Mozambique Health Information Network (MHIN)

Final Technical Report
November 2010

Published by: AED-SATELLIFE
Location: 30 California Street, Watertown, MA 02472, USA
IDRC Project No: 103746-001
IDRC Project Title: Mozambique Health Information Network
Country: Mozambique

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This report is presented as received from project recipient. It has not been subjected to peer review or other review process.
Abstract
The MHIN project was designed to support health data collection and reporting through a two–way communications system utilizing the existing cellular telephone network and low-cost, simple-to-use, and energy-efficient handheld computers (also known as Personal Digital Assistants or PDAs.)

The project developed the Mozambique Epidemiological Surveillance System (officially called Sistema de Vigilância Epidemiológica or SIS-VE) – an electronic system combining mobile, wireless, and fixed technologies for improving epidemiological surveillance data collection, reporting, and analysis. All eleven provinces and 43 districts in Gaza, Inhambane, and Zambezia provinces are utilizing SIS-VE for epidemiological surveillance data gathering and reporting as a cost-saving alternative to paper-and-pen-based approaches. The system developed by the project is enabling the districts and provinces to receive and analyze high-quality data on time, to track outbreak prone diseases, and to respond in a timely manner to disease outbreaks. A cost-effectiveness study showed that the MHIN system reduced the cost of managing epidemiological data by 20% compared to traditional paper-based manual systems. The key lessons learned include addressing in the design of research projects the value of testing innovations and research versus the costs represented by “pilot project fatigue”; institutionalizing the crucial role of champions; and the dependence of sustainable outcomes on long term investment, partnership, and consistent support. Continued user support and improvement of the system to include additional features and functionalities is sine qua non to the sustainable use of the system. AED-SATELLIFE and MISAU recommend continuing building the capacities of the technical personnel of the Ministry of Health to manage and enhance the system. Expanding the use of the system for other data collection needs of the health sector is also recommended.

Keywords: Integrated Disease Surveillance and Response, mHealth, cost-effectiveness, epidemic-prone diseases surveillance and response
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1. Synthesis

The primary goal of Mozambique Health Information Network (MHIN), Centre Grant Number 103746-001, was to support the actions of the Ministry of Health of the Republic of Mozambique in equipping various levels of the health system and frontline health care practitioners with reliable, fast, and cost-effective data collection and communication tools necessary to achieve the improved standards of national health care articulated by the country’s Health Sector Strategic Plan 2007-12 (Plano Estratégico do Sector Saúde or PESS)\(^1\). The period of performance of MHIN was November 2006 – October 2010.

The project initially focused on improving routine Health Management Information System (HMIS) data gathering and reporting processes. During the initial deployment of MHIN (2007-2008), the project successfully developed, deployed, and supported a system for daily collection of routine HMIS (Sistema de Informação para Saúde or SIS) data using handheld computers (also known as Personal Digital Assistant or PDA) at the point of care and subsequent transmission of this data through the wireless telecommunications network to a server at the Ministry of Health (Ministério da Saúde or MISAU). Health workers in five pilot districts collected SIS data on both paper and PDA. However, simultaneous use of both the paper-based and handheld-based collection processes proved to be an added burden on the health system. MISAU determined that the system could be more useful if employed solely for the collection and reporting of epidemiological surveillance data.

Therefore, beginning in June 2009, in accordance with MISAU needs and priorities, the project had the following objectives.

1. To improve the timeliness and quality of epidemiological data collection and reporting in districts and provinces by providing access to the MHIN services, including the use of handheld computers, African Access Points (AAPs), and the existing cellular networks for the capture, transmission, and reporting of epidemiological data.

2. To develop the processes and determine the organizational requirements for the national rollout of MHIN for epidemiological data collection, transmission, and reporting.

3. To determine the cost-effectiveness of MHIN for epidemiological data collection, transmission, and reporting compared to paper-based approaches.

Simultaneously, the geographic focus of the project shifted from piloting the system in only seven districts to deploying it to 43 districts and all eleven provinces.

The project’s primary research agenda was to determine the cost-effectiveness of MHIN for epidemiological data collection, transmission, and reporting compared to paper-based

approaches. A cost-effectiveness study of the network showed that it reduced the cost of managing epidemiological data by 20% compared to traditional paper-based manual systems that are cumbersome, delay-prone, less reliable, and often yield incomplete data.

The 43 districts are continuing to use the MHIN system for gathering and reporting epidemiological data from health facilities all the way up to the Ministry of Health. Follow up activities agreed by the MOH and AED-SATLLIFE include enhancing the MHIN system with additional data analysis capabilities; expanding the use of MHIN to other health data collection needs of the MHIN; transitioning MHIN from PDAs to cell phones for gathering and reporting health data; building the skills of MOH technical personnel to manage, expand and improve the MHIN system; and continuing to assess the cost-effectiveness of the MHIN approach vis-à-vis paper-based approaches.

### Major Project Outcomes

(A full discussion of Project Outcomes can be found beginning on page 44.)

- All 11 provinces and 43 districts in Gaza, Inhambane, and Zambezia are utilizing electronic tools and processes developed by MHIN for epidemiological surveillance data gathering and reporting as a cost-saving alternative to paper-and-pen-based approaches.
- District and provincial health offices established faster, better-functioning networks for communication and collaborative work with health units and other public agencies.
- The development and use of MHIN for epidemiological surveillance fostering meaningful policy dialogue among MISAU leadership and technical managers, the Ministry of Science and Technology, IDRC, Eduardo Mondlane University, and other organizations in Mozambique.

### Lessons Learned

(A full discussion of Lessons Learned can be found beginning on page 48.)

- **Address value of research versus costs to health system.** The value of testing innovation and the costs represented by pilot project fatigue and burden on the health system are fundamental issues that must be addressed when research projects involving testing of innovative ideas through pilot projects are designed.
- **Institutionalize the role of project champion.** The support of dedicated champions is very important at all stages, but depending solely on the abilities, good will, and actions of a few individuals can have a disastrous effect on the project. It is crucial that the role of champion be institutionalized to ensure long term success of the project.
- **Sustainable outcomes depend on long term investment, partnership, and consistent support.** Answering key research questions, adopting new solutions and institutionalizing them into the health system, building local capacity to maintain and improve systems, and formulating policies based on research findings are long-term efforts requiring long-term investment and commitment from donors and governments. Support for technical assistance at macro-scale is necessary to foster the widespread adoption of eHealth solutions and enable meaningful change. Mechanisms need to be developed for taking research-driven pilot projects that proved to be effective to nationwide rollout.
2. Research Problem

The ability to collect, analyze, and utilize reliable and timely data is vital for the efficient allocation of scarce resources and the empowerment of health workers to provide cost-efficient and effective healthcare to the population. Despite the recognized link between improving health information systems and advancing the quality of healthcare delivery, the effectiveness of Health Information Management Systems (HMIS) in developing nations is constrained by lack of resources, the poor quality, high cost, and limited accessibility of existing communications services including telephone and Internet, and fragmentation of health data collection and management processes.

Successful HMIS data collection in Mozambique - integral to quality healthcare service delivery - is hampered by these conditions and others. The Ministry of Health of Mozambique (MISAU) is charged with developing a program of evidence-based policies and practices for health care in Mozambique. There are about 1,210 health units in Mozambique each of which is required to report to the district health office regularly on its activities, the services it has delivered, and the health conditions in its catchment area. Each district is required to report to its provincial health directorate (Direcções Provinciais de Saúde or DPS) that in turn reports to the national Ministry of Health headquartered in Maputo. The data thus reported is the foundation of the Health Information Management System that supports decision making on policy, resource allocation, and response to disease outbreaks.

Many of the 1,210 health units struggle to maintain regular communication with the district and provincial health offices. Overall, infrastructure in Mozambique is weak. 60-70% of the roads are unpaved or in very poor condition; only about 10% of the road network is in good condition. While there have been many improvements in the telecommunications system it remains inadequate, covering only a small fraction of business and households. Fixed-line teledensity in Mozambique is extremely low; the system serves less than 1% of the population and its growth is stagnant. Limited transportation and communication infrastructure thwart MISAU’s desire to collect relevant data in a consistent, cost-effective manner.

HMIS data collection and reporting in Mozambique is primarily paper-and-pencil-based. Data collected on paper is prone to transcription errors, loss, and damage. Entering data from paper records into computer databases takes an extensive amount of time and introduces additional opportunities for human error. Furthermore, due both to the labor-intensive nature of the process and the geographic and technological barriers to data movement within the system, disease surveillance data reported from paper-based collection rarely reaches policymakers in time to support informed decision making on the basis of accurate epidemiological analysis. Useful feedback on the data is reported back to the field with even less success and frequency.

In order to coordinate healthcare at the various levels of a national health system, an effective HMIS requires accurate data that is compiled, analyzed, and communicated from point to point within the system in an accurate, timely, and cost-effective fashion. Relevant analysis of the data must be returned to frontline health workers in a context
that enables them to improve their practices and respond to contemporary health problems. Building an effective HMIS in Mozambique is dependent on the establishment of a reliable system of communications among the various departments at MISAU, the various provincial and district health offices, and the health facilities, and will require the development and use of sound data collection tools. Improving the quality of healthcare in Mozambique necessitates the expanded flow of information and data and improved communication throughout all levels of the health system starting at the point of care.

Cognizant of the importance of reliable health data to properly designing health policy and allocating health resources, the Mozambique Minister of Health approached AED-SATELLIFE in November 2005 with a request to replicate the IDRC funded Uganda Health Information Network (UHIN), that uses mobile computing devices for improving data and health information flow in Uganda. After a series of conversations, a team of AED-SATELLIFE staff and a representative from the International Development Research Centre (IDRC) traveled to Mozambique to determine if and how UHIN could be replicated to address MISAU’s HMIS data collection and reporting needs.

Initially focused on improving routine SIS data gathering and reporting processes, the project, in close consultation with MISAU’s Department of Health Information (Departamento de Informação para a Saúde or DIS), developed electronic SIS data collection forms for use on MHIN. During the initial deployment of MHIN (2007-2008), the project successfully developed, deployed, and supported a system for daily collection of SIS data using PDAs at the point of care and subsequent transmission of this data through the wireless telecommunications network to a server at MISAU. Health workers in the five districts involved in the MHIN pilot test collected SIS data on both paper and PDA. However, simultaneous use of both the paper-based and handheld-based collection processes proved to be an added burden on the health system. MISAU determined that the system could be more useful if employed solely for the collection and reporting of epidemiological surveillance data. Therefore, beginning in June 2009, in accordance with MISAU needs and priorities, the specific objective of MHIN became improving the timeliness and quality of epidemiological data collection and reporting in districts and provinces by providing access to the MHIN services for the capture, transmission, and reporting of epidemiological data. Simultaneously, the geographic focus of the project shifted from piloting the system in only seven districts to deploying it to 43 districts and all eleven provinces.

MHIN sought to examine several aspects of eHealth deployment. The project partners conducted a cost-effectiveness assessment of the ICT-based health data collection system vis-à-vis paper-and-pencil-based manual data collection processes. The principal research question the project investigated was, “Does the use of a system integrating mobile computing devices, wireless access points, the existing mobile network, and the Internet result in cost savings related to disease surveillance and other health data capture and transmission activities compared to paper-based approaches?” The project partnered with Universidade Eduardo Mondlane (UEM) to conduct the cost-effectiveness assessment of the MHIN system.
3. Major Findings

Major findings of the project include the following:

1. The MHIN system improved timeliness of health data reporting significantly. The electronic system developed by the project has enabled the districts using it to report epidemiological surveillance data within one week while the paper-based approach used elsewhere takes a minimum of four weeks.

2. A cost-effectiveness study of MHIN conducted by independent consultants in 2010 showed that the network reduces the cost of managing health information by 20% compared to paper-based manual systems that are less reliable, and, in some cases, incomplete. The districts participating in the project reported benefits including improved data quality, more timely access to data for analysis and decision making, and more rapid response to emerging situations.

3. The MHIN system enabled MISAU and the provincial health offices to view public health data down to the facility level. The paper-based system aggregated data at each level. Thus, the data ultimately received at the provincial and national levels and used by MISAU and other partner organizations reflected activity on the district level only. Due to the lack of facility level information, one could not ascertain if reported data was timely, complete, or accurate. MHIN, on the other hand, supports the disaggregation of data to allow decision makers to view the public health situation at any one facility. This data is the foundation of a health management information system that supports informed policy formulation, resource allocation, and response to disease outbreaks.

4. Parallel use of electronic and paper-based systems for gathering and reporting the same data sets is a major impediment to the success of eHealth interventions. During the initial periods of MHIN, health workers were required to collect HMIS data on both paper and PDA. Simultaneous use of the two processes was an added burden to an already overtaxed health workforce. The shift from paper-based epidemiological data collection and reporting to MHIN enabled the districts and provinces to realize the benefits of the electronic system. (A full description of this finding can be found on page 46.)

4. Fulfillment of Objectives

The overall goal of MHIN was to support the actions of the Ministry of Health of the Republic of Mozambique in equipping various levels of the health system with reliable, fast, and cost-effective data collection and communication tools necessary to reach the improved standards of national health care articulated in MISAU’s strategic plan.

The project initially focused on improving routine HMIS data gathering and reporting processes, and improving frontline health workers’ access to clinical information on health issues affecting the population they serve. Beginning June 2009, MISAU decided to re-focus the use of MHIN on gathering epidemiological surveillance data.
The discussion on how MHIN objectives were met is provided in two parts to distinguish the achievements and challenges that characterize the period November 2006 – May 2009 during which the system was used to support the exchange of the full range of routine HMIS data and the delivery of content; and the period June 2009 – October 2010 wherein the focus of the project shifted to supporting epidemiological surveillance data collection and reporting only.

**MHIN Objectives: June 2009 – October 2010**

The specific development and research objectives of the project during this period were the following:

*Objective-1*: To improve the timeliness and quality of epidemiological data collection and reporting in districts and provinces by providing access to the MHIN services, including the use of handheld computers, African Access Points (AAPs), and the existing cellular networks for the capture, transmission, and reporting of epidemiological data.

*Objective-2*: To develop the processes and determine the organizational requirements for the national rollout of MHIN for epidemiological data collection, transmission, and reporting.

*Objective-3*: To determine the cost-effectiveness of MHIN for epidemiological data collection, transmission, and reporting compared to paper-based approaches.

**MHIN Objectives: November 2006 – May 2009**

The specific development and research objectives of the project during this period were the following:

*Objective-1*: To strengthen the health information systems in the pilot districts by providing access to MHIN services for the exchange of HMIS data and the transmission of health information to all health centers in the districts.

*Objective-2*: To support district public health leadership in making informed and prompt decisions by increasing the accuracy and timeliness of HMIS data.

*Objective-3*: To support frontline health workers in the pilot districts by providing them with relevant health information related to the major health problems of the districts.

*Objective-4*: To develop processes and determine organizational requirements of MHIN including developing a plan for expanding MHIN in the event that it
was determined to be a cost-effective response to MISAU data and information needs.

**Objective-6:** To investigate if MHIN meets the needs of the MISAU for improved data collection and HMIS data exchange between remotely located health centers and the provincial and national offices of the ministry.

**Objective-7:** To determine the cost-effectiveness of MHIN for HMIS data collection, transmission, and reporting, and clinical information delivery to rural health workers compared to paper-based approaches.

The fulfillment of those objectives is detailed below.

4.1 **MHIN June 2009 – October 2010**

4.1.2 **Improving Timeliness and Quality of Epidemiological Data Collection and Reporting**

The Mozambique health system, like other systems, aims to achieve and sustain good health for the population. Healthcare services in Mozambique are provided through five levels of the health system. At the first tier are a network of community health workers (CHW) most of whom serve on a voluntary basis. Especially in rural areas, traditional healers and herbalists also provide health services at this level. The second tier in the chain of access to health care is comprised of health posts and health centers. These facilities are the first formal link between the health system and the population served and provide basic curative and immunization services. Rural Hospitals and General Hospitals comprise the third level, providing essential preventive care, medical, surgical, maternity, and laboratory services. Each of these facilities is managed by a medical officer and is staffed by an epidemiological surveillance officer (vigilante epidemiológica) who is responsible for gathering, reporting, and analyzing epidemiological surveillance data. On the fourth level are Provincial Hospitals receiving referrals from the rural and general hospitals. The provincial hospitals are relatively well equipped with necessary staff and tools. Forming the tertiary health care institution of the formal health system, the provincial hospitals also serve as teaching hospitals for medical schools. At the top tier of the healthcare delivery are the central and specialized hospitals located in Maputo, Beira, and Nampula which provide the highest level of referral services in the country.

The first post-independence epidemiological surveillance system for Mozambique was established in 1979. MISAU revised the system in 1985 and redesigned its approach through the introduction of two primary sub-systems referred to as Boletim Epidemiologico Semanal (BES), a weekly epidemiological bulletin, and Boletim Epidemiologico Mensal Dos Posto Sentinela (BEM-PS) a monthly epidemiological bulletin for sentinel sites. The BES is used by health facilities for reporting eleven epidemic-prone diseases, including measles, neonatal tetanus, acute flaccid paralysis (AFP), whooping cough, diarrhea, cholera, dysentery, rabies, plague, meningococcal
meningitis and malaria. Each health facility is required to report the number of cases and deaths related to each of these disease and conditions to the district on a weekly basis. Each district aggregates data received from all facilities within their catchment area and reports to the provincial health directorate every week. The provinces in turn report to MISAU headquarters every week.

The BEM-PS is a sentinel surveillance system. Data collection and analysis is conducted by facilities that are selected based on their specialty, geographic location, their capacity to make accurate diagnoses, and their ability to issue accurate reports. The BES-PS sites include the three central hospitals located in Maputo, Beira, and Nampula, and an additional seven provincial hospitals. In addition to the eleven epidemic-prone diseases, MISAU has required reporting of non-communicable diseases to the sentinel system since 2005. These non-communicable diseases include hypertension, cardiovascular diseases, diabetes, trauma, asthma, and cancer. However, like any other sentinel surveillance system, the coverage of rural areas in Mozambique is very limited. Therefore, BEM-PS is used primarily to augment the BES sub-system and answer specific epidemiological questions.

The following diagram illustrates epidemiological surveillance data flow (using BES) and the reporting lag at health facilities, district offices, provincial health directorates, and MISAU headquarters.

![Diagram of epidemiological surveillance data flow](image)

Timeliness and completeness of data related to epidemic prone diseases is a key factor in informing the health sector decision-making process and enhancing MISAU’s capacity to adequately combat epidemics. While MISAU’s epidemiological surveillance requires health facilities to report on epidemic-prone diseases to MISAU headquarters every week using the BES system, the paper-based reporting process takes on average four weeks. The inability to report surveillance data in a timely fashion hampers the health system’s ability to respond swiftly to outbreaks.

An assessment of the epidemiological surveillance system conducted by MISAU and the World Health Organization (WHO) in 2006 found issues such as discrepancies between cases registered and reported by health facilities, delays in reporting, incompleteness of
data, and incorrect understanding on the part of health personnel of the epidemic thresholds of priority diseases\(^2\). While MISAU’s epidemiological surveillance strategy requires timely analysis and use of analyzed data for action, the assessment found that only about 35% of the health centers and about 22% of the districts make proper analysis and use of data sets. The findings of the study in relation to knowledge of epidemic thresholds of priority diseases that health personnel must recognize and respond to are very alarming. The national threshold for AFP, cholera, meningitis, and plague is a single case; and for measles the threshold is three confirmed cases or five suspected cases per month in a district with an estimated population of 100,000 people. The percentage of facilities that demonstrated correct knowledge of epidemic thresholds for reporting on selected priority diseases is provided in the following table\(^3\).

<table>
<thead>
<tr>
<th>Disease</th>
<th>Provincial, district and rural hospitals</th>
<th>District level health facilities</th>
<th>Rural health facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>AFP</td>
<td>60%</td>
<td>77.80%</td>
<td>21.70%</td>
</tr>
<tr>
<td>Measles</td>
<td>20%</td>
<td>44.40%</td>
<td>8.70%</td>
</tr>
<tr>
<td>Cholera</td>
<td>60%</td>
<td>66.50%</td>
<td>30.40%</td>
</tr>
<tr>
<td>Meningitis</td>
<td>0%</td>
<td>0%</td>
<td>0%</td>
</tr>
</tbody>
</table>

The multiple activities undertaken by the project to improve the timeliness, completeness, accuracy, and use of epidemiological surveillance data are detailed below.

**Developing Electronic Epidemiological Data Collection and Reporting Tools**

The project developed the Mozambique Epidemiological Surveillance System (officially called Sistema de Vigilância Epidemiológica or SIS-VE) to improve MISAU’s epidemiological surveillance data collection, reporting, and use.

The system uses PDAs and desktop computers for data entry, the cellular network or the Internet for data transmission, and a server at MISAU for hosting the national database for epidemiological surveillance. SIS-VE has two major components: the routine data collection and reporting module and the outbreak module. For technical information on these modules, please see Appendix 1.

**Informing MISAU Health Information Systems**

MHIN is interoperable with MISAU health information systems at all levels. The district epidemiological surveillance database built by the project, based on MISAU preferences and to ensure compatibility with existing systems, is in Microsoft Access. MISAU’s HMIS database, called Modulo Basico (or MB:SIS), is also built in Microsoft Access enabling seamless synchronization between the MHIN district database for epidemiological surveillance and MB:SIS. Although data is collected on the mobile computers using forms developed with Palm-compatible Pendragon Software, MHIN presents data using the Microsoft Access application. Very widely used to create database solutions, Microsoft Access is simple enough to be used by novices, but

\(^2\) Assessment of Epidemiological Disease Surveillance system in Mozambique, 2006. MISAU and World Health Organization (WHO)

\(^3\) Ibid
powerful enough to serve the needs of professional developers creating global corporate applications, web deployments, and real-time applications. Microsoft Access can be used as part of complex applications where it is integrated with other technologies. Data can be exported from or import to Microsoft Access from a broad array of data management systems including Microsoft Excel, ODBC databases, XML files, HTML documents, SQL, and many others. It can be used either as a standalone product, as the 'front end' for other product for 'back-end' systems such as Microsoft SQL Server, Oracle, and Sybase, or as the back end for front ends such as Visual Basic.4

The national epidemiological surveillance database was developed by MHIN in MySQL. Data from the Microsoft Access-based district database is seamlessly transferred via ODBC link. This flexibility makes it possible for the MySQL-based MHIN national database and the Microsoft Access-based MHIN district database to readily link with each other and with a wide variety of existing MISAU HMIS systems including the district level and the MB:SIS databases and other legacy systems. MHIN data from MySQL and/or Microsoft Access can be exported to a wide range of open source health care software resources, including OpenEMR, THIRRA, and OpenMRS.

**Deploying SIS-VE to Provinces and Districts**

MISAU’s desire was to rollout the MHIN solution for epidemiological surveillance to all 128 districts and eleven provinces. However, lacking sufficient funding to support nationwide rollout, the project limited its activities to a total of 43 districts in three provinces. Nevertheless, the electronic data collection tools; data transmission protocols and processes; data storage, analysis and reporting systems for district, province, and national levels developed by the project are designed to support a future whole-country MHIN implementation.

The project successfully deployed SIS-VE to all eleven provinces at the Provincial Directorates of Health and to 43 districts in three provinces (17 in Zambézia province; 14 in Inhambane province; and 12 districts in Gaza province.) The districts where SIS-VE is operational are listed in the following table.

<table>
<thead>
<tr>
<th>Province</th>
<th>Districts’ Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaza</td>
<td>Bilene Macia, Guija, Chibuto, Chicalacuala, Chigubo</td>
</tr>
<tr>
<td></td>
<td>Cidade de Xai-Xai, Distrito de Xai-Xai, Chockwe, Manjacaze, Massingir, Mabalane, Manssagen</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Govuro, Homoine, Jangamo, Inharrime, Massinga, Morrumbene</td>
</tr>
<tr>
<td></td>
<td>Panda, Vilanculos, Zavala, Inhassoro, Funhaloro, Mabote Maxixe, Inhambane</td>
</tr>
<tr>
<td>Zambezia</td>
<td>Alto Molocue, Chinde, Gile, Gurue</td>
</tr>
<tr>
<td></td>
<td>Ilé, Inhassunge, Lugela, Maganja de Costa, Milange, Mocuba, Mopeia, Morrumbala, Namacurra, Namarro</td>
</tr>
<tr>
<td></td>
<td>Pebane, Nioadala, Quelimane</td>
</tr>
</tbody>
</table>

Total number of districts where SIS-VE is deployed: 43 Districts

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4 wikipedia.org/wiki/MS_Access
For details on the equipment deployed, please see Appendix 2.

**SIS-VE Major Applications**

To improve both the accuracy and timeliness of epidemiological data at the district, provincial, and national levels, the project developed electronic data collection tools for use on PDAs and desktop computers including:

**Boletim Epidemiologico Semanal** (BES): a weekly epidemiological bulletin for gathering and reporting cases and deaths related to the eleven epidemic-prone diseases. Sample screen shots from the PDA version of BES are provided below.
BES data can also be directly entered into a computer using the user interface for data entry, reporting, and analysis developed by the project. The following diagram shows the first screen from which users can choose to enter data, send data to the server at MISAU, analyze data from local database or national database, and generate reports.

**Boletim Epidemiologico Mensal Dos Posto Sentinela (BEM-PS):** a monthly epidemiological bulletin for sentinel sites.

Sentinel sites can enter BEM-PS data directly to their computers and send the data via ODBC link to the national database.

**Resumo diário de Doenças Epidemiológicas:** a form for gathering daily data on cases and deaths related to cholera. The use of this tool will be expanded to cover all epidemic-prone diseases in the future. This form is developed for use on PDAs and client computers.

**National epidemiological surveillance database:** SIS-VE has an analytic epidemiological surveillance database built on MySQL, which was chosen because it is an open-source relational database management system (RDBMS) designed to provide
multiple users with access to multiple databases. The SIS-VE has a graphical user interface (GUI) for monitoring data upload and retrieval. Developed using MySQL Workbench, the GUI can be used to maintain, modify, redesign, or scale the SIS-VE database. SIS-VE users can see the date and time that health facilities, districts, and provinces have entered their data into the system.

**Data analysis tools:** The SIS-VE is equipped with data analysis tools for producing reports based on data obtained from health facilities and sent to the server hosting the MySQL database at MISAU. The tool generates reports with a data summary of notified cases and deaths of any of the eleven epidemic-prone diseases. The summaries are presented by province, district, and locality taking into account variables such as age, sex, and other categories. Reports can be generated for a selected epidemiological week, and/or for a user-defined period providing the cumulative summary for the period.

SIS-VE users can disaggregate data to the health facility level enabling provinces and the national MISAU to see if data is received from all health facilities, assess the quality and completeness of data reported, and identify local characteristics and trends of disease conditions. Using the paper-based system, data about the individual health facility is lost through aggregation at the district level leaving the provinces and MISAU with no way of knowing the local characteristics of epidemic-prone diseases and whether or not the combined data is representative of all health facilities.

**Utilization of SIS-VE by Various Levels of MISAU**

The views of some of the users from districts, provinces, and MISAU are provided below to illustrate utilization of the system for epidemiological surveillance.
District Users:

Ms. Manhique is responsible for community health-related activities including managing epidemiological surveillance of the district. She is one of the primary staff using SIS-VE for recording data into the district database, analyzing data for submission to the district Chief Medical Officer, and reporting summary data to MISAU.

Manjacaze, in Gaza province, is one of the 43 districts where SIS-VE has been deployed to the district level.

“I work with the epidemiological surveillance system provided by the AED-MHIN project. This project has many benefits for us because it helps us to see the previous epidemiologic information and, it also helps us to see which health facilities have not sent their weekly epidemiological reports on time so that we can update the data in the following week and make decisions in case of outbreaks. When the number of cases increases, it is easy to access the database and verify what the epidemiologic situation of that week or month is and make any decision as fast as possible. It also has the advantage that before, we had to wait several weeks until the BES reached the Ministry. Now, with SIS-VE system, the BES leaves the district and on the same day arrives at the Ministry and thus, we can look at the information at the same time.”

“I have to say that SIS-VE epidemiological surveillance system is helping us to rapidly visualize the epidemiologic information in our district. Thus, we can provide directives to locations where we detect problems and that way, we can reinforce the supervision activities and technical support to those sites and help the health facilities to meet the deadlines.”
District Director of Health Services, Woman and Social Affairs of Chibuto district, Mr. Moises is responsible for managing all health related programs of the district.

Provincial User:

Mr. Marcos Chipanga is the Epidemiological Surveillance team leader of Gaza Provincial Health Directorate.

MISAU/National User:

Dr. Jeremias Micas Mate is an epidemiologist at MISAU in charge of data analysis. Dr. Jeremias was also one of the primary counterparts of the project on behalf of MISAU.

“We are using the system SIS-VE, developed by MHIN, funded by IDRC, and executed by AED. This system is important because it makes it easy to organize the epidemiological data in a timely fashion, and it facilitates decision making. For example, a week ago, the new Provincial Health Director visited our district and we used the system to provide him with the most current information on epidemiologic surveillance at our district. It was very quick for us to find the information from the system, and in very short time, we had the information that we were looking for. We think in the future, that information will help us in making decisions in case of diarrhea diseases which are very frequent in our district.”

“SIS-VE is a system for epidemiological surveillance, and with this system we can improve the reporting time. The weekly epidemiological data that used to be reported every 4 weeks, now only takes one week. The system also helps all levels to have information access starting with the health units, which is different from the current system which only has information summarized at every level. This will be very good for us because it will allow us to identify exactly when and where it’s collected and determine whether health problems are outbreaks or epidemics.

“The Epidemiological Surveillance System installed with the support of MHIN project helps us, as data managers, to receive information on time, and it also helps the analysis of the information; it is also easy to see that all districts’ peripheral health facilities are sending data and the data is immediately sent to the higher level at the Ministry of Health and the province. That is why the system is better, because it is easy for the health facilities to send their information to all levels.”
4.1.3 Determining the Cost-Effectiveness of MHIN for Epidemiological Data Collection, Transmission, and Reporting

A study of a project’s cost-effectiveness refers to an economic analysis of the intervention\(^5\) (UCSF, 2002). A method of comparing the cost and effectiveness of two or more alternatives, such investigation involves more than determining cost as it entails assignment of a value to the outcome\(^6\). Cost-effectiveness is also defined as the comparison of the relative expenditure (costs) and outcomes (effects) associated with two or more courses of action. It is typically expressed as an Incremental Cost-Effectiveness Ratio (ICER), the ratio of change in costs and change in effects. Different from cost-benefit and cost-utility, both of which are commonly used to relate costs and outcomes, cost-effectiveness of a health project assesses outcomes in terms of health, while cost-benefit assesses outcomes in monetary value, and cost-utility evaluates the outcomes in terms of subjective value to the decision maker\(^7\) such as cost per Quality Adjusted Life Years (QALY). Cost-effectiveness analysis can be useful for assessing the relative costs and effectiveness of different programs, but all relevant factors for policy-making and resource allocation can rarely be incorporated in a single analysis\(^8\).

The cost-effectiveness analysis of MHIN looked at two alternative scenarios: the paper-based mechanisms of epidemiological surveillance data collection/transmission and the use of a SIS-VE integrating handheld computers, wireless access points, Internet and the cellular network for facilitating epidemiological data gathering and reporting. The underlying assumption was that the alternatives are associated with different costs and different results. By choosing the scenario with the least cost associated with a given or improved outcome, the MISAU can use resources more efficiently and potentially expand the network to other districts and health facilities.

Similar studies were conducted in Uganda by AED-SATELLIFE in collaboration with Uganda Chartered HealthNet (UCH), the Ministry of Health of Uganda, and Makerere University to determine cost-effectiveness of the UHIN project for HMIS data collection and transmission. The study conducted in 2004 through IDRC funding revealed that the UHIN system can yield economic benefits to the health sector, offering about 24 per cent more benefit per unit of spending than manual approaches. In 2009/10, the UHIN project conducted a follow up study to measure cost-effectiveness of UHIN and it showed that UHIN results in 25\% cost savings compared to paper-based approaches.

The cost-effectiveness study revealed that the MHIN solution provided a 20% cost saving compared to paper-based epidemiological surveillance data gathering and reporting through the elimination of supply, printing, storage, and transportation costs.

Methodology
The study used Cost-Effective Analysis (CEA) to compare the electronic and paper-based epidemiological surveillance data collection and reporting approaches. This entailed estimating the costs associated with completing a paper-based epidemiological surveillance data collection form and reporting the data from the districts to the provinces and MISAU headquarters and comparing this with the cost involved in gathering and sending the same information electronically using SIS-VE. The three data collection and reporting tools that the study compared for both approaches are the following:

1. *Boletim Epidemiológico Semanal (BES)* – a notification system used for gathering and reporting cases and deaths related to eleven epidemic prone diseases.
2. *Boletim Epidemiológico dos Postos de Sentinela* – a tool used by sentinel sites for reporting epidemic prone diseases and other priority diseases identified by MISAU.

The study also employed the Cost Utility Analysis (CUA) to measure perceptions of the effectiveness of the health information systems (paper-based and MHIN-based), assuming that the government has limited resources to invest in improving HMIS. In this case the Health Utility Index (HUI) was used to rate each system. After obtaining the utility index, the cost-utility ratio of each of the health information systems under comparison was computed.

Data Collection Approach
The primary units for data collection consisted of the district and provincial epidemiological surveillance units and MISAU headquarters. The data collection methods consisted of interviews, document review analysis, and observation.

The collected data was classified into costs, effectiveness measures and benefit measures. The cost data include the cost for developing and deploying SIS-VE and the corresponding costs of the paper-based approach. All cost items were annualized using conversion factors. The effectiveness measures include the proportion and/or number of districts that submitted complete reports since SIS-VE became operational. The benefit measures include scores provided by respondents regarding accuracy, timeliness and other perceived benefits of each system.

Quantitative Methods
The study adopted the ingredients method which relies on the view that every intervention uses ingredients that have costs. The total costs are thus the sum of recurrent costs and capital costs. Recurrent costs consist of salaries and benefits, office supplies,
transport costs, water, electricity, and communications; while capital costs consist of buildings, equipment, vehicles, and training.

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Identification Categories</th>
<th>Measurements</th>
<th>Valuation Method</th>
<th>Sources of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recurrent</strong></td>
<td>Personnel</td>
<td>Time spent on these activities</td>
<td>Average salary per hour of health personnel</td>
<td>Ministry of Finance salary structure</td>
</tr>
<tr>
<td></td>
<td>Office Supply</td>
<td>Quantity consumed</td>
<td>Interviews (primarily districts)</td>
<td>Market prices</td>
</tr>
<tr>
<td></td>
<td>Transportation</td>
<td>Number of kilometers travelled</td>
<td>Interviews (primarily districts)</td>
<td>Actual expenditure on oil, gasoline and maintenance</td>
</tr>
<tr>
<td></td>
<td>Utility</td>
<td>Average costs of each item per month</td>
<td>Interviews (primarily districts)</td>
<td>Actual expenditure</td>
</tr>
<tr>
<td><strong>Capital</strong></td>
<td>Buildings</td>
<td>Acquisition Value</td>
<td>Interview</td>
<td>Replacement Price</td>
</tr>
<tr>
<td></td>
<td>Equipment</td>
<td>Acquisition Value</td>
<td>Interview</td>
<td>Replacement Price</td>
</tr>
<tr>
<td></td>
<td>Vehciles</td>
<td>Acquisition Value</td>
<td>Replacement Price</td>
<td>Expenditure reports</td>
</tr>
<tr>
<td></td>
<td>Training</td>
<td>Average cost of training</td>
<td>Actual costs</td>
<td>Actual expenditure</td>
</tr>
<tr>
<td></td>
<td>Applications Development</td>
<td>Cost of developing SIS-VE applications</td>
<td>Average cost of training</td>
<td>Actual costs</td>
</tr>
</tbody>
</table>
Cost-Effectiveness Ratio

The cost-effectiveness of the paper-based and SIS-VE data gathering and reporting methods was calculated by totaling the costs of all ingredients associated with a specific form aggregated at the district level and dividing that sum by the total number of forms successfully filled out at the district health office levels.

4.1.4 Key Findings

The cost-effectiveness study showed that the use of mobile devices for epidemiological surveillance data collection and reporting is a superior system for gathering and reporting data compared to paper-based approaches. The MHIN solution provided a 20% cost saving compared to paper-based epidemiological surveillance data gathering and reporting through the elimination of supply, printing, storage, and transportation costs. The MHIN solution provides opportunities to the Mozambican Government for savings and reallocation of financial resources from expenditure related to the traditional epidemiological surveillance system which will finance activities that further enhance the effectiveness of the electronic system.

In addition, the MHIN solution provides timely and accurate data, allowing health managers to make informed decisions faster which speeds the process for rapid action and reduces risks associated with delayed responses to epidemic prone diseases. Key findings of the study include:

1. Paper-based epidemiological surveillance data gathering and reporting requires more hours for data entry and aggregation than the MHIN solution. While it took a total of 26.4 hours/month for data entry and aggregation of the epidemiological surveillance forms\(^9\) using paper-based approaches, the MHIN solution took 5 hours to complete the same tasks. An epidemiological surveillance team at the district level can complete data gathering and aggregation processes using SIS-VE in about 19% of the time it takes using paper-based systems.

2. Electronic epidemiological surveillance system developed by MHIN automatically aggregated data and generated reports, reducing the incidence of errors and shortening processing and response time.

3. The MHIN approach results in 37.15% savings in office supply costs compared to the paper-based approach.

4. Transportation costs are the largest element of the total cost of the paper-based system. On average, provincial health directorates spent 5,796.06 MZN on transportation costs. The MHIN solution reduces this cost substantially.

5. The MHIN approach results in 11.56% savings in buildings operations and maintenance costs such as water, electricity, and telephone compared to the paper-based approach.

\(^9\) The three forms are: Boletim Epidemiológico Semanal; Boletim Epidemiológico dos Postos de Sentinela; and Resumo Diário de Doenças Epidemiológicas.
6. In terms of capital costs, the MHIN incurs higher costs compared to the paper-based system. In this category, the paper-based approach results in 53.25% savings in capital costs compared to MHIN system. This translates to approximately 3,868.29 MZN savings per form/year/district (about US $104.55 per form/year/district). This is due to the initial high investment required for equipment (such as PDAs, AAPs, server, computers) to initiate operation of the system. However, these are once-off investments with an average life span of about six years before requiring a replacement.

7. The computed Cost-Effectiveness Ratio (CER) shows that the MHIN solution is more cost-effective than the paper-based approach. The CER for the MHIN system is lower than that for the paper-based system, suggesting that the former is less costly and more efficient than the latter. The paper-based solution costs are 20% above those of the MHIN.

8. The qualitative analysis supports the initial finding derived from the quantitative analysis. The Health Utility Index (HUI) indicates a preference of the MHIN system over the paper-based system. The HUI for the paper-based system is low (0.1820) in comparison with the HUI for MHIN system (0.4240). This suggests that the respondents believe that they derive more benefits and higher utility from the MHIN system than the paper-based system.

9. Sensitive analysis results show that in the unfortunate situation of a disease outbreak of epidemic proportions, the MHIN system is a better option than the paper-based system. In a situation of 50 percent increase in the volume of data collected due to increased burden of epidemic-prone diseases, the MHIN solution costs less compared to the paper-based system.

10. The qualitative evaluation of the MHIN supports the findings of the quantitative analysis. MHIN users testified that they spend less time for data collection using MHIN; it enables rapid data processing and sharing of results facilitating faster public health decisions by health managers; and it enhances collaborative efforts among the different levels of MISAU.

Based on those findings, the study team from Universidade Eduardo Mondlane (UEM) provided the following recommendations.

a) The MHIN solution provides a less costly and more efficient solution for epidemiological surveillance, maximizing evidence-based decision making and policy evaluation in the area of Integrated Disease Surveillance and Response. The rollout of MHIN will benefit the Mozambique government in terms of cost savings and will enhance its ability to respond to public health concerns.

b) Additional training of health professionals is required. Ongoing on-the-job training, regular supervision, and monitoring of health worker activities are needed at all levels especially in enhancing their computer skills. Such trainings will improve efficiency, enhance the performance of health professionals, and ensure high quality data that can readily be used for decision-making.
c) There was no specific evidence regarding the use of the system during a disease outbreak because no disease outbreaks occurred during the cost-effectiveness assessment of the project. Therefore, prior to scaling up and rolling out to more districts, a second evaluation is recommended to assess the efficiency of the system in such conditions.

d) Some of the computers at the districts are old. Equipping districts with robust computers will enhance utilization of MHIN.

Research has shown that cost-effectiveness analysis may suffer some limitations when conducted over a short period of time. For example, costs may vary depending on how long a program has been operating. The MHIN cost-effectiveness study was conducted 2-4 months after the deployment of SIS-VE to the districts. AED-SATELLIFE and the study team believe that the period the MHIN system was used by the districts and provinces was too short to make a conclusive analysis of project efficiency and that a follow up study is required to provide more complete and reliable research results related to cost-effectiveness.

The cost-effectiveness study report is provided as Attachment-C.

4.2 MHIN November 2006 – May 2009

As noted earlier, during the initial period of implementation (November 2006 – May 2009), the project focused on improving routine Health Management Information System (HMIS) data gathering and reporting processes. In addition, the project conducted research in areas that are vital for MHIN expansion including: (a) determining if the network meets MISAU’s needs for improved data collection and health data exchange; and (b) conducting a cost-effectiveness analysis to determine if MHIN provides an efficient alternative for health data capture and transmission compared to traditional paper-based approaches.

The project worked closely with MISAU’s Department of Health Informatics (Departamento de Informação para a Saúde or DIS) to develop electronic versions of HMIS/SIS data forms selected by DIS for use on MHIN. The primary selection criteria used by MISAU to determine which forms to use with MHIN was whether the data collected using those forms could feed into the District, Provincial, and national Modulo Basico databases. Based on DIS team decisions, 13 paper-based SIS forms were converted to electronic forms for data collection at the point of care and subsequent transmission through the network. The SIS forms deployed to MHIN pilot sites included three immunization forms (SIS A); four MCH and Family Planning forms (SIS B); four outpatient consultations forms (SIS C); and two inpatient consultations forms (SIS D).

The key activities performed during this period are detailed below.

4.1.5 Strengthening Health Information Systems in Pilot Districts

To improve access to reliable SIS data collected from health facilities and thus foster effective policy making, resource management, program coordination, and monitoring and evaluation of MISAU programs, the primary focus of MHIN during this period was improving MISAU’s Health Information System (Sistema de Informação em Saúde or SIS) data collection and transmission processes. The project’s efforts during this period focused on creating an information and communication network in the pilot districts, training MISAU technical personnel and frontline health workers on using the network, preparing existing SIS forms for electronic data capture and transmission, and initiating the use of the network.

For detailed information relating to the technologies deployed in MHIN November 2006 – May 2009, please refer to Appendix 3.

**PDA Customization, Distribution, and End User Training:** Each PDA was assigned a unique user ID and a unique email address. Custom applications, such as the SIS data collection tool programmed by AED-SATELLIFE, an email client, and clinical information relevant for diagnosis, treatment, and patient care related to major health problems of the districts were pre-loaded prior to PDA distribution to end users.

The statistical officers of the district health directorates served as MHIN’s principal focal persons. They received training to manage SIS data received through MHIN and to deliver PDA training to others. The district focal point training guides are provided at Attachment-D and Attachment-E.

Health workers enter data on PDAs and generate reports based on MHIN data.

AED-SATELLIFE prepared an end-user training guide in Portuguese. A total of 109 PDA users were trained on general PDA use; data collection; data upload to the AAP; downloading information and applications from the AAP; and composing, receiving, and
sending emails using PDAs. 98 PDA users were trained by MHIN and MISAU technical personnel; 11 were trained by district focal persons. The end user training guide is provided at Attachment-F.

<table>
<thead>
<tr>
<th>District</th>
<th>Trained by MHIN team</th>
<th>Trained by focal persons</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chókwe</td>
<td>25</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Manjacaze</td>
<td>29</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td>Morrumbene</td>
<td>11</td>
<td>2</td>
<td>13</td>
</tr>
<tr>
<td>Nicoadala</td>
<td>16</td>
<td>4</td>
<td>20</td>
</tr>
<tr>
<td>Namacurra</td>
<td>17</td>
<td>3</td>
<td>20</td>
</tr>
<tr>
<td>Massinga</td>
<td>24</td>
<td>0</td>
<td>24</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>122</strong></td>
<td><strong>11</strong></td>
<td><strong>133</strong></td>
</tr>
</tbody>
</table>

Training of end users in Chokwe district lasted for two days. Assessment, however, showed that end users needed additional instruction and more hands-on training in filling in SIS forms on PDAs. In response, MHIN partners increased subsequent PDA training sessions to three days. This change has improved results, raised the confidence level of health workers to use the PDA for SIS data entry, and minimized occurrence of data entry errors.

**MHIN Users Profile**
- 55% of MHIN end users were female (71 users) and 45% (59 users) were male.
- The majority of MHIN users were nurses. The following table provides the number of MHIN users by category. (Note: Massinga district related data not included in the table.)

<table>
<thead>
<tr>
<th>Category</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elementary Nurse</td>
<td>19</td>
</tr>
<tr>
<td>Preventive medicine Agent</td>
<td>10</td>
</tr>
<tr>
<td>Preventive medicine Technician</td>
<td>7</td>
</tr>
<tr>
<td>General medicine Technician</td>
<td>2</td>
</tr>
<tr>
<td>General medicine Agent</td>
<td>3</td>
</tr>
<tr>
<td>Specialist Nurse</td>
<td>1</td>
</tr>
<tr>
<td>General Nurse</td>
<td>6</td>
</tr>
<tr>
<td>Basic Nurse</td>
<td>13</td>
</tr>
<tr>
<td>SMI basic Nurse</td>
<td>20</td>
</tr>
<tr>
<td>Hospital Technical Admin</td>
<td>1</td>
</tr>
<tr>
<td>Elementary Midwife</td>
<td>2</td>
</tr>
<tr>
<td>Nurse Midwife</td>
<td>1</td>
</tr>
<tr>
<td>Curative medicine Technician</td>
<td>1</td>
</tr>
<tr>
<td>Curative medicine Agent</td>
<td>15</td>
</tr>
<tr>
<td>Doctor</td>
<td>5</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>106</strong></td>
</tr>
</tbody>
</table>
The majority of MHIN users were from Centro de Saude-II (Health Center-II) (55%) and Centro de Saude-I (15%), the levels of health facility that serve the majority of the population in the districts.

**Network Deployment Challenges**

The major challenge in setting up the MHIN solution was related to the AAP software. Upon configuration and installation of the server, and installation of the AAPs in Chokwe district in August 2007, limitations affecting overall performance of the network were discovered including:

- AAP settings were lost requiring re-configuration of the unit(s);
- AAP registration into the server occasionally failed;
- AAPs were losing default settings (factory installed settings); and
- IrDA port of the AAP behaved in a very temperamental way.

The issues that required further customization of the AAP applications, with the exception of those related to the IrDA port, were resolved and the network became fully operational in early June 2008.

Poor GSM/GPRS signal quality at the health centers presented another challenge. AED-SATELLIFE introduced external antennas to boost the GSM/GPRS signal. Low-cost, very easy to install, and virtually maintenance free, the external antennas have proven to be a viable solution. Based on the experiences gained in Mozambique, AED-SATELLIFE introduced a similar solution for the IDRC-funded Uganda Health Information Network project.

### 4.3 Increasing Accuracy and Timeliness of Health Data Received from Rural Health Workers

MHIN partners aimed to support district public health leadership in making informed and prompt decisions by increasing the accuracy and timeliness of health data received from
field health workers through the preparation of SIS forms for electronic data capture, transmission, and analysis.

Health workers collect and enter by hand on daily registers data on all health center activities (outpatients, inpatients, immunizations, maternity, etc.) The health units are responsible for aggregating daily register data and reporting it to the Directorate of District Health Services weekly, monthly, quarterly, and annually. Recording and tallying paper-based records is time consuming and prone to arithmetic errors. DDS offices consolidate all SIS reports from health centers within their jurisdiction and report aggregated data to the Directorate of Provincial Health Services (Direcção Provincial de Saúde or DPS). The DPSs report to the Ministry of Health.

AED-SATELLIFE and MISAU identified the most commonly used daily registers and reporting forms and developed electronic versions of the forms. The MHIN solution allowed users to collect SIS data daily on their PDAs. Data aggregation and generation of reports for submission to DDS was done automatically on the device.

The following paper-based SIS forms were converted to electronic forms for data collection at the point of care and subsequent transmission through the network.

**Category A (Immunization):**

*Form A01*: Registo Diário BCG/DPT

*Form A02*: Vacina Anti-Tetanica

*Form A03*: Resumo Mensal (monthly report - automatically generated by the PDA)
Category B (MCH and Family Planning):

Form B01: Maternidade

Form B02: Pré Natais Post Parto PF

Form B03: Consultos 0-4 Anos

Form B04: Resumo Mensal (monthly report - automatically generated by the PDA)

Category C (Outpatient Consultations):

Form C01: Consultos Externas

Form C02: Novos Casos de Doenças

Form C04: Medicamentos Kit A (monthly report)

Form C05: Medicamentos Kit B (monthly report)

Category D (Inpatient):

Form D01: Internamentos

Form D02: Internamentos Cirúrgicos

The relationship between data collected at health units using PDAs and reports generated by district health offices is provided in the following table.

<table>
<thead>
<tr>
<th>Health Facility Level</th>
<th>District Level</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Daily Register Forms (Data collected on PDAs)</strong></td>
<td><strong>Monthly/Weekly Report Forms (Generated by PDAs)</strong></td>
</tr>
<tr>
<td>A01: Registo Diário BCG/DTP</td>
<td>A03-1: Novo PAV</td>
</tr>
<tr>
<td>A01: Registo Diário CG/DTP_BM</td>
<td></td>
</tr>
<tr>
<td>A01: Registo Diário CCV</td>
<td></td>
</tr>
<tr>
<td>A01: Registo Diário CCV_BM</td>
<td></td>
</tr>
<tr>
<td>A02: Vacina Anti - Tetânica</td>
<td>A03-2: Novo PAV-VAT</td>
</tr>
<tr>
<td>A02: Vacina Anti - Tetânica_BM</td>
<td></td>
</tr>
<tr>
<td>B01: Maternidade</td>
<td>B07: Maternidade</td>
</tr>
</tbody>
</table>
Health Units Using PDAs for SIS Data Collection and Transmission

68 of the 70 health units in the five pilot districts were using PDAs for SIS data capture and transmitting SIS reports via the AAPs.

<table>
<thead>
<tr>
<th>Health Units Using PDAs for SIS Data Collection/Reporting</th>
</tr>
</thead>
<tbody>
<tr>
<td>District</td>
</tr>
<tr>
<td>-------------------</td>
</tr>
<tr>
<td>Chokwe</td>
</tr>
<tr>
<td>Manjacaze</td>
</tr>
<tr>
<td>Morrumbene</td>
</tr>
<tr>
<td>Nicoadala</td>
</tr>
<tr>
<td>Namacurra</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Health workers in the five districts were collecting SIS data on both paper and PDA. The use of both the paper-based and handheld-based collection processes was an added burden to the health workers and it became the major reason for MISAU to shift focus of the project from general HMIS to epidemiological surveillance data collection and reporting. Despite the added burden, health workers recognized the advantages of the digital system and were aware of the benefits that MHIN provides compared to paper-based systems. An e-mail sent by a rural health worker from her PDA in Portuguese is provided below (with English translation):

Date: 2008/9/24
Subject: Vantagem do modulo basico usado pela RMIS
To: aed.rmis@gmail.com

A grande vantagem do modulo basico usado pela RMIS em comparacao com o modulo basico actualmente usado no MISAU e que o da RMIS nao precisamos de introduzir dados porque o processo todo e automatico enquanto que o modulo basico usado pelo misau e necessario sentar para introduzir os dados no final do mes e pela quantidade de dados acumulados ate ao fim do mes existe o risco da pessoa que esta digitar
cometer falhas que irão alterar os dados, e é um processo muito cansativo, se fizermos uma comparação do tempo no sistema da RMIS usamos um terço do tempo que se usa actualmente no misau.

[The great advantage of the RMIS (MHIN) Database compared to the current database used by MISAU is that on the MHIN Database, there is no need to manually enter cumulative data from different health clinics into the database at the end of each month, which is very tiring and there is always a risk that one can make mistakes when entering data that will affect the overall aggregated data. Comparing the time spent on both processes to compile district health data and print reports, the MHIN requires 1/3 less than the time we spent using the existing MISAU process.]

SIS data beamed to AAPs is transferred to the districts and MISAU in a matter of minutes allowing district health officials to make informed decisions and respond promptly. The following diagram shows the SIS data flow model implemented by the project.
Preliminary field assessments indicated that health workers and district officials highly favor the use of MHIN over the traditional paper-based approach for SIS data collection and transmission.

A team composed of MISAU and AED-SATELLIFE\(^\text{11}\) conducted on-site monitoring and evaluation at several health units in Namacurra, Nicoadala, and Chokwe districts in October 2008. The assessment covered 12 health units and over 20 health workers. Observations from this assessment include:

- Given the choice, health workers prefer using MHIN for SIS data collection and reporting over paper-based approaches. Among the reasons for their preference are that data is stored electronically; reporting to districts is done almost instantaneously; traveling to districts for submitting reports is

\(^{11}\) The team included: Dr. Ercilia Almeida, MISAU Health Information System Director; Berhane Gebru, AED-SATELLIFE Program Director; Bina Langa, MISAU SIS Officer; Cicero Salomao, MHIN System Operator; Gombassusso Chilenge, MHIN Training and User Support Officer and District MHIN focal persons.
avoided; summaries are automatically calculated using MHIN solution; monthly reports are generated automatically; paper work is reduced; email communication is enabled; and the ability to play music on the PDA helps relax after a long day;

- Almost all users felt confident employing PDAs for SIS data collection and reporting. All indicated they want to use PDAs for whatever tasks can be done with the devices and therefore desire additional training on the other PDA applications;
- All health workers wanted all paper forms being used in their health unit to be converted to electronic format for use with MHIN;
- Using PDAs made users feel that they had advanced in their career. The impact of using PDAs in raising self-esteem was expressed strongly by several users; and
- Almost all of the PDAs users employed the device for playing music and games during leisure time. Experience shows that users take better care of their PDAs (for example, keeping it charged) if they are allowed to use the unit for personal entertainment in their free time.

4.4 Providing Health Workers with Relevant Health Information

Health care information obtained from MISAU was pre-loaded to all PDAs. Selected to contribute to improving the quality of care health workers deliver to the populations they serve, the information included MISAU policy and procedures manuals; polio, measles, and dysentery treatment manuals; and malaria vaccination and treatment manuals. These extensive guidelines, disseminated in HTML format, provide information on the diagnosis, treatment, and patient care approaches mandated by the Ministry of Health. Health workers were trained on using MobiPocket software, an e-book tool provided on the PDAs, for browsing and viewing health information provided on the PDAs.

Project partners planned to commence using the network for weekly broadcasts of health information to MHIN participants in Chokwe, Manjacaze, Morrumbene, Nicoaodala, and Namacurra districts in January 2009, however, these plans were terminated due to MISAU’s desire to focus system use exclusively on epidemiological surveillance data collection and reporting.
4.5 Cost-effectiveness Assessment

Increased investment in health is dependent upon improved evidence of positive changes in health outcomes. As such, there is a critical need for good health information. In recognition of this, global efforts have been targeted towards strengthening electronic Health Management Information Systems. It is believed that improved data quality and timeliness will enhance evidence-based policy formulation leading to improved accountability and effectiveness at all levels of the health system.

In Mozambique, increased demand for health information and the potential opportunity to supply it calls for an investment in building a sustainable national HMIS; this has been highlighted in a number of papers. Studies assessing the costs and cost-effectiveness of electronic HMIS in Mozambique, however, are very scarce.

The project worked with the Academic Registration Directorate of Eduardo Mondlane University (Universidade Eduardo Mondlane or UEM) to conduct a cost-effectiveness assessment of the network for SIS data collection and transmission. A methodology for conducting the study was developed by UEM and the project. The methodology included mechanisms for identifying and comparing the costs of accessing, sharing, and communicating information among health care providers, managers, and policymakers using MHIN technology versus the existing alternatives. By comparing costs and benefits the study aimed to provide recommendations as to whether MHIN is viable and whether the network should be replicated elsewhere in Mozambique. The results of the study were expected to guide policy makers in making informed decisions regarding a full scale MHIN roll out for HMIS data management to all districts.

The cost-effectiveness study was designed to involve quantitative and qualitative data collection and analysis. The study team developed a structured questionnaire for gathering data on operational and start-up costs of both paper-based and MHIN-based HMIS approaches.

Baseline data collection for the study was planned to begin in December 2008. Follow-up data collection was expected to continue through the end of the project. Due to MISAU’s preference to shift the focus of the project from general HMIS to epidemiological surveillance, follow-up data collection and analysis was not conducted. However, the methodology for cost-effectiveness assessment developed during this time was used for assessing the cost-effectiveness of MHIN-based epidemiological surveillance vis-à-vis paper-based approaches of data collection and reporting. The results of the study are provided in previous sections of this report.

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Kimaro and Nhampossa (2005). “Analyzing the problem of unsustainable health information systems in less-developed economies: case studies from Tanzania and Mozambique.”
4.6 Outcome Mapping

The foundations for applying outcome mapping (OM) for answering MHIN research questions were laid during the initial implementation periods of the project. MHIN partners engaged Ms. Ineke Buskens as OM and Action Research (AR) consultant. A three-day OM/AR workshop was held in Maputo at MISAU, May 2-5, 2007. The workshop, facilitated by Ms. Buskens, was designed to enhance the capacities of key players of the project with skills that are needed to successfully engage in an OM/AR process, to familiarize key players with the project and its purpose, and to develop personal relationships among all those involved in the project.

A second OM/AR and Gender Awareness workshop was conducted to review and update the OM/AR framework developed in May 2007, and to solidify the foundation for OM/AR and gender awareness as viable processes for thinking and practice within the project. This workshop was held in Maputo May 26-28, 2008 and was attended by MHIN staff, MISAU key personnel, district health directors and statistical officers, and officials from provincial health offices.

MHIN partners used OM/AR tools to document the processes of participation, collaboration, and utilization of the MHIN technology solutions. The district focal persons, MHIN project staff, and PDA users contributed their insights on the use of MHIN for health data exchange and as a communications tool in accordance to the framework developed during the two OM/AR workshops.

The roles and task description for the four main MHIN role-player groups identified during the OM/AR workshops were:

- The users, health workers in the clinics who handle the PDAs and the AAPs;
- The District Focal Points, centrally located at the District offices and responsible for health data analysis and generating reports for submission to provincial health offices;
- The MHIN training and technical staff, and the Project Manager, located in Maputo at the MHIN office; and
- The data managers at the Ministry of Health who are responsible for receiving health data from the various provinces, aggregating the information, and generating reports for policy makers and managers at MISAU.

The OM/AR process is successful when the major role-player groups (or “boundary partners”) as frequently as required document their reflections as is and critique the situation as is. However, documentation of the OM/AR process by the key role players has been weak. Per the framework suggested by the OM consultant during the workshops, the role-player groups were expected to write their reflections and critiques every morning. They found this to be an extremely cumbersome assignment, and all of the users complained that this approach was impractical for their situations. In consultation with IDRC and MISAU, the project stopped the use of OM as a tool for documenting behavior changes among MHIN role-player groups.
5. Summary of Project Activities

MHIN was managed by AED-SATELLIFE in partnership with MISAU. A project office was established in Maputo in early 2007. During the period January 2007 – September 9, 2009, the project leased office space from the Mozambique Information and Communication Technology Institute (MICTI) located at the Centre for Technology Development, Av. Base Tchinga 210 in Maputo. Beginning September 10, 2009 the project leased office space from the Universidade Eduardo Mondlane (UEM) located at the main University Campus in Maputo, Complexo Pedagógico, Bloco 02, 2º Piso, Gabinete 02B.

An MHIN Steering Committee (MHIN-SC) composed of representatives of each of the partner organizations and chaired by MISAU was established in January 2007. Providing guidance on project focus and implementation, and determining the direction of MHIN expansion, the Steering Committee worked to enhance intra-ministerial and institutional collaboration. AED-SATELLIFE and MISAU established an email distribution list to ensure that all MHIN-SC members were updated on the progress of the project.

Day-to-day MHIN operation was conducted primarily by the AED-SATELLIFE Project Director and by the Mozambique-based MHIN staff comprised of the following:

<table>
<thead>
<tr>
<th>Title</th>
<th>Responsibilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Manager</td>
<td>Day-to-day management of the project, working closely with AED-SATELLIFE home office staff and MISAU.</td>
</tr>
<tr>
<td>System Operator</td>
<td>Network operation and maintenance.</td>
</tr>
<tr>
<td>Training and User Support Officer</td>
<td>Training of end users on the MHIN system and providing ongoing user support.</td>
</tr>
<tr>
<td>Logistics Officer</td>
<td>Ensuring that all required equipment is in place as needed; bookkeeping; handling project-related financial transactions in Maputo.</td>
</tr>
<tr>
<td>Driver/Logistics Assistant</td>
<td>Providing general support; driving; performing preventive maintenance of the project vehicle.</td>
</tr>
</tbody>
</table>

During the initial period of the project (2007-2008), MISAU and MCT assigned technical counterparts who devoted one to two days a week to working with MHIN staff. After shifting MHIN’s focus to epidemiological surveillance, the project team primarily worked with MISAU counterparts from the epidemiology department and DIS. End user and district focal person training, and support provision to districts and health units using MHIN were jointly provided by MISAU and MHIN technical personnel.

The following key activities were performed during the period of performance of the project:

**MHIN Steering Committee:** An MHIN Steering Committee (MHIN-SC) composed of the representatives of MISAU, MCT, and AED-SATELLIFE was established, and held
its first meeting on December 19, 2006 at which preliminary implementation plans for the project including final selection of pilot districts were discussed.

**Project Office:** AED-SATELLIFE established an MHIN project office in Maputo (January - April 2008), purchased supplies and equipment to outfit the office, and established a financial relationship with a local bank to manage project transactions.

**Staff Hire:** MHIN project staff (Project Manager, System Operator, Training and User Support Officer, and Logistician) were recruited and interviewed by the Steering Committee. MHIN staff members were initially hired as consultants pending AED registration in Mozambique with the Ministry of Foreign Affairs. This process was completed on September 2, 2007 and MHIN personnel were duly hired as regular employees.

Recruiting and hiring staff with the requisite skill sets and experience was a major challenge. MHIN staff hired at the beginning of the project (early 2007) either resigned or their employment was terminated due to inefficiency. Beginning 2008, MHIN was staffed by a vibrant and innovative team.

**MHIN Stakeholders Meeting:** Two major stakeholders’ meetings took place in Maputo during the period of performance of the project. Attended by MISAU representatives (MISAU key personnel, provincial and district health directors, and other decision makers), AED-SATELLIFE, MCT, IDRC, and representatives of other donors and organizations involved in health and/or ICT, the first meeting was conducted on May 7, 2007 to introduce the objectives, approaches, and work plan of the project; the second was conducted April 11, 2008 to discuss achievements and challenges faced during implementation of the project and to provide direction for the future plans of MHIN. Engagement of key stakeholders helped in promoting coordination and harmonization of activities undertaken by MHIN and other institutions.

**MHIN Technical Personnel Training:** AED-SATELLIFE trained MHIN, MISAU, and MCT technical personnel on the collection, storage, and transfer of health data, and the preparation of content to a format suitable for PDAs and the MHIN network. AED-SATELLIFE hired Uganda Chartered HealthNet (UCH) to conduct this training in Maputo. Lessons learned on end user training and the development of forms for the PDA from the IDRC-funded UHIN project were shared with MHIN and MISAU staff.

MHIN, MISAU, and MCT technical personnel received successive training on: MHIN server operation, management, and troubleshooting; African Access Point (AAP) interfaces and functionalities; AAP performance requirements, capabilities, limitations and management; AAP security features and security management; AAP operation, maintenance and troubleshooting; and email exchange using the MHIN network.

Project staff also received training in business and project management policies and procedures. The AED-SATELLIFE Financial Manager traveled to Maputo twice to train the project logistician; the AED-SATELLIFE Director of Programs provided on-the-job
training on project planning, implementation, and evaluation processes during numerous visits to the Maputo office. Project staff also attended AED-led training in Pretoria on project management approaches and financial management. AED covered the training costs in Pretoria and no expense was charged to the project.

**Site Selection:** During MHIN’s engagement on routine HMIS data management and content dissemination (November 2006 – May 2009), six districts were selected by MHIN-SC based on site assessments and rigorous analysis of health facilities density, cellular coverage, power access, staffing, and current data reporting practices. Each Province was visited for meetings with senior political and health officials to brief them on the project and engage their participation.

After realigning objectives of the project to epidemiological surveillance, the project in close consultations with MISAU and IDRC selected all 43 districts in 3 provinces where MHIN was deployed and all 11 provincial health offices. The project team visited all 11 provinces and 43 districts for meetings with relevant MISAU officials to discuss project objectives and agree on work plans.

**Outcome Mapping (OM) and Action Research (AR):** To document the processes of participation, collaboration, and utilization of the MHIN solution, two workshops on Outcome Mapping and Action Research were conducted in Maputo facilitated by Ms. Ineke Buskens of Research for the Future (South Africa). The first three-day OM/AR workshop was held in Maputo at the Ministry of Health on May 2-5, 2007. A second workshop took place in Maputo May 26-28, 2008 to lay the foundation for Outcome Mapping, Action Research, and Gender Awareness to become viable processes for thinking and practice within the project. Staff from AED-SATELLIFE, MHIN, MISAU, MCT, and the districts attended these training sessions.

**Equipment Procurement:** A server was acquired, configured, and installed by the project at MISAU headquarters in Maputo. The server facilitates data exchange among districts, provinces, and MISAU headquarters. The server also hosts the national epidemiological surveillance database.

Sixty African Access Points were manufactured in South Africa and shipped to Mozambique in two batches: 30 units at the end of July 2007; and 30 units in July 2010.

AED-SATELLIFE acquired and delivered a total of 195 Palm Tungsten E2 handheld computers in two batches: 110 units on April 2007; and 85 units on October 2008. 195 units are currently in use in the districts and 11 provinces.

AED-SATELLIFE procured 55 PDA solar chargers from Uganda for deployment to health centers that are not connected to the national electric grid. 15 solar panels for recharging AAPs were procured from the US and shipped to Mozambique.

Computers for the district health offices and MISAU health information department were acquired locally, configured for MHIN use, and deployed.
Training of District Focal Persons: MISAU and MHIN technical personnel trained 86 district and 22 provincial epidemiological surveillance team members on using and managing the MHIN system for epidemiological surveillance data collection, reporting, analysis and alerting.

Training of PDA Users: During the initial period of MHIN (November 2006 – May 2009), a total of 133 PDA users from health facilities located in the six pilot districts were trained by MHIN and MISAU technical personnel and district focal persons.

Applications Development: During the initial period of MHIN, 13 health facility-based SIS forms were converted to PDA format by AED-SATELLIFE staff in collaboration with MISAU technical counterparts.

During the period June 2009-October 2010, three epidemiological surveillance data gathering and reporting tools were developed for use on PDAs and desktop computers. A national epidemiological surveillance database was built on MySQL. Web interfaces for accessing the national database, generating reports and analyzing data were developed and deployed.

6. Project Outputs and Dissemination

6.1 Summary of Project Outputs

The project outputs include:

- 195 handheld computers complete with recharging cables and Secure Digital (SD) cards for additional memory acquired (110 units with 512MB and 85 units with 1GB capacity).
- 55 PDA solar chargers acquired and distributed to handheld users at facilities without national electric grid access.
- Ten handheld GPS (Garmin eTrex H) units acquired and in use for health facilities location mapping;
- 133 health workers trained on using handheld computers for data collection and transmission and accessing content broadcast through the network;
- Ten district health statistics officers from five pilot districts trained on training new handheld users, troubleshooting the network, and using data tools such as MS Access;
- 86 district epidemiological surveillance officers from 43 districts trained on using the MHIN system for epidemiological surveillance data collection, reporting, and analysis;
- 22 provincial epidemiological surveillance officers from 11 provinces trained on using the MHIN system for epidemiological surveillance data management;
• One server for hosting the national epidemiological database, AAP remote administration, and content deployment acquired, configured, and installed at MISAU;
• 60 African Access Points (AAPs) acquired, configured, and deployed to participating districts;
• Two MISAU counterparts as well as two MCT technical personnel trained on AAP configuration, deployment, and administration;
• Three epidemiological surveillance forms developed for use on MHIN;
• Thirteen SIS forms converted to format suitable for MHIN use and deployed to health centers;
• Mechanism for synchronizing SIS data collected and transmitted through MHIN with the national health information systems and databases developed and tested; and
• Cost-effectiveness assessment of the network for epidemiological surveillance and reporting conducted.

6.2 Capacity Building

Developing MISAU’s capacity to maintain, manage, and modify the network is essential to ensuring the long-term sustainability of the project. To realize this, AED-SATELLIFE engaged in progressively building MISAU’s capacity to use the system, provide user support, train new users, and troubleshoot the system. The capacity building approaches followed by the project include the following:

Target group: The groups targeted for the project’s capacity building activities were comprised of technical personnel from the Department of Health Information (Departamento de Informação para a Saúde or DIS) and the Epidemiological Surveillance Department at national level; provincial epidemiological surveillance team; and district epidemiological surveillance officers. Selection of trainees was made by the Epidemiological Surveillance Department in close consultation with provincial offices.

Capacity Building Methods: The project used a combination of capacity building methods to optimize learning and take advantage of the relative strengths and weaknesses of each method. The following methods were used to improve the knowledge, skill, and attitudes of the different target groups.

Workshop training: The project designed a three-day intensive training workshop to allow provincial and district users to gain practical knowledge about the use of the system and to enhance experience sharing among trainees and trainers. During early phases of the project, training workshops were delivered for two days. Evaluation of the efficacy of the training conducted by the project team indicated that two days was inadequate to build the users’ confidence. Increasing the number of days to three proved to be effective. Due to the high costs of workshop training, users received such training only once.
**User manuals and documentation:** The project team prepared user manuals for end users at the district level and for system administrators at DPS and MISAU. The documentation is designed to serve users and system administrators as aids for the effective use and maintenance of the system. The SIS-VE end-user guide and the advanced manual for system administrators are provided as Attachment-A and Attachment-B respectively.

**On-the-job training:** Throughout the project, AED-SATELLIFE provided on-the-job training to the MHIN project team on developing, deploying, maintaining, and improving the MHIN system for epidemiological surveillance data management. The Maputo-based MHIN project team in turn provided similar training to the MISAU team at the national level. In addition, AED contracted S-Curve Technologies, a South Africa-based company that manufactured the AAPs, to provide ongoing training and technical support to both the MHIN and MISAU teams on AAP and AAP server management and troubleshooting. The approach of provided ongoing training and support proved to be effective especially for the extremely busy MISAU technical team because it was less disruptive than workshop training.

**Training of Trainers:** The project trained two epidemiological surveillance officers from each province as trainers through a three-day training workshop. The provincial trainers were trained prior to the training of district users. The provincial trainers from Gaza, Inhambane, and Zambezia provinces participated in the delivery of training workshop to districts in their jurisdiction. The technical team from national level MISAU also participated in training sessions delivered to provincial and district teams. This approach supported MISAU and DPS staff in learning and practicing the training process.

**Mentoring:** The project provided regular support to the various target groups. AED provided ongoing mentoring to the in-country MHIN team on project management, applications development and enhancement, capacity building, and other areas critical to the success of the project. The MHIN project team provided ongoing mentoring to the provincial and district team. To facilitate mentoring and remote technical support, the project established a toll-free number which district/provincial users can dial free of cost to speak to the training and user support officer of the project. Mentoring was especially crucial during the first three months of deployment to provincial and district users.

**Peer-to-peer support:** MHIN users at districts have varying degrees of competency in using computers. Novice users of technology frequently experience difficulties with equipment and software and may require extensive assistance to overcome these challenges. If circumstances do not allow district users to get support from the project team, the project encouraged users to seek support from each other. When circumstances permit, such as during staff meetings, users with technical difficulties get support from their peers.
AED-SATELLIFE successfully developed the technical and project management competencies of MHIN Mozambique-based staff to operate the network, and to train and provide ongoing support to end users.

Major capacity building activities undertaken by the project included:

**MHIN Personnel:** Mozambique-based MHIN staff received successive advanced training on developing electronic data collection and reporting tools for use on mobile devices; server configuration, administration, and troubleshooting; project planning and management; and financial management.

**MISAU Headquarters Staff:** AED-SATELLIFE engaged in various activities designed to progressively build the technical capacity of MISAU’s staff. Technical personnel at the national office received training on network management, transferring health data collected/transmitted through the network to existing back-end databases, training of new users, converting paper forms to a format suitable for the network, content and applications deployment to frontline users, and troubleshooting network problems.

**District and Provincial Surveillance Team:** 86 district and 22 provincial staff received training on using MHIN for epidemiological surveillance and reporting. The training objective was to provide the provincial and district health workers with the skills necessary to use the SIS-VE application with PDAs or desktops computers to collect epidemiological data and to transmit surveillance data via the cellular network or the Internet. The provincial team received additional training on training of new users.

The provincial health offices consulted with MISAU’s epidemiological surveillance department in selecting the provincial staff to participate in the SIS-VE training. Two epidemiological surveillance teams from each of the eleven provinces were trained in Sofala province (Beira town) on April 20-23, 2010. The provincial SIS-VE teams are responsible for epidemiological surveillance and preventive health in their respective provinces.

After the conclusion of the SIS-VE training, the provincial teams were unanimous in saying that the use of SIS-VE will improve the quality, reliability, and timeliness of epidemiological surveillance data. They were also unanimous in their recommendation that to make the best use of SIS-VE the system be deployed at least to the district level.

Training of district epidemiological surveillance teams was conducted at the three provinces with the full participation of the respective provincial teams. Training of the district surveillance teams took place April 26 – June 11, 2010. A total of 86 epidemiological surveillance personnel from 43 districts (2 per DDS) were trained on the use and basic management of SIS-VE.

District team training took place at the following locations and dates.
**Inhambane:** Two staff members from each of the fourteen districts in this province were trained in Inhambane city for three days, May 17 – 19, 2010.

**Zambezia:** Two staff members from each of the seventeen districts in this province were trained in Quelimane city for three days, May 30 – June 2, 2010.

**Gaza:** Two staff members from each of the twelve districts in this province were trained in the provincial city Xai Xai for three days, June 21 – 24, 2010.

District personnel received training in the following major areas:
- Using PDAs for data collection;
- Using desktop computers for data collection;
- Data transfer from PDAs to the district epidemiological surveillance database;
- Data transfer to MHIN server at MISAU through AAPs and via the Internet;
- Epidemiological data analysis using application installed on the district computer; and
- Generating epidemiological reports based on indicators determined by MISAU for district use.

**Health Facility Personnel:** 133 health workers were trained on PDA and AAP use, HMIS data collection using mobile devices, sending/receiving information through the network, basic troubleshooting, and preventive maintenance of mobile devices. Capacity building focused on expanding the skill base of frontline health workers to use the network and to use PDAs for data collection.

### 6.3 Dissemination

During the course of the project, AED-SATELLIFE has disseminated information and lessons learned through the process that generated the outputs listed above. Dissemination channels within both the health and ICT sectors are briefly described below.

- **Rwanda Health and Education Information Network (RHEIN) Workshop:** A presentation featuring MHIN was made by Berhane Gebru during RHEIN’s workshop in Kigali, Rwanda, May 28-29, 2008.

- **Making the eHealth Connection Conference:** AED-SATELLIFE Director Holly Ladd and Director of Programs Berhane Gebru shared MHIN experiences with meeting participants during the July 13-18 and July 27-August 1, 2008 sessions. The conference was held in Bellagio, Italy.

- **MobileActive08:** A presentation featuring MHIN was made by Victorino Nhabangue (MHIN Project Manager) and Henk Boshoff (S-Curve Technologies, South Africa) at the MobileActive08 meetings in Johannesburg, South Africa October 13-15, 2008 on the theme “using mobile technology for social impact.” MHIN was offered as a viable solution that uses the mobile network for low-cost data exchange.
• **Internet Governance Forum (IGF):** MHIN was presented as a pro-poor ICT solution for implementing projects at the community level during IGF’s meeting in Hyderabad, India December 3-6, 2008. The Association for Progressive Communications (APC) selected MHIN “for inclusion in this toolkit because it illustrates the fulfillment of a number of critical requirements for moving a project from prototype to pilot and eventual sustainable roll-out”. The reasons provided by APC for MHIN selection include: “1) the application of an innovative and affordable technology solution involving mobile networks and the use of PDAs by individuals unfamiliar with the use of ICTs, in this case health workers, who are often of an older age and therefore more resistant to the adoption of new technologies; 2) government commitment to providing better health services to communities, while benefiting from the better availability and accuracy of health data from the field; 3) cost savings and increased productivity in terms of data collection from districts, including the monitoring of paper-based versus digital data collection systems; and 4) the gradual up-scaling of a development project through a collaborative partnership between an NGO (AED-SATELLIFE) and the Ministry of Health, Mozambique”. The toolkit is available at: [http://www.apc.org/en/node/9476](http://www.apc.org/en/node/9476) in English, French, and Spanish and is also provided at Attachment-G, Attachment-H and Attachment-I respectively.

### 7. Project Outcomes and Lessons Learned

#### 7.1 Project Outcomes

Over the four years of research, the MHIN project yielded valuable results and lessons learned that have contributed to the body of knowledge on the use of ICTs in health and development. Specific outcomes of the project include the following.

**Epidemiological surveillance data collection, analysis, and sharing**

All 11 provinces and 43 districts in Gaza, Inhambane, and Zambezia provinces are utilizing electronic tools and processes developed by MHIN for epidemiological surveillance data gathering and reporting as a cost-saving alternative to paper-and-pen-based approaches. The system developed by the project is enabling the districts and provinces to receive and analyze high-quality data on time, track outbreak prone diseases, and be better equipped to respond in a timely manner to disease outbreaks. The district users assert that the MHIN system is helping them to support health facilities to meet their reporting deadlines, assess and report epidemiological surveillance data in a timely fashion, analyze trends of outbreak prone diseases efficiently, and make informed decisions.\(^\text{13}\)

\(^\text{13}\) Tania Manhique, Community Health Officer, Chibuto district; Andre Matsinhe, Director of Health and Women’s Affairs, Manjacaze district; and Moises Malo, Director of Health and Women’s Affairs, Chibuto district. Video Interview, August 2009.
Prior to the introduction of the MHIN system, the districts were using paper-and-pen to aggregate and analyze epidemiological surveillance data received from health facilities in their jurisdictions. Aggregate reports were then sent to the provincial health offices where multiple district reports were aggregated to produce provincial reports. The provinces in turn sent their reports to the national ministry of health for nationwide aggregation of epidemiological surveillance data. Listed below are problems associated with the paper-based approach and advantages of the MHIN system noted by the districts, provinces, and national level staff:

- The paper-based system aggregated data at each level. The data ultimately received at the provincial and national levels and used by MISAU and other partner organizations reflected activity on the district level only. Due to the lack of facility level information, one could not ascertain if data had been received from all facilities in each district or if and when each facility had reported. Further, it was not possible to detect variation of outbreak-prone diseases within each district or identify those localities that are most affected or likely to be affected by outbreak prone diseases. MHIN, on the other hand, supports the disaggregation of data to allow decision makers to view the public health situation at any one facility. As a result, the district, provincial, and national MISAU team prefers using the MHIN system for epidemiological surveillance and reporting.

- MISAU’s epidemiological surveillance system requires health facilities to report on epidemic-prone diseases to MISAU headquarters every week. However, the paper-based reporting process takes a minimum of four weeks to reach MISAU through district and provincial health offices. The inability to report surveillance data in a timely fashion hampers the health system’s ability to respond swiftly to outbreaks. The MHIN system has enabled reporting of data from health facilities within one week, resulting in an increased use of the system by the districts. In some instances, district epidemiological surveillance teams have used Internet Cafes for uploading surveillance data to the server at MISAU when the Internet connection is down at district health offices.

- The MHIN system minimizes data aggregation and transcription errors. Data entered to the server at MISAU by the districts is automatically shared with mandated personnel at the provincial and national health offices. The district and provincial health offices stated that this benefit is an additional impetus for the districts’ and provinces’ preference of MHIN over the paper-based approach.

- There was no disease outbreak during the deployment of MHIN for epidemiological surveillance. However, all levels of MISAU agree that timeliness and completeness of data related to epidemic prone diseases is a key factor in informing the health sector decision-making process and enhancing MISAU’s capacity to adequately combat epidemics. As a result, there is a broad consensus among the users and managers that the MHIN system creates an enabling environment for making prompt and informed decisions for combating diseases outbreaks before they become epidemic.
Enhancing Communication and Collaboration

District and provincial health offices established faster, better-functioning networks for communication and collaborative work with health units and other public agencies.

Unlike the paper-based approach, the MHIN system allows districts and provinces to view reporting from each health facility and evaluate the timeliness, completeness, and quality of the data. The system enables the identification of those health facilities where data reporting is delinquent or missing and facilitates the assessment of the level of remediation needed to meet MISAU standards. With this information, districts are able to provide proactive technical support to health facilities; and provinces to districts.

There are indications of improved collaborations among different government bodies in Gaza province because of the increased reliability and timeliness of data gathered and reported by the MHIN system. The district health office in Chibuto district is sharing epidemiological surveillance data with the municipality to ensure that the municipality is logistically and politically prepared for any emerging outbreak issues. The provincial health office also shares epidemiological surveillance data gathered using the MHIN system with the Instituto National de Gestao de Calamidade (INGC – National Institute of Disaster Management) monthly and, if the situation related to epidemic prone diseases is bad, weekly. Such data sharing has been done consistently since the introduction of the MHIN system for epidemiological surveillance. Timely sharing of epidemiological surveillance data enables the municipalities and INGCs to enhance disaster preparedness of the institutions.

Fostering Policy Dialogue

The development and use of MHIN for epidemiological surveillance is the outcome of numerous discussions with MISAU policy makers and technical managers, Ministry of Science and Technology, IDRC, Eduardo Mondlane University and other organizations in Mozambique.

Initiation of the MHIN project is one of the direct outcomes of the IDRC funded Uganda Health Information Network (UHIN). AED-SATELLIFE met the Mozambique Minister of Health in November 2005 in New York during the TIME Global Health Summit. During this meeting, the approaches and outcomes of UHIN in improving health data management and improving information access to health workers were discussed. The minister saw the potential of applying the UHIN model for improving health data collection, analysis, and information dissemination for Mozambique and requested that AED-SATELLIFE implement a similar network in Mozambique to facilitate health information data capture and transmission from remote health facilities to district, provincial, and national health services.

Representatives of AED-SATELLIFE and IDRC visited Mozambique in February 2006 at the invitation of the Minister of Health and the Minister of Science and Technology
(Ministério da Ciência e Tecnologia or MCT) to determine the feasibility of developing a health data collection and information system similar to the UHIN project in Uganda.

After numerous consultations with senior MISAU, MCT, and IDRC, the parties agreed to introduce the use of mobile technologies for daily collection of HMIS data using PDAs at the point of care and subsequent transmission of this data through the wireless telecommunications network to a server at MISAU. The system was successfully deployed to health workers in five pilot districts, and health workers collected HMIS data on both paper and PDA. The decision to use both paper-based and electronic data collection was made because MISAU wanted to have one system for the whole country. The project deployed MHIN in 5 out of 128 districts, and MISAU and the project wanted to avoid abandoning the paper-based system in the project districts (about 4% of the total) for a system that had not been fully tested in Mozambique.

The justification for using both paper and electronic data collection and reporting methods in the 5 pilot districts was correct. However, simultaneous use of both the paper-based and handheld-based collection processes proved to be an added burden on the health system. Health workers using MHIN, while recognizing the advantages of the MHIN system and the benefits it provides compared to paper-based approaches, complained to the project and MISAU policy makers that the concurrent use of both paper and MHIN placed an unreasonable added demand on their meager time.

The complaints from the MHIN users were legitimate. According to MISAU\(^{14}\), Mozambique faces a critical shortage of health workers with only 1.26 health workers per 1000 population, including fewer than 900 doctors and 4,300 nurses for a population of 20 million people. The ministry recognizes that increased progress towards the Millennium Development Goals (MDG) is not possible without a massive scale up of the health workforce. The issue of overburdening the health workers by asking them to use both electronic and paper-based systems for gathering the same data sets, therefore, became a major policy discussion at MISAU and resulted in the provisional suspension of the project in December 2008.

The policy issues that emerged included the following:

- The project had demonstrated that the use of MHIN for health data collection and reporting can be a viable alternative compared to paper-based approaches. Therefore, the question was asked, “Why continue piloting it?”
- Additional knowledge and evidence might be obtained from the concurrent use of both paper and MHIN, but the value of possible improvements in healthcare provided to the population represented by the learning objective of the project are outweighed by the costs inherent in added pressure on the health workers.
- MISAU had had several pilot projects that were never adopted into the health system. This prompted the question, “Could the fate of MHIN be the same if it is not deployed nationwide?”

\(^{14}\) Sufficient and Competent Health Workers for Expanded and Improved Health Services for the Mozambican People. MISAU, 2008
• The possibility that available funding would not be available to support the deployment of MHIN nationwide for HMIS raised the question, “What other data collection needs of MISAU can be met using MHIN without requiring users to use both paper and electronic approaches?”

Both AED-SATELLIFE and IDRC participated in a long dialogue with MISAU to reach agreement on an approach that met the needs and priorities of MISAU and addressed the research agenda of the project. After a series of discussions, MISAU determined that the MHIN system could be most useful if employed solely for the collection and reporting of epidemiological surveillance data at district, province, and national level.

To ensure that they were not overburdened by collecting the same data sets twice, the districts using MHIN for epidemiological surveillance were not required to also use a paper-based approach. The cost of a nationwide rollout would be reduced if the deployment were limited to district and higher levels compared to deploying the system to all health facilities in the country. MISAU and the partners determined that the lessons learned from district/province wide rollout could be used for deploying the system to health facilities when and if MISAU decides to do so.

MISAU mandating the use of MHIN for nationwide epidemiological surveillance and response was one of the most significant outcomes of the project, and the dynamics that led to this outcome are equally significant.

7.2 Lessons Learned

Address issues of testing innovations and “pilot project fatigue.” Some health sector policy makers, while realizing the importance of knowledge construction through research, seem to harbor “pilot project fatigue”. Their antipathy towards pilot projects is rooted in the fear that the learning gained through the pilot project may never be utilized due to the inappropriateness of the technology for the country and/or the lack of adequate funding for institutionalizing the project into mainstream activities of the ministry. In addition, they perceive that pilot projects are “dumped” onto an already overstretched health workforce that has little or no time for performing the additional activities required.

On the other hand, improving health systems calls for the testing of innovative ideas that promise better health for the population, evaluating innovations to determine their cost-effectiveness and potential for expansion, and assessing whether these innovations can be successful on a broader scale. The question of innovation and pilot-project-fatigue, therefore, becomes a fundamental issue that must be addressed when research projects involving testing of innovative ideas through pilot projects are designed.

Institutionalize the role of project champion. The role of dedicated champions motivated by the benefits a project will potentially bring is very important for the success of any project. The MHIN project had dedicated allies at both MISAU and the Ministry
of Science and Technology championing the use of technologies for health data management and the establishment of a culture of innovation. During the early periods of the project (2007-2008), the role of MHIN supporters at MISAU was critically important in promotion of the project at the ministry, deployment of the system to the 5 pilot districts and health facilities, and adoption of the mandate to use the MHIN system for HMIS alongside the paper-based system. However, with the departure of one of its key champions from MISAU, the project’s ability to resolve issues that required support from senior ministry officials diminished significantly.

The key lesson learnt from this experience is that, while the support of dedicated champions is very important at all stages of the project, it is crucial that the role of the champions be institutionalized to ensure long term success of the project. Depending solely on the abilities, good will, and actions of a few individuals can have a disastrous effect on the project.

**Sustainable outcomes depend on long term investment, partnership, and consistent support.** There has been very rapid growth in the number and scope of eHealth solutions. eHealth projects can be designed and implemented rapidly. However, answering key research questions, adopting new solutions and institutionalizing them into the health system, building local capacity to maintain and improve the system, and formulating policy based on research findings are long-term efforts requiring long-term investment and commitments. The introduction of ICT for improving health systems and processes is not a silver-bullet that can be integrated into the health system on a wide scale over a short period of time. Multi-year commitment of donors, governments, and technical assistance at macro-scale is necessary to foster the widespread adoption of eHealth solutions and enable meaningful change.

This lesson is primarily drawn from MISAU’s desire to scale up nationwide the MHIN system for epidemiological surveillance over a relatively short period of time on the one hand, and the limited funding and mandate of IDRC in supporting development projects. There was significant reluctance from MISAU to scale up MHIN in phases, preferring the nationwide scale up of the system at once. While MISAU’s desire to have one harmonized system working in the entire country is commendable, there are financial, human resource, infrastructural, and other challenges that make rapid nationwide rollout extremely difficult if not impossible. On the other hand, IDRC supports research projects that can influence policy formulation and dialogue; long term development support is outside of IDRC’s mandate. Despite the promise projects like MHIN offer, therefore, their integration into mainstream health system can be hindered due to lack of continued support. There is no mechanism in place for taking IDRC supported pilot projects that proved to be effective to nationwide rollout.

8. **Overall Assessment and Recommendations**

The Mozambique Health Information Network project concluded October 2010 after having successfully deployed SIS-VE to all 11 provinces at the Directorate of Provincial
Health and to 43 districts at the Directorate of District health services in Gaza, Inhambane, and Zambezia provinces. The SIS-VE became fully functional in the 11 provinces and 43 districts in June 2010. The DPSs are using the system for epidemiological surveillance data collection, reporting, and analysis.

Users’ perceptions of the extent to which a new information system will improve their performance in their workplace and the level of effort required to use the system are critical factors that determine behavioral intentions to utilize a new electronic system. As demonstrated in the “cost-effectiveness assessment” section of this report, SIS-VE district and province users are enthusiastic about the system because it eases their workload and enhances their performance; thus management at the national, the provincial, and district levels are eager to continue using the system.

MISAU is very keen to expand the SIS-VE nationwide for epidemiological surveillance data collection, reporting, and analysis. One of the key determinants for expanding use of eHealth solutions is the value the system provides to the health system. Public health workers and decision makers at MISAU use SIS-VE to send and/or receive timely, accurate, and reliable data that is used as the basis for making informed decisions and responding rapidly to outbreaks. These users of the system clearly see the benefits of the SIS-VE compared to other approaches.

Building on the lessons learned from the project, responding to feedback from the current districts, and improving the system to include additional features and functionalities such as the capability for trend analysis (graphs, charts, etc.) will contribute to sustainable use, but the long term success of MHIN in achieving its goal of supporting the Mozambican Government in its efforts to reduce morbidity and mortality of the populace from major causes of ill health is dependent on SIS-VE deployment to the rest of the country. The ability of the health offices to integrate the network into the national, provincial, and district health system and to meet information needs at all levels of the health sector is sine qua non to the sustainable use of the system. Continuing to build the capacities of MISAU, district, and provincial health offices’ technical personnel for network and data management, user training, and technical support must be one of the key follow-up activities.

To address these issues, AED-SATELLIFE and MISAU have submitted a proposal for the continuation of MHIN. Key aspects of the proposed extension are the application of lessons learned from the previous phase of the project and the building of capacity among MISAU, provincial, and district health personnel to integrate the network into the national, provincial, and district health system, to manage and maintain the network and databases, to develop and deliver end-user training, and to provide technical support. The extension will enable MHIN partners to fully realize several desirable outcomes for which the groundwork has been laid and which will significantly enhance the quality of project research, including on-going assessment of the economic benefits of the network over traditional paper-based approaches for Integrated Disease Surveillance and

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Response (IDSR) data collection and transmission. The project partners also propose conducting research to measure the impacts of MHIN on MISAU’s ability to respond to infectious disease outbreaks, and to assess how MHIN affects health facility-District, District-Province, and Province-MISAU relationships.

The preliminary processes and organizational requirements developed and/or identified for nationwide rollout of the SIS-VE are summarized below.

Data Collection, Reporting, and Analysis

Health facility level: Currently, the district health service is the lowest level to which the SIS-VE is deployed. Health facilities are still using paper-based data collection and reporting tools resulting in a minimum of a one week delay in health facility reporting to districts. SIS-VE can be deployed to the health facility level to further improve overall timeliness, completeness, reliability, and use of epidemiological surveillance data throughout the health system.

Since MHIN’s inception, PDAs have been surpassed in functionality and features by mobile phones, many of which offer the same applications and computing power as the handheld computers in devices that also offer multiple options for wireless communication (voice, SMS, and email.) As a result, PDAs no longer hold the cost-to-benefit advantage they once offered and we project that they will become increasingly difficult to source in the commercial marketplace. Therefore, we propose transitioning MHIN from PDAs to cell phones for gathering and reporting health data.

Some personnel at health facilities are already using their personal cell phones to send epidemiological data via SMS to their counterparts at districts. SIS-VE users at the district enter the data received via SMS to the district’s local database from which it is automatically sent to the server at MISAU through SIS-VE. This process, however, is haphazard and is dependent upon the willingness and technical skill of the health worker at the health facility. In addition, data is not entered to the cell phones in a structured and systematic way, making it prone to errors.

Our recommendation is to use mobile phones for capturing data and SMS or GPRS for sending data over the cellular network to the server at MISAU. The use of mobile phones at health facility level for epidemiological surveillance can be enhanced through the introduction of the GATHERdata platform.

Designed and developed by AED-SATELLIFE, GATHERdata is an interoperable platform for data collection and reporting from multiple front-end devices such as cell phones (using either GPRS or SMS), Global Positioning Systems (GPS), desktop and laptop computers, and fixed landlines. Open source and freely available for non-commercial use, GATHERdata conforms to the official World Wide Web Consortium (W3C) standard for next-generation data collection and interchange which use XML to express the vocabulary of the forms technology developed by the XForms working group. GATHERdata also conforms to the interoperability standards for transactions
derived from the HL7 Foundation models and vocabulary that define communications produced and received by computer systems.

The GATHERdata platform generates data in MySQL, an open source relational database management system that runs as a server providing multi-user access to a number of databases. MySQL is a popular choice for use in web applications, and is a central component of the widely used LAMP web application software stack. (LAMP is an acronym for "Linux, Apache, MySQL, PHP"). Used in some of the most frequently visited Internet sites including Facebook, Wikipedia, Google, and YouTube, MySQL is the de-facto standard for high-traffic web sites because of its high-performance query engine, fast data insert capability, and strong support for specialized web functions like fast full text searches. These same strengths also apply to data warehousing environments. MySQL is widely used and runs on many different platforms including Linux, UNIX, Symbian, and Windows. 16 Because the GATHERdata platform generates data in MySQL, data collected and reported through the system can be readily exported to MISAU’s existing Access-based MB-SYS, its MySQL-based national health information database, and other legacy systems.

The GATHERdata platform has powerful built-in modules that support data aggregation, data analysis, automated alerting via email or SMS, data visualization, and report generation. AED-SATELLIFE has successfully deployed GATHERdata for health data collection, reporting, and analysis in Uganda; health service delivery and supply chain tracking in Mexico, and for improving Education Management Information Systems in Liberia, Uganda, and Mali. AED-SATELLIFE is also in the process of deploying GATHERdata for the Malaria Action Program for States (MAPS), a 5-year USAID-funded comprehensive malaria program to increase coverage and use of life-saving malaria interventions in support of the Nigeria National Malaria Strategic Plan and the National Malaria Control Program (NMCP). AED-SATELLIFE will provide the open source GATHERdata platform and transfer the knowledge and skills required to operate and maintain it to the MISAU technical team.

GATHERdata will allow data collection at the health facility level using ordinary cell phones and data transmission directly from health facilities and district offices to the national epidemiological surveillance database built by MHIN. The staff person responsible for epidemiological surveillance will enter data into an electronic form on the cell phone and transmit the data to the server through the cellular network. The transition to mobile phones and the deployment of GATHERdata will enable the program to rapidly expand SIS-VE to health facilities that have cellular coverage from any of the cellular providers in Mozambique. The system will also allow users to access data related to their facilities on the phone.

Yet to be determined by MISAU is whether or not the facilities will keep a paper copy of the report they send through cell phones. Our experience in many previous ICT-based projects shows that concurrent use of paper-based and electronic systems for health data collection and reporting is a major de-motivating factor; in some instances it has been the

16 wikipedia.org/wiki/MySQL
major reason for an eHealth initiative’s failure. On the other hand, in rural health facilities where there is very limited power for recharging electronic devices and where the cellular signal can be spotty, relying solely on a remote database may not be a pragmatic approach. AED-SATELLIFE will continue investigating this issue in collaboration with MISAU during the proposed MHIN extension.

**District level:** In the current configuration, districts are the lowest level using the SIS-VE. There are two distinct processes for data transmission implemented in accordance to infrastructure available at the district. Districts with Internet access enter data received from health facilities directly into the district database. The SIS-VE automatically sends a copy of the data to the server at MISAU. The districts in this category have the option of accessing data directly from their local database or by accessing the national database at MISAU through an ODBC link.

Districts with no Internet access enter data received from health facilities into PDAs. Data is beamed from the PDA to a wireless access point via infrared or Bluetooth for transmission to the server over the cellular network. The districts synchronize their data to the district database for storage and data analysis using SIS-VE. With the introduction of GATHERdata, AED-SATELLIFE and MISAU will replace PDAs with mobile phones and will eliminate the use of wireless access points.

Internet connectivity in Mozambique is expected to improve significantly with the introduction of the SEACOM and the Eastern Africa Submarine Cable System (EASSy) fiber optic submarine cables connecting the east coast of Africa, South Africa, Mozambique, Tanzania, and Kenya with the rest of the world. Future development efforts of the project for transmitting data from districts to provinces and MISAU will be focused on the use of Internet.

**Province level:** All provinces access epidemiological data from the national database through the Internet. Authorized personnel from provinces can enter data into the national database, generate reports, and analyze data using the MHIN user interface.

**National level:** The national epidemiological surveillance database is hosted at MISAU on a MySQL database. MISAU will establish tiered access to the national database by granting appropriate privileges to district, provincial, sentinel sites, and other institutions. Authorized MISAU personnel can access the database and use its analytic tools via Internet or Local Area Network (LAN).

**Human Resources**

Human resource requirements for the nationwide rollout of SIS-VE affect different functions differently. The use of SIS-VE at district, provincial, and national level will reduce the time needed for data entry, reporting, and analysis. Therefore, additional staff may not be required for using SIS-VE.
However, MISAU’s IT support team must be strengthened to support continued use, maintenance and enhancement of SIS-VE. Suggested improvements for supporting SIS-VE at district, province, and national level include the following.

**District level:** The minimum skill set for using and troubleshooting SIS-VE at the district level is computer literacy including MS Access, Internet, and Windows environment. Users in the 43 districts where SIS-VE is deployed possess varying degrees of experience ranging from those with very rudimentary knowledge and inadequate skills to those with reasonably high levels of understanding of computers and software. It is vitally important that statistical officers and community health officers at the district level receive additional basic computing training.

**Province level:** The Nucleo de Estatistica e Planificaçao (planning and statistical unit) at provincial health offices is responsible for providing IT-related technical support to the provincial and district health offices. The staffing plan calls for these units to be administered with two personnel trained in statistics and IT. In practice, however, some of the provinces are not staffed according to the staffing standard and in others the primary responsibility of the assigned staff members is data management. As a result, IT support to districts is very limited. IT needs of the provinces must be reviewed and staff strengthened according to findings of the review to ensure that the districts receive full IT support from the provinces.

**National level:** At the national level, the division of informatics (Repartição de Informática or RI) and Department of Health Information (Departamento de Informação para a Saúde or DIS) are responsible for supporting MISAU’s IT and health data management needs. The RI is staffed with four personnel and is expected to manage MISAU’s IT system including maintaining MISAU servers and providing support to all eleven provinces on any IT-related issue. The DIS, among others, is responsible for developing, maintaining, and using electronic data management tools. The DIS staff is also expected to provide data management support to the provinces. Despite RI’s four staff and DIS’s seven dedicated staff members, the need surpasses their ability to provide sufficient levels of support. An in-depth review must be conducted to determine the additional staffing needs of DIS and RI to ensure that the various levels of MISAU receive adequate IT support.

**Equipment and IT Policy**
All of the provinces and most of the districts have computers. However, some of the computers are very old, few have current anti-virus software installed, and operating systems and applications are not standardized. Lack of standardization makes provision of IT support more difficult and time consuming. To rollout SIS-VE, functioning computers at each district must be available. It is recommended that MISAU develop and implement IT Policies and Procedures regarding account privileges, admin rights, antivirus, the determination and disposal of obsolete IT equipment, firewall, IT support,
network security, server backup, configuration, and space usage, and wireless networking and wireless security access.\textsuperscript{17}

9. List of Appendices and Attachments

**Appendices:**

- Appendix - 1: Technical Information on SIS-VE Modules
- Appendix - 2: Equipment

**Attachments:**

- Attachment-B: Mozambique Epidemiological Surveillance System (SIS-VE) Manual for System Administrators
- Attachment-C: MHIN Cost Effectiveness Study Report
- Attachment-D: MHIN Data Download and Synchronization Training Guide for District Focal Persons
- Attachment-E: MHIN District Focal Persons User Guide
- Attachment-F: MHIN End User Manual (for SIS)
- Attachment-G: Pro Poor ICT Access Toolkit – MHIN Case Study (English)
- Attachment-H: Mise en Oevre de projects RMIS Etude de cas (French)
- Attachment-I: Modulos de acceso a las TIC - RMIS Estudio de caso (Spanish)

\textsuperscript{17} The list provided here is not exhaustive; it is meant to identify some of the gaps that need to be bridged in order to support a fully functioning system.
Appendix 1: Technical Information on *SIS-VE Routine Data Collection and Reporting Module* and *Disease Outbreak Data Collection and Reporting Module*

**Routine Data Collection and Reporting Module**

The data collection, transmission, and reporting process for the routine data collection module is illustrated below.

For routine epidemiological data collection and reporting, the process using SIS-VE entails the following steps.

**Health units** submit weekly epidemiological data on paper to the district surveillance team by the end of the week following the reporting epidemiological week. For example, if the current epidemiological week is Week 31, health units will be submitting the report...
for epidemiological Week 30 to the districts. Personnel at some health units use their personal cell phones to send data using SMS messaging. The mechanisms for data collection and reporting to the districts using cell phones is not systematized, however, and can be a source of error. This activity is limited in scope.

**Districts with no Internet** connection use PDAs to enter data to electronic epidemiological surveillance data collection forms that were programmed by the project. Data entered to PDAs is then “beamed” to African Access Points (AAP) installed at district health offices. The AAPs are programmed to automatically make cellular calls to the server at MISAU in Maputo on a regularly scheduled basis. Upon initiation of the call, data from the AAPs is transferred to the AAP server. The AAP server automatically routes the data to the national epidemiological surveillance database built by the project. This process is completed in a matter of minutes.

After successful transfer of data from PDAs to the server at MISAU, the district team synchronizes the data to a local district database developed by the project. This arrangement enables the districts to access their data sets easily, analyze data, and generate reports using the reporting modules developed by the project.

**Districts with Internet** connection enter data received from health facilities directly into the district epidemiological surveillance database developed by the project. The data is seamlessly transferred to the server installed by the project at MISAU via an Open Database Connectivity (ODBC) link. The data transfer process from districts to the server at MISAU is optimized for low-bandwidth environments. For example, if Internet connection is interrupted during a transmission process, the system has a built-in system to recognize the point at which data transmission was interrupted, compare data sets at the server and the district database, and resume data transfer from the point it previously stopped.

The districts in this category have the option of accessing their data sets from the local database or from the national database, an important feature in areas where Internet connection is intermittent. Reliance on accessing data only from the national database would impede the districts’ ability to generate reports when no Internet connection is available. Redundancy allows the districts to generate reports from either the local district database or the national database, with a project-designed audit system in place to ensure data consistency and integrity at both levels.

All **provincial health directorates** have Internet access and can access data sets relevant for their province directly from the national database via ODBC link. The user interface enables them to generate reports for the whole province, individual districts, or specific health facilities. In the paper-based system, data received by provinces and MISAU show the pattern of epidemic-prone disease by districts only. The ability to analyze data for each health facility enables MISAU to understand the local case variations and equips rapid responders with the information needed to develop site specific strategies for the containment of outbreaks.
Relevant departments at MISAU, such as the Epidemiological Surveillance Department and the Department of Health Information Systems, access data from the national database via ODBC link and/or MISAU’s Local Area Network (LAN). The national MISAU team can access data related to any individual health facility, district, or province; generate standard reports; and analyze data using the system developed by the project. Access privileges to the national database are determined by MISAU.

**Disease Outbreak Data Collection and Reporting Module**

MISAU has established thresholds for priority epidemic-prone diseases to detect situations where immediate actions are required to minimize negative public health outcomes. As indicated previously in this report, the national threshold for polio, cholera, meningitis, and plague is a single case; and for measles the threshold is three confirmed cases or five suspected cases per month in a district with an estimated population of 100,000 people.

During outbreaks, MISAU deploys surveillance teams from districts and provinces to the localities where ongoing outbreak exists. During major outbreaks, teams from the national MISAU headquarters may also be deployed. The ability to report quickly and accurately on new cases and deaths caused by epidemic-prone diseases is critically important for determining appropriate actions and responses. During outbreaks, SIS-VE is used for reporting the number of reported cases and deaths on a daily basis. An alert system on the MySQL database generates daily reports detailing the number of cholera cases and deaths. The system can send email messages with the daily report to officials who must be notified about the events. While the alert system currently works only for cholera based on MISAU priorities, it can be easily extended to the other epidemic prone diseases.
Appendix 2: Equipment

AED-SATELLIFE acquired and shipped to Mozambique a total of 195 Palm Tungsten-E2 handheld computers\(^1\) equipped with additional memory\(^2\) and accessories. Palm Tungsten-E2 units have non-volatile flash memory to ensure that data or applications loaded on the handhelds are not lost in cases of power loss.

AED-SATELLIFE and the Ministry of Science and Technology (Ministério da Ciência e Tecnologia or MCT) attempted to procure solar panels in Maputo, but found no local vendors capable of delivering them. 50 solar chargers (3 Watts capacity) for recharging PDAs were therefore procured in Uganda in April 2007.

60 African Access Points (AAP) were manufactured in South Africa by S-Curve Technologies and Thalamic Systems under contract with AED-SATELLIFE\(^3\). Fifteen solar panels with charge controllers for recharging standard 12 volt car batteries were procured and shipped to Mozambique by AED SATELLIFE for use in areas that are not connected to the national grid. Two 40 Watt rated output solar panels are required to

\(^{1}\) (110 PDAs with accessories were acquired and shipped in April 2007; an additional 85 PDAs with accessories in October 2008).

\(^{2}\) 110 SD Cards with 512MB capacity; and 85 SD cards with 1GB capacity

\(^{3}\) The AAPs were manufactured in two batches. The first batch consisting of 30 units was manufactured by Thalamic Systems. The 2\(^{nd}\) batch consisting 30 units was manufactured by S-Curve Technologies because Thalamic Systems shifted its focus from device manufacturing to software development.
recharge a 12V/50A car battery. A fully recharged car battery (12V/50A) can power an AAP for two days. In areas where the cellular signal is weak, the AAPs are fitted with external Yagi antennas that are capable of boosting the signal by 12dB gain.

A Linux server for managing data exchange between remotely located health centers, district health offices, provincial health offices, and the Ministry of Health was acquired, configured, and installed at MISAU. A second server for hosting the national epidemiological surveillance MySQL database developed by the project was also acquired, configured, and installed at MISAU. The project also provided ten desktop computers to district and provincial health offices that did not have computers and to MISAU headquarters for the management and analysis of epidemiological surveillance data received through MHIN.

Network Deployment
The main components of the network include handheld computers, African Access Points (AAP), a cellular network, and a server/router located at MISAU in Maputo. Handheld computers were distributed to health workers at health facilities. AAPs were installed at centrally located health centers within a reasonable walking distance for health workers.

Server Configuration and Installation: Applications for the server were primarily developed as part of the AAP development project though IDRC funding. AED-SATELLIFE developed a data routing tool (“send script”) which uses the AAP ID to facilitate automatic routing of SIS data received from health facilities to designated databases at the districts and national level based on the type of data being collected and its ultimate repository.

AAP Configuration and Installation: AED-SATELLIFE trained MHIN local staff, MISAU, and MCT technical personnel on network management, transferring HMIS data through the network to existing back-end databases, training of new users, converting paper forms to an electronic format suitable for the network, content and applications deployment to frontline users, and troubleshooting network problems. MHIN local project staff and MISAU technical personnel configured the AAPs for deployment to health facilities including registering AAPs to the server, enabling AAPs for email exchange, and scheduling AAP connections to the server.

The MHIN team, in close consultation with MISAU and District health directors and based on site-specific technical assessments, selected sites for the installation of the AAPs in the five districts. Selection criteria included: availability of cellular network, proximity of the site to multiple health centers and handheld users, and number of PDA users within the “catchment” area of the AAP.

In areas where the cellular signal is weak, the AAPs were fitted with external Yagi antennas that are capable of boosting the signal by 12dB gain.
District SIS Data Management and Training of District Focal Persons: The project provided desktop computers to the six district health. AED-SATELLIFE developed SIS data synchronization tool for automating the data transfer process received from the server. The tool was installed at district computers with capabilities to automatically pull data from an FTP site specifically created for this purpose. District focal persons simply click a button at their desktop and the data is automatically downloaded to MISAU’s district database, MB:SIS (Module Basico SIS). The program that downloads the data from the FTP site requires Internet connectivity. MHIN partners set up GPRS Internet connection for the six districts. The district database, MB:SIS, generated reports in accordance to MISAU requirements based on data received from health units.

Serving as MHIN’s principal focal persons, the statistical officers of the district health directorates were responsible for migrating data received through MHIN to MISAU’s MB:SIS, participating in the training of new PDA users, and providing on-going user support to MHIN users at health facilities in their district.

Site Selection
Selection of MHIN operational districts was made through intensive discussions among MISAU, AED-SATELLIFE, and the Ministry of Science and Technology of Mozambique (Ministro da Ciência e Tecnologia or MCT). Criteria for selection were: (1) the availability of cellular signal covering large portions of the district; and (2) the presence of a large number of health facilities in the district. MHIN activities during this period took place in the districts of Chokwe and Manjacaze in Gaza Province, Morrumbene and Massinga in Inhambane Province, and Nicoadala and Namacurra in Zambezia Province.
To aid the selection process, the health facilities location map was overlaid with cellular coverage maps acquired from the two leading cellular providers in Mozambique, mCel and Vodacom.

Districts with high densities of health facilities overlapping with wide cellular coverage were selected for the project.

MCT was instrumental in negotiating with mCel to acquire services at competitive rates for MHIN. MCT met jointly with mCel senior management and AED-SATELLIFE to reach agreement on reasonable pricing and helped the project to establish a good working relationship with the company. At that time, mCel offered better cellular coverage in rural districts; Vodacom has since expanded its services in rural districts creating a more competitive market.

The selection of districts was followed by on-site technical assessment of health centers in the five districts. A team comprised of AED-SATELLIFE and MISAU staff conducted site-specific assessments of 82 health facilities to gather information for determining AAP location, number of PDAs needed, solar panel requirements, number and type of standard SIS forms used at each health facility, and the quality of cellular signal. The teams also captured geographic coordinates for each health unit using a GPS receiver provided by the project.

Based on the data collected from 75 health facilities, MHIN partners produced a map for each district providing the location of health facilities linked to a database providing basic information about the health units. The map for Morrumbene district with basic information for the Centro de Saude Gotete health facilities appears above.
Manual de Utilizador do Sistema Moçambicano de Vigilância Epidemiológica SIS-VE

(Projecto da AED Número: 3746-01)

Este trabalho foi realizado com a ajuda de fundos concedidos pelo Centro de Pesquisa para o Desenvolvimento Internacional em Ottawa, Canada (International Research Centre, IDRC).

As actividades do projecto foram realizadas com o apoio financeiro do Governo Canadiano através da Agencia Canadiana de Desenvolvimento Internacional (Canadian International Development Agency, CIDA).
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Introdução

O projecto RMIS (Rede Moçambicana de Informação de Saúde), é um projecto do Ministério da Saúde (MISAU) em parceria com a Academia para o Desenvolvimento Educacional (AED-SATELLIFE), financiado pelo Centro de Pesquisa para o Desenvolvimento Internacional (IDRC) que, pretende equipar o MISAU a vários níveis, com ferramentas de recolha e transmissão de dados para a melhoria do sistema de Informação de Saúde. Este projecto consiste na utilização de PDA’s, Pontos de Acesso Africano (AAP), computadores de mesa, rede local de telefonia móvel e Internet.

**PDAs** também são conhecidos como *Computadores de Bolso* ou *Computadores de Mão*. Os PDA’s têm várias utilidades tais como: como calculadora, relógio, calendário e contém jogos para diversão e pode aceder à Internet (para envio e/ou recepção de E-mails). Os PDA’s possuem uma tela de cor e capacidades de áudio, podendo ainda, serem usados para visualizar e ou armazenar vídeos e fotografias, servindo ainda como um rádio ou aparelho de som.

Os AAP’s são aparelhos constituídos por um cartão de telefonia móvel (cartão GSM) e com uma capacidade de armazenamento temporário de informação recebida do PDA ou de outros aparelhos tais como (Servidores ou outros dispositivos) para posterior encaminhamento aos seus destinatários, sejam eles outros PDA’s ou Servidores.

No presente manual, abordaremos as formas de preenchimento e envio de dados colectados através do PDA e através do computador pessoal. Abordar-se-á também temas sobre envio e recepção de email, conteúdos e configuração do PDA para poder realizar determinados serviços.
I. Breve introdução ao PDA

Assistente Pessoal Digital, é um computador de dimensões reduzidas (cerca de A6), dotado de grande capacidade computacional, cumprindo as funções de agenda e sistema informático de escritório elementar, com possibilidade de interconexão com um computador pessoal e uma rede informática sem fios para acesso a correio electrónico e internet.

Os PDAs de hoje possuem grande quantidade de memória e diversos programas para várias áreas de interesse.

Informação detalhada sobre o uso e cuidados a ter com o PDA, poderás encontrar no catálogo que vem como acessório na caixa do PDA. Aconselhamos que leia cuidadosamente o catálogo. O presente manual contém informação básica necessária de como usar o PDA para preencher formulários de saúde.

Recomendamos que leia este manual com o PDA na mão.
A seguir descrevemos as partes e acessórios que compõem o PDA.

- **Visor, Ecrã ou Tela de toque** – permite a visualização das aplicações e da informação contida no PDA. Este visor é sensível ao toque;

- **Stylus ou Caneta** – é um utensílio de escrita, semelhante a uma caneta ou esferográfica moderna. Permite inserir informações no PDA. A interacção é feita pressionando sobre o visor, para activar botões ou fazer escolhas de menu, usar um teclado virtual. O teclado é mostrado na tela de toque.
Para usar a Caneta, remova-o do orifício e segure-o como se fosse uma caneta ou um lápis.
Pode-se usar a ponta do dedo no lugar da Caneta, mas não use a unha, uma caneta real ou qualquer outro objecto pontiagudo para tocar na tela.
Sempre se deve repor a Caneta no orifício de onde a retirou depois de ser utilizado, pois este pode facilmente perder-se.

- **Botão de ligar/desligar** – este botão serve para ligar e/ou desligar o PDA e ainda desbloquear a tela (caso a função esteja activada). Tem uma linha verde sobre ela.

O PDA funciona com base numa bateria recarregável, por isso aconselhamos a desligar o PDA sempre que não estiver em uso para evitar a perda de carga.

Na parte inferior do visor encontram-se quatro figuras circulares, uma de casa que é a primeira vista do visor do PDA, a lista de menu vertical, a estrela para mudar a forma de apresentação do visor do PDA e a lupa para localizar algo no PDA.

Há também o ícone do relógio para verificar o tempo no seu e outros países simultaneamente; o ícone de brilho para mudar o brilho do visor; os ícones 123 e o ABC para visualização do teclado alfanumérico. O teclado é mostrado no visor.

Existem outros botões adicionais na parte mais inferior do PDA da esquerda para a direita: atalhos para o calendário, contactos, botão navegador de 5 direcções, tarefas e notas. A familiarização com estas e mais funções do PDA adquire-se através da prática constante no uso do PDA. Note que é preciso praticar sempre para ter domínio do PDA.

### 1.1 Inicializando o PDA

Para inicializar o PDA, há que considerar os passos seguintes:

- Abrir a cobertura, ligar através do botão ligar/desligar e retirar a caneta. Quando ligas o PDA, verificarás no visor alguns ícones ou figuras, esta vista é chamada de casa. Cada ícone representa uma função ou aplicação que pode ser executada no PDA, incluindo a calculadora, calendário e uma lista de tarefas.


Na categoria RMIS encontram-se todas as aplicações que usarás para colectar dados de saúde, receber conteúdos, enviar e receber emails e enviar dados.

### II. Formulários de saúde no PDA

Atualmente encontram-se convertidos em formato para PDA os seguintes formulários da Vigilância Epidemiológica:
• Boletim Epidemiológico Semanal (BES)
• Boletim Mensal do Posto Sentinela (BEPS)
• Resumo Diário de Doenças Epidemiológicas (RD)

Estes mesmos formulários convertidos em PDA encontram-se também disponíveis nos computadores provinciais e distritais com acesso a Internet.

Notas importante:

➤ Em todos os campos a vermelho do PDA, o preenchimento é de caráter obrigatório, pois, caso não seja preenchido, não poderá seguir à página seguinte.

➤ Os botões *Fim, Anterior e Seguinte*, tem como significado respectivamente, *Fim* (ao clicar neste botão estará a terminar com o preenchimento da ficha), *Anterior* (ao clicar neste botão estará a voltar a página precedente, o que geralmente se faz quando se pretende fazer algum tipo de correção) e *Seguinte* (ao clicar neste botão estará a prosseguir com o preenchimento para a página seguinte).

➤ Não pode existir mais do que uma ficha ou registo com todos os campos obrigatórios iguais. Para o caso de BEPS, não podem existir dois registos com mesma província, mesmo distrito, mesmo posto sentinel (Unidade Sanitária), mesmo ano e mesmo mês simultaneamente.

➤ Para o caso de BES, não podem existir dois registos com mesma província, mesmo distrito, mesma unidade sanitária, mesmo ano, referente a mesma semana epidemiológica e mesma semana epidemiológica actual simultaneamente.

➤ Para o caso de RD, não podem existir dois registos com mesma província, mesmo distrito, mesma localidade, mesmo dia, mês e ano simultaneamente.

Estas mesmas notas são válidas quando se preenche as fichas no computadores de mesa nas províncias e distritos onde há internet.

1. Introduzindo dados no PDA

Embora existam três fichas convertidas para o PDA, usaremos para preencher neste manual, como exemplo a ficha de BEPS. A forma lógica de preenchimento desta e de outras duas fichas são equivalentes.

1º Usando a Caneta, aceda a ficha desejada indo primeiro à Categoria RMIS. Para aceder a Categoria RMIS, clique no canto superior, sobre o menu vertical de categorias, clique em RMIS. Assim estarão disponíveis todas as aplicações que usarás para a colecta de dados incluindo o aplicativo de envio de dados e outros.
2º Clique uma vez sobre o ícone MOZESS conforme mostra a figura abaixo, assim serão visualizados todos os três formulários: Boletim Epidemiológico do Posto Sentinela, Boletim Epidemiológico Semanal, e Resumo Diário.

3º Uma vez selecionada a ficha desejada, neste caso, o BE-PS, Usando a Caneta, pressione no botão Novo que se encontra na parte inferior esquerda do visor. O que significa que está a criar um novo registo. Após a página de apresentação da ficha, pressione no botão Seguinte.
4º Pressione o botão procurar **Procurar** e selecione o nome da **Província** onde te encontra a trabalhar. O campo inferior será preenchido automaticamente pelo código da respectiva província. Este código é o usado em outros sistemas do Ministério, como é o caso do Módulo Básico. A seguir pressione em **Seguinte**. Recorde-se que os campos a Vermelho são de preenchimento obrigatório. Não poderá passar à página seguinte sem antes preenche-lo.

5º Pressione o botão procurar **Procurar** e selecione o nome da **Distrito** onde te encontra a trabalhar. Todos os distritos da província seleccionada anteriormente serão listados. O campo inferior será preenchido automaticamente pelo código do respectivo distrito. A seguir pressione em **Seguinte**.
6º Seguindo, os mesmos passos que oscitados acima, pressione o botão **Procurar** e seleccione o nome da **Unidade Sanitária** onde te encontra trabalhar. Todas as unidades sanitárias do distrito seleccionado anteriormente serão listados. A seguir pressione em **Seguinte.**
7º Através do teclado numérico mostrado no visor, introduza o Mês e o Ano. Lembre-se os meses de Janeiro à Dezembro tem valor que variam de 1 à 12. Pressione em Seguinte.

NOTA: para os meses de 1 à 9, não introduza o zero “0” antes do número. E o ano deve ter a forma xxxx, como por exemplo “2010”, e não somente “10”.

8º Comece a introduzir os número de casos e óbitos das doenças epidemiologias Transmissíveis. Pressione em Seguinte para visualizar as doenças epidemiológicas, começando por Paralisia Flácida Aguda. Pressione primeiro na linha em frente a Casos de modo que o cursor pisque indicando que já pode introduzir o dado. Através do teclado
virtual introduza o número de casos da PFA. Usando os mesmo passos, introduza o número de Óbitos de PFA. Em seguida pressione em **Seguinte** para introduzires os dados das outras doenças epidemiológicas.

**NOTA:** Todos os campos devem ser preenchidos, se em alguma situação o número de casos ou de óbitos for zero, introduza o zero “0” neste respectivo campo, ao invés de deixar em branco.

![Imagem de um celular mostrando o caderno de doenças transmissíveis e os campos de introdução de dados]

9º Imagine-se numa situação em que o número de óbitos seja maior que o número de casos. Nesta circunstância, ao pressionar em **Seguinte**, uma mensagem (“**O número de Óbitos é o maior que o número de Casos?**”) será mostrada no visor. Se o número de Óbitos for de facto maior que o número de Casos, pressionar no botão **Sim** em para passar à página seguinte. Se o número de Óbitos não for maior que o número de Casos, pressione em **Não** e o cursor voltará para o número de casos da respectiva doença de modo a introduzir o número de casos certo.
10º Pressione em **Seguinte** para ir preenchendo para cada doença epidemiológica, incluindo as não transmissíveis.

11º Pressione em **Seguinte** para preencher os dados das doenças não transmissíveis. Da mesma forma mostrada no **passo 8**, preencha para as doenças não transmissíveis.
12º Pressione em seguinte até acabar de preencher todas as doenças não transmissíveis. A última doença não transmissível da ficha é a Neoplasias Malignas.

13º O preenchimento da ficha só terá chegado ao fim sempre que o visor mostrar os botões **Fim** e **Anterior** conforme se vê na figura abaixo. Pressione **Fim** para terminar o preenchimento e fechar a ficha ou, pressione **Anterior** se quiser mudar algum dado introduzido na ficha.
2. Revisão e correção de dados

Uma vez preenchidas e gravadas, todas as fichas podem ser revistas e actualizadas. Em seguida será descrito o modo de proceder para rever e corrigir algum dados. Neste caso usaremos a ficha de BEPS.

1º Primeiramente aceda a categoria RMIS (como foi mostrado acima) caso não esteja visualizando os aplicativos desta categoria. Pressione sobre MOZESS.
2º Selecione a ficha desejada, sobre ela aparecerá uma barra azul (como se mostra abaixo), neste caso é o BEPS. Uma vez seleccionada, pressione no Botão Rever. Em seguida escolha o registo que deseja rever/corrigir. Neste caso será escolhido por unidade sanitária. Assim a primeira página da ficha é visualizada no visor. Clique no Botão Seguinte até a página que deseja corrigir.

3º Suponhamos que tenhamos introduzido o número incorrecto (ao invés de 2, queríamos introduzir 7 no número de casos de Difteria). Pressione na linha em frente ao campo Casos de modo que o cursor pisque. Em seguida pressione sobre o botão Del no teclado virtual mostrado no seu visor de modo a apagar o 2. Uma vez apagado o valor anterior, pode-se já introduzir o valor correcto (neste caso o 7). Clique sobre o botão Fim se não tiver outro valor a alterar. Se houver outros valores a serem actualizados, clique o botão Seguinte até a pagina desejada e faça a actualização conforme mostrado neste parágrafo.

**NOTA:** Os dados devem ser actualizados no PDA antes de serem enviados para o AAP e antes de serem sincronizados no computador do distrito.
3. Apagando um registo completamente

Muita atenção a situação em que se deseja apagar todo registo. Só apague um registo por completo se anteriormente já tiveres enviado os dados através do AAP para o Servidor central, e se tiveres a certeza que já sincronizaste localmente no computador do distrito.

Nota: Note que durante a sincronização via cabo para o PC todos os dados são retirados do PDA para o PC, isto é, os dados são completamente apagados do PDA, evitando deste modo a sobrecarga do PDA.

1º Seleccione a ficha desejada na qual contém os dados que deseja apagar. Neste caso, estamos usando a ficha BEPS como exemplo.

2º Pressione o botão *Apagar* localizado no canto inferior direito, ao lado do botão *Rever*. 
3º Após selecionar o registo que deseja apagar, pressione o botão **Apagar**, localizado no acima do botão **Terminado**.

4º Pressione o botão **OK** se tiver a certeza que deseja apagar o registo. Se não tiver a certeza, pressione **Cancelar**. Ao terminar, pressione sobre o botão **Terminar**.
4. Ponto de Acesso Africano ou African Access Point (AAP)

Ponto de Acesso Africano (AAP ou mesmo African Access Point (em inglês), é um dispositivo usado para transmitir dados através de um cartão GSM para um computador central (Servidor). PDAs e telemóveis podem estabelecer comunicação com AAP via Infra Vermelho (IR), Wireless (comunicação sem fio), Bluetooth (BT). Mais detalhes sobre AAP podem ser encontrados em http://wiki.openwrt.org/.
Para o nosso caso, o AAP será usado para transmitir os dados recolhidos das unidades sanitárias, receber e enviar emails, e receber conteúdos. A via de comunicação entre o AAP e o PDA será através de Raio Infra Vermelho ou Bluetooth.

4.1 Activar Bluetooth

O Bluetooth é o aplicativo que será usado no seu PDA para não só para a transmissão de dados, mas também para envio de outros tipos de ficheiros como músicas, fotos, documentos, etc.

Para activar o Bluetooth, vá até o canto superior direito do seu PDA, e seleccione em Tudo.
Pressione no ícone **Bluetooth**. Em seguida pressione em **Ligado**. Se o bluetooth estiver ligado e desejar desligar, pressione em **Desligado**.
Em seguida pressione no botão 🔄 para voltar a janela principal. Deste modo pode-se enviar dados e outros tipos de ficheiros via bluetooth.

5. Enviar dados via Raio Infra-Vermelho

O envio de dados usando o Raio Infra-Vermelho, é feito com recurso ao aplicativo BeamPro. Em seguida mostraremos os passos para enviar os dados com recurso a BeamPro.

5.1 Configurando o BeamPro

1º Usando a caneta, aceda a Categoria RMIS e selecione o ícone BeamPRO do aplicativo BeamPRO.
2º Na página seguinte, na parte inferior, ao lado do botão **Send**, pressione na seta virada para baixo ao lado da palavra “**To**” e escolha **Other**. Mais para o lado direito, ao lado da palavra “**VIA**”, pressione na seta virada para baixo e selecione **Infrared**.
Assim, enquanto não se mudarem estas configurações, o PDA já está pronto para poder enviar dados para o AAP via Infra Vermelho. A seguir mostraremos os passos de selecção e envio de dados.

5.2 Enviando dados

Para o envio de dados do MOZESS (BEPS, BES e Resumo Diário), é necessário que se seleccione todos os ficheiros relativos ao MOZESS. Em seguida mostramos os passos de selecção dos ficheiros.

1º Aceda ao aplicativo BeamPRO seleccionando o ícone relativo no visor do seu PDA;

2º No canto superior direito do visor do seu PDA, pressione a seta e, sobre o menu vertical, seleccione Creator ID Filter… Seleccione o filtro mESS de modo que sejam filtrados somente todos os ficheiros do MOZESS. Em seguida pressione o botão OK.
3º Uma vez filtrados todos os ficheiros do MOZESS, selecione todos os ficheiros. Para selecionar todos os ficheiros, vá para a barra de menus do BeamPro (canto superior esquerdo do BeamPRO, com o fundo azul), e selecione **Select All**. Todos os ficheiros ficarão com “Certinhos” em seus respectivos quadrinhos.
4º Em seguida, tire os “certinhos” em todos os ficheiros com a figura de cadeado (🔒) em frente.

5º Uma vez selecionados todos os ficheiros que devem ser transmitidos, posicione o PDA de modo que a Porta de Infra-Vermelho esteja frente a frente com a porta de Infra-Vermelho do AAP de tal forma que a distância que separa o AAP do PDA não seja superior a 1 metro, conforme mostra a figura abaixo. E aguarde pelo sinal de reconhecimento do PDA no painel do AAP.
6º Fique atento a mensagem que aparece no visor do AAP, pois se houver algum conteúdo no AAP para si, não poderá enviar nada sem antes receber o conteúdo. Após o reconhecimento do seu PDA, uma mensagem contendo o texto “….Beam Content or Sync mail now” aparecerá na parte inferior do visor do AAP. Assim já podes enviar os ficheiros. Pressione o botão Send do BeamPro, localizado no canto inferior esquerdo do visor.
6º Uma vez clicado o botão Send, as seguintes mensagens aparecerão consecutivamente no visor do seu PDA: “Preparando: Selected Files”, “Pesquisando…”, “Enviando: Selected Files” respectivamente. Aguarde até que a mensagem “Enviando: Selected files” desapareça do visor do seu PDA, e o mapa de África reapareça no visor do AAP.
NOTA: Considera-se envio bem sucedido ao AAP quando a mensagem “Enviando: Selected Files” desaparece do visor do seu PDA.

6. Recebendo Conteúdos do AAP via Raio Infra-Vermelho

Para além de mensagens electrónicas (emails), podes receber através do AAP no seu PDA jornais, material de formação contínua (guiões), ordens de serviço, e mais.

O AAP prioriza sempre um conteúdo que deve ser entregue ao utilizador em detrimento de dados ou emails por mandar ou receber, isto é, se um utilizador quiser enviar dados, receber ou enviar email via Raio Infra Vermelho enquanto existe um conteúdo no AAP para ele, o utilizador deve cancelar a operação desejada e receber primeiramente o conteúdo.

Para receber o conteúdo,

1º Aponte o PDA ao AAP e fique atento ao painel do AAP, a mensagem “Press the HotSync Button now to receive the Content” que quer dizer em português “Pressione o botão de HotSync no seu PDA para receber o Conteúdo”.

2º No seu PDA, pressione o botão de HotSync e aguarde até que a sincronização termine. Quando termina a sincronização a mensagem “Press the HotSync Button now to receive the
“Content” é substituída no painel do AAP por “No content available. Beam content or Sync email now.”. Assim já podes enviar dados ou mesmo receber e enviar emails.

7. Configuração de Bluetooth no PDA para envio de dados e ou recepção de emails

Para o envio e recepção de emails via Bluetooth através do AAP, é necessário que se estabeleça uma comunicação via Bluetooth entre o AAP e o PDA.

Em seguida mostraremos como configurar o seu PDA para poder enviar e receber emails via Bluetooth.

1º Active o Bluetooth conforme mostrado no ponto 4.1.

2º Ainda visualizando a janela de Bluetooth, pressione o botão Configurar dispositivos
3º Pressione o botão *Configuração de LAN*
4º Pressione o botão **Avançar**. Aguarde até que o AAP seja localizado via bluetooth. Selecione “**OpenWRT**”, e pressione o botão **OK**.

5º Pressione o botão **Sim** quando questionado “Deseja adicionar OpenWRT à lista de dispositivos confiáveis?” Em seguida pressione o botão **OK**

6º Introduza **1234**, e pressione o botão **OK**

7º No campo **Nome do usuário**, introduza o nome do seu PDA. Como exemplo usaremos RMIS082. Para introduzir a senha, toque conforme é indicado no visor. Introduza o mesmo nome que introduziu no Nome do Usuário, e neste caso será RMIS082. Assim no campo nome do usuário introduziremos RMIS082. Pressione o botão **Avançar** e pressione o botão **OK**.
8º Voltando à página de configuração do Bluetooth, pressione o botão **Conectar** para conectar-se aos serviços da rede OpenWRT. Aguarde até que a conexão seja estabelecida. Uma vez conectado, o botão **Conectar** é substituído pelo botão **Desconectar**. Assim pode-se ir ao Versamail e enviar e receber emails via bluetooth.
7.2 Configuração de LFtp e envio de dados via Bluetooth

Para o envio de dados via Bluetooth usaremos o programa LFtp contida na Categoria RMIS.

7.2.1 Configuração de LFtp

Nota: Antes de iniciar a configuração do LFtp certifique se tem o ficheiro mozess no Memos do seu PDA. Caso não tenha, transfira de um PDA que tenha para o seu via Infra Red.

Uma vez configurado o LFtp, não mais preciso configurá-lo, salvo numa situação em que se instale outra vez o LFtp.

1º Aceda ao programa LFtp clicando sobre o respectivo ícone na categoria RMIS.
2º Uma vez aberto o programa, se o Bluetooth não estiver activo, uma mensagem será visualizada informando para activar o Bluetooth. Pressione o botão *OK*. Se o Bluetooth estiver activo, passe imediatamente ao passo seguinte.

3º Pressione a barra de menu do programa LFtp localizado no canto superior esquerdo e siga a sequência de instruções Misc ➔ Preferences.
4º Introduza os detalhes do perfil.

**Server:** 192.168.1.1  
**Login:** deve ser o nome do seu PDA conforme está na página do HotSync. Neste caso é RMIS082.  
**Password:** introduza o mesmo que introduziu no Login. Neste caso é RMIS082.  
**use scripted cmds:** introduza o certinho pressionando no respectivo quadrado  
**no PAVS:** introduza o certinho pressionando no respectivo quadrado.

Introduza as seguintes linhas de texto conforme se vê na figura:

- `cd upload`
- `execmemo mozess`
- `quit`

**use prefs:** introduza o certinho pressionando no respectivo quadrado
5º Pressione o botão **OK**.

**Nota:** Estas configurações são permanentes, isto é, enquanto não se desinstalar o LFtp, ela permanece no PDA.
7.2.2 Envio de dados via Bluetooth

Conforme anunciado acima, o programa LFtp é o programa que será usado para o envio de dados via Bluetooth. Uma vez configurado, podemos enviar dados sempre.

Para enviar dados:

1º Aceda ao programa LFtp clicando sobre o respectivo ícone na categoria RMIS.

2º Uma vez aberto o programa, se o Bluetooth não estiver activo, uma mensagem será visualizada informando para activar o Bluetooth. Pressione o botão OK. Se o Bluetooth estiver activo, passe imediatamente ao passo seguinte.

3º Acompanhe o processo de envio de dados no visor do seu PDA. O processo termina quando surge no visor do seu PDA a Exited FTP.

Nota: Após terminar o envio de dados, desligue o bluetooth no seu PDA para poder permitir outras conexões ao AAP. Enquanto existir uma conexão via bluetooth entre um PDA e outro, nenhum outro PDA pode estabelecer conexão com este mesmo AAP.
7.2 Configuração de conta no Versamail

Para podermos enviar e receber email, é necessário que criemos e configuremos uma conta no aplicativo Versamail.

Em seguida mostraremos como configurar uma conta no versamail:

Primeiramente devemos aceder ao aplicativo Versamail:

- Pressione a barra de menu, no canto superior esquerdo
  - Selecione “Contas”;
  - Selecione “Configuração de conta…”;
  - Na página seguinte, selecione o “Versamail”;
  - Pressione o botão “Editar…”

Nome da Conta: por defeito aparece Versamail;

Serviço de email: pressione a seta e selecione “Outro”;

Protocolo: pressione a seta e selecione “POP”;

Apenas para sincronização: por defeito aparece sem o certinho;

- Pressione o botão Avançar
Usuário & Senha:

**Usuário:** introduza o nome gravado no canto superior direito da página do **HotSync** do seu PDA;

**Senha:** introduza outra vez o nome introduzido acima;
• Pressione “Avançar”

Endereço de email: a seguir ao sinal “@” acrescente “rmis.org.mz”;
Servidor de email de entrada: introduza 192.168.1.1;
Servidor de email de saída: introduza 192.168.1.1;

• Pressione “Avançar”
• Pressione “Avançar”
  o **Excluir mensagens no servidor quando elas forem excluídas no Versamail:** pressione o quadradinho correspondente de modo que este tenha o certinho;
  o **Deixar correio no servidor (e.g. para ver no Desktop mais tarde):** pressionando no quadradinho correspondente, retire o certinho de modo que o quadradinho esteja vazio.
  o **Tamanho máximo de mensagem:** introduza 2048. Este é o limite máximo de uma mensagem permitido pelo PDA.
Deste modo o PDA, já está configurado para poder enviar e receber emails.

**NOTA: Estas configurações são feitas um única vez. Pode voltar a fazer em caso de por qualquer eventualidade desinstalar o Versamail ou fazer o HardReset no seu PDA.**

7.3 Envio e recepção de Emails via Bluetooth

O Versamail é o aplicativo que é usado nos PDA’s para o envio de emails. Através do email podes enviar textos sem limitação do número de caracteres receber outros emails contendo alguns anexos (attachment). Estes anexos podem ser música, outros documentos, imagens, vídeos, etc.

7.3.1 Enviando um e-mail

1º Usando a caneta, vá até a Categoria RMIS e aceda ao aplicativo Versamail pressionando no ícone do aplicativo.

2º Em seguida pressione o botão Novo. Na parte superior esquerda do visor, em Para, introduza o endereço do email do destinatário. Ex: aed.rmis@gmail.com. Em Assunto, introduza o assunto do conteúdo da sua mensagem, neste caso “Primeiro Email”. Para escrever a mensagem do email, posicione o cursor na parte imediatamente inferior a Assunto no visor do seu PDA e através do teclado alfanumérico, introduza o seu texto.
Uma vez terminado de escrever o texto da mensagem, pressione o botão **Enviar (Env)** no canto inferior do Versamail. Aguarde, observando no visor o processo de envio da mensagem, até que a mensagem seja enviada.

7.3.2 Recebendo um e-mail

1º Uma vez estando com o Versamail aberto, pressione o botão **obter e-mail** entre os botões **Novo** e **Exibir**.

2º Selecione a opção **Mensagens**. Pressione o botão **OK**
3º Aguarde até que a sessão seja inicializada. Se não houver nenhuma mensagem para o utilizador receber. As seguintes mensagens serão visualizadas consecutivamente no visor do seu PDA: “Conectando com o ISP…”, “Iniciando a Sessão”, “Estabelecido”, “Conectando com o Servidor de Correio...”, “Conectando com o Servidor SMTP...” respectivamente. Se não houver nenhuma mensagem, será visualizada a seguinte mensagem no visor do seu PDA:
Se houver alguma mensagem, a seguinte mensagem será visualizada no seu PDA: “# mensagens novas”, onde # é o número de mensagens novas recebidas.

4º Pressione em OK.

5º Para ler um e-mail, no visor do VersaMail, selecione o e-mail que desejas ler, e em seguida ele abrirá dando-te a possibilidade de ler. E em seguida pressione o botão Ok.
III. Introdução de dados via Computador de mesa

Os computadores dos distritos, e províncias com acesso à Internet serão usados para a colecta de dados da Vigilância Epidemiológica usando os mesmos formulário do BES, BE-PS e RD do PDA contudo, especialmente desenhados para o uso em computadores.

Todos os utilizadores do sistema terão acesso ao sistema através do nome do utilizador e uma senha (Password). Com o Nome do utilizador e a Password, o utilizador terá acesso a todos os serviços do sistema incluindo introdução de dados e geração de relatórios.

Neste capítulo mostraremos como aceder e preencher a Ficha do Resumo Diário das Doenças Epidemiológicas usando formulários desenhados para computadores. A forma de preencher esta ficha é equivalente ao modo de preenchimento das outras duas fichas (BES e BE-PS). Mostraremos também como actualizar dados, gerar relatórios em Excel e gerar o Calendário Epidemiológico Semanal.

1. Acedendo ao Sistema

1º Para aceder ao Sistema de Vigilância Epidemiológica (SIS-VE), siga a sequência de instruções: Start ➔ All Programs ➔ MOZESS ➔ MOZESS Database conforme se vê abaixo. Pressione uma vez sobre MOZESS Database.
2º Introduza o Nome do Usuário e a Password. Neste caso o nome do usuário é **Teste** e a Password que o Administrador do Sistema lhe forneceu é **12345**.

**NOTA:** A **Password deverá ser mudado assim que o utilizador aceda ao sistema pela primeira vez. De 30 em 30 dias a password também deverá ser mudada e deve ser diferente que a anterior.**

Suponhamos que seja a primeira vez que acedemos ao Programa. O Administrador do Sistema deu-lhe a seguinte password 12345, e deve mudar para **123456**.
3º Vamos agora mudar a password para uma que seja fácil de te lembrar e difícil para que outros adivinhem. Neste caso mudaremos para 123456. Após pressionar o botão **Entrar**, a mensagem de que a password expirou será visualizada. Pressione o botão **OK** e o formulário de mudança de password será visualizado.

No campo **Password**, apague 12345 e introduza **123456**. Pressione o botão **Gravar e Sair**. O menu principal será visualizado no seu monitor.
2. Preenchimento das Fichas

Conforme foi dito acima, mostraremos somente como preencher a Ficha de Resumo Diário. Do mesmo modo preenchem-se as restantes fichas.

**NOTA: Todos os campos escritos a vermelho, o preenchimento é de carácter obrigatório.**

1º Selecione a opção “Introduzir Dados” no menu e pressione o botão **Processar**.

2º Selecione a opção “Resumo Diário” e pressione o botão **OK**.

3º Comece por introduzir os dados relativos ao Distrito, Localidade, Dia, Mês, Ano e o Nome da doença Epidemiológica. O campo Província, será preenchido por defeito com o nome da Província onde te encontra a trabalhar. Neste caso é Cabo Delgado.

**Nota: Todos campos citados acima não podem ser vazios. O campo Data Caso Índice deve ser introduzido no formato “mm/dd/aaaa”, onde mm é o mês, dd é o dia e aaaa é o ano.**
4º Após preencher todos os restantes campos, pressione o botão **Gravar** de modo que os dados sejam gravados na sua base de dados e na base de dados Central. Aguarde até que a mensagem de confirmação de que o registo foi efectuado com sucesso seja mostrada.

5º Pressione o botão **Terminar** se tiver a certeza que não tem mais dados de Resumo Diário a introduzir.
3. **Actualização de Dados**

Actualização de dados significa corrigir dados que tenham sido introduzidos incorrectamente. Os campos a serem actualizados não devem ser os de preenchimento obrigatórios, isto é, os campos escritos a vermelhos jamais poderão ser modificados.

Usaremos como exemplo os dados que introduzimos acima na Ficha de Resumo Diário do Distrito de Ancuabe e localidade de Grafiti.

Para actualizarmos este registo referente a Grafite, devemos antecipadamente conhecer o nome do Distrito, da localidade, o dia, o mês, o ano e a Doença Epidemiológica. Estes dados aqui referidos jamais deverão ser modificados.

**Nota:** Os dados modificados localmente, serão automaticamente modificados na base de dados central.

A seguir mostraremos passo a passo para a actualização de dados.

1º No menu principal seleccione a opção “Actualizar Dados” e pressione o botão **Processar**.

2º Em seguida seleccione a opção “Resumo Diário” e pressione o botão **OK**

3º Suponhamos que o número de casos de óbitos de Cólera em femininos de 0 à 4 ano seja de 5 e não 1 como havíamos introduzido anteriormente. Apagamos o 1 e introduzimos o 5. Se
tivermos a certeza que não desejamos modificar nenhum outro dado deste registo, pressionamos o botão **Gravar** e aguardamos a mensagem de confirmação de que o registo foi gravado com sucesso.

4º Pressione o botão **OK** e em seguida pressione o botão **Terminar**.

4. **Gerar relatórios**

Todos os dias às 7:00 horas da manhã os MISAU precisa do relatório dos dados de Resumo Diário de cada Doença Epidemiológica notificada em cada localidade.

A ficha do Resumo Diário das doenças epidemiológicas no computador assim como no PDA só será preenchida em caso de verificação de um surto.
Para gerar relatórios diários como exemplo, usaremos os dados de Resumo diário que introduzimos acima.

A seguir mostraremos como gerar o relatório em Excel. Todos os relatórios no SIS-VE serão gerados no formato Excel.

1º No menu principal selecione a opção “Gerar Relatórios” e pressione o botão **Processar**.

2º Em seguida selecione a opção “Resumo Diário” e pressione o botão “**OK**”

3º Introduza as variáveis para gerar o relatório: Distrito, Dia, Mês, Ano e Doença Epidemiológica. Em seguida pressione o botão **OK**. Aguarde até que a mensagem de que deseja gravar o relatório seja mostrada. Pressione o botão **Terminar**.

4º Pressione o botão **Yes** para gravar o relatório e abri-lo automaticamente.
5º Uma vez aberto o relatório no formato Excel, podemos visualizar o relatório de cada localidade reportados naquele dia e os cumulativos de cada localidade desde o início do ano.

Através deste relatório, podemos concluir que no Distrito de Ancuabe, na Província de Cabo Delgado, foram reportados casos de Cólera nas Localidade de Grafite e Mariri.

5. Calendário Epidemiológico

O Calendário Epidemiológico é usado para preencher a Ficha de Boletim Epidemiológico Semanal.

Através do SIS-VE podemos gerar o Calendário Epidemiológico para cada ano de forma automática. Após um calendário ser gerado, podemos exportar para o formato Word, imprimir e disponibilizar para os demais colegas. Ao invés de exportar para o formato Word, temos também a opção de imprimir directamente no sistema.

A seguir mostraremos como gerar o relatório e como visualiza-lo dentro do sistema.
5.1 Gerar Calendário Epidemiológico

Para gerarmos o Calendário Epidemiológico, seleccionamos primeiramente a opção “Calendário Epidemiológico” no Menu Principal e pressione a opção Processar.

O Calendário Epidemiológico deverá ser gerado a cada dia 1 de Janeiro de cada ano.

1º Uma vez pressionado o botão Processar, seleciona a opção “Actualizar” e pressione o botão OK.

2º Introduza o ano para o qual deseja que o Calendário Epidemiológico seja criado. Como exemplo introduziremos o ano 2016. Em seguida pressione o botão OK. Aguarde até que a mensagem de confirmação de que o calendário foi criado seja visualizado.

3º Pressione o botão OK em seguida seleccione.
3º Seleccione a opção “Terminar” e pressione o botão OK.

5.2 Visualizar Calendário Epidemiológico

Para visualizar o Calendário Epidemiológico:

1º Seleccione a opção “Visualizar” no Menu do Calendário Epidemiológico e pressione o botão OK.

2º Introduza o ano o qual deseja visualizar o Calendário Epidemiológico. Introduzimos 2016 como no exemplo anterior.

3º Pressione a botão e aguarde que o calendário seja mostrado no seu monitor. A seguir mostramos um extracto do calendário para o Ano 2016.
## Calendário epidemiológico para o ano 2016

<table>
<thead>
<tr>
<th>Mês</th>
<th>Semana</th>
<th>Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
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<td>3-9/2016</td>
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<tr>
<td></td>
<td>2</td>
<td>10-16/2016</td>
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<tr>
<td></td>
<td>3</td>
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<tr>
<td></td>
<td>25</td>
<td>22-28/2016</td>
</tr>
</tbody>
</table>
IV. Solução de alguns problemas comuns

1. Com o seu PDA

Muitas vezes, para a solução de problemas do PDA, recorremos a re-inicialização do PDA. A seguir mostraremos duas formas de re-inicializar o PDA, o Soft RESET e o Hard Reset.

Execução de uma re-inicialização a quente (Soft RESET)

1.1 Para executar uma re-inicialização a quente:

Use a ponta da Caneta ou um clipe de papel desdobrado (ou objecto semelhante não pontiagudo) para pressionar cuidadosamente o botão de re-inicialização (RESET) no orifício localizado no painel posterior do PDA.

1.2 Execução de uma re-inicialização a frio (Hard RESET)

Na re-inicialização a frio, todos os registos e entradas do PDA são apagados. Até mesmo alguns aplicativos instalados, tal é o caso dos formulários que usualmente usamos para colecta de dados, BeamPro, Versamail, Lftp, Jogos e mais.

Só execute uma re-inicialização a frio se a re-inicialização a quente não solucionar o problema.

Para executar uma re-inicialização a frio:

1º Mantenha pressionado o botão ligar/desligar (Power) do PDA.
2º Em simultâneo que mantêns o botão de ligar/desligar pressionado, use a ponta da Caneta ou um clipe de papel desdobrado (ou objecto semelhante não pontiagudo) para pressionar cuidadosamente, durante pelo menos 3 segundos. Solte o botão de re-inicialização (RESET).
3º Aguarde até ver o logo Palm Powered; em seguida, solte o botão de energia.
4º Quando uma mensagem for exibida na tela do PDA avisando que todos os dados nele armazenados serão apagados, siga um destes procedimentos:
   – Pressione a seta para cima no navegador para concluir a re-inicialização a frio e exibir a tela calibragem.

Obs: Na re-inicialização a frio, a data e a hora actuais serão mantidas.
As preferências de formatos e outras configurações serão restauradas segundo as configurações padrão de fábrica.

1.3 Não se vê nada na tela do PDA

- Pressione um botão de aplicativo para verificar se o PDA está ligado;
- Carregue o PDA;
- Execute uma re-inicialização a quente. Se, mesmo assim, o PDA não ligar, execute uma re-inicialização a frio.

1.4 O PDA congelou (Encravou / Não reage)
• Se uma conexão de rede tiver sido encerrada inadequadamente, o PDA poderá parecer congelado por até 30 segundos. Se ela permanecer congelada após 30 segundos, execute uma re-inicialização a quente.

1.5 Quando se pressiona nos botões ou nos ícones da tela, o PDA aciona o recurso errado

• Vá a Pref e a seguir clique em Tela de Toque, e depois, cuidadosamente, calibre o visor pressionando com o ponta da Caneta no ponto central das espirais que aparecerem na tela.

1.6 O ecrã do PDA não acende ao ligar-se o Botão de ligar/desligar o PDA

• Conecte o PDA ao carregador para carregar por pelo menos 3 horas, e tente ligar novamente.

1.7 O PDA não emite nenhum som

• Verifique as configurações de som do sistema, do alarme e dos jogos.

1.8 Toquei no botão ‘Hoje’, mas ele não mostra a data correcta

• O PDA não está definido para a data actual. Verifique se a caixa Definir data na tela Preferências – Data e hora exibe a data actual.

1.9 Não consigo realizar uma operação de HotSync

• Verifique se a base/cabo do HotSync está conectado correctamente.

1.10 Não consigo executar uma operação de HotSync por infravermelho

• Verifique se a porta de infravermelho do computador de mão está alinhada directamente à frente, e afastada alguns centímetros, do dispositivo de infravermelho do dispositivo com que se pretende comunicar.
• As operações de HotSync por infravermelho não funcionam depois que for emitido um aviso de bateria fraca. Verifique a carga da bateria do PDA. Recarregue a bateria interna.

1.11 Não consigo transferir dados para outro dispositivo com porta de infravermelho

• Se a transferência estiver sendo feita para outro PDA Palm, verifique se a distância entre os aparelhos se situa entre dez centímetros e um metro e se o espaço entre eles está livre de obstáculos. A distância de transferência para outros dispositivos com porta de infravermelho pode ser diferente. Aproxime o PDA do dispositivo de recebimento.
• Certifique-se de que as configurações do BeamPro estão corretas, se a via de transmissão é Infrared e se é To Other.

1.12 Não consigo fazer o envio de dados para outro dispositivo através da tecnologia Bluetooth

• Certifique-se de que a comunicação Bluetooth está activada tanto no PDA quanto no outro dispositivo.
• Certifique-se de que o dispositivo receptor tem um aplicativo instalado compatível e o Bluetooth activo.

2. Durante o uso do SIS-VE no computador

2.1 Quando quero gerar relatório aparece a mensagem “No Current Record”

• Significa que não existem dados relativos aos parâmetros introduzidos no formulário de geração de relatórios, na base de dados central.

2.2 Quando pressiono o botão Test do MySql Connector/ODBC DataSource configuration diz Connection Failed: [HY000] [MySQL][ODBC 5.1 Driver] Unknown MySQL server host ‘mozess.rmis.org.mz’ (11004)

• Significa que o sinal de conexão à internet é extremamente fraco ou inexistente. Aguarde até que o sinal de internet seja recuperado.

2.3 Quando pressiono o botão OK do MySql Connector/ODBC DataSource configuration diz ODBC – Connection to ‘MOZESS’ failed

• Verifique se o sinal de internet é forte. Aguarde até que o sinal de internet seja recuperado.

2.4 Quando pressiono o botão Gravar aparece a mensagem “Index or primary key cannot contain a Null value”

• Significa que pelo menos um dos campos obrigatórios não está preenchido, isto é, está vazio. Verifique e introduza o(s) valore(s) deste(s) campo(s).
Conclusão

Para melhor ter domínio do seu PDA, suas funcionalidades e outras aplicações é necessário que pratique sempre.

Não só podes usar o seu PDA para preencher os formulários integrados nele ou que aprendeste durante a formação, podes usar também para cálculos através da calculadora, podes fazer anotações, e programas para que o PDA te recorde ou na hora ou mesmo dias antes da data prevista.

Em caso de dúvidas, consulte este manual antes de tomar alguma acção. Posteriormente, consulte o teu supervisor a nível provincial e ou faça o uso da linha verde da RMIS para apoio imediato.

Recomenda-se que carregue o seu PDA todos os dias no final do dia ou mesmo a noite durante 15 a 30 minutos, digo todos os dias. Não espere que o PDA não tenha carga para poder recarregar.

Faça o uso constante do serviço de email providenciado pelo sistema.

Aconselha-se que em caso de perda da Caneta, use o dedo seco ou mesmo esferográfica mas sem a ponta pontiaguda.

Para limpeza do visor do seu PDA, uso um pano macio e não deixe o seu aparelho em locais empoeirados.

Para terminar, faça bom proveito do seu PDA, nós aguardamos pelos dados por semanalmente, no caso de Boletim Epidemiológico Semanal, ou em base diária para o Resumo Diário e, mensalmente para o caso de Boletim Epidemiológico das Unidade Sanitárias e Posto Sentinela.
### Suporte técnico

| Contactos para assistência técnica: | 82 000 7647  
aed.rmis@gmail.com |
|------------------------------------|---------------------|
| RMIS                               | **Telefone ao supervisor da Província**  
**Qualquer funcionário treinado para fazer supervisão a nível da Provincia** |
Ministério da Saúde (MISAU)

REDE MOÇAMBICANA DE INFORMAÇÃO PARA SÁUDE (RMIS)

O projecto RMIS é uma parceria da Academia para o Desenvolvimento Educacional (AED), MISAU e Ministério da Ciência e Tecnologia.

Manual de Administrador do Sistema Moçambicano de Vigilância Epidemiológica
SIS-VE

(Projecto da AED Número: 3746-01)

Este trabalho foi realizado com a ajuda de fundos concedidos pelo Centro de Pesquisa para o Desenvolvimento Internacional em Ottawa, Canada (International Research Centre, IDRC).

As actividades do projecto foram realizadas com o apoio financeiro do Governo Canadiano através da Agencia Canadiana de Desenvolvimento Internacional (Canadian International Development Agency, CIDA).
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I. Introdução

O projecto RMIS (Rede Moçambicana de Informação de Saúde), é um projecto do Ministério da Saúde (MISAU) em parceria com a Academia para o Desenvolvimento Educacional (AED-SATELLIFE), financiado pelo Centro de Pesquisa para o Desenvolvimento Internacional (IDRC) que, pretende equipar o MISAU a vários níveis, com ferramentas de recolha e transmissão de dados para a melhoria do sistema de Informação para a Saúde.

No presente manual abordaremos a configuração da base de dados para receber dados do PDA, sincronização directa no computador de mesa, instalação de programas no PDA e gestão de AAP’s.
1. Configuração da Base de dados para sincronização de dados do SIS-VE

Para que os dados coletados através do PDA sejam sincronizados na base de dados do SIS-VE, é necessário que esta base de dados esteja configurada de modo que receba dados vindos do PDA.

Suponhamos que queiramos configurar o base de dados para receber dados do PDA PMaputoC01 e PMaputoC02.

1º Aceda ao programa SIS-VE através da sequência de instruções Start → All Programs → MOZESS → MOZESS Database.

2º Pressione o botão **Editar lista de usuários** localizado no lado inferior direito do formulário de entrada no sistema.

3º Conforme ilustra a figura em baixo, introduza os nomes dos PDA’s (PMaputoC01 e PMaputoC02) sob a coluna do User Name e, sob a coluna da opção **Active**, clica no quadradinho de cada um dos nomes dos PDA’s, para activar cada um deles.

4º Pressione o botão **List** para terminar de introduzir os nomes do PDA’s.

5º Ainda na entrada do sistema SIS-VE, pressione o botão **Editar grupo de usuários** localizado imediatamente abaixo do botão **Editar lista de usuários**.

6º Pressione o botão **Edit Members…**
7º Selecione o usuário criado anteriormente e selecione todas as opções de formulário para este usuário conforme mostram as figuras abaixo.
8º Para terminar, pressione o botão 📢. Assim os PDA’s já podem sincronizar dados de Vigilância Epidemiológica neste computador.

2. Sincronização directa no PC

A sincronização directa no PC, para além de permitir a transferência de dados do PDA para a base de dados, ela permite que vídeos, fotos, contactos e outros sejam transferidos para o computador, como também permite que uma cópia de toda informação contida no PDA seja transferida para o computador como backup.

A sincronização directa no PC dos dados de vigilância epidemiológica só deverá ser feita depois que os dados tenham sido enviados para o AAP. A sincronização deverá também ser efectuada em caso de instalação de um novo programa no PDA transferir alguma informação do PDA para o computador e vice-versa.

A seguir os passos para a sincronização:

1º Conecte o cabo de sincronização contido no conjunto de acessórios disponível na caixa do seu PDA. Conecte o lado do cabo que contém o botão no PDA e a outra parte USB na porta USB do computador.
2º Uma vez conectado o cabo no computador e no PDA, pressione o botão de sincronização contido no cabo ligado ao PDA conforme mostra a figura. O processo de sincronização iniciará.
3º Aguarde que o processo inicie e acompanhe o processo de sincronização no seu computador ou no visor do seu PDA.
4º: Uma vez terminado o processo, será visualizada no monitor do seu computador uma mensagem conforme mostra a figura abaixo. Pressione em Ok para terminar a sincronização.

3. Criação de utilizadores no Palm Desktop

O programa Palm Desktop, é o programa usado nos computadores de mesa para a gestão de utilizadores. Entende-se por gestão de utilizadores, a criação, a renomeação e a exclusão de utilizadores.

Através do programa Palm Desktop podemos visualizar nos computadores as anotações feitas em nossos PDA’s. as fotos, vídeos, emails, calendários, contactos transferidos do PDA para o computador.

Somente após a criação de um utilizador através deste programa, pode-se instalar e sincronizar um PDA neste determinado computador.

3.1 Criação de utilizadores no Palm Desktop

Para a criação de utilizadores usando o Palm Desktop:

1º Aceda ao programa Palm Desktop seguindo a sequência de instruções: Start → All Programs → PalmOne → Palm Desktop
2º No menu **Tools**, selecione a opção “**Users…**”
3º Para adicionar um novo usuário, pressione o botão **New** e introduza o nome que deseja dar ao seu PDA. Para o nosso caso, usaremos como exemplo o PMaputoC01. A seguir pressione o botão **OK**.

4º Pressione o botão **OK** se tiver a certeza que não quer introduzir mais nenhum nome. Note que quando termina de introduzir um nome, o mesmo passa para a janela de usuário conforme se vê destacado na figura abaixo.
5º Para terminar o programa Palm Desktop, pressione o botão localizado no canto superior direito da janela do Palm Desktop.

4. Instalação de programas no PDA

Existem duas formas distintas de se instalarem programas no PDA. Uma em que o ficheiro de instalação do programa tem a extensão (.prc) e a outra em que o ficheiro de instalação tem a extensão (.exe). Embora estas formas de instalação sejam distintas, elas tem algo em comum, elas culminam com um processo de sincronização.
4.1 Instalação de programas (.prc)

Para a instalação de programas (.prc) nos PDA’s é necessário que tenhamos instalado em primeiro lugar, o Programa PalmOne Quick install. Este é o programa principal necessário para a instalação dos aplicativos (.prc) num PDA.

Mostraremos a seguir, como instalar um aplicativo (.prc).

1º Aceda ao programa PalmOne Quick Install seguindo a sequência de instruções: **Start ➔ All Programs ➔ PalmOne ➔ PalmOne Quick Install**

2º Pressione no User selecione o nome do PDA no qual deseja instalar o programa. Para o nosso caso queremos instalar no PDA PMaputoC01.

3º Através do Windows, vá até o directorio onde se encontram os ficheiros (.prc) a serem instalados no PDA. Arraste-os com o mouse para o PalmOne Quick Instal na janela abaixo de **Handheld**. Em caso de desejar instalar no cartão de memória do seu PDA, arraste o(s) ficheiro(s) para a janela abaixo do **Expansion Card**.
Nota: Pode-se em simultâneo instalar diversos programas usando o PalmOne Quick Install.

4º Execute a operação de sincronização (conforme mostrado no ponto 1) usando o PDA no qual deseja instalar os programas. Neste caso é o PMaputoC01.

5º Uma vez terminado o processo de sincronização, as janelas Handheld e Expansion Card estarão vazias.
6º Para terminar o programa PalmOne Quick Install, pressione localizado no canto superior direito do PalmOne Quick Install.

4.2 Instalação de programas (.exe)

Nem todos os programas que são instalados no PDA têm a extensão (.prc). Alguns deles como o Versamail, RealPlayer, Adobe Reader e outros tem a extensão (.exe).

No presente manual, usaremos o disco de instalação de programas da Palm que faz parte do kit do PDA, especialmente para o Windows. Existem discos de instalação para outros sistemas operativos como o Mac OS.

No disco de instalação pode-se encontrar programas como Versamail, Adobe Reader, Jogos, Realplayer e outros.

No presente manual mostraremos como instalar o Versamail no seu PDA usando o disco de instalação. O mesmo procedimento pode ser usado para instalar outros programas contidos em discos de instalação da Palm.

1º Introduza o disco no CD-Rom. O disco abrir-se-á automaticamente mostrando as opções de linguagem. Selecione Português como opção de língua.

Nota: Dependendo da linguagem que selecionar, o programa será instalado no PDA com a linguagem selecionada.
2º Selecione a opção Adicione Software a seu computador de mão.
3º Selecione a opção **palmOne VersaMail**.

**Softwares adicionais**

Parabéns! Você concluiu a instalação do Palm Desktop.

Aproveite mais o computador de mão com estes programas essenciais. Depois de instalá-los, você poderá trocar documentos do Office, músicas e vídeos entre o computador de mão e o de mesa.

- **Manual introdução** (no computador de mão)
- **AudiblePlayer** (aplicações em áudio)
- **RealPlayer Desktop** (reprodução de vídeo e áudio)
- **Enterprise Software** (gerenciamento de nível corporativo)
- **Handmark Solitaire** (jogo de paciência)
- **Windows Media Player/DirectX** (instalação do Windows Media Player B)
- **Adobe Reader para Palm OS** (visualização de documentos PDF)
- **Apple QuickTime** (visualização de vídeo e áudio na internet)
- **AddIt** (procure os softwares mais recentes)
- **palmOne VersaMail**
- **eReader** (ler e-books)

4º Na janela seguinte pressione em **Instalar** e aguarde até que o processo inicie. Acompanhe o processo através do monitor do seu computador.

**palmOne™ VersaMail**

Desenvolvido para os usuários de computadores de mão, o VersaMail facilita o acesso e o gerenciamento de e-mails pessoais e corporativos enquanto estiver em trânsito. O VersaMail oferece suporte a vários clientes de e-mail para computador de mesa bem como contas IMAP e Internet POP. Além disso, você pode fazer o download de e-mail sem fio ou com uma operação de HotSync®.
5º Selecione a opção **Reinstalar** e pressione o botão **Avançar**.

![InstallShield Wizard](image1.png)

6º Aguarde até que a janela de seleção de usuário seja visualizada no monitor do seu computador. Selecione o usuário. Neste caso é o PMaputoC01. Pressione o botão **Avançar**.

![InstallShield Wizard](image2.png)
7º Acompanhe o processo através do monitor do seu computador. A janela seguinte será visualizada no monitor do seu computador.

8º Execute a operação de sincronização (conforme mostrado no ponto 1) usando o PDA no qual deseja instalar os programas. Neste caso é o PMaputoC01.

9º Após terminar a sincronização, a janela seguinte será visualizada no monitor do seu computador, pressione o botão **Concluir** para terminar a instalação do Versamail no PDA.
5. Gestão de AAP’s

Entende-se por Gestão de AAP a realização das seguintes operações sobre o AAP:

- Inserção de novos utilizadores;
- Calendarização de chamadas para ligação ao Servidor;
- Modificação dos detalhes do utilizador.

No presente manual mostraremos como executar as operações acima citadas.

5.1 Conexão entre o computador e o AAP

Para que a comunicação entre o computador e o AAP seja estabelecida, é necessário que se estabeleça uma rede entre os dois dispositivos.

Para que se estabeleça uma rede entre os dois dispositivos precisamos de 1 Cabo de Rede (disponibilizado pelos técnicos da RMIS), 1 AAP e um computador.

Em seguida:

1º Conecte o cabo de rede numa das portas 1, 2, 3 ou 4 do AAP e na respectiva entrada do cabo na placa de rede do computador.

2º Aceda à placa de rede do seu computador seguindo a sequência de Start → All Programs → Connect To → Show All Connections conforme se vê na figura abaixo.
3º Selecione a opção da LAN clique sobre o mouse no lado direito. O menu vertical aparecerá, selecione a opção *Properties*.

4º Selecione a opção *Internet Protocol (TCP/IP)* e pressione o botão *Properties*. 
5º Selecione a opção *Use the following IP address*. E introduza os seguintes valores para os respectivos campos:

- **IP address**: 192.168.1.20
- **Subnet mask**: 255.255.255.0
- **Default Gateway**: 192.168.1.1

**Nota**: Sempre que se conecta o AAP é necessário que se façam estas configurações. Após terminar de usar o AAP desconecte o cabo e siga os mesmos passos para voltar à configuração inicial. Se o computador tiver uma única placa de rede e se usar esta mesma para aceder a Internet, enquanto o AAP estiver conectado ao computador não se terá acesso a Internet neste computador.
6º Pressione o botão **OK**

7º Pressione o botão **Close**. Assim a conexão entre o AAP e o computador está estabelecida.

### 5.2 Acesso ao AAP

Uma vez estabelecida a conexão entre o AAP e o computador, o acesso ao AAP é feito através de um Navegador (Browser) mediante um nome de usuário (Username) e uma senha (Password).

1º Abra um Navegador. Por defeito usaremos o Navegador **Internet Explorer**. Para Aceder ao Internet Explorer, siga a sequência de instruções: **Start** → **All Programs** → **Internet Explorer**.

2º Na barra de endereços, introduza o endereço IP 192.168.1.1 e pressione o botão **Enter** do teclado do seu computador. A página de entrada no AAP será visualizada no seu monitor.
3º Introduza o Username e a Password. Por defeito o Username é **admin** e a password é **healthnet**. Em seguida pressione o botão **Submit**.

*Nota: Sempre que desejar aceder ao AAP use este username e este password. E deve estar tudo escrito em letras minúsculas.*

![Username and Password Input](image)

4º Assim que se acede o AAP, a página principal será visualizada no monitor do seu computador com o menu de todas as operações que se podem realizar sobre no AAP.

![AAP Menu](image)

### 5.2.1 Menu Gerir Pontos de Acesso (Manage Access Points)

Através deste menu pode-se adicionar e modificar Access Points, programar as ligações que o AAP fará ao Servidor, e verificar as estatísticas das operações efectuadas pelo AAP.

No presente manual mostraremos apenas como fazer o uso do sub-menu de horário de ligações ao Servidor.
5.2.1.1 Programar as ligações (AP Connection Schedule)

1º Selecione o menu AP Connection Schedule para programar o horário em que o AAP fará as ligações ao Servidor para download e upload de dados, conteúdos e emails.

2º Para introduzir um horário novo, introduza a hora em Hour e minutos em Minute. Como exemplo usaremos 14:15 (catorze horas e Quinze minutos). Em seguida pressione o botão Add New.

NOTA: De acordo com este horário, todos os dias a esta hora será o AAP efectuará uma ligação para o Servidor localizado em Maputo, no MISAU. Grave o horário das ligações de modo a saber em que altura do dia o AAP está conectado com o Servidor. Enquanto o AAP estiver conectado com o Servidor, nenhuma conexão entre AAP e PDA será estabelecida, ou seja, nenhum PDA poderá enviar ou receber quaisquer dados do AAP.

3º Se se quiser que a ligação seja efectuada imediatamente de modo que alguns dados estejam disponível no Servidor sem esperar que pelas horas já programadas, pressione o botão Sync Now. E acompanhe o processo através do monitor do seu computador.

5.2 Menu gerir Utilizadores (Manage Users)

Através deste menu pode-se criar utilizadores que terão privilégios de mandar e receber dados do servidor, receber conteúdos, enviar e receber emails usando este AAP.
5.2.1 Adição de um utilizador (Add User)

1º Seleccione o menu Add User.

2º Introduza os dados do PDA. Suponhamos que queiramos introduzir um PDA para transmitir dados no AAP mozess.

Os detalhes do PDA são:

First Name (primeiro nome): Lichinga (Distrito onde se localiza o PDA)
Surname (Apelido): Niassa (a Provincia onde o PDA se localiza)
Username (Nome do PDA): PNiassa01.

Nota: O nome do PDA (Username) deve coincidir com o nome que foi dado ao PDA. Este nome localiza-se no canto superior direito da página do HotSync.

Password (Senha): PNiassa01. Deve ser o mesmo com o Nome do PDA.
Retype Password (reescreva a Password): PNiassa01. Deve ser igual ao que foi escrito no campo da Senha.
3º Pressione o botão **Add New** e aguarde pela mensagem de confirmação de que o utilizador foi criado com sucesso.

New User created successfully.
New login account successfully added.
Created mail directory for user 'PNiassa01'

5.2.1 Apagar um utilizador do AAP (Edit/Delete User)

1º Para apagar um utilizador seleccione o utilizador pressionando sobre o nome, neste caso **PNiassa01**.

2º Seleccione a opção **Edit/Delete User**. Em seguida selecione **Delete This Entry** pondo um certinho no seu respectivo quadrinho. Pressione o botão **Update**. Assim o utilizador será apagado automaticamente.
5.3 Saindo do AAP

Para sair do AAP, selecione a *Logout* no menu principal do AAP.
Cost Effectiveness Assessment of Mozambique Health Information Network

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Eduardo Mondlane University
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November 2010

Work related to UHIN was carried out with the aid of a grant from the International Development Research Centre, Ottawa, Canada
Executive Summary

Health is a priority goal, given its central input into economic development and poverty reduction. Developing countries have higher than average mortality rates, higher levels of mortality and limited access to health care (OECD, 2003; Sachs, 2001). Lack of access to accurate and timely health information is an important contributory factor. In addition, the social and economic burden of disease in developing countries is further worsened by feedback link between health and economic development (Kennedy School of Government, 2001). Investment in health is important for improved access to affordable and quality health services.

Health Information Technology and surveillance systems have been promoted worldwide to facilitate and increase the access to relevant and timely health data. A systematic and timely analysis of the health trends has been identified as increasingly important for evidence-based policy and programs improving communication and access to health care information. An analysis is also crucial to inform policies, set priorities, and ensure the appropriate and effective use of resources to improve the health service performance and the health of the community.

The Mozambique Health Information Network (MHIN) for health information management resulted from the joint commitment between Ministry of Health of Mozambique (MISAU) and the AED-SATELLIFE Center, through grant funding from the International Development Research Centre of Canada (IDRC) to implement an electronic health information system for management. The project initially focused on improving MISAU’s routine data collection and reporting of health information at the point of care all the way up to the national level. During this time, the project focused on six districts in Zambézia, Inhambane and Gaza provinces. Based on MISAU’s needs and priorities, the project focused on improving MISAU’s Integrated Disease Surveillance and Response (IDSR) system. The project covered 43 District Health Offices in Gaza, Inhambane and Zambézia provinces, 11 provinces and the national level Ministry of Health.

Rationale and Relevance of the Study

In Mozambique, given the outbreak of several diseases, this implies that the current health information system (paper-based) has to generate hundreds of pages of paperwork in order to
inform the MoH headquarters. However, this process often characterized by long waiting weeks or months of data entry implies high costs for the SIS as a whole.

The rationale of conducting a cost-effectiveness study of the paper-based system vis-à-vis the system developed by MHIN is to inform policy makers in terms of the most appropriate HMIS to ensure higher quality and reliable health information on epidemic-prone diseases in Mozambique. The successful implementation of such a system will strengthen the HMIS in Mozambique, by reducing the average time to report disease information to the Ministry of Health from an average of four weeks to one.

**Objective**

This objective of this study is to assess cost-effectiveness of the for epidemiological surveillance data collection and reporting compared to the traditional paper-based system, and to assess which one of the options yields higher benefits and better quality of health data.

**Data Collection Approach**

The data for this study was collected from district health offices and the Ministry of Health in the provinces of Gaza and Inhambane. A total of 13 districts were visited, 6 in Gaza and 7 in Inhambane, over a period in August 2010.

**Main Results**

In general, the MHIN provides a less costly and highly efficient alternative for data capturing, analysis and storage of epidemiological surveillance data. In addition, it provides timely and accurate data, which reduces risks and speeds up the process for rapid response, allowing for faster and accurate decision making by policy makers. The key findings of the study are the following.

1) The paper-based system requires more person-hours than the system to perform a similar activity. On average under the MHIN it takes about 5 hours per month, while in paper-based system takes about 26.4 hours to aggregate and transcribe the forms. Therefore, under the electronic HMIS, health workers save time in dealing with
epidemiologic data capturing of disease, and may spend more time on data analysis, report writing, and other activities.

**ii)** In terms of personnel costs, the electronic HMIS is a cost-saving option. The MHIN approach results in 34% savings in personnel expenses compared to paper based approach. Additionally, using the MHIS system does not involve any aggregation costs, since this is implicitly incurred into the form transcription. Moreover, the MHIS system provides automatic generation of reports. Once again, no additional costs are incurred by this activity.

**iii)** The MHIN approach results in 37.15% savings in office supply costs compared to paper based approach. Therefore, the MHIN system is cost-saving in terms of office supplies when compared to the paper-based system.

**iv)** Transportation costs are the largest element of the total cost of the paper-based system.\(^1\) On average, provincial health directorates spent about 5,796.06MZN on transportation costs. The MHIN reduces this cost substantially, and simultaneously reduces the expenditure, once again dispensing money for savings and/or reallocation, since the MHIN does not incur such costs.

**v)** The MHIN approach results in 11.56% savings in buildings operations and maintenance costs such as water, electricity and telephone compared to paper based approach. This translates to approximately 2,358.72MZN savings per form year/district (about US $6.45 per form per year/district). The MHIS offers solutions to the Mozambican Government for savings and reallocation of financial resources from unnecessary expenditure related to the traditional epidemiological surveillance system, which will finance activities that further enhance the effectiveness of the electronic system.

---

\(^1\) The vehicles are not solemnly used to transport HMIS paper-forms it is also used for other purposes. Therefore, with the news, this cost is mostly likely to reduce significantly given that the number of trips to and from the DPS is highly likely to reduce.
vi) In terms of capital costs, incurs higher costs compared to the paper-based system. The Paper-based approach results in 53.25% savings in capital costs compared to MHIN system. This translates to approximately 3,868.29MZN savings per form, per year per district (about US $104.55 per form per year/district). The required an initial high investment in equipment (i.e.: PDA, 3GSM card, AAPs) to quick start the operation of the system. However, these are once-off investments with an average life span of about 6 years, before requiring a replacement.

vii) The computed Cost-Effectiveness Ratio (CER) shows that the MHIS system is more cost-effective than the paper-based. The CER for MHIN system is lower than those for paper-based system, suggesting that the former is less costly and more efficient than the latter. The cost of running the MHIN are 80% that of the paper-based system. That is, MISAU can save as much as much as 20% in HMIN under the MHIN system in comparison with the paper-based system. This finding shows that the electronic health information system reduces the average cost of operating the system and simultaneously maximizes efficiency in the collection, analysis and storage of health information data. By implementing this system, the MoH will improve their decision-making, monitoring and evaluation of policies.

viii) The qualitative analysis supports the initial finding derived from the quantitative analysis. The Health Utility Index (HUI) indicates a preference of the MHIN system over the paper-based system. The HUI for the paper-based system is low (0.1820) in comparison with the HUI for MHIN system (0.4240). This suggests that the respondents believe they derive more benefits and higher utility from the MHIN system than the paper-based system. This finding suggests that on average respondents have more benefits from the paper-based and at a lower cost.

ix) In general, the CUR for the MHIN system is lower (514,513,293MZN) than that of the paper-based system (224,977,296MZN). Under the condition of limited budget allocation for SDSMAS, the MHIN system provides a 53.7% cost-saving alternative for epidemiology disease surveillance, in comparison with the paper-based system.
x) Sensitive analysis results show that in the unfortunate situation of a disease epidemic, the MHN system is a better option than the paper-based system. In a situation of 50 percent increase of total forms saves more costs in comparison with the paper-based system, while simultaneously keeping a high rate of effectiveness for health workers. For the Mozambican Government, the will provide them with a rapid and reliable response in a situation of a cholera outbreak, especially in rural and less developed provinces. Therefore, it is recommended that MISAU considers the option of expanding the electronic HIS throughout the country.

xi) The qualitative evaluation of the MHN supports the findings from the quantitative and benefit analysis. It shows that the MHN is superior to the paper-based system. On average, the MHN is time and cost savings on data collection, enables processing and sharing of information, facilitating clinical decision making, and enables communication and collaborative practice, quality and safety of the epidemiological data.

Recommendations

Therefore, following the above discussion and conclusion, the following recommendations are proposed:

i) The new electronic system developed under the Mozambique Health Information Network is highly recommended to the Government of Mozambique. It provides a less costly and more efficient solution for epidemiological surveillance, hence maximizing evidence-based decision making and policy evaluation in the area of Integrated Disease Surveillance and Response (IDSR).

ii) Additional training of health professionals is required. Ongoing on the job-training, regular supervision and monitoring of health worker activities are needed at all levels, should be done and emphasize basic computer skills. The training will improve
efficiency, enhance the performance of health professionals, ensure high data quality and readily to be used for decision-making.

iii) There were no specific evidences regarding the use of the system during disease outbreaks because no disease outbreaks happened until date of the project evaluation. Therefore, prior to scaling up and rolling out to more districts, a second evaluation would then be recommended to assess the efficiency of the system in such conditions.

iv) Ensure that all stations have access to a functional computer, with at least the minimal requirements to run the MHIN.

v) According to Blaya et al (2010), the use of PDA and mobile devices can be very effective in improving collection, time and quality of health data in developing countries. Hence, it is recommended the introduction of mobile devices in the MHIN, such that to improve the overall efficiency of the electronic HMIS.
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<tr>
<td>AAP</td>
<td>African Access Point</td>
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<tr>
<td>BE-PS</td>
<td>Boletim Epidemiológico dos Postos de Sentinela</td>
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<td>BES</td>
<td>Boletim Epidemiológico Semanal</td>
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<td>CEA</td>
<td>Cost-Effectiveness Analysis</td>
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<td>CER</td>
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<td>CUR</td>
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<td>DPS</td>
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<td>IDRC</td>
<td>International Development Research Centre of Canada</td>
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<td>INE</td>
<td>National Statistics Institute</td>
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<tr>
<td>MCT</td>
<td>Ministry of Science and Technology</td>
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<tr>
<td>MHIS</td>
<td>Mozambique Health Information System</td>
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<tr>
<td>MISAU</td>
<td>Ministério da Saúde de Moçambique</td>
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<tr>
<td>MoH</td>
<td>Ministry of Health</td>
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<td>NGOs</td>
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<tr>
<td>PDA</td>
<td>Personal Digital Assistant</td>
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<td>SDSMAS</td>
<td>Directorate of District Health, Women and Social Affairs</td>
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1. Introduction

Health is a priority goal, given its central input into economic development and poverty reduction. Developing countries have higher than average mortality rates, higher levels of mortality and limited access to health care (OECD, 2003; Sachs, 2001). Lack of access to accurate and timely health information is an important contributory factor. In addition, the social and economic burden of disease in developing countries is further worsened by feedback link between health and economic development (Kennedy School of Government, 2001). Investment in health is important for improved access to affordable and quality health services.

Health Information Technology and surveillance systems have been promoted worldwide to facilitate and increase the access to relevant and timely health data. A systematic and timely analysis of the health trends has been identified as increasingly important for evidence-based policy and programs improving communication and access to health care information (Dlamini et al, 2008). An analysis is also crucial to inform policies, set priorities, and ensure the appropriate and effective use of resources to improve the health service performance and the health of the community.

The electronic Health Information System (HIS) collects, analyzes, and converts data into information that will be useful in determining the actions of the health system. Such data must be reliable, accurate and timely. Few developing countries have the ability to effectively implement such systems, due to poor infrastructure, lack of resources and the high degree of organizational complexity of the health system composed by large number of institutions ranging from the small and simple health care up to large advanced hospital. The implementation of HIS requires cooperation among government agencies and departments that play a role in advancing the understanding and use of Health Management Information Systems (HMIS), coordinating across all vertical programs and jointly with the private sector.

The use of Information technology (IT) for Integrated Disease Surveillance and Response (IDSR) brings an opportunity for improvement in health care delivery system. Countries can reap multiple benefits such as: i) improved access to information and support evidence-based decision making, ii) timely communication and evaluation of health/disease trends, iii) cost reduction and iv) improved access to health care.
In Mozambique, the health information system, known as SIS, is the main instrument used in setting objectives, program priorities and distribute resources. It also helps the health sector policy makers in the monitoring and evaluation of decisions made. The epidemiological surveillance department at the Ministry of Health of Mozambique (MISAU) uses a paper-based approach to gather routine data on ten epidemic prone diseases. This traditional approach takes an average of about four weeks for a data gathered by health units to reach the headquarters.

The Mozambique Health Information Network (MHIN) is a joint undertaking of the Ministry of Health of Mozambique (MISAU) and the AED-SATELLIFE Center for Health Information and Technology through grant funding from the International Development Research Centre of Canada (IDRC). The main objective of this project is to develop an electronic health information system that will equip MISAU at various levels of the health system, and frontline practitioners in Mozambique, with reliable, fast, and cost-effective data collection and communication tools necessary to realize the improved standards of national health care articulated by MISAU’s strategic plan.

The project uses handheld computers (also known as Personal Digital Assistants or PDA), wireless access points, existing cellular network, Internet and other ancillary tools for capturing, reporting, analyzing and storing the health data, which can be exchanged with all health centers in the health system. The system is designed to improve the exchange of health information of epidemic prone diseases between remotely located health centers and the provincial and national health departments.

The project is currently in its first stage and aims to improve the quality and timeliness of the health management information system (HMIS) through enhanced data collection, transmission and reporting in the participating districts. The usefulness of the network will be bettered by its application to the collection and reporting of the data related to epidemiology surveillance. The following surveillance forms, have been developed for use on computers and PDAs, namely: Boletim Epidemiológico Semanal (BES), Resumo Diário de Doenças Epidemiológicas and Boletim Epidemiológico dos Postos de Sentinela (BE-PS).

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2 The epidemic-prone diseases consist of the following: Cholera, meningitis, diarrhoea, shigelloses, malaria, AFP, measles, rabies, neonatal tetanus and plague.
This study assessed the cost-effectiveness of the paper-based vs electronic data collection and transmission for the overall goal of improving the quality of the health care and services provided to the Mozambican citizens.

The report is divided into the following sections: Following this introduction, section 2 is an overview of the Health Information System and System of Epidemiologic Surveillance of Mozambique, and also the rationality, relevance and objectives of the study. Section 3 gives an overview of the literature review, while section 4 presents the theoretical framework. The methodology used for the qualitative and quantitative analysis is presented in section 5. Section 6 presents and discusses the results of the cost-effectiveness assessment. Finally, section 7 concludes and presents some policy recommendations.
2. Background

2.1. The Mozambique Health Management Information System

The Mozambique HMIS is a set of interrelated instruments, norms and activities which produce information for developing policies, strategies and plans in the health sector. Within the Health Information System is a sub-system for surveillance of transmittable and non-transmittable diseases.

The economic transformation of many developing economies has been dramatic. In Mozambique, the decolonization process marked the beginning of the political and economic transition period around 1974/1975. During this period, the health sector was characterized by a high degree of disorder and lack of qualified health officers and health services characterized by curative services and primary health care mostly operated in urban areas.

After independence, less than ten percent of the population had access to health care (Mwaluko et al, 1996). Consequently, the Government of Mozambique adopted a series of policies and strategies to extend the health services to the rural areas. In addition, the National Health Information System in Mozambique was created in 1976, but its objectives were not clearly defined (Mukama, 2003).

Later in 1979, the Ministry of Health (MISAU) established a mechanism of data collection at every health facility of the national health system, based on annual inquiry records that led to the first national panorama of the country’s situation. In 1985, a notification system for communicable diseases was introduced.

In 1989, MoH revised the HMIS/SIS due to constraints caused by the lack of defined objectives, complexity of forms and data duplication. This decision led to a reduction in the number of forms for epidemiology surveillance in the HMIN from 60 to 13, and some basic indicators were introduced in the forms for the use of district and health units. Later in 1992, the first a computer-based system was introduced at provincial levels. In 1997, a system of obligatory notification was introduced for a list of communicable diseases on a weekly basis for every health facility (MISAU, 2009).³

The organizational structures of the health facilities as well as the SIS flow chart are illustrated in Figure 1.

![Organizational Structure of the Health Sector in Mozambique](image)

**Figure 1:** Organizational Structure of the Health Sector in Mozambique

**Source:** MISAU, 2009

The MISAU has been trying to develop information and communication systematic the regional and national levels. However, due to limitations such as the lack of trained professionals to the diverse and complex activities required for the proper functioning of SIS, this is still far from complete. In addition, there are still significant problems in the SIS, such as constant delays and unreliability of information; consequently, the information is not being regularly used for decision making (MISAU, 2009).

The HIS starts collecting data from the health units (health centers, health post) and sends it to the District Directorate of Health, Women and Social Services (SDSMAS). The SDSMAS then sends the data to the Provincial Directorate of Health (DPS) which in turn elaborates a report and sends it to the national department MISAU as presented in Figure 1.

The health information system is comprised of facilities at all levels of the health system, though most of these facilities are located in very remote areas. Currently, the SIS encompasses about 1311 health units (INE, 2008). These are distributed across the four levels of health units as follows: Central and Provincial Hospitals (11); Rural and General Hospitals (40); Health Centers
The degree of complexity of health services provided as well as the required health information system depends on the level of the health facility, with the most complexity in the Central and Provincial Hospitals.

According to MoH, the current paper-based health information system for epidemiology surveillance uses the following process: Initially, data from the health units are compiled into one of the 13 current SIS forms on a weekly, monthly and annual basis. These forms are continually and respectively sent to the SDSMAS that also make their own compilation into 4 distinct forms that are sent to the DPS. At the DPS, these forms are then forwarded to MoH headquarters in Maputo.

In simple terms, the data starts by being entered into well-designed forms on paper and as the data is transferred from a Health Post to a Central Hospital it finds its way onto the computers. Finally, the information generated through this system is used to produce reports that are used for strategic planning of the health sector in the country.

2.2. The System of Epidemiologic Surveillance: Paper-Based vs MHIN Solution

The Epidemiological Surveillance System (ESS) is a health information system for the systematic collection, analysis and interpretation of data. It is through this HIS that epidemic-prone diseases are first tracked and controlled.

In Mozambique, the System of Disease Surveillance was firstly introduced in 1997. Its main objective was to provide weekly notifications of a selected list of diseases, covering all health units in the country. Later in 1985, a system of notification of communicable diseases through sentinel sites was introduced. In 1997, MoH introduced a system of obligatory notification for a list of communicable diseases on a weekly basis for every health facility.

The system currently in place produces processes and disseminates information for decision-making of managers in the NHS at all levels, for resource planning based on evidence, for monitoring of epidemics and diseases and to measure the health status of the population, for support for research and for reporting to national and international community.
The current paper-based health information system for epidemiological surveillance is comprised of three forms that are used routinely, namely:  

i) **Boletim Epidemiológico Semanal** (BES) - a notification system used in the health unit. It introduces the notification of disease that constitutes a threat/problem to public health.

ii) **Boletim Epidemiológico dos Postos de Sentinela** (BE-PS) - includes the notification of diseases of more complicated diagnosis and it’s only used at the provincial and central hospitals.

iii) **Resumo Diario de Doenças Epidemiológicas** - only used in the situation of a Cholera outbreak.

The epidemiological surveillance department at MoH uses a paper-based approach to gather routine data on ten epidemic prone diseases. This traditional approach takes an average of four weeks to reach the headquarters, and works as follows: Register forms are used at health facility level to record weekly information about the epidemic-prone diseases, which at the end of the week are submitted to the district office. Then, health facilities compile this information monthly and submit it to the district health office. Health facilities in turn are in charge of completing a monthly report about the health facility and sentinel-post and daily record of epidemic diseases only in the case of a cholera epidemic. SDSMAS are in charge of aggregating the reports submitted by health facilities. Once reports are aggregated and transcribed, then the district offices submit these to the DPS (MISAU, 2002a, 2002b, 2003).

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5 The epidemic-prone diseases consist of the following: Cholera, meningitis, diarrhoea, shigelloses, malaria, AFP, measles, rabies, neonatal tetanus and plague.
The Mozambique Health Information Network (MHIN) solution for epidemiological surveillance is an electronic information system for the control and management of epidemic-prone diseases. It uses handheld and desktop computers, wireless access points and internet for capturing, reporting, analyzing and storing the health data. The project is designed to improve the exchange of healthy information of epidemiology prone diseases between remotely located health centers, the provincial and national health departments, through the use of a network integrating system.

The new electronic system allows timeliness and completeness of data related to epidemic prone diseases, a key factor in informing the health sector decision-making process and enhancing MISAUs capacity to adequately combat epidemics. The process of deploying data collection and transmission tools developed under the new project enables SDSMAS, DPS, and MoH headquarters to receive epidemiological surveillance within one week.

**Figure 2: Surveillance Report Diagram**
The data flow from health facilities through MoH headquarters works as follows:

- Health units submit weekly epidemiological data on paper to SDSMAS surveillance team within one week following the reporting week.
- District surveillance team at SDSMAS enters data onto PDAs if there is no Internet connection, or directly into computers if there is Internet connection.
- Districts with no Internet connection transfer data to a wireless access point (AAP) located at the SDSMAS for immediate submission to the server at MoH. Data from districts with Internet connection is seamlessly transferred to the server at MoH over the Internet.
- SDSMAS surveillance team synchronizes epidemiological data from PDAs to a computer at the SDSMAS. This will enable each district to have its own database. For districts with Internet access, the local database is always kept current whenever new data sets are entered.
- Data from server is transferred to weekly epidemiological bulletin database for storage and analysis.
- SDSMAS, DPS and MoH headquarters with Internet connection retrieve epidemiological data through web-interface.

In addition, during outbreaks, the system is designed to be used for tracking the number of reported cases and deaths on a daily basis. The system was developed to use the three surveillance instruments used in the traditional reporting process, that is, BES, BE-PS and Resumo Diario de Doenças Epidemiológicas.
2.3. Rationale, Relevance and Objective of the Study

a) Rationale and Relevance of the Study

Governments around the world face budget constraints that compel them to make tough decisions about how best to invest funds for public health. They need a way to evaluate which investments will address the most pressing health problems and bring the greatest health gains.

Electronic medical record systems improve the quality of patient care and decrease medical errors, but their financial effects have not been as well documented (Wang et al., 2003). Cost-effectiveness analysis is an essential evaluation tool that allows Governments, policymakers and health planners to compare the health gains that various interventions can achieve with a given level of financial inputs (Disease Control Priority Project, 2008).

In Mozambique, given the outbreak of several diseases, this implies that the current health information system (paper-based) has to generate hundreds of pages of paperwork in order to inform the MoH headquarters. However, this process often characterized by long waiting weeks or months of data entry implies high costs for the SIS as a whole.

The rationale of conducting a cost-effectiveness study of the paper-based system vis-à-vis the system developed by MHIN is to inform policy makers in terms of the most appropriate HMIS to ensure higher quality and reliable health information on epidemic-prone diseases in Mozambique. The successful implementation of such a system will strengthen the HMIS in Mozambique, by reducing the average time to report disease information to the Ministry of Health from an average of four weeks to one.

The main goal of this study is to shed light on the complexities of cost-effectiveness of the paper-based health information system in Mozambique. It is expected that Government and donors can use the findings from this baseline study to put in place policies that will improve the process of data collection of vital health information and enhance long-run sustainability of MHIN countrywide.
b) **Objectives of the Study**

The overall objective of the study is to assess if the provides a cost-effective alternative for epidemiological surveillance data collection and transmission compared to the traditional paper-based system, yielding higher benefits and better quality health data.
3. Literature Review

This section provides an overview of empirical evidence on the use of electronic information system in the health care system. In addition, it argues for the necessity to have a cost-effectiveness assessment of the paper-based and system developed by the Mozambique Health Information Network.

Health information technology has the potential to improve the quality, safety and efficiency of health care (Medcap, 2004). Increased health care spending has been argued to be largely due to technological change (Jena et al, 2009). Electronic information technology in the health sector improves the quality and safety of patient care, efficiency of decision-making and reduces medical error. However, their financial effects have not been as well documented (Wang et al, 2003; Medcap, 2004).

Wang et al (2003) performed a cost-effectiveness analysis for electronic medical records in primary-care in a developed country. This study finds that the implementation of an electronic medical record system in primary care can result in a positive financial return on investment to the health care organization. Benefits accrue primarily from savings in drug expenditures, improved utilization of radiology tests, better capture of charges, and decreased billing errors. Additionally, the magnitude of the return is sensitive to several key factors (proportion of patients in capitated health plans and laboratory savings).

Keeler et al (2006) assess the evidence base regarding benefits and cost of health information technology system. The results find that health information technology has the potential to enable a dramatic transformation in the delivery of health care, making it safer, more effective. However, insufficient data were available on the cost and cost-effectiveness of implementing such system. Consequently, such analysis was not performed.

Empirical evidence for developing countries is very limited. Studies in several African countries including Ghana, Uganda, and Zambia indicate that the introduction of Information and Communication Technology (ICTs) in the health sector followed by a gradual replacement of the traditional paper-based health information system has significantly contributed to improve the quality, reliability and readiness of health data (Yarney, 2005; Tumwesigye, 2007; Zambia’s Ministry of Health Report, 2007; Weddi, 2005; Shinyekwa, 2010). This is believed to have
improved efficiency and effectiveness of the assistance provided by investors to the health sector in these countries. The cost-effectiveness for Ugandan Health Information Network, additionally shows that the electronic HMIS emerged as a superior system for transmitting data when compared to the Paper-based HMIS as it provided cost savings of up to 25 percent. This arose especially from absence of transport, printing and office supply costs (Shinyekwa, 2010).

Muschel (1999) reviewed the results of the implementation of District Health Information Systems (DHIS) in eight health districts in five provinces in South Africa. In this study, it is found that data analysis and feedback was very weak despite the increasing use of computers instead of paper-based forms to capture health data. However, this study did not make any clear observation about the cost-effectiveness of the process of setting up a DHIS in South Africa.

Most of the studies on cost-effectiveness have been on government intervention/programs and not necessary on electronic health information system. For instance, Kumaranayake et al (2006), estimate cost and cost-effectiveness of different Public-Private Partnerships (PPP) arrangements in the provision of tuberculosis (TB) treatment, and the financing required for the different models from the perspective of the provincial TB programme, provider, and the patient. It finds that PPP models could significantly reduce costs to the patient by 64–100%, hence, government should adhere to this practice.

In Mozambique, the increased demand for health information and the potential opportunity to supply it calls for an investment in building a sustainable national HMIS (Chilundo and Aenestad, 2003; Kimaro and Nhampossa, 2005). Despite this body of evidence, studies aiming to assess the cost-effectiveness of the HMIS in Mozambique are very scarce.

Under the Mozambique Health Information Network (MHIN), a joint project of the Ministry of Health of Mozambique (MISAU) and the AED-SATELLIFE Center for Health Information and Technology, which aims at developing an electronic health information system with reliable, fast, and cost-effective data collection and communication tools necessary to improve standards of national health care in the country. A cost-effectiveness analysis on the paper-based and electronic system for health data collection and transmission mechanism is required to assess the overall benefits gain per unit of spending, between the two HMIS. This will constitute the first
study of this kind. The empirical results obtained will constitute the basis to recommend the Government of Mozambique the use of an electronic HMIS.
4. Theoretical Framework

This section outlines the conceptual issues surrounding cost-effectiveness analysis. The theoretical framework, methodologies and measures of effectiveness are also discussed.

The study uses Cost-Effectiveness Ratio (CER), Cost-Utility Ratios (CUR) and Sensitivity analysