in intervention and control measures at different levels
2. Forecast of speed of spread of epidemics and public events in order to take control measures for developments.
3. Determination of factors contributing to occurrence of epidemics or events of disease and deaths.
4. Follow up and evaluation of unexpected event or development of a particular disease and consequences in relation to age and sex.
5. Evaluation and monitoring of interventions and control measures decreasing morbidity and mortality rates.

Types of surveillance

- Sentinel site surveillance
- Lab surveillance
- Community based surveillance

The system is collecting data on 2 categories of diseases

- Category A or immediate reported diseases.
- Category B or weekly reported diseases.

Standard procedures to carry out surveillance and secure quality

Notification: As a first step in surveillance, a series of procedures are followed to both quantify and qualify cases to case definitions in order to determine danger zone. Case definition is used as set of standards and characteristics that should be fulfilled to qualify a case to a particular category; that's to say whether suspected, probable or confirmed case.

Acute watery diarrhea as an example is suspected when a sudden rise water diarrhea without stomach pain, may be followed by throwing out, especially in over five of age. The situation is probable when the above mentioned symptoms are sustained increasing fluid loss and death in case not rehydrated. Finally the syndrome is confirmed by growing cholera cultures from stool sample or rectum sample.

Notification takes place from a sentinel site following standards procedures of who to collect, what to collect of data, when to send and to whom, and the quality assurance procedures that should be followed as doing this.

Verification: Here again are a set of procedures to evaluate a notification and to control false alarms and rumours.

Conformation: at this level a case is confirmed entering the next stage of sampling and analysis.

Analysis: the most deciding level of procedures to decide whether a situation is beyond the threshold and different interventions and steps to undertake.

Report writing: divided into main epidemics report, regular and routine reports, early warning reports and rumours defeat reports.

Declaration: starting from reports are prepared, official bodies and institutions to contact, communication and exchange of information and partners and stakeholders involvement.

Indicators collected are several and disease specific in some cases. As an example the case fatality rate is presented:

Indicator Example

Purpose: measures the quality of case management, detection, and response.

Calculation

Numerator: Total number of deaths reported from a disease causing the outbreak in a given time period.

Denominator: Total number of reported cases from the same disease that caused the outbreak during the same time period.

(Total number of deaths reported from a disease causing the outbreaks in a given time period ÷ Total number of reported cases from same disease that caused the outbreak during the same time period.) X 100 = ___ %

Data Sources: Patient register, case-based reporting forms, and outbreak investigation report.

Frequency: Calculate and monitor this indicator quarterly and annually.

Target: vary for disease to disease that is measured.

The Support functions of a National Program for Epidemics Control

1. *Monitoring and evaluation*
2. *Planning and insure Resources.*
3. *Provision of Standards and guidelines*
4. *Training of cadre.*
5. *Supervision of plans and activities in the states.*
6. *Coordination with stakeholders and partners in all sectors.*

Levels of surveillance in the country

1. **Sentinel site:** as the first and lowest unit in the system and the hierarchy of surveillance, data are collected and sent up the system to the locality through health teams or directly to state in some cases.

Sentinel sites are selected according to set of criteria, including

- Representativeness of localities of a state
 - Coverage of hospitals and centers of high frequency
 - Covering IDPs areas
 - Covering geographical areas of earlier epidemics
 - Covering geographical areas of recurrent epidemics and natural disasters
2. **Health team at the locality level:** epidemics unit at the locality is the nest in the system after sentinel sites, and represents the local and lowest level of health care executive.
 3. **The state level:** administration of epidemics in states is the coordinating body between localities and directly supervising lower levels, in addition to the state laboratory.
 4. **The national level:** surveillance section of the national program for control of epidemics and zoonotic diseases at the FMOH, responsible of follow up of the system in the states in addition to the national central laboratory.

Challenges

- Organizational/ structural
 - A position is taking different and various functions
 - The program is not convinced by evidence-based planning and, and M and E.
 - Lack of process orientation and continuous supervision.
 - Lack of standardization of case management; that's mainly available for meningitis, acute watery diarrhea and influenza, lack of standards procedures.
 - Development at states level is quite restricted due to the fact that the national teams are often taking the responsibility and leadership in times of incidences.

- The national laboratory is a separate independent unit from the ministry.
- Resources
 - Limited resources and in particular donors restrictions.
 - Activities are resources based rather than objectives based.
 - Stability of cadres, especially in the peripheries.
 - Limited training possibilities compared with others in the ministry.
 - Demand of extra payment for sending reports and notifying
- Data management
 - The program has a wealth of data and unprocessed information that is unutilized and acted upon that could be valuable for research and development.
 - There is limited analysis capacity especially at the state level, together with remarkable poor feedback activities.
- Data quality
 - Notifications mistakes
 - Problems with timely sending of reports

Opportunities

- Organization and structure
 - Activation of laws governing notification
 - Intensifying of supportive supervision
 - Coordination with the directorate of Planning and M and E
 - Political commitment
 - Computerization of the data management system
- Collaboration of statistician and medical personnel in surveillance
- The international support and the IHR
- Stability of cadres (at the national level)
 - Selection of resident cadres for the functions of surveillance
 - Interest, locals
 - Active training
 - Carrier

5.4. The state program for communicable disease surveillance

The Department was established in the middle of 1998 following the outbreak of acute watery diarrhea in sections of Omdurman, representing the front line for the SMOH. Following the same goals of surveillance and control for communicable diseases and outbreaks, the Program received both immediate reports from 154 sentinel sites in the state.

The program is caring supervisory activities to both health administrations at the locality level as well as sentinel sites routinely in addition to extra-routine visits in times of outbreaks. The program also cooperates with other vertical programs, importantly is the Malaria Program, PHC and the curative services for disease control and interventions.

Seasonal surveillance

The example of it is the meningitis starting from 1st of February to the end of June; where weekly reporting continued in addition to daily reporting.

Meningitis: the focus is surveillance of meningitis in hospitals and residency areas according to the following:

Confirmation of cases is done through the lab analysis of samples from the spinal fluid – that's available in 20 state hospitals and 4 national hospitals free of charge.

Localities of the state are divided into (86) residential sections of an approximate population density of 30.000 – 100.000 each section.

Consequently each section is having both an ALERT THRESHOLD and an EPIDEMIC THRESHOLD following the standard procedures. Thorough investigation are carried out in case of alert threshold in a section in residential areas around cases, and when epidemic threshold is reached mass vaccination of all from 2 years up over is the target then.

Cases are registered in hospitals with reference to geographical residency in order to serve the surveillance purpose.

Second focus: preventive meningitis vaccination

The program started in 1994 targeting school children and other educational institutions.

5.5. Annual meeting 2009: “Epidemics a thread for public health”

The security dimension and standard procedures was the theme of the annual program conference with the participation of states and partners. The gathering aims were

- Promotion and sensation of public health risks as security concerns both for individuals and the country as whole.
- Presentation of the national and international laws and regulations that govern control of public health hazards.
- Standardization of frames for facing public health hazards focusing on the national program for control of epidemics and zoonotic disease founding for standardized ideology and support both national and state levels to achieve goals.
- Review for the duties and roles of the national program for epidemics control as the front line facing public health hazards.
- Connect surveillance for epidemics at the national and state in a forum to exchange experience and lessons.

Conclusions and recommendations for improvement of disease surveillance were

1. Adoption and auspices of surveillance system for epidemics of high legal, executive and political structures.
2. Improvement of high standards lab surveillance as an effective and swift measure to detect outbreaks and epidemics.
3. Strengthening of basic surveillance capacities in the entry point to keep up with the requirements of the International Health Regulations.
4. Introduction of the epidemics forecasting in the surveillance system as advancement in public health surveillance in collaboration with relevant institutions.
5. Efforts to reproduce and change and activation of laws and regulations connected to public health and threads related to it both at the national, state and local levels.
6. Activation and promotion of tools to achieve legal issues mentioned in point 5.
7. Standardization of capacity building system for cadre of surveillance in the states to cover technical, administrative and skills needed.
8. Deign a standardized training model for service providers; both before starting service and in-service model.
9. Standardization of administrative, policies and strategies and structures, and standard procedures and indicators according to modern international concepts and national priorities.
10. Review of notifiable disease list in accordance with national and international priorities.
11. Importance of involvement of localities in disease surveillance.
12. Widening of field training and exchange of experience to include both the national and the state level.

5.6. Epidemiological malaria surveillance system

The HMN wrote: Weekly epidemiological data including mortality and morbidity for malaria was available from the sentinel sites since July 2001. In general this information is collected and compiled regularly every week. The National Malaria Control receives the weekly data within 2-3 days of the end of the week and sends feed back to under secretary, Federal Minister of health, states ministries of health and state malaria control program at the same week.

The system is well established since the RBM project was launched. Currently the system covered 15 northern states with 200 sentinel sites distributed across the country. At the National Malaria Control office level, weekly data is entered into a computer immediately and contrasted with previous week's cases. Graphs are made and feedback sent to health facilities and states. At the sentinel site level, weekly data is compiled and sent to the State and National level in addition to making graphs, which are displayed on the wall. Weekly reporting rates 70-100% reaching undersecretary of the FMOH and feedback to the states is provided. The weekly number of cases and deaths are compiled at the end of the week and on the graphs. Subjective observation of any increase in the number of cases or deaths relative to the previous week's value is performed. The graphs would have been instrumental for early detection of malaria epidemics if threshold levels accompanied them.

M and E situation analysis amended: *"The **Malaria** program has its own sentinel surveillance sites (some of which overlap with the infectious disease surveillance sites). The program claims that all health facilities report to them. In order to generate such a high response rate they use both supervision and negative incentives such as withholding ACT malaria drugs or salary of staff, if reports do not come in. Reports are only shared with the NHIC once a year. They are aware that there is duplication in information collection between the program and the general HIS, which also includes data collection on malaria, and are also aware of the new manual. They organize regular feedback through reports and meetings and some states are starting to use the data for their own planning" [79].*

5.7. The National Tuberculosis Program (NTP) surveillance system

Described by the HMN report; The NTP surveillance system is organized according to the IUATLD guidelines. Patient information, diagnosis, treatment regimen and compliance are registered on patient's treatment cards. Data regarding diagnosis, smear results, outcomes, place of treatment are registered on the tuberculosis management unit (TBMU) treatment register. Laboratory results of sputum examination per patient are registered in the laboratory register. Quarterly reports are compiled by each TBMU and forwarded to the state coordinator. The data is then compiled and forwarded to the NTP. The NTP is responsible for summarizing all case finding, treatment outcome, and analyzing data. The system of reporting is paper-based and some of TB management units do not regularly report to the state coordinators especially in the war-affected areas.

The program routinely collects 11 indicators from the 300 TB management units and 900 DOTS centers for which they have a data dictionary. These indicators are used to report both to the FMOH and the GFATM. They quarterly send info to the NHIC. The program seems to be somewhat more integrated into the FMOH than the HIV/AIDS and the malaria programs. At the states level, taking the state of Khartoum as an example, there are 52 diagnostic centers. Data are collected in 4 formats; TB registry, vaccination registry, registry for targeted and a registry for surroundings and encounters of patients. The program is well established producing monthly reports collected from centers, through the health teams of the locality to the state office. The state office is composed of 6 staff members. The program has a supervisory structure where centers are visited by both localities monthly and the state office every 6 month.

5.8. The Sudan National AIDS Control Program (SNAP) Surveillance system

The HMN report wrote; The SNAP surveillance system is composed of two components: the first component includes: 32 ANC sentinel sites covering both the ANC attendants in the general health facilities (29) and the refugees and internally displaced peoples (3). The second component of the system is HIV/AIDS/STIs cases reporting: From the National Health Laboratory and 15 SNAP state units. Thus the contents of the two components cover the HIV/AIDS and the major sexually transmitted infections. The Federal surveillance unit issues registered cases in quarterly annual reports.

The **HIV/AIDS** program has an own HIS with data sheets for each of the 65 indicators that they collect data on in the health facilities – only 11 are reported to the FMOH, a separate HIV surveillance system (in VCT and PMTCT centers) and they conduct sero-surveys among pregnant women.

5.9. E P I Information system

The program has trained focal persons in most facilities they are operating carrying out the duty of reporting and systematically commutating with the headquarters of the program. A typical story of development, that both due to donors need for information and at the same time the lack of trust into the RHIS to deliver. The EPI together with nutrition, reproductive health, IMCI and school health, are in an initiative to integrate and to benefit from the model of the first as both a well functioning HIS and M and E system.

Data collected monthly in EPI information System Include:

1. Coverage data telling number of vaccinations given in each age group.
2. Data about completeness and timeliness of reports.
3. Data about vaccines received during the month, used, and vaccine wastage rate.
4. Cold chain functionality and equipments failure and the data it stopped.
5. Vaccine preventable diseases surveillance data; cases, deaths, age group, vaccination status per locality.
6. Data used to monitor implementation of micro-plans: Implementation of planned immunization sessions, defaulter tracing, non functioning fixed sites and the cause, Implementation of monthly meeting of state immunization officers with their locality officers, planned and implemented immunization vehicles activities.

All these data are collected in specific forms to form the monthly report.

Data source	<i>Dissemination</i>	<i>Integration</i>	<i>Use</i>
Facility based statistics	Facility level three copies of the reports are produced, State: produced limited number of quarter and annual reports. Federal: produced an annual report - widely disseminated. Despite health information is incomplete; it is available at all levels for all users and researchers.	PHC level: No integration with vertical programs. State and the federal level - some integration. Lately there are promising efforts with vertical health programs at the PHC level concerning integration which will be applied soon.	Research work – widely used by institutions. Health administration and planning - limited at all levels.
Communicable disease surveillance	Limited dissemination of the surveillance information is encountered at different levels of the health care delivery system	No integration with the NHIS.	Information is mainly used at levels of the system for epidemic detection and control.
The national tuberculosis program (NTP)	The information is not included in the state and federal annual statistical reports. Due to incompleteness of the data at both the state and federal levels, dissemination limited.	The system is not integrated within the HIS at both the federal and state levels.	They are used regularly for monitoring and evaluation. Limited utilization of surveillance information.
HIV/AIDS national program	Reports to partners and feedback during regular meetings. Copies of these reports are available for media and researchers on demand.	The system is not integrated within the health information system at both the federal and state levels.	The usage of the surveillance information is limited. SNAP and the concerned UN agencies are currently the main users of the surveillance information for improving the interventions.
EPI	Data is presented informs of graphs, charts, and maps are used. Feedback; monthly to states, annual administrative reports, and monthly meeting Localities and teams.	Immunization information system is vertical and there is no integration with the national health information system at any level.	The use of data is limited for the program purposes.
Malaria surveillance	Data is send to the undersecretary of the FMOH	The program is vertical with minimal integration with the NHIS.	Widely used at the different levels of the programs for feed-back reports, monitoring, evaluation, planning and early epidemic detection.

Table 6: Dissemination, integration and use of data across disease surveillance systems

5.10. Other data sources

Research: Research relevant to policy and planning – which is important for evidence based practice is not well developed yet. However, it is a low-prioritized source for information and lacks adequate funding and resources, as well as weakness in areas of coordination of the research activity at the national level.

Other: The private sector as health provider is growing rapidly in Sudan. However, the magnitude of the health services provided is unknown. The same is valid for information available about NGOs as providers of health care services; regarding their plans, budgets and areas of working.

Census: As a door-to-door study, a new census was carried out by the Central Bureau of Statistics (CBS) using a short questionnaire for all residents, amended by a longer one for a sample of 10 % to cover other related areas like disability, educational level, marital status...etc.

Vital statistics: Unlike the census which is done every 10 years, vital statistics derived from birth and death registration is important indicator for reliable estimates. The Sudan Civil Registration Organization (CRO) established at the Ministry of Interior in 2001 function as a pool for registration of vital events in the country. It costs 15 Sudanese pounds for birth certificate, among others represented obstacles to achieve higher coverage and completeness.

Surveys: Demographic and Health Survey, among most important surveys, are nationally-representative household surveys that provide data for a wide range of monitoring and impact evaluation indicators in the areas of population, maternal and child health, nutrition, HIV and malaria. The rationale behind conduct of national surveys is to generate the information needed to fill the gaps of the information routinely collected through the health information system.

The HRH Observatory: Supported by the WHO to set up a national observatory of human resources at the FMOH since end of 2007, the data base rely on data from HIS, private sector, police and military.

Facility mapping: In mid 2008 the department of Health System Strengthening at the PHC Directorate of the FMOH conducted a survey covering the 15 northern states registering infrastructure like equipment, water, electricity, transport and communication. Gaps and shortages are measures against the set of standards.

5.11. Health information system in disasters

Draft document from the International Health Section, FMOH November 2006.

Information for evidence based planning and evaluation is by far the most central in most programs for the time being. The department of disaster at the FMOH is no exception. Acknowledging other information systems serving the FMOH like the routine HIS, vertical programs, surveillance system early warning system at the Ministry for Humanitarian affairs, WFP early warning system with regard to food situation, UN-OCHA following humanitarian interventions, Centre for Research of Epidemics in Disasters CRED, the department is founding its own system.

The department was established in 2003 concerned in the first place about situation of floods in the country in cooperation with civil defense and Ministry of Water and Irrigation, and recently with the health hazards situation in Darfur region.

The department adopted the structure from the articles of Maxwell and Watkins from 2003 **Humanitarian Information Systems and Emergencies in the Greater Horn of Africa: Logical Components and Logical Linkages** [81]. The department of international health has also used experience gained in the field from neighboring countries and organizations like the WHO.

The model has 7 components:

1. Basic analysis for susceptibility: aiming at determining geographical areas of high susceptibility; population and categories most vulnerable, as well as identifying resources available to utilize.

WHO has a set of indicators for stipulating dangers and hazards a flood might represent:

- a. Probability of flood
- b. Area expected to be covered/ affected.
- c. Time frame for the flood.
- d. Ability to control and manage the flood.

Information is needed about demography of the area, source of drinking water sewage system, building, human activities and relations. Maps are drawn showing all that in order to allocate resources and anticipate moves and fluctuations. The GIS is the tool basically to enter and update this information to use when needed.

2. Early warning system: as defined by the ISDR, 2003 is “the provision of timely and effective information, through identified institutions, that allow individuals exposed to a hazard, to take action to avoid or reduce their risk and prepare for effective response. Early warning systems include of three primary elements (i) forecasting of

impending events, (ii) processing and dissemination of warnings to political authorities and population, and (iii) undertaking appropriate and timely actions”.

The system is supposed to:

- a. Endemic and epidemics diseases could be evoked by flood in the particular geographical areas and its surrounding.
- b. Register and follow up water levels in the arteries of concern.
- c. Whether forecast and dynamic changes of importance to stipulations.
- d. Health care delivery institutions in the region.

Partners

System requirements

- Central coordination unit at the FMOH concerned with decision-making and feedback to the states, and similar organization in the states.
 - Human resources, trained for the purpose.
 - Communication mechanisms; telephones, radios, fax, computer.
3. Assessment of urgent needs: in coordination with other programs there's a need to assess the quantitative need in order to provide correctly and mobilize sufficiently. All demographical information, health care deliver, referral service, water and sanitation, environmental health, prevention of communicable disease, availability of emergency medications, number of falling residences, death and rates of utilization of available health care services.
 4. Programs' follow up
 5. Assessment of effects: measuring the effects compared to aims. There's a tendency among humanitarian organizations to let evaluate interventions depending on the urgent need for deployment. It is highly important to monitor health status of population groups affected by the flood in this example, however.
 6. Follow up of surroundings: an additional component is added to those of early warning system and that is the capacity of affected community to regenerate and cope with the situation. In Darfur regions, emergency coordinators are filling three particular forms for that purpose including security situation.
 7. Evaluation of the program and lessons learnt: here meant both positive and negative effects of interventions. A 3-5 years period for survey and these types of rounds is the trend.

5.12. Sudan Health Information System: assessment

The NHIC in collaboration with the Health Metrics Network achieved an assessment report in May 2007 that gives well over-view of surveillance programs and their information systems. National communicable disease surveillance program and Health Information System HIS are the data sources I worked most with, therefore, more details are included analyzing other documents of relevant to them in this thesis.

The report represents a fresh assessment of HIS of the FMOH and mild-stone in the configuration and further adjustment towards more efficient data operations and evidence based practices. It summarizes sources of information feeding in the NHIC and the annual report, as well as giving an overview of the impression of the national HIS system [8].

- *The use of information in setting national resources allocations, setting resources allocations in the annual budgets and use of information to advocate for equity and increased resources for the disadvantaged groups and communities is poorly practiced at different levels of the health care delivery system especially the state and locality levels.*
- *The data management processes for collection, storage, analysis and distribution (through centralized electronic depository) showed marked limitations and insufficiencies.*
- *Practices, dissemination, integration and use. It is observed that there are about 7 vertical surveillance systems designed within the national vertical programs for data collection, analysis and information products specific for these programs. Integration of reporting for disease surveillance is important to reduce the burden for those completing and those reviewing the reports. As well integration may increase the opportunity for use and dissemination of the reported information.*
- *HIS institutions, human resources and financing are present but not adequate and this is reflective of the limited resources available for the HIS especially at the state and locality levels.*
- *Integration with the national vertical programs is limited and this negatively affects the data –base integrity, the overall quality, the effective utilization of the available information in policy formulation and decision making.*

A recent situation analysis with regard to establishing a monitoring and evaluation plan for the system has characterized the HIS by:

“Weakness of monitoring and supervision, low availability of registration books and formats, system based upon health units with minimal use of the information at the community level, problems with timely sending of reports, poor local utilization of data, lack of feedback systems. In addition the system is paralleled by a number of vertical health information systems without clear coordination and integration. Not the least basic and continuous training is missing, and programs for statistical clerks are inadequate.”

5.12.1. Death Certificate: guidance document in registration and issuing

National Health Information Centre has produced a document targeting training purposes for health personnel as well as an education tool for undergraduates in the different medical specialties and para-medics, treating standardization and internationalization gaps. Crucial indicators of death registration could offer main reason causing death in a community, and death in different age groups and sex distribution, and which causative diseases in each. Death indicators are considered by statisticians and epidemiologist as an opportunity to render better health care offer and organization. In addition to the value of analyzed, extract of information on treatment, prevention and rehabilitation component of health care would be valuable for health planners, clinicians and health care providers in general.

In Sudan data on death is restricted to a greater extent on cases taking place in hospitals, which is at the same time lacking precision and accuracy in diagnosis and fulfillment. Medical personnel, even doctors are lacking the necessary training into filling of death certificates and death reasons. Standardization of diagnosis codes is yet another challenge facing not only the registration of death, but also the whole health information as whole.

Death certificate is considered as an important that it document for death occurrence at the first place, then with regard to legal issues related to death, research and study purposes, as well as an important source for health planners deciding causes of death. Studies showed that only 6-10 % of death is registered in the country, and that is crudely death cases from hospitals registered voluntary from the side of doctors without obligation. This low rate of registration could be attributed to both lack of guidelines on who and how doing though there's a law in place, regulation for burring and grave yards, lack of organized channels to register death in the community and outside institutions, and fear of doctors of registration and legal consequences in case of investigation. According to regulations death certificates are to be written by consultants or registrars. However, practices showed that it is doctors during their internship are the ones issuing that, to times confirming with their superiors whether or not death was natural. Cause of death is often copied from medical records as disease or situation a patient was treated for. Other cases that requires post-mortem are; accidents, homicide, suicide, poisoning, disaster, violence, sudden infant death syndrome, suspicious circumstances, during anesthesia, sudden and unexpected death. Criminal cases are to be abducted filling form 8, when other cases require consent from families and relatives.

The new certificate following the international standards includes personal data, cause of death, and disease or condition leading directly to death, antecedent cause: morbid condition if any given rise to the above causes, stating the underline condition last, and other significant conditions contributing to the death, but not related to the disease or condition causing it.

5.13. Communication and IT technology in surveillance and routine health information

5.13.1. Mobile phones network

The mobile phone network is a recent development at the program of communicable disease surveillance to cover

1. Sentinel sites (Permanent)
2. Health teams at the level of localities
3. States
4. The national level
5. Intervention teams (temporary)

Level	No. Of Phones
National	10
States	45
Localities	140
Sentinel sites	895
Total	1.100

The advantages of this program are among others; stability and regularity in information flow, reduce cost, operating in a closed circuit, and possibilities for collective messages and feedback. However, there are challenges like ownership of states, finance, stability and technical development.

5.13.2. Computerization

Epidemics network project

Level of connectivity between the national and the state level

The advantages of which are among others; stability and flow of data, reduce costs, closed communication network, simple support, operation and follow up system, possibility for common SMS both alert and feedback, control over expenses and potential for development.

Internet communication

- The program has three axes; notification reports and follow up of plans.
- Web-based.
- Accept development and upgrade.
- Secure.

Mode	National and state (%)	State and locality and other levels (%)
Paper	-	1.9
Radio	13.3	3.0
Fax	60	0.0
Phone	86.7	18.8
Mobile	100	76.3
Internet	86.7	-

Advantages; storage memory keeping both numbers and emails for notifications, facility to have quality control system, capacity to send all possible types of data, improvement of documents, swift exchange of data, storage of data, practical when at the field, data quality and connect the system all the time.

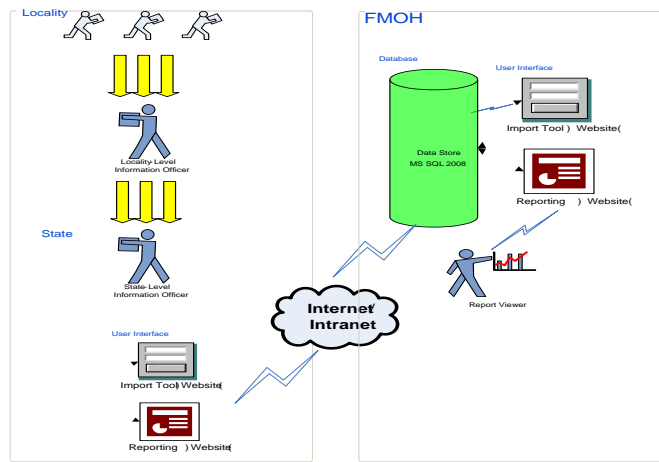
Challenges; power supply, connectivity, protection of data, private use, high primary and maintenance cost in the early phase, training, hardware, maintenance and provision to lower levels. Phases; first is to connect states with the national level, then to include localities.

The network will also give possibility for application of the electronic epidemic surveillance, simplicity and swiftness of data transfer, control and lowering of expenses, video conferencing.

The website

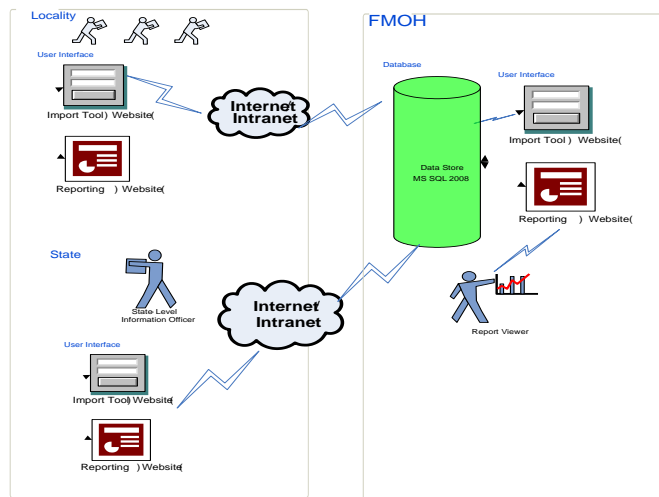
Phase 1

Is to connect states to the national level.



Phase 2

Is to connect localities to the network.



Conclusions

- ✚ Creation of data base, information exchange and institutional memory.
- ✚ Easiness of analysis, determination of governing relations and thus effective interventions design.
- ✚ A step towards standardization of performance.

5.13.3. Dashboard Proposal of the NHIC

The NHIC has developed a document proposal for a dashboard as advancement in the information dissemination and promoting for use in evidence-based planning, monitoring and evaluation, and management[82]. It is a user-friendly interface that somewhat resembles an automobile's dashboard; organizes and presents information in a way that is easy to read. It is by means of dashboard in information technological world the WHO six building blocks of a health system could monitor performance which are; governance and leadership, finance of the health system including financial risk protection of the served population, the human resources, information, medicine and other service technology and service delivery.

The proposal is to cater for the governance concept that is defined by the WHO is participatory, consensus oriented, accountable, transparent, responsive, effective and efficient, equitable and inclusive and follows rules of law. Data for monitoring the health workforce are generated by a variety of sources: national population censuses, labor force surveys, health facility censuses, professional registration databases, civil service payroll databases and the staffing reports submitted each month or quarter by each health facility or district. Each of these data sources has its particular strengths and limitations.

Measurement of rules-based health system governance indicators will, in most cases, rely on both expert analysis of available sources and expert judgment. In the case of outcome-based governance indicators, however, these sources will need to be supplemented with other data sources, such as facility surveys, public expenditure reviews, or client assessments. Among other administrative records Health facility surveys and assessments, national financing data, public expenditure tracking surveys (PETS), public expenditure reviews (PERs), and population-based surveys.

Dashboard indicators: The document divided indicators into groups, see Appendix V and VI

Group 1: TB indicators

Group 2: Population indicators

Group 3: Mortality indicators

Group 4: Financing indicators

Group 5: Human and resources indicators

Group 6: Morbidity indicators

Group 7: Service indicators

Group 8: Safe water and sewage disposal indicators

5.13.4. Data Ware House: Feasibility Study

Commissioned by the FMOH, the Geo Space Foundation 2009 carried out a feasibility study for data ware house producing a document called “Functional Specification for the Sudan Data Ware House”. It describes the current mode of collection, processing and presentation of data and information as beyond expectation and satisfaction. Data are collected manually at all levels filling forms of excel sheets, compiled first at the locality, and then at states and then feed on the pool of the Federal National Information Centre. The later produced quarterly and annual statistical reports of health indicators, and surveillance data.

Further the study appreciated the progress of the computerized program that the IT department at the FMOH is preparing to launch on all states for the purpose of systemic, timely and quality data collection, processing and dissemination. The program was according to report was supposed to start working on February 2009. Mr. 2 scenarios for application for the purpose were proposed:

1. The fist; is to deploy at both the locality and the state, where data collected at the health unit are compiled at the locality and entered into the application, the same step is to take place at the state level and then be viewed at higher level as well at the subsequent levels with access to the webpage of the program.
2. The second scenario was to deploy the application from the state level only and server at the national level.

In order for the Data warehouse to realize its full potential Internet access is required between Locality and State if the application deployed at locality level. Internet access is also required between the states and the NHIC.

The table below lists the hardware and software requirements for each user of the system. Rather than list specific hardware requirements, only the software that needs to be installed on the relevant computers is listed, and the hardware requirements may be obtained from the relevant vendor as they change with time.

User	Requirements
State and Locality Information Officer	Internet Explorer v7.0 or higher
NHIC Statistician	Internet Explorer v7.0 or higher
NHIC (Server)	MS SQL Server 2008 Express or Standard Internet Information Server v6 or higher MS SQL Reporting Services
Reporting User	Internet Explorer v7.0 or higher

Users of the ware house are to interact with the data ware house through means website with users name and passwords specified with the function of the particular level. The website could be the same or different of that carrying the data ware house hosted at the NHIS.

A high critical risk was foreseen by the developer of the plan is that the completion of the system reaching out to all states. A critical risk is the state as responsible for the hard or software and maintenance of data. Two medium risks were anticipated; the fist is the internet connectivity and availability, the second is the IT personnel competencies and capacities. The later was considered optimum at the national level and represents a satisfactory platform for the start with emphasis on training on the new technology to implement.

5.14. Result-oriented Monitoring and Evaluation Strategy Health Sector 2010 – 2016

Document: Result-Oriented Monitoring and Evaluation strategy Health Sector 2010-2016 [83]

Sudan like other countries has moved from input-oriented planning to result-based planning, budgeting and management. This is motivated by the fact and the experience documented that assessment of achievement with regard to objectives won't be attained only by monitoring inputs into system such as infrastructure, equipment, drugs and human resources. Being evident that inputs will lead to desired results, results-oriented M and E system and good practice have the potential to reinforce evidence-based planning, improve performance of the health sector in general. Quality of data and timely relevant information therefore produced by this system is crucial for decision makers.

5.14.1. Achievements and challenges for M and E

Monitoring of 25-years Health Sector and National Health policy and plans is not done systematically. There's not unity between the states in this prospect; where some are monitor and evaluate the 5-Years strategy on the state level, others develop their own 5-years strategic plan on the basis of the national one.

Many of health indicators are calculated in rates and ratios; infant mortality is indicated as number of infants that died per 1.000 live births per year, and number of medical doctors is often represented per 10.000 population. The situation is challenged by the poor registration of vital events (birth and death) across the country which is crucial to produce correct denominators at the different levels; the locality, state and at the national level.

Information on monitoring of health status is provided by the HIS, the surveillance system, monitoring system of vertical programs, and the Sudan House Hold Survey (SHHS). The HIS provides a wealth of data, however, little processed and analyzed and hardly related to policies and planning. 90 % of the data is provided by hospitals, though quality is questioned due to the fact that diagnosis and treatment is recorded by non-medical personnel. While data from HCs and Basic health units (BHUs) with a response rate of only 40 %, reliability is considered good. The system is weakened in addition by the fact that other health care delivery agencies like the military, the police, the national health insurance and the growing private sector are not included.

Monitoring of inputs is carried out in separate exercise for human resources, infrastructure and equipment, and for drugs and supplies. A survey was carried out in 2006 mapping human resources, later data been transformed into the what is known today "The observatory" that is a database recording issues with relation to human resources, across health agencies

including the private, military and the police. Facility mapping was an exercise carried in 2008 by the FMOH, shortages and gaps were accessed in relation to the basic set of standards. Drugs and supplies are reported monthly from faculties and ordered when shelves are empty.

Opportunities

- The HIS as an instrument that could provide better with better management.
- The national statistician institute that could offer more advanced courses in data management to the already existing capacity of technicians.

The M and E system

The system has a vision to provide information that is reliable for planning and decision making. A fully functioning M and E system would assess the achievement of health sector objectives and inform result-oriented and evidence-based planning, priority setting and management at all levels.

Strategies to improve the M and E in Health Sector

Objective 1: Improve the M and E system in the health sector

- Build a partnership with the CRO to improve the vital registration system; abolishing registration fees and promoting engagement of personnel at all levels.
- Institutionalize and expand the Sudan Health Household Survey to be repeated every 5 years; around mid 2011 towards the end of the 5-years health strategy, and in time to inform discussion for the strategy 2012-2016. Questions will be expanded to cover non-communicable diseases, injuries accidents, as well as questions to on client satisfaction with health care services.
- Pilot a sentinel network of primary care providers to collect data on disease rather than collecting all patient-related data from all facilities. A pilot in Khartoum and Blue Nile state using the International Classifications of primary Health Care ICPC-2, 2003, and state of Kassala will act as a control by making special efforts to complete HIS. Non-clinical data will be taken care off as (performance-based) funding by vertical programs or localities.
- Monitor inputs for all PHC health facilities and hospitals against set of basic standards initially through facility mapping, and later through making use of GIS.
- Improve quality of M and E indicators at all levels from all sources
- Increase the use of research as an information source for M and E; by allocating at least 1 % of its budget and encourage postgraduates to design research in accordance with priority areas.
- Improve completeness of information by including all providers in M&E/HIS systems through engagement with other health care providers like the police, military and the private sector.

- Scale up the soft data flow from the field to the locality and state level; mobile phones used by the surveillance system already, RapidSMS by the UNICEF, and mobile wireless broadband.
- Conduct mid-term reviews and final evaluations for major programs and plans.

Objective 2: increase utilization of information generated by the M and E

- Institutionalize utilization of information within the FMOH; weekly Undersecretary meeting, and a quarterly meeting including others like police, military and the NHIF and donors, in addition to an annual meeting involving all stakeholders.
- Institutionalize supportive supervision on data collection, analysis and utilization at all levels of the health system; through organized visits and feedback mechanisms.
- Produce and distribute an accessible FMOH (bi) annual report.
- Produce and distribute overview of completed studies in Sudan.

Objective 3: Build M & E capacity at federal, state and locality and health facility levels of the health system

- Ensure that the M and E Section of the FMOH has the authority and capacity to fulfill its mandate and responsibilities
- Ensure well coordinated and efficient data collection from all sources through the establishment of the “Information Council” within the FMOH. The council will include the NHIS, vertical programs the HRH Observatory, health economics and research sections, as well as the M and E department.
- Build M and E capacity at state and locality level; 2 full time positions at the state and one at the locality level.
- Ensure institutionalization of and sustainable funding for M and E activities at all levels.

5.15. Interviews: Background information

This section begins with background information on the different programs been mentioned during informant's interviews.

5.15.1. WHO HIS and surveillance system

The information unit is providing information to different departments of the office, and reaching out with assistance when needed. Darfur is the major focus for the WHO operation and field assistance for the time being, targeting both IDPs and non-IDPs. The work is structures through states' representatives who collect and compile; from one state hospital and 5 rural hospitals in the region. Reports are sent to the central information unit which carries the task of information dissemination within the organization. Main users of that is the IHA and others on ad-hoc basis.

The surveillance system collected general data, work load on the different department of the hospitals, death details in different departments, pathological diagnosis, injury/ trauma details (gunshots ...etc), and surgical operation details. Information processes through the system is then used for fund raising, M and E activities, and identifying gaps. This process is complemented with field visits and follow up to mind gaps and improves flow.

5.15.2. The state Tuberculosis Program (NTP) surveillance system

The program routinely collects 11 indicators from the 300 TB management units and 900 DOTS centers for which they have a data dictionary. These indicators are used to report both to the FMOH and the GFATM. They quarterly send info to the NHIC. The program seems to be somewhat more integrated into the FMOH than the HIV/AIDS and the malaria programs. At the states level, taking the state of Khartoum as an example, there are 52 diagnostic units serving patients referred from other centers lacking the service. Data are collected in 4 formats; TB registry, vaccination registry, registry for targeted and a registry for surroundings and encounters of patients. The program is well established producing monthly reports collected from centers, through the health teams of the locality to the state office.

The state office is composed of 6 staff members. The program has a supervisory structure where centers are visited by both localities monthly and the state office every 6 month.

5.15.3. National Programme for control of Epidemics and Zoonotic Diseases

National surveillance division

Surveillance division

The table down shows number of units for each level by 2009, and future expansion plans.

Level	Number	%	Aim
National	1	100	1
State	15	100	15
Locality	22.5	31	138
Sentinel sites	837	36.1	2321

Involvement and activation of localities in the surveillance system in order to take responsibility from the state, achieve goals of decentralization, improve interventions and response, and helps identify needs and new sites.

There are other data sources outside/ not covered by the surveillance system; example of which is health institutions not covered with the current system, NGOs – both national and international, community (rumors), health institutions in neighboring countries, security institutions, mass media, community political and social leaders, and academic institutions. Therefore, expansion priorities are to cover localities, health facilities of high frequency, areas of historical recurrent epidemics, and areas of potential epidemics (disasters, camps, and security conflicts, high density populated areas, entry points and borders.

Specification for surveillance cadre are basically training basics of surveillance at minimum, acceptance of the duty to notify as part of his/hers post, resident in the area, and local knowledge of the area.

Reports and notification are met with several challenges among that late notification, incomplete reported data, not binding to notification channel, incorrectness of notification, demand of incentives for notification, lack of patient journals and records, and political obstacles leading to delay in notification/ reporting and limiting it.

The programs is aiming for better quality through measures among them is complete and accurate analysis, improvement of archive, simplify of the system, possibility to exchange information efficiently, and trained and committed cadre.

Surveillance system of the FMOH was one unit earlier, called the epidemiological department. The divide happened when donor's funded programs established, more disease-focused, with own needed for information and reporting systems. However, the system is still collecting data on diseases that they are taken care by the vertical programs. So the discussion during the recent annual meeting recommended upgrading of the disease list.

National disease control division

Major responsibilities of the section are enhancement of surveillance activities (supervisory role), and case management – achieved in collaboration with the department of clinical medicine, in addition to the co-responsibility of logistics and vaccines in collaboration with the logistic and supplies division. The division is also responsible of health education and mobilization in collaboration of department of Health Education and Promotion. Among activities performed in cooperation with the states are safe water and sanitations, hygiene promotion, and vector control. The unit is built of 3 persons or functions. In the states, there's often an incomplete structure and thus double responsibilities of cadres.

The office is also responsible of foundation of new sites in cooperation with the surveillance office in case of necessity. There are minimum criteria for a health unit in order to be pointed/ included as a sentinel sites, and that is by the presence of a statistician (who perform reporting), a medical doctor/ assistant (for determination of match with case definitions), and laboratory personnel (for sample collection).



Picture 1: Data follow board at the surveillance program

Planning and M and E

M and E mechanisms of the program are through annual meeting and reports, and supervisory visits. And a new system for planning and M and E is required to improve performance of the administration as whole, enhance quality of performance and product, satisfy the need for a system that accept continuity and standardization, and the need for documentation and filing capacity; intuitional memory for the section.

Relations to other HISs within the FMOH working on surveillance

Zoonosis and Influenza pandemic

Table 7: Communicable disease surveillance interaction with other programs

Program	Data sharing and cooperation
Malaria	Lab specific data
EPI	Polio cooperation and report and follow up share
TB	Nil
AIDS	Nil
RHIS	Reports to the national information centre
Polio	Nil

The unit started as a cooperation partner to the Ministry of Animal Resources in times of the avian flu adopting of the INAP, until the formulation of the National committee for avian flu. 28th March 2009, the INAP strategy was established as core document, and then came the role from the medical site, rather than working with the animal sector. As staff member was divided the responsibility of the unit to start with, therefore, the whole office divided the functions according to their initial functions.

When H1N1 epidemic started, activities are organized not very different from the times of the avian flu fulfilling functions of planning and coordination, points of entry, disease surveillance, training and isolation centers, supplies and logistics; PPEs, vaccines, and communications. Real start was from phase four of the pandemic, limited by funds and early for the section. Primers were bought from China before the supplies arrived from the CDC, from the States. The national lab provides results within 2-6 hours, unfortunately not working during night. A number of 6 cases was the starting activity for both national and international patients. However, lacking of an international back up confirmation capacity was one setback compromising the standards. The later is a political challenge partners are acknowledging and working on. Regular operational meetings to monitor the situation and international development (on daily basis in the first two month), technical committee weekly meeting, and consultancy committee (with the leading of the undersecretary; together with other bodies outside the FMOH – civil defense and others.



Picture 2: 1: Isolation Center for H1N1

Second place activity was the allocation and preparation of the isolation centers both at the national and state levels, then priority was given laboratory preparation to secure local central capacity of diagnosis through PCR; though lacking capacity of virus isolation.

Seasonal influenza which is **lab surveillance** through limited number of centers – Sudan is using 3 centers for this purpose. The purpose of it is to characterize prevalent type of influenza, discover new type of virus's strains and contribute to development of new vaccines through.

Fact and developments

- There was virus isolation until 1968.
- Activities of seasonal influenza started by the end of 2007; 3 centers. Avian flu 2006, PCR first case in April (-ve), as joint venture with animal resources.
- Availability of funds, surveillance of seasonal influenza in state of Khartoum is not prioritized, whether to be part of the routine surveillance or not.
- Case definitions; a case matching with criteria should be tested in the 3 designed centers.
- The experience of seasonal influenza is the base for improvement in preparation for current situation with regard to H1N1.

5.15.4. Khartoum State Program for Communicable Disease Surveillance

The program is carrying same functions states by the national program, and the work is organized the same way also. My informant explained that

There was one system for surveillance for disease and outbreaks before, and that was part of the health information system. However, due to quality issue and need for weekly reporting, the department was established in 1999 after the watery diarrhea epidemic in 1998.

The state has its peculiarity as a capital state and the weight of capacities and thus traffic and health hazards accordingly. Therefore extra measures are taken with regard to registration of where patients treated in the state hospitals are resident both from different parts of the state as well as from outside the state. *“There are some issues related to be a capital state; among them is fact that the FMOH is responsible of the three main hospitals, and this is causing us some administrative difficulties as well as surveillance issues”.*

In addition to regular continuous surveillance *“The program is carrying out seasonal surveillance; meningitis is an example of that starting from 1st of February to the end of June. The other example is the influenza where surveillance started in May 2009 and ended in March 2010.”*

At the level of localities the work is organized through the department of Preventive Health that carries both surveillance, control as well as supervision functions. My informant continues that *“This is the same channel that works for both Malaria program, TB and HIB/AIDS programs. Common supervisory visits are conducted to sentinel sites which are common for these activities.”*

Malaria is reported 2 times; first from the 52 sentinel sites to the Malaria program, but it is also reported by the 154 reporting sentinel sites for the program for communicable disease surveillance. The 52 Malaria sites are included in the 154 sentinel sites for the state program of communicable disease surveillance.

5.15.5. The State Health Information Centre (SHIS)

Following the organization chart of the department positions are filled accordingly. There is

- **Head of the office**
- **Surveillance officer**
- **Planning and M and E: GIS officer**
- **3 statistics officers**

Data source

Localities; the state is administratively divided into 7 localities submitting their reports. The statistics office of the health services administration at the 7 localities are compiling reports from all health centers (159), private clinics (76) and NGOs (254).

Communicable disease surveillance: reports from sentinel sites to health teams, aggregated at the administration of health services/ preventive section and from there to the state office that hand in a collective monthly report to the SHIC.

Hospital administration: the state there are 28 hospitals, is divided into 3 administrative areas, where each area collects monthly reports from hospitals, compiling it and handing it the state submit re at the curative medicine department of the SMOH/ hospital administration enters data directly on a copy of the software on monthly basis – from the.

99 **Private health care clinics** from the state total.

PHC department provides a monthly report on their activities including; nutrition, reproductive health, vaccination, school health, and professional/ occupational health. The report is send from the PHC administration at the SHIC to the SHIC.

Other programs at the ministry like **TB, malaria and HIV/AIDS** also provide monthly reports to SHIC as well as to their headquarters.

Population consensus data updates are received regularly from the central state office of consensus.

Supervision: for the SHIC the target for supervisory rounds is 3 localities, 5 health teams each month. An officer in the team is assigned for this function.

Data management electronic program: the soft ware is installed in all localities, been refreshed with a new version in 2007. Localities are bringing their report both in hardcopy and

soft copy. This is accompanied with a great deal with virus threads and corruption for the system at the central level.

There is a manual for the usage of the program software program of the SHIS.

In a group of chosen 5 HC centers in the state, a model for a HC is tried currently with regard to information use locally and standardization. In these centers, a model of a “dashboard” is tried presenting essential indicators with monthly updates in a poster.

Health Centre Statistics

The HC is a complete unit that serves the function of the primarily contact between a patient and the health care system, including both curative and preventive functions. The finance of service is divided between public expenditure and the national health insurance fund. The cycle inside the HC for a patient started at the registration office and then the doctor who will right the primarily diagnosis on back side of the form. After the lab and the diagnosis, patient sees the doctor again before the pharmacy and the registration office for the final round. Among the challenges that affect the continuity and quality of in particular information include instability of medical personnel, where the majority of them are placements for civil services or other temporal types of employment.

Medical doctor is writing primarily and final diagnosis on the initial patient form, the same document that will rotate between the lab, x-ray, registration office for the final stamp and reg. of diagnosis, before the final destination which is the pharmacy.

Departments:

- Clinic, lab, x-ray, pharmacy, theatre surgical,
- PHC (nutrition, vaccination (number of vaccinated), health visitor)
- Lab
- Surgical and dressing unit
- Health Insurance system (ophthalmology, UL, and surgical theatre and dressing unit)

Reports:

1. Immediate notification of communicable diseases (Category A) via mobile phones to the health team of the locality.
2. Weekly report (Category B diseases) through the health team to the Preventive Health Department at the Locality.
3. Monthly reporting to the statistics office at the locality on basic statistics from the centre. The report divides data into male and females from the clinics record, including both types of patients visiting the centre; whether insured or e economical financed.

The report is discussed monthly in a meeting including the different departments with the medical director to identify needs and reports.

4. The PHC unit within the HC is collecting its own report sending it to their head quarter.
5. The centre does not treat TB patient, therefore, they are referred to the nearest centre in the area.

Indicators:

1. Percentage of reporting (compared to the month before and the same month from the previous year).
2. Increase in disease parameters.
3. Indicators of man power
4. Number of visits per HCs, hospitals, private and NGOs.
5. For the hospitals the report includes details of divisions, diseases, investigations – laboratory and diagnostic.
6. Top 10 diseases presented during the month.



Picture 3: Reports and reports preparation at a HC

On the issue of fragmentation, my informant commented that

There are too many functions and actions that take place simultaneously in the centre; the curative serves funded by both the insurance and private, PHC services. However, data collection by these units couldn't be gathered in one place but could be coordinated. It is my responsibility at the end of the day to collect and compile data from the different departments and present it to the locality.

Information use:

Data and information produced at the HCs is valuable and highly used in addressing situations and future plans for the performance of the unit. The data collected at the centre, believes my informant, that they are used in planning and decision making by higher levels, in addition to feedback activities by both the locality and the state.

5.15.6. Hospital administration and curative services

The function of the unit is to compile reports from the 3 sections of the state Khartoum, Bahri and Omdurman and enter that into the electronic program of the SHIC. The state has 28 working hospitals; between specialized hospitals in Pediatrics, Obstetrics and gynecology, Surgery or general hospitals.

The unit produces a monthly reports covering:

1. Visits to the different clinics/ departments of the hospital.
2. Work force (provided by the administration of human resources of the hospital).
3. Hospital units
4. Diseases of higher observation in the period.
5. Ophthalmology clinic records.
6. Dynamics of wards within the hospital (pediatrics, obstetrics, surgery, internal medicine, orthopedics and dermatology on those with this capacity).
7. Outpatient clinics.
8. Admitted cases to the hospital and stay over 24 hours.
9. Classification of causality admissions.
10. Surgical operations (major, medium and small surgery).
11. Refer clinics and other clinics.
12. Radiology department.
13. Laboratory.

The report is compiled by each hospital and collected by the section where discussions also takes place before sending/ handing it to the state office on the 5th (maximum the 6th or the 7th). The administration is also responsible of supervision for the sections as well as for the hospitals.

Hospital statistics

(Interviews were conducted in two hospitals in one region of the state capital)

The function of the unit is to collect and compile data from the different units of the hospital on monthly basis, prepare a report that is discussed in a meeting involving all units and the medical director of the hospital. The unit in addition is the information archive for the hospital. Under supervision of the curative services from the SMOH, teams are carrying out supervisory visits monthly to advice and ensure quality. However, feedback is minimum and missing.

Challenges facing the unit among others are the dilemma of diagnosis codes and missing diagnosis, difficulties in storing paper files for 10 years and challenges in finding them back, and not the least informant emphasized importance of training and upgrading. Moreover, the unit is preparing reports several programs; the facility-based statistics, the communicable disease surveillance in addition to other disease programs. One of my informants expressed the wish for integration saying

Our task would have been easier, if we were to have all data in one place and then programs could take what is of interest for them.

Data sources are outpatient clinics, short stay files, and the long stay files

The report's indicators

2 types of patient files; short stay – saved for 6 month and long stay – saved for 5 years.

A patient file has an index number that's linked with personal data.

IT: one PC at the information unit + one more in one of the wards.



Picture 4: Hospital archive; short stay patient's files



Picture 5: Hospital archive; long stay

5.16. Challenges

Diagnosis codes

There are limitations of standardization, in particular with regard to diagnosis and utilization of the ICD-10. It is quite often seen undiagnosed cases, a situation that could be attributed to neglect from recorders, disagreement on term, or shortage in communication where statisticians need to consult with medical personnel in charge often to ensure recorded diagnosis. Using the modified "form 5" prepared by WHO has been among solutions for the dilemma.

Training particularly in-service training is limited, statistics technicians; are trained for 6 month in the institute for statisticians of the FMOH, then upgrade with many years of experience. And a statistician officer has a degree after graduation and 5 years of experience.

Logistical and technical issues

Delay in production of the report due to both logistical and technical limitations at the peripheries as well as at the state office. There are logistical challenges with transport and communication challenges where availability of computer to produce the report and transport means represents major challenges for many of the levels of the system and the information cycle flow.

Technical issues for some centers; where some old officers are suffering a bit from using and application of the new technology. It is often heard as an old surveillance officer in one of the localities expresses that saying:

"Problems started just after the new electronic program of yours has been introduced, everything was going smooth before this program."

Fragmentation

In most localities reports are produced at the preventive health unit in completion with the PHC report. Officers in this unit are responsible for production of communicable disease weekly report, routine health report and program reports. This is the station where fragmentation is largely manifested, where production of some four separate reports those end up to their own path on the statistical month and then the annual report.

Organization of services at the local level

An informant explained his experience during the short period at the locality with the issue of division and being between the administrative/political locality and the technical belonging to

the PHC. The informant viewed the situation as a challenge facing decentralization and organization within the system. Expressed as

“The situation is so complex, we are technically belonging to the PHC and the programs we are doing job for; that’s to say the communicable disease surveillance, TB program, Malaria program and HIV/AIDS. Administratively, we are part of the preventive health office at the locality, a position that leaves us between two stools in a number of issues; here to mention limitations in means of transportation, stationeries and office establishment, and financial rewards and overtime.”

However, immediate solutions depend pretty much on personalities and courage from cadre working on the different localities. The preventive Department at the locality is in a negotiation position to establish itself as a multi-functions department serving different programs at the same time.

Data flow from facilities to localities

The surveillance unit as part of the preventive section at the locality is structurally composed of a Surveillance officer, medical director and psychology adviser. The preventive section at the locality served the function of collecting and compiling data for the surveillance system for communicable diseases, Tuberculosis program, Malaria Program and the Bilharsiasis and HIV/AIDS when active at the level of the locality.

Table 8: Communicable disease surveillance units

Reports at this level are compiled at the Sunday afternoon and shared with the State level on Monday. The work is routine and described as *“This job became a routine for us and it not problematic compared with duties served by the unit for other programs”*.

Epidemics weekly report of the Locality of Omdurman as an example with its three health teams; head of these teams collect reports on the Sunday from their respective health units, prepare the report and communicate it to the head of the surveillance unit at the locality level. Here in this case it’s the locality of Omdurman, centered at the Health Centre of Abdel Muniem – a non reporting unit itself due to low visit.

Locality	Health teams	Units
Omdurman	1	9
	2	
Khartoum	4	23
Umbada	3	22
Bahri	3	20
Karari	1	16
	1	8
Jabel Awlia		
Sharag Alnil		

Health team surveillance officers drive motor bikes collecting reports from reporting health units on Sundays. The same day reports are compiled and passed to the locality, where report is compiled from the different health teams and delivered the next day (Monday) to the state surveillance system on.

Communication and the mobile telephone system

As described by surveillance officer and medical responsible at the locality level, mobile phones in the surveillance work were introduced by the state office in order to facilitate and improve both coverage and communicability between different parts of the system. They are used to report mainly diseases and cases of the A category, and in the second place for weekly reporting in case of a situation that make it difficult to meet on the Sunday, the day in which most of the work and communication is taking place among different levels of the system. Reporting of a case follows the hierarchy; from the reporting unit to the health team, to the locality and further to the state. Interventions are carried out initially by the health team in collaboration with the reporting unit, and then with enforcement from the locality and then the state team when needed.

The emergency telephone numbers those were made public represents an extra burden on surveillance staff by demanding 24 hours a availability that is a day where both the public and health personnel calls inn.

Transport means

It has been agreed that a locality rent a mini-bus for the coordinator to carry his tasks for the 4 programs functions and responsibilities that include the duties of communicable surveillance department, malaria, Bilharziasis and HIV/AIDS programs. These vehicles serve during the working hours (8 – 15). This has shown and reported by majority to be limiting clearly during the period of the H1N1 pandemic. During the later time, interventions and movement was the whole day around not only during formal working hours, and teams were asked then to find their means to cover by themselves and apply for compensations later. One of my informants explains that:

“We were having more than 7 cases to investigate a day, all which after the minibus (that was rent for us during the day) is gone. We are asked to meet that challenge; find a means of transport ourselves, take samples, and doing interventions sometimes, and then ask for compensations later on.”

Transport after 15 in the afternoon has been considered in the beginning

“Budget for movements and assignment outside the routine and working hours, especially during the H1N1 time and avian flu before represents challenges for the system and extra burden on its cadre where they were asked to facilitate the job from own resources and apply for compensations later on. This could go for some, but not

everybody. However, tasks were achieved satisfactory. During rainy season we are used to get a budget to facilitate our job and then we report back expenses. This could be a way to work for other departments too."

Nevertheless, he continued sharing that work is done, and we are both very interested and committed. The surveillance system for communicable disease is the oldest and most established, it surprises us sometimes in spite of all obstacles the achievement is great and work is done.

Health teams are on the other hand using office motor bikes for collecting weekly reports and paying supervisory visits monthly to both reporting and not reporting units.



Picture 6 : A member of a Health Team collecting reports from HCs

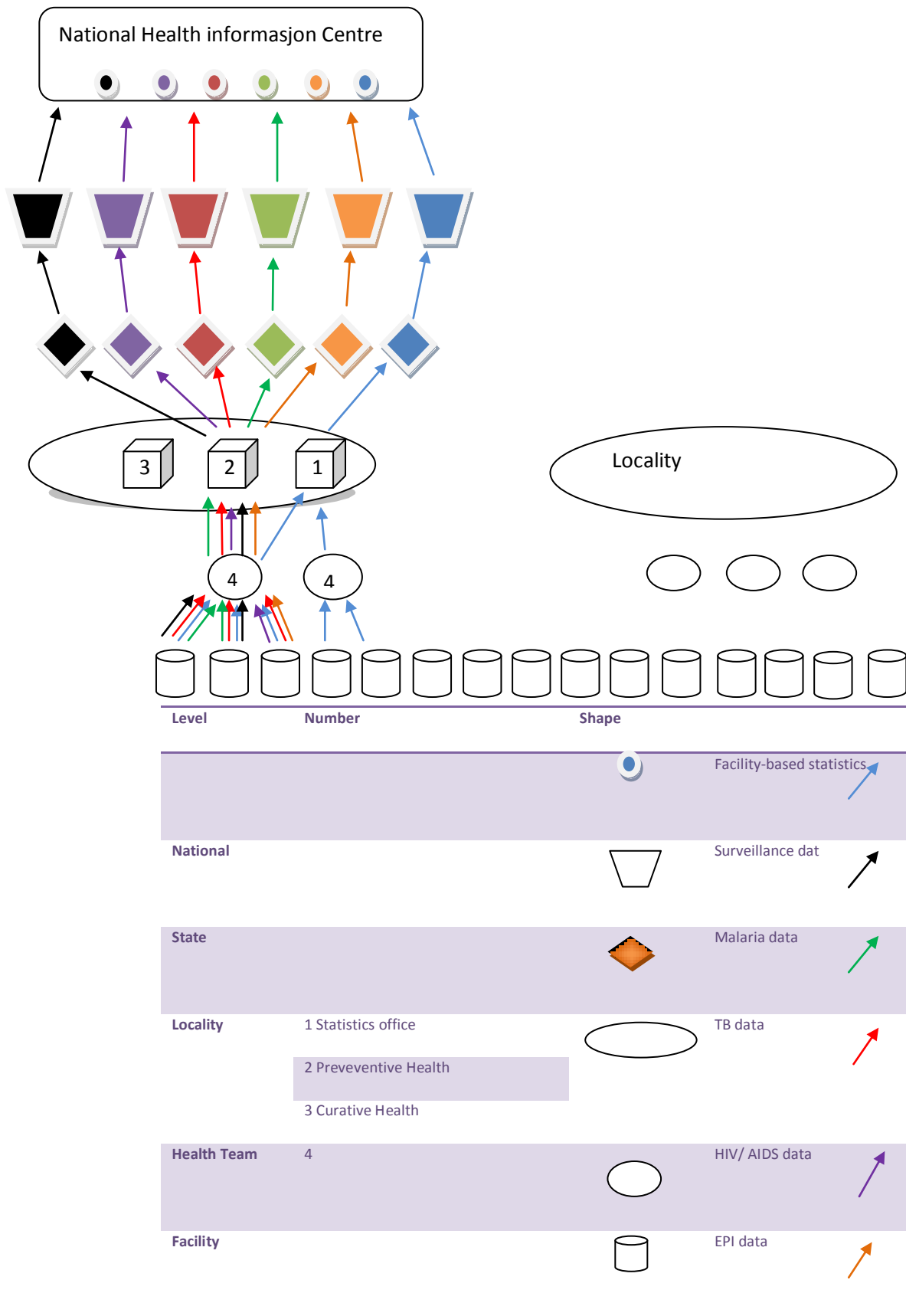


Figure 8: Data flow from data sources

Table 9: Summary of challenges at the different levels

Level	Challenges	
Locality	Logistics & Communication	Organizational
	Transport and working facilities Computer, network, and stationeries	Limited training The position of his office as being between the locality and the PHC
Health team	Communication with information centers at the different levels	Routines within the HC Lacking personnel politic and development
	Limited training possibilities	
Facility	Time frames for collection and analysis	Medical doctors at HC Temporality of job of leading to delay in system development;
	Over-time payment and compensations	They know less of the category A of notifiable diseases

5.16.1. Computerization and HIS

The statistics section at the hospital has prepared a proposal for “scanner project” aiming at linking and scanning patient’s files and save them to the index number. In addition the section has also prepared an “Electronic patient file system” in collaboration with some computer experts who had an attachment to the hospital for a previous period. Head of the statistics section explained

We are looking forward for realization of this project, hoping to improve performance and spare time for analysis and processing of data rather than exhausting the scare human and material resources in efforts of collection and aggregations.

An informant from a the other hospital has amended that

Advantages of a computerized system could be among others; facilitation and enhancement of communication between the different units in a more systemic and organized way. The current practice of going around collecting information from the different units is tiresome and not so effective. Furthermore, a new system could assist in filing and secure a better way of storage and archive.

A group discussion towards the end of my field work, involving participants for Planning and the IT Departments, articulated the current situation with regard to use of technology in HIS

The different departments are asking for electronic programs to serve and facilitate functionality and effectiveness of the information system. However, it is not all departments that have been patient enough to follow the development through the whole way. Majority has dropped out either to due to loss of interest or need for the requested technical solution, or to limitation in translating the vision into IT demands and specifications. The immediate adverse effect of the later was overburdening for the IT department with the number of programs and vast variety of demand and knowledge of departments with regard to IT and potentiality of such programs.

The capacity of the department and the variable programs being developed during the past years represents an asset and valuable experience for any further development in the field. Personnel of the department are highly competent and mobilized for the vision of systematizing and computerizing processes at the ministry for other end users of the system. However, they are for the time being delivering wishes of users, they are quite reflective and committed to vision a common and integrated solution to serve the health care system comprehensively.

Nevertheless, the IT department referred to successful experiences within the ministry; the program for the internship doctors, both for registration and payments was a success story was an example of that. Factors to attribute for the success were among others, the target group that was to use the program, and here they are young new doctors who mostly are computer literate as well as equivalent from the ministry.

In a visioning exercise, suggestions for improvement in this aspect were to vision and visit the need of the ministry as whole for IT technology. As one of informants expressed it

It is a healthier step to consider programming rather than using computers for internet and writing purpose as is the case per today. A comprehensive vision is needed by the FMOH to direct the design of a program to serve the purpose for the whole but with modular structure to accommodate peculiarities of programs

The IT Department of at the Khartoum SMOH is quite developed and engaged. It consists of a group of programmers with good capacities. In a group discussion at the Department, one of the programmers continued the same direction as the informant above

The unit has produced several programs and solutions for the ministry in the last years upon request. Some of these proposals are evolving currently and some others are not followed up and going nowhere. During the recent years it has been quite fashionable to start thinking computerization and systemization of information work. Therefore, most department of the SMOH has in a point time or another approached the IT department for the issue.

The most successful and well functioning of those programs, "Access based" program, was used by the SHIC since the year 2000. However, it went through several modifications and upgrade during these years, the latest and biggest took place in 2003, the design of the program is based on facility reports and several other functions. A copy of the program is installed at the level of the localities and the administration of hospitals at the SMOH. Personnel at the locality level got the necessary training to run the application and get routine supervisory visits. Both hard ware provision and maintenance, and network have been the responsibility of the state office until this point of time.

Reports from the grass root (the HC and hospitals) are prepared and compiled manually before the level of the locality. It is the responsibility of the statistical cadre to prepare these reports on monthly basis at the HC level, collected and compiled by officers of the respective health teams, who in turn handed reports to localities. With very limited analysis capacity, data is collected at lower levels passing through these several levels to SHIC, where reports are produced on monthly basis. A pilot project started sending reports from some centers as zipped copies through email.

There are troubles facing hardware in the HC and localities, both with regard to availability and maintenance capacities, where often central office is involved in resolving such bottlenecks resulting in delays and compromises of efficiency. The transfer of reports by means of flash and memory pens is often connected with viruses' hazards and destructions. The central office of SHIC is currently suffering from delays and reduced functionality because of that.

The system has limited capacity for continuous **training** of cadre in peripheries and involvement. Besides, there is resistance from some older cadre to the software program, referring to it as the cause of delay and problems – *one of end users referring to the application said that your program has caused a lot of troubles for us; we had better performance with it before.*

With regard to the whole computerization process in the SMOH, using computers for more purposes of programming rather than just writing tools and for the internet, this process lacks

cohesion and a common vision as a whole in order to proceed forward. In addition, an overall vision for computerization of processes within the SMOH's system is missing yet, individual department are taking initiatives to express their wishes to the department of programs to facilitate daily tasks and productivity. One of the programmers has states that:

During the past years, we've designed several programs and software solutions for different department of the ministry, and we are ready to produce more if we are asked to do so. However, we miss coherency and continuity, not the least seriousness and follow up of orders, especially designing processes are consuming and demanding.

5.16.2. HIS reform: relationship between the national and the state level

Commenting on the relationship between the state and the national, one of my informants told that

The FMOH would lead the whole Sudan with slow steps that suit all states and their capacities, where Khartoum is efficiently running faster steps with the peculiarity and the strategic position of being the capital. The district health system is quite developed and reached further steps compared to the rest of the country, in a period where informant was working there they even started with community based activities.

The national and the state have an old relationship of development, most of the cadre of the national used to work for the state too. They used to have one common IT section. The fraction of the state today managed to develop and run a computerized HIS for the routine data, and reached further steps in integrating some of the other functionalities in earlier steps of production of the report, example of that is the Hospitals and the PHC. The relation is liable for transformation and could carry great potential for both.

The capital state expresses a written and a genuine wish and a proposal to the national level requesting technical support to assess the SHIS and suggest improvements through a technical support package of experts from the WHO for example. The state was questioning the methodological grounds of the system and whether that is scientific enough; questioning the basis for the whole health information system. And whether it serves its purpose? And to what extent would changes be accepted? Is there has been any sort of evaluation? Are the different part/ division speaking the same language with regard to the system? What is needed to be done?

Together with the national authority of research and information, the discussion continued to explore enabling factors for such a process that demands fundamental inquiry for current practices and correspondence with policies and practices trends in the region and the world. Among others the loyalty of the NHIC whether it is for the FMOH or the Council of ministers, as most often said by the Information centre.

“Building of a strong and valid information system does mean a strong health system in General. Therefore, the routine system which has often been referred to as the “Railway” that needs reform and rehabilitation to catch up with changing world and evolving demands”. My informant directing words to the head of epidemics department, he amended:

You have decided to go for an express intercity fast train instead of waiting for the routine system to develop and deliver. Doing so has in fact compromised emphasis and resources to modernize and improve the system. As most all vertical programs the epidemics needed a “vertical information system” to keep up with information that I could understand.

5.16.3. Information use and evidence-based practices

In the context of the decentralization project with efforts in the 4 states of Blue Nile, Kassala, Red Sea and South Kordofan as poorly developed and post-conflict areas - states those were proposed as a place to start for the implementation of the DHIS and piloting for the ministry in the beginning of the study. My informant states that

As health planners we would like to have information to improve performance of our system, be able to plan based on the fact that reflect real needs and produce results. The HIS whether national or state should continue to evolve producing reports that satisfy this genuine need. The statistics office in the HC is responsible to record activities/ compiles reports that reflect performance during a period of time and act as archive for that. Records are therefore, should answer questions about the performance of the centre, whether efficient tools are employed, needs are met, and so on.

A major concern was how to implement a system that mitigate the divide between records and reports, that's to say data and information needed. The project has been seeking data-base program to inform the capacity building process since data and information is minimum in these areas for states and reporting percentage is far below accepted.

The collaboration between IT unit, information unit and M and E department is inevitable for the correction of the reform process and that could only be done under the directorate of health economics and information. A package is needed to inform the process of health system strengthening and evidence based practice. The report from HCs and hospitals are not reflecting the performance of these units. It doesn't show the relation between expenses and output and outcome. In addition the excuses of the NHIC that the problem due to fragmentation of HIS and existence of the driving force of "vertical programs" are outdated. It is in contrary the responsibility of the NHIC to produce a convincing monthly and annual report, a comprehensive document that reflect performance and highlight gaps of institutions in order to attract "others" to join and integrate.

"Therefore, computerization is a major concern and seen as the way out of low quality, irrelevance of data and fragmentation of the system as whole, rendering the situation of today which could be described as below satisfying". Informant continued that NHIS has a responsibility to develop and improve product:

The national centre for information should take measures to improve its report to include vaccination, nutritional activity and so on, all activities that take place to reflect the real performance and product of the facilities, which will turn attract "vertical programs" to join later when convinced by the product.

The Khartoum SMOH is exerting an effort to develop basis on solid ground of quality applying both international and Arabic standards in quality of care. This process is paved by a number of obstacles and challenges not limited to the function of quality in specific, but characterizing all aspects of dynamics within the SMOH and rest of the health care system. My informant amended that:

Information is the core need to develop and address needs in an organized manner. An orientation of an organization is decided with its functions and task to achieve, and all that is shaped a frame by the size and magnitude of challenges to face. The SMOH as other health care administrations in the country is lacking standards; SoPs, policies and guidelines.

The SHIC started in October 2008 as a pilot project in 6 HCs calling them for “**Model centers**” promoting use of information at the site of collection. In these centers a dashboard presentation of a monthly report showing main indicators and achievements is highlighted to strengthen and empower end users. The centers are Wad Numawi, Abu Agla, Alshagara, Alshabia, Aldaw Hagog and Hilat Koko.

The center is working in close contact and coordination with the IT department in maintaining and developing the program to satisfy the need. Concerning inter-ministry dialogue on reaching consensus on more integration of efforts to produce the “Common report”, the SHIC has gone further steps with receiving reports on hospitals performance entered directly onto the electronic program, future step will be the PHC and closer cooperation with their head office.

The software and the program enable localities to produce reports directly from the copy they have, however, without details of the sub-units.

He started with underlining the fact that time is in for result based planning simultaneously underpinning the pooriness of processes with regard to management of data the ministry processes to each time. *“Nonetheless, from quality prospective there’s a gap in monitoring and evaluation basics and integration with fractions of information and information generation unit, and here to mention the SHIC. As a third arm for this complex, IT department is an important player in the team if to found for and strengthen quality issues in the health care system and responsibility of the SMOH in general”*.

The discussion yield certain areas of concern in the process of improvements and health system strengthening in general, and these are:

- Capacities in the field of information generation are in general lacking; either due to low education, over burdening, or for the fact that most of the staff in this prospect are non medical, referring to statisticians.

- The fact that most information about the patient are written before diagnosis, here meant the patient complains, weakens the process a great deal. The same registration in addition is taking place in all stations a patient is visiting during his/her round between the doctor and the pharmacy.
- The later is a circle tells the retardation in utilizing technologies available to enhance performance and productivity. Huge resources are put this way into collecting data, whereas a minimum weight and effort is left for analysis and transfer and thus transformation into useful information.
- The importance of computerization of the processes to achieve effectiveness coupled with integration of the different parallel systems of today. This process will not save time and efforts only, but would maximize benefit of assets the organizations.
- Another area that is forgotten or less prioritize in the ministry is research; very little of it is done in particular health system research which is the cornerstone in any change, and informed process.

To reflect on the situation today, continues the informant:

We could call both lacking input as well as process in this operation or operations. For the first part, we could both refer to marginal data, human resources as well as coverage. When it concerns processes, majority of human resources and cadre are over burdened by multi-responsibilities. Therefore, core or main functions are not done properly and developed. The later is a known situation in the whole Sudan and systems.

The discussion continues involving the head of the SHIS addressing reasons for weakness and multi-functioning of most ministry personnel. Major areas highlighted were on the relationship between qualification and functions, which is quite deficient and compromising progress.

Other challenges mentioned:

- Institutionalization of health system strengthening efforts is lacking. The situation today is characterized by many good wills and efforts, however, scattered.
- Standards, job description and clearer functions for the various posts.
- Lack of structured training programs and processes to upgrade. Quite much resources are spent on the seasonal workshops/ seminars organized by the different departments without clear thread of continuity and aim.
- Involvement of end users in visioning of change processes which is respect to local authority, a step that is mostly forgotten.

5.17. Computerization and evidence-base practices

Information centres whether national or state are part of the directory of Health Economics, Research and Health Information, and monitoring is a function that is under the directorate of Planning at the National level. My informant explained that *“Whereas the IT department is a separate unit for itself serving the whole ministry is situation that has added to the conflict of interest and structural difficulties that is compromising development with regard to information use in evidence-based practice”*.

Information culture and use in decision-making is not mostly practical in the reform and initiatives to improve. *“Statistical centre is trying to improve tools and data quality from their side, and planners are designing templates for achievements and progress for the ministry and outcomes of health policies and programs. The later is a situation that disables the evolution of information system as a tool for both in planning and decision making”*. However, in this reality, it is the effort of the Monitoring and Evaluation Section and its development into a unit – not decided where to be positioned – represents light on end of that tunnel.

The Section has achieved a process of identifying indicators for each Department of the FMOH in order to guide planning and evaluation, not the least monitoring of progress toward health goals. The M and E plan wrote *“The FMOH 5 years and 25 years strategies were written through a consensus exercise compiling sectors plans. However, further effort to coordinate and comprehensively modify tract taking in consideration the need evidence based planning and resource allocation. Mentioning this, will information stands as a corner stone for this process and guiding. Therefore, coordination at this level and for future steps was inevitable and mandatory”*.

My informant from the state suggested that *“Training of the existing cadre and competence building in the field of information use and technology and TORs and job description are among necessary steps to undertake to accelerate change processes and bridge gaps in both information need and management”*.

6. Discussion

In this part I am discussing the finding both from document analysis and interviews with reference to the literature I have used in this research work. First I will review the strategies and plans of the FMOH and discuss how they are relating to international and regional documents with regard to topic of research. Secondly, the issue of fragmentation would be highlighted from the angle of data flow and information pyramid, and the role of decentralization onto that. Then the experience programs have with technology and HIS, followed by discussion around the issue of information use and evidence-based planning. Towards the end of this section, the experience of the program of communicable disease surveillance would be visited as it has illustrated a potential the program and the system has to meet challenges of disease and outbreaks.

6.1. Strategy and plans

The IDS strategy has paved the way for states to formulate and inform implementation of strategies for communicable diseases surveillance, and widened the scope for catering of other non-communicable health hazards and other conditions. Sudan has a well defined 5 years strategic plan for the years 2007 - 2011, designed for the purpose of promoting health and development [59]. The national health policy would lead a reform in the sector on scientific basis with strategies among others design and implementation of comprehensive HIS and revamp existing disease surveillance system. The NHIC strategic plan is designated to detect and control emerging endemic health problems; monitor progress towards health goals and promote equity [80]. The 5-years strategy describes the HIS as weak, unreliable and fragmented, with own correct indicators that has no clear means of verification (MoV).

The cooperation level with international bodies here to mention the WHO through technical country cooperation plan [11], HMN assessment report for the HIS [8], and development of strategies and plans in close cooperation with the planning section of the FMOH. From first section of finding which the document analysis, plans for optimum surveillance and preparedness for current challenges and emerging hazards seems to be updated level of planning matching international lines and guidelines. The latter indicated harmony and national responsibility for global events and concerns. This has been realized in the recent influenza pandemic (H1N1) that contributed to positive developments in such directions which inform further organizational changes and cooperation with the FMOH and with partners otherwise. Following the WHO global agenda [84] the country strengthened the INAP plan from the year before from times of the avian flu.

Validity of the results

The study describes the surveillance system of disease and outbreaks in Sudan, aiming at describing surveillance subsystems and the potential for integration between them. Further the study focus on the capability of the system to withstand challenges and eligibility to develop and grow. Of the nature of qualitative research, generalization does not gain the same momentum as in quantitative research where sample is bigger and issues of randomization and representativeness are central. The descriptive qualitative approach pays an effort to study how the surveillance system for communicable disease and HIS are conceived in the general structure.

Meaning of categories is elucidated by quotations to allow evaluate the validity of categories. Besides, data have been only examined by the researcher.

6.2. Fragmentation of the health information system in Sudan

HIS researchers have described in general both the development and implementation of HIS as (faced) with a number of challenges which are similar in many developing countries. These challenges from the literature could be grouped into three main areas; lack of a clear information strategy within MOH, scarcity of human and non-human resources; and the problem of information system design that caters only the needs of top level national healthcare system without addressing local information needs. A situation that results in **fragmentation** of the HIS. These areas of concern are interrelated and associated with the socio-cultural, economic, political and organizational structures that shape the healthcare sector [85-87]. Sudan does not seem to be an exception; program leaders inform that HIS was one unit in the beginning before formation of the epidemiological department as a vertical program, now called the national program of communicable disease surveillance.

Later on in the process other donors formulated disease oriented programs, now called vertical disease programs, and divided the surveillance responsibility with the mother communicable disease surveillance, which still collects data as before. Informants at lower levels, who are mostly new to the system, wish for integration and unified format for reporting and data collection to save resources and achieve data quality.

6.2.1. Data sources and Information flow

It is clear that public health decision-making is critically dependent on the timely availability of sound health information. Accordingly, the role of HIS is to generate, analyze, use and disseminate data or information. However, in practice, HIS rarely functions systematically [19, 28]. Sudan has the oldest HIS in the east African region starting from the 1950s, which is also described as the biggest data operation in the whole country by the HMN report. The system with its center at the NHIS, represents the final destination of data aggregated the whole way down from health facilities, to localities, and then to the SHICs before arriving on quarterly basis at the national level to produce reports. The NHIS is responsible for annual statistical report of the FMOH, and thus the whole health sector.

Applying the concept of the Information Cycle of Heywood and Rohde [38], data from different sources are collected mostly by same personnel in the facility level, undergoing different levels of processing and use at the respective program and then meet at the statistical annual report of the NHIC.

Data collection

Routine data, and routine reporting system in health care facilities are the building blocks for HIS in the public health sector of developing countries [10, 37]. The report of the HMN from document analysis has identified data sources including “vertical programs” and others. Although **data collection** of different surveillance programs takes place through almost identical channels, and mostly by the same personnel, whether service providers or statisticians, harmonization of data mostly does not happen before the final stages of preparing quarterly or annual reports.

- Statistical officer at HC is collecting data for both facility based statistics (HIS) and the communicable disease surveillance (weekly), as well data for other vertical programs.
- Health teams are collecting reports from facilities for both HIS, surveillance of communicable disease, malaria and HIV/AIDS.
- The Department of Preventive Health at the locality is the pool for these reports before sending them to the respective program in the state level.

Informants from all visited facilities mentioned that they are preparing the monthly report to the HIC and vertical programs operating at their facilities. In addition they are reporting both weekly and immediately to the program of communicable disease surveillance. These functions are separated in some facilities, examples of which are the hospitals with a separate channel for notification of both immediate and weekly. In addition hospitals are the source of 90 % of data, which is described as of poor reliability due to the fact that it is

managed by non medical personnel reporting. HCs have more reliable data as being processed by medical personnel, however, only 40 % are reporting.

Health workers in Sudan are overloaded with many tasks; on top of the medical duties, they are **collecting** data for different health programs run at their facilities. Where there are no statisticians in all HCs and other BHUs, medical personnel are carrying out the duty of both statistical monthly report and program specific reports. However, improving to the reliability of reports compared to reports written by non-medical (statisticians), it compromises either medical duty or quality of data for the report. The same applied to personnel at the preventive section at the locality levels. A consequence of this is that health workers at the facility level are usually little motivated to the task of HIS as mentioned by different researchers, leading to compromise of quality data generated. This can exacerbate the situation poor quality data in the system.

Other challenges have shown to be related to diagnosis and codes, human resources, reliability of information, fragmentation (vertical programs with own HIS), no common standardized format, and no inclusion of data from other sources (military, police and the private sector).

Data processing and analysis

Although quality of data and indicators are described as relatively good by the HMN assessment, issues of processing into information are still poor due to marginalized analysis capacity. In Sudan, HIS is centrally planned and managed [88], thereby data processing and analysis are mainly the responsibility of centrally located offices. In addition data collection, aggregation and transmission up the hierarchy, slows down the production of feedback consequently [48]. Although data are aggregated using the software program in the capital state of Khartoum, the SHIC is analyzing data manually using Microsoft excel program, representing to achieve the right mix of computer and manual systems [29]. In general, data collected by HIS are transformed **hardly to Information** and analysis of data mainly produces rates and ratios, see appendix 1 for indicators of the annual report.

One Example is the infant mortality = No. of dead infants/No. of born under 1 year x 100

Issues of denominator are worsening the situation and adding to lack of accuracy of these figures where both birth and death registration is a problem in the country. Documents from the NHIC center indicated that only 6 -10 % of actual death cases are registered and that is what is registered at hospitals voluntarily from the side of the doctor. The death certificate prepared by the NHIC is a step forward to push the agenda towards better registration regulations and procedures addressing both challenges of cost as well as practicalities.

For communicable disease surveillance, the program calculates case fatality rates, attack rates, early detection and timely reports by sentinel sites.

Case-fatality rates for outbreaks of diseases % = (Total number of deaths reported from a disease causing the outbreaks in a given time period ÷ Total number of reported cases from same disease that caused the outbreak during the same time period.) X 100

Data presentation and dissemination

Ideally, data presentation and communication (feedback) should be customized to users at all levels and their functions in order to promote information use. Good feedback needs to be based on meaningful comparisons; time comparisons, geographical comparisons, or comparisons of actual versus mean or planned performance [29, 40]. Neame and Boelen stated that *“it is only when those providing the data begin to receive meaningful and useful feedback that they will begin to appreciate the value of data and will therefore take appropriate steps to improve the quality, timeliness and quality of the data they provide”* [41]. The dashboard pilot of SHIC of the model HCs promotes local information use as a promising data transfer among the staff (horizontal transmission) is a development and an empowering exercise. It also promotes effective data flow among health units and system management (vertical transmission) [39]. The SHIS in general is also using GIS in presentations, among others it is used to plot vaccination coverage. The dashboard proposal of the NHIC is advancement in promoting information dissemination, presentation as well as use at local levels.

Data use and integration

From Figure 1 on the integration and use of program data, data and information from most vertical disease surveillance programs are used for internal program purpose, and the statistical report is an archive at the end of the day. Data and information provided by the HIS even of its good quality as expressed by the HMN report, is of low value to planners and managers who face deadlines and time constraints in their daily decision making. Informants on the study explained that decision making are often taken on other grounds than the statistical report that is produced around the middle of the year for the year before. Therefore, they are depending on other formal information systems as Garrib stated [31] and observational information as well as other types of soft information [32-34]. As my informant from planning category stated that the NHIC has to improve its product – that is the statistical report – in order to attract other vertical programs to join and unify. It is challengeable to inverse the situation and promotes information use for decision making for effective management.

Furthermore, the tendency of using these data and the information produced into evidence based practice and decision making is jeopardized by the “poor information culture”, as well

as, less trust of decision makers on the data as perceived by planners (informants). Sudan, as not an exception as other developing countries, has HISs that are challenged by different organizational and socio-cultural paradigms. Lippeveld and others, promoted active participation of users in the system design to achieve ownership and relevance of information, for the potential users of information. The later also could only be achieved by, maintaining data quality, aggregate data at the right level, and produce information in a timely manner.

It is evident that Sudan is living the challenge as other countries in the region to generate the data needed to monitor progress towards the MDGs [5], the problem seem to be not lack of data but rather poor processing and utilization of information [1], and not lack of resources as an affordability, but rather organization and management. The system is challenged by many problems regarding the quality of data, data collection, systematic storage, timeliness, utilization and dissemination.

6.2.2. Essential Data set and information pyramid

Among priorities of the NHIC is to work with Essential Data Set (**EDS**) and reach consensus with all health programs on that. **ESD** is one of the key elements in HIS, and involving indicators which reflects the health status of a district/ community [38]. HIS is obviously collecting information that is nice to know rather than “must know”. Therefore, falling from the initial assumption of Shaw [42] who indicated that ESD would allow alterations and amendments according to emerging needs. The NHIS is an ongoing dialogue with programs aiming at shortening their data elements that’s needed to be collected through the facility based statistics. However, health programs are delivering list of indicators they wish to have through the NHIC without prioritization or considering alternative methods for data collection. Surveys, however, is an alternative mechanism as suggested for the NCD department during their workshop on visioning a surveillance system. The basic characteristics of surveys are their ability to provide useful information, which affects the management decisions, cannot be obtained elsewhere, are easy to collect, do not require much work or time, and can be collected relatively accurately.

The huge amount of data collected in the HIS is sent up the system the whole way without applying any “filters” to make EDS to suit levels of function and use [38]. The later is a fact that consumes resources on collection and aggregation operations, leaving little if any time and resources to analysis and presentation. As identified by this study, in case of Sudan data collected at the facility level are transferred as row data up the hierarchy to the NHIC, these including data that should have stayed at the administrative locality for action or even at the facility level.

6.2.3. Health information system and decentralization

Decentralization is the framework for organization of the health system in Sudan. FMOH is responsible for formulating national policies, ensuring supervision, development and management of human resources, and managing international relations. It represents a challenge as well as a power question between the traditionally designed systems and the demand to delegate and at the same time empower and involve “the states and localities” in shaping the system and enriching it. The later is a challenge that will not be managed without a solid and functioning channel of communication and a back bone of information system. The District level is again another entity of the mash of a (HIS) where integration of (HISs) and competing donors’ and programs’ interests on data and the human resources collide; collecting, compiling and sending [17, 18].

Health information systems are mostly **centrally** planned and managed, and therefore the peripheries and so-called end users are little if any they can contribute to the design and implementation to such endeavors in the health reform’s efforts. The HIC of the state of Khartoum is not an exception of that. The later is a situation that is worsened when the new trend of **decentralization** as the current direction of health system reform. Neither the process of decentralization is complete nor does it enable local authorities to carry on their “decentralized tasks”, nor does the evolution of HISs updated to meet up the present challenges. Informants from localities are experiencing divided positions between programs they are working for and the locality as an administrative unit they are employed by. Clearly, this was reflected on the surveillance activities in comparison with the PHC which is more recognized at the Preventive Department at the locality.

6.3. Technology and health information systems

6.3.1. Mobile phones in surveillance

The experience of the mobile network in surveillance by the program of communicable disease surveillance is the first of its type in Sudan. Since mobile network is covering most geographical areas of the Sudan, utilization of this technology came as a natural substitute for radios, landline telephone network and fax. The service is effective solving coverage and timeliness challenges, and several voices are calling for using it in routine reporting and other information systems. Among challenges is documentation and information base, since transformation of data is directed towards the centre without measures to secure database in the district or states. The trend could be seen as repetition of centralization of health information system instead of efforts to promote decentralization and local government. Nevertheless, it has a great potential when considering capacities of messages and alert system that is already used by the UNICEF for an example.

6.3.2. Computerization

Computerization of HIS, as another dimension of evolution of HIS worldwide, it represents a power question between the centre and the peripheries. The higher levels feel threatened by letting more power to peripheries and the lower levels, on the other hand, may not be ready to receive so much power to decide and manage resources and responsibilities that they are not prepared for. In addition problems are interrelated and are associated with the socio-cultural, economic, political and organizational structures that shape the healthcare sector in addition to the technology itself as described in the literature [10, 32, 36, 45, 46].

Taking the national level first; the IT Department has started a pilot program software build on Microsoft Access-based to serve data collection of facility based statistics from the states. The program was launched and piloted in the River Nile state in August 2008; however, not finalised yet. Further the feasibility study for a **data ware house** from 2009 gave the premises for development in the direction of technology. Both scenarios in the study suggested placing the main server in at the national level, where in the first deployment would reach the level of the states, and then localities as a second phase. The plan has described technical specification for the ware house; build on a SQL –server with a mean of a website as an interphase for users. The main server is placed on the national level as foreseen hazardous not to have a back up for the states in case copy is corrupted.

The IT Department is currently engaged in designing and testing web-based program software for the program for communicable disease surveillance. The plan is to deploy in two phases; first is to connect states to the national level and secondly to join localities to the system. As the feasibility for the data ware house, main server is to be placed physically at the national level. However, sounds practical and safe to design and managed centrally, states ownership and concept of information for local use are not fully taken care of.

The capital state Khartoum HIC has gone further steps along the road using computer technology in HIS. The SHIC is using a software program produced and maintained by the IT-Department since 2000. The program is used mainly to collect and aggregate data from facilities both through localities and hospital administration at the state level. The program has a limited capacity to view reports at these respective levels of collection and aggregation, it has not analysis capacity. Therefore, analysis and processing is carried out using Excel Microsoft.

Both the FMOH and the SHIC of the capital state of Khartoum have chosen to invent their own software programs instead of buying or using ready designed products from abroad. This looks safer way to go with regard to local needs and following what Azubike called piecemeal mode of developing [26], however, carries risks of falling short for quality and standardizations. As one of the informants from IT department reflected that starting to think computers for more than writing and internet, referring to programming is a huge

potential this technology has, is a positive development. However, both the national and the state have reflected on lacking of vision for computerization of health information system processes within the MOH system. The current trend of individual initiatives by health programs' leaders is a positive development in one hand, but also delaying a comprehensive vision and plan for the whole institution. In contrary, an implementation project of HIS is in fact an organizational change that demands collaboration, common vision and participation of all actors to achieve the common aims [13].

Issues of **local ownership, satisfaction and thus commitment** are central when it comes to implementations of new or computerized HIS. Internal resistance within an organization for a change has been reported from the literature, and is described as reason for reported underutilization [43, 46]. Our finding showed that Key stakeholders', who are users of the program are not fully **understanding** of the goals of the new automated IS and justifications for the validity of the created **expectations**. Another limitation for computerized system is scarcity of structured evaluation for best practices in information systems which is highlighted in many HIS literatures, here to mention the WHO bulletin by Tomaci and Facchini [89, 90] cited in Framework Prism by Agil and Lippeveld [15]. Both development and implementation of HIS are influenced by socio-cultural and technical aspects in [91]. Sudan, as other countries in its level, is affected by donors' dependency, lack of institutionalization and integration into everyday routine of the user organizations. Besides, lack of participation of stakeholders is evident and represents major obstacles in these processes [18, 20, 23, 92, 93].

The **DHIS** software and concept was introduced in several rounds for the different health programs and the directorate of planning during field work answering request as well as a visioning exercise for an integrated system of information and surveillance. However, it was the starting point for the whole endeavor; an implementation research for program in Sudan, the process became longer going through stakeholders' mobilization to needs assessment and description of current realities.

Seen in the light of the current realities of the MOH and the technical specifications, the DHIS is quite a suitable option not only for HIS per se, but also to promote decentralization and power of information use at the local levels. In addition to the software program's characteristic of been designed originally for the district where main information and thus server should stay. The latest group discussions including IT members, planners and information executives landed on the agreement to go for soonest implementation viewing the DHIS as a suitable variant and internationally proved. The later came as a natural step after the endorsement of the M and E plan and plans for health information.

6.3.3. Implications of quality of data on evidence-based practice

Poor quality of data is an important factor for why health information is not being used to support decision making. Data that are not in time or up-to-date could lead to unwanted consequences on management and decision-making and old data have only historical value [9]. Decisions must be made based on current information. Therefore, decision-makers are correct in saying that, unless an HIS produces good-quality data, it is not accomplishing its goals and not important to action.

The NHIC has gone further steps in identifying a strategy based on the HMN report, the feasibility study for the “data ware house”, and lastly the “dashboard project”. Nevertheless, information use is not its responsibility and duty. The centre remains to be a delivery entity; however, good product could promote use. Restructuring of the process is the responsibility of Directorate of Health Economics, Information and Research as informants came to in discussions. It is an organizational moment, where functions needs to be coupled with responsibilities and hence information specific-needs.

Several HIS researchers argue that solutions to the problem of poorly functioning HISs must be comprehensive. Money alone is likely to be insufficient unless accompanied by sustained support to country systems development coupled with greater donor accountability and allocation of responsibilities. There are good examples exist of the use of data for evidence-based decision-making leading to better health, and they argue that such examples need to be extended and scaled up [19, 28]. District level is another level of HIS many thought that integration between the different components of the system is possible. However, it is where competing donors and programs’ interests on data and human resources running parallel collecting, compiling and sending to higher levels [17, 18].

The M and E plan, formulated by international consultant based on the planning section of the FMOH has given a new dimension to the issue of HIS and use of information, and the whole notion of evidence-based practices in Sudan. In addition the plan is achieved through a consensus building exercise of a collective dynamic around this multi-facet issue. The evidence-oriented M and E plan for the FMOH has appreciated the great value and role to play by HIS providing adequate information support [8] in particular in intermediate indicators such as outputs and outcomes. However, strengthening and restructuring is a necessity to deliver expectations and anticipated capacity. Through this plan, the Directorate of Planning has achieved a consensus on indicators for monitoring and evaluation for the system outputs and performance. This has been done in ultimate harmony with the NHIC plans and paved the path for the step to follow which is the implementation of a program to satisfy and realize those visions.

6.4. Influenza pandemic (H1N1) implications for HIS

The national program for communicable disease surveillance and zoonosis is the authority and executive of setting strategies and plans for communicable disease surveillance and outbreaks interventions. Based on grounds of epidemiological surveillance as Arita [54] and Frerichs [55] illustrated, the program has been standing up with the surveillance and control of communicable disease, with its 2 categories: immediate notified diseases and weekly reported ones. It has been the main body carrying out these functions before disease-oriented programs established, reporting to disease-specific information need and donors effects [10]. The influenza pandemic of 2009 was a real stack for the program; as a viral disease of global dimension, presenting with high morbidity and mortality in annual epidemics, and in pandemics which are of infrequent occurrence but have very high attack rates [56]. The pandemic has demanded an intensified surveillance and delivering HIS in a manner unprecedented in the countries before. However, emergence of avian flu in the year before has given the INAP as strategy and a template to tailor plans, the complexity and peculiarity of the H1N1 has demanded an added alertness and need for re-thinking early preparedness and surveillance.

The national surveillance system in collaboration with state surveillance programs has played the anticipated role by researchers as Cox [58] who perceived the role of these programs as guiding during time of the epidemic as well as inter-pandemic phases. The national program has actively carried out the functions of surveillance, defined by Noah [52] systemically collecting data, analyzing, interpreting and acting upon. The introduction of mobile phones on the surveillance as well as applying modern methods in scanning for new cases at entry points was an advancement and sign of strength and alert.

However, seasonal influenza was a practice from before; the disease has been added as number 24 to the list of notifiable diseases. Influenza pandemic has been the exercise my fieldwork has experienced most both at the national and the state level. Another dimension the situation has brought about was the obligation to notify even from not sentinel/ reporting health facilities. Though the later was indicated by the law and profession, majority of facilities both public and private were not doing so. The state of Khartoum has organized a workshop for treating medical personnel in 50 non-reporting facilities, which I participated on and got to interact with participants. Majority of them either didn't know/ or didn't reflect on the obligation to notify. The capital state, Khartoum, is routinely intensifying surveillance and interventions for meningitis in the period February to June, and acute watery diarrheas in the rainy season and floods time in the late summer and autumn. The state took over the responsibility of the national airport after the FMOH as an entry point was a great challenge and a peak for the surveillance system to test its capacity and limits for cooperation. Both state and national isolation centers were in full preparation, and technical support was cooperative vendor between the state and the national level.

At lower levels, not an exception but rather a moment of confrontation of realities and gaps, the surveillance personnel at both the sentinel sites, health teams and the localities has done an outstanding job carrying out functions in surveillance in scarce resources and challengeable conditions. Patients and families were ringing throughout day and night, and asking for advice to reporting symptoms, which represented a situation that is not catered for. The job was done satisfactory as responded most informants, and appreciated as a duty and learning exercise.

However, *"International donors are largely responsible for the problem [of complex, fragmented, and unresponsive health information systems], having prioritized urgent needs for data over longer-term country capacity building"* [1], been part of the globe of increasing travel and interaction between its geographical entities calls for cooperation and local measures for international standards. It is known that having accountable (HISs) is a backbone of development. The H1N1 pandemic imposed great challenges on the national program of communicable disease surveillance; first adding the disease to category A (immediately notifiable disease) and secondly activating "seasonal surveillance" that is otherwise will be forgotten. All resources were allocated to meet the challenge and mind gaps. However, the whole exercise was an endeavor that strengthened the program and widened cooperation scope and peak for preparedness.

6.5. Summary

In Summary, this research showing the historical reasons for fragmentation of Surveillance information system in Sudan. The efforts of different stakeholders, including the promising policies and strategies to make unified surveillance system were sought. However, integration of different vertical programs has faced difficulties due to different reason as indicated by the findings of this study and other HIS researches. Thus, the challenges of integrating different components of the surveillance system were also addressed.

It is also noted that, health workers spend a considerable amount of time by collecting information, whereas analysis and use of the available information is not practiced commonly, specifically at the lower level in the health care hierarchy.

As a solution for many problems of HIS of developing countries, integration of the fragmented HIS is recommended by international HIS literatures, by the national level decision makers, as well as, by the health Metric Network. Integrated HIS can decrease workload of the health staff, who are participating in data collection and reporting, thereby can help to produce better quality data. It also facilitate information and resource sharing by different health programs, which in turn probable information use and has impact in decreasing morbidity and mortality from killer communicable diseases. Nevertheless, the reverse is true for fragmented HIS as described by the following diagram.

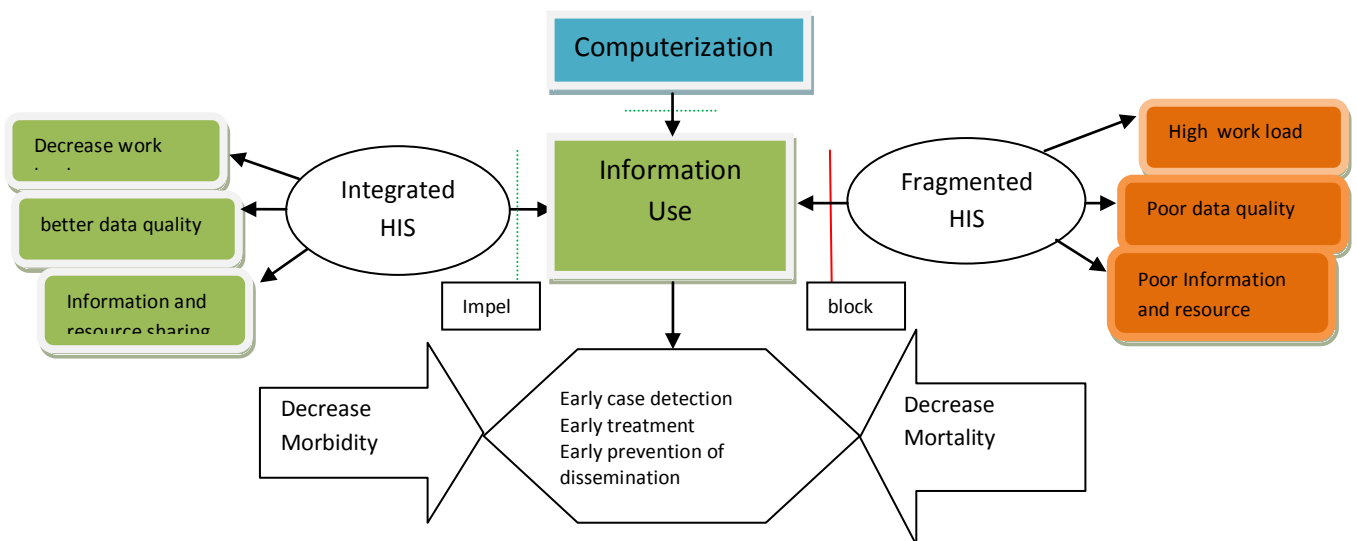


Figure 9: Conceptual Frame work of the study

7. Conclusions

This thesis aimed at describing the surveillance system for disease and outbreak in Sudan; covering the national and the capital state level, with emphasis on both the facility-based statistics HIS and the program for communicable disease surveillance.

The health system seems to have a concrete anchoring in the global tradition and Sudan is engaged in improvement processes, however, lacking cohesion.

The facility based HIS was the only mechanism for both disease surveillance and information gathering between the 1950s – 1990s. In the early 1990s, the communicable disease surveillance program, previously called the Epidemiological Department, emerged as a vertical program. Later separate donor sponsored disease focused programs were established adding to the fragmentation of the surveillance system. Moreover, these programs (malaria, TB, HIV/AIDS and EPI) overlap with the communicable disease surveillance program in surveillance functions leading to data duplication. Both at the national and state levels, the annual statistical reports make up the pools of data and information used for long term planning. At the capital state level statistical reports are produced monthly with wide dissemination and use. These reports, produced by SHIC, are presented on the monthly meetings on the 27th of the consecutive month. However, information produced is similar to the product sent to the national level, with little analysis and processing.

The data quality in general is described as fairly good by the HNM assessment report. However, lack of integration between different data sources (programs), processing and analysis capacity as well as limited utilization of data in evidence-based practices, remains a challenge. Nevertheless, vertical programs, including the national program for communicable disease surveillance, are using data and information within their respective programs for intervention and planning.

Decentralization as a health reform is a huge organizational change that demanded both resources and standards to succeed. One of the greatest challenges is organizational restructuring and health system strengthening. The process is falling short of its ideals due to limited decentralization of resources, competencies and decentralization of level of HIS and disease surveillance. The locality level aggregates data which it receives from the facilities. It then passes on the data to the respective programs at the state level without much further analysis and integration.

Mobile phone services has covered most areas of Sudan, rendering the country as leading in this field compared with other neighbouring countries. The surveillance system for communicable disease has been utilizing the mobile phone technology in its surveillance system for several years contributing to coverage and standardizations. As the

implementation of new technology has shown to be successful, it is tempting for other programs to this experience. However, coverage and network connection is limited in some parts of Sudan making it challenging to rely on this means of communication.

Computer technology is making its way into HIS development and disease surveillance. The communicable disease surveillance program is designing and piloting on web-based software to serve for surveillance purposes. The NHIC has started a pilot in an Access based software program designed also by the IT Department for data collection from the states amending the paper form reporting. However, this is put on hold by the IT Department due to limited capacities to deal with both programs. Lack of a common vision for utilization of information technology in HISs within the MOH system, whether national or state, renders fragmented efforts falling short of expectations and efficiency. A recent feasibility study for a data-base ware house represents a positive development in the direction of integration and information use.

Information is needed by all levels of the health system, and should therefore be collected and managed on the appropriate level. Participation of stakeholders at the different levels is an empowering process which mobilizes resources and informs change towards restructuring. NHIC throughout the years has been taking the lead and engaging in data processes to improve quality. However, re-designing performance indicators and tailoring information to functions could contribute to improve the quality and use of data.

The newly launched plan for M and E system based at the Directorate of Planning, as well as the establishment of a M and E unit is an unprecedented step in the process of information use and evidence-based practices. It added a new dimension to consensus and revitalization of issues around health information culture and use, as well as organizational structural changes.

The 2009 influenza pandemic represented a challenge for the program for communicable disease surveillance both as a national and international confrontation with realities and capacities. The experience added to the capacities of the program; widening its scope and empowered creation of interdisciplinary partnerships.

In general, disease and outbreaks surveillance system in Sudan has undergone a period of fragmentation during the past two decades due to needs that were not satisfied by the conventional facility-based statistics HIS. Re-integration of these surveillance systems is a moment of restructuring and health system strengthening that would be facilitated and empowered by computerization and redefinition of performance indicators.

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8. Appendices

8.1. Appendix 1: The interview guide

A. For health workers at the facility level

1. What is surveillance system is about?
2. How are data for these programs being collected?
3. Is there common platform that contain the data for all communicable disease surveillance? Is it a problem? Why?
4. Do you sometimes need to report the same data element more than once?
5. What are the problems associated with data collection?
6. Do you have any written guideline (protocol) on data collection?
7. What tools do you use to collect data? Do you face shortage?
8. How do you send the weekly report? To whom?
9. Do you process and use the data at the facility level? If not, why?
10. Are the data you report being processed and used by the managers at higher levels?
11. Do you receive regular feedbacks and supervision?
12. What problems or difficulties you face due to presence of independent reporting systems?
13. How do you look at integrating the surveillance system to a unified system?

(1) For program managers at both the national and the state levels

1. What are surveillance systems is about?
2. How its information system working? Is it integrated for these systems?
3. How much of resources are allocated for the surveillance system?
4. How disease and outbreak surveillance data are collected from the facilities?
5. What are the problems associated with data collection?
6. Do you receive data reported on time?
7. How do describe the quality of data you receive?
8. Please can you describe how surveillance data flow starting from the facility level and up to the national level?
9. Are these data being analyzed, calculate indicators and used? If yes, who use it and for what? If no why?
10. Are there any training practices and/or supervision for health workers with regard to health information generation and use?
11. Are you satisfied with performance of programs of surveillance system? If yes why? If no, what do you suggest for improvement?
12. What do you think the reasons behind existence of program-specific, vertical reporting systems?
13. What are the effects of the fragmentation on the surveillance system?
14. How are the surveillance systems being funded (governmental/non-governmental)?
15. How do you look at integration of these independent information systems?

8.2. Appendix 1: Indicators in Annual Statistical Report + comments

Indicator	Source
Total population by state (+%)	CBS
Demographic info: CBR; CDR; annual growth rate; natural increase rate; % pop<15; % pop >60; TFR; % urban pop	Census CBS/UNFPA pop data sheets
Socio-economic data: 15+ literacy rate; % econ active pop>10; dependency rate/1000; GNP p/c USD; GDP p/c USD;	MICS 2000 Census
Health expenditure: P/HE % of GDP; P/HE p/c USD	FMOH
Tot Fed HE approved/actual + breakdown by Ch 1 Salaries, Ch 2 Soc. Support and Oper costs, Ch 3 Dev	HEcon dpt FMOH
Tot Fed HE as % of Tot Fed E approved/actual	HEcon dpt FMOH
Breakdown of Dev Exp over projects approved/received	HEcon dpt FMOH
% budget execution Tot Fed HE	HEcon dpt FMOH
Tot Fed HE in USD	HEcon dpt FMOH
Tot Fed HE p/c in USD and SDG	HEcon dpt FMOH
Tot Fed HE as % of GDP	HEcon dpt FMOH
Health activities	
% pop for whom HC is available	Papchild 1992
% pop w/ safe drinking water	SHHS
% pop adequate excreta disposal fac.	SHHS
% pregnant women attended by trained personnel	SHHS
% of infants attended by trained personnel	Papchild 1992
% pregnant women given +2 doses TT	EPI/FMOH
% of children immunised DPT	SHHS
% of children immunised OPV	SHHS
% of children immunised Measles	SHHS
% of children immunised BCG	SHHS
Health status	
% newborns weighing at least 2500 g	MICS 2000

% children w/acceptable weight/age	SHHS
<5 mortality/1000 live births	SHHS
Infant mortality	
Maternal mortality	SMS 2000
Life expectancy at birth	Census 1993
% of children vaccinated OPV, DPT, Hep B, BCG and measles (per dose)	EPI?
Idem per state (15)	EPI?
% pregnant women 2+ TT per state (15)	???
% CBAW 2+ TT per state (15)	???
Health inputs (public sector)	
Nr of PHC Units by state + total	
Nr of dressing stations per state + total	
Nr of BHUs per state + total	
Nr of HCs per state + total	
Nr of hospitals per state + total	
Nr of beds per state + total	
Availability of spec. PHC services by state (MCH, ORS, Nutr Units, Immun)	
Availability of spec. other services by state (dialysis, EEG, ECG, U/S, endoscopy, lab, X-ray, blood bank)	
Hosp distrib by admin level, gen/spec and by state	
Hosp Bed distrib by specialty by state	
Total number of hosp, beds, HCs, dispensaries, dressing stations, PHC Units, blood banks and X-ray units by last 5 years	
Nr of hosp and beds/100,000 pop by state, North/South and total Sudan	
Nr of private health sector units by state (veterinary, pharmacy, X-ray, lab, dental clinics, GP, Specialist clinic, hosp/HCs, beds)	
Total Nr of all cadres HR expected to graduate 2004-2013, compared to required (g+gap/surplus)	
Nr of med specialists by specialty (univ/ministry) by state	

Nr of MDs by state (Gen MD, registrars, med spec, dentist, pharm)	
Nr of technicians by state (16 diff spec)	
Nr of MAs by state (11 diff spec)	
Nr of nurses by state (diff levels)	
Nr of environm health staff (11 diff kinds) by state	
Nr of RH staff by state (9 kinds & levels)	
Nr of non-med personnel by state (drivers, storekeepers, clerks, personnel, accountants etc.)	
Total nr of MD, dentist, med spec, technician, MA, nurse, PH off, midwife, health visitor/100,000 by state	
Nr of MD, med spec, dentist, pharm, techn, MA, nurse /100,000 over 5 years for Sudan	
Nr of med spec by specialty over 5 years for Sudan	
Total nr of med spec, MD, dentist, pharm, MA, techn, nurse, PH, Sanit, HV, midwife, nutr and soc worker over 5 years for Sudan	
Health Training Institutes	
Important diseases	
Top 10 diseases treated in health units (outpatients) / 1000 pop and % of total; for Sudan	
Top 10 diseases treated in health units for <5; % of total; for Sudan	
Top 10 diseases treated in outpatient clinics by state; absolute + % of total + /1000 pop	
Top 10 diseases hosp admission; absolute + % of total; for Sudan	
Top 10 diseases hosp admission; absolute + % of total; by state (15)	
Top 10 causes of hosp deaths; absolute + % of total; by state (15)	
Top 10 disease spec hosp death as % of disease cases; by state (15)	
Top 10 diseases hosp admission <5 absolute + % of total, for Sudan	
Top 10 causes of hosp deaths <5 absolute + % of total, for Sudan	

8.3. Appendix 2: Sample of statistics from monthly report from Khartoum

Type of unit		First half 2009	First half 2008
Central state hospitals		100	100
Peripheral state hospitals		100	100
Health Centers	Model	100	100
	A	100	100
	B	100	99
	C	100	100
Centers and private units		100	100
Dispensaries and dressing units		99.7	99.4
NGOs		100	99.4
Health centers (emergency)		100	100
Private health institutions		86.3	88.2

Table 1: Utilization of services, a comparison between 2008 and 2009

Table 2: Data from Malaria Surveillance

	First half 2009	%	First half 2008	%	First half 2007	%
Malaria cases	55995	3.28	51923	3.76	70974	5.73
Malaria admissions	2077	2.26	1571	1.91	4374	5.5
Death rate	0.07	-	0.04	-	0.08	-
Laboratory cases	39757	71.00	30693	59.11	37134	52.3
Clinical cases	16238	29.00	21230	40.89	33840	47.7

Epidemic disease	First half 2009				First half 2008		First half 2007	
	Cases	%	% admissions	CFR	Cases	%	Cases	%
Meningitis	1274	0.07	1.38	0.01	968	0.07	1370	0.11
Typhoid	11753	0.69	0.07	1.7	7930	0.57	45333	3.66
Measles	290	0.017	0.01	0.003	216	0.02	121546	9.82

Table 3: Showing cases of meningitis, typhoid and measles, a comparison between 2007, 2008, and 2009.

8.4. Appendix 3: Summary of the HIS assessment and policy implications

The table is from the HMN assessment report of the Sudan HIS in 2007.

Main categories		Score
(Process)	Data management	17%
(Impacts)	Dissemination & use	40%
(Process)	Data sources	41%
(Inputs)	Resources	42%
(Outputs)	Information products	62%
(Process)	Indicators	69%
Impacts on dissemination and use		
	Resource allocation	5%
	Implementation/action	44%
	Planning & Priority Setting	46%
	Analysis and Use of Information	41%
	Policy and Advocacy	65%
Process of Data sources		
	B. Vital statistics	15%
	A. Census	53%
	F. Administrative records	27%
	E. Health service records	46%
	C. Population-based surveys	74%
	D. Health & diseases records	30%
Resources		
	Policy and Planning	25%
	HIS institutions, human resources and financing	46%
	HIS Infrastructure	61%
Overall quality of Information products		
	Estimation method/transparency	76%
	Periodicity	62%
	Data collection method	58%
	Timeliness	69%
	Consistency/ completeness	50%
	Representativeness/ appropriateness	65%
	Desegregations	57%
Quality of Information products by type of indicator		
	Mortality	64%
	Health system	56%
	Overall health indicators quality	62%
	Health status	70%
	Risk factors	63%

8.5. Appendix 4: Analysis of Strength, Weakness, Opportunity and Threat

HMN assessment report 2007, summarizing strength, weaknesses, threads and opportunities the system as whole has.

STRENGTHS	WEAKNESSES
<ol style="list-style-type: none"> 1. Identified core indicators. 2. Specified methods for measurement of the indicators. 3. Core indicators include those related to MDGs indicators. 4. Adequate overall health indicators quality. 5. Adequate HIS infrastructure. 6. Adequate national capacity for conduct of population-based surveys. 	<ol style="list-style-type: none"> 1. Poor use of information in resource allocation. 2. Weak vital registration system. 3. Non-availability of electronic centralized data depository. 4. Poor integration of the vertical surveillance systems with the NHIS. 5. Inadequate resources of the NHIS. 6. Poor capacity for analysis and use of information at sub-national level. 7-The NHIS is facility-based rather than community-based. 8. Weak monitoring and supervision system. 9. Non-existence of feed-back systems.
OPPORTUNITIES	THREATS
<ol style="list-style-type: none"> 1. More information users are concerned. 2. Increased utilization of modern information technology and communication. 3. Upgrading of the health statistical technicians Training centre. 	<ol style="list-style-type: none"> 1. Turnover of the qualified/trained staff 2. Different information users with different information needs

Appendix VI: Summary of core indicators and data collection methods

Data collection method	Definition	Indicator	
Country reports	Survey plan comprises modular contents with periodicity for specific indicators calibrated to achieve maximum sensitivity and efficiency. Includes data collection related to health-related behaviours and bio-clinical measurements.	Country has a 10 year costed survey plan that covers all priority health topics and takes into account other relevant data source	1
Country reports: DHS , MICS		Two or more data points available for child mortality in the past 5 years ²	2
Country reports: DHS , MICS		Two or more population –based data points for maternal mortality in the last	3
Country reports: DHS , MICS	Comprising coverage of key maternal and child health care interventions, risk behaviour, care seeking	Two or more data points for coverage of key health interventions in the last 5 years	4
Country reports: DHS , MICS	Nutritional status clinically measured	One or more data point on smoking and adult nutritional status in the last 5 years .	5
Civil registration or	<i>Numerator:</i> Number of births	Percentage of births	6

² Indicators 2 and 3 only relevant to countries without complete civil registration systems (>90% coverage of births and death)

<p>sample registration systems</p> <p><50% score 0</p> <p>50 – 89 % score 1</p> <p>>=90 % score 2</p>	<p>registered, as reported by civil or sample registration systems, hospitals and community based reporting systems.</p> <p><i>Denominator:</i> Total births for the same time period and geographic region. Where information on total births is not available because of incomplete civil registration, total births can be estimated by extrapolating from the census or on the basis of information about natality rates derived from population surveys.</p>	registered	
	<p><i>Numerator:</i> Number of deaths registered, as reported by civil or sample registration systems, hospitals and community based reporting systems.</p> <p><i>Denominator:</i> Total deaths for the same time period and geographic region. Where information on total deaths is not available because of incomplete civil registration, total deaths can be estimated by extrapolating from the census or on the basis of information about mortality rates derived from population surveys.</p>	Percentage of deaths registered	7

Data collection method	Definition	Indicator	
<p>Routine HMIS reports</p> <p><50% score 0</p> <p>50 – 89 % score 1</p> <p>>=90% score 2</p>	<p><i>Numerator:</i> Number of district hospitals using ICD-10 to certify cause of death.</p> <p><i>Denominator :</i> Total district hospitals</p>	ICD10 used in district hospitals and causes of death reported to national level	8

Bureau of the Census, National Statistics Office and Ministry of health		Census completed within past 10 years	9
		Population projections for districts and smaller administrative areas available in print and electronically, well documented	10
Country HIMIS reports	Include deliveries in public, private and NGO facilities.	Number of institutional deliveries available , by district, and published within 12 months of preceding year	11
National Aids Committee reports		HIV prevalence for relevant surveillance populations published within 12 months of preceding year	12
Country HIS reports		Country web site for health statistics with latest report and data available to the general public	13
Country HMIS reports		Reporting of notifiable diseases makes use of modern communication technology and reporting of statistics from district to national levels is web-based	14
An accurate listing of public and private	<i>Numerator.</i> Number of health districts with timely and complete	Percentage of districts that submit timely , complete,	15

service delivery points should be available in all countries (see 19)	reporting of key data series. <i>Denominator:</i> Total districts. Countries should define core data series that should be reported by all facilities and reported to districts and compare reports against this list .	accurate reports to national level	
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Data collection method	Definition	Indicator	
Information available from health statistics reports.	Validation by an independent reviewer would be needed to ascertain the extent of analysis and validation	Survey data are used to assess and adjust routine reports from health facility on vaccinations with the results published within 12 months of the preceding year	25
		A burden of disease study has been conducted within the last 5 years by national stakeholders	26
		A study of health systems performance has been carried out within the last 5 years by national stakeholders	27

Review of annual health statistics report	Published health data include meta data descriptors, margins of uncertainty , methodologies	There is national commitment to transparency in data dissemination and acknowledgment of uncertainty	28
Review of annual health statistics report		The official annual health statistics report has been published within 12 months of the preceding (calendar or fiscal) year	29

Data collection method	Definition	Indicator	
Country HMIS reports	Assessment should cover routine all administrative data sources (eg civil registration, facility reports)	Data quality assessments carried out and published within last 3 years	16
Country health sector reports	Compliant with IHR monitoring and evaluation framework	International Health Regulations implemented according to international standards	17
NHA report		At least one national health completed in last 5 years	18
Health facility assessments (see also 21)	Database should separately distinguish public, private and non-profit facilities ; should also include key infrastructure , human resources, medicines equipment and supplies, and service availability	National database with public and private sector health facilities, and geocoding, available and updated within last 3 years	19
National health sector review	Database comprises data from multiple sources, including census, labour force survey , professional registers, training institutions , facility assessments	National database with health workers by district and main cadres updated within last 2 years	20
Essential medicines reviews; health facility assessments	Aligned to national essential medicines list	Annual data on availability of tracer medicines and commodities in public and private health facilities	21 142

<p>National health sector reports</p>	<p>Ideally , the body should be quasi autonomous or independent and should adhere to Fundamental Principles of official Statistics</p>	<p>There is a designed and functioning institutional mechanism charged with analysis of health statistics, synthesis of data from different sources and facility sources</p>	
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National health sector reports	Indicators cover key issues including health determinants, health system inputs, processes and outputs, use of health care services, mortality, morbidity, health system responsiveness etc.	There is a national set of indicators with targets and annual reporting to inform annual health sector reviews and other planning cycles	23
		There is a national micro data archive for health surveys and census that is operational	24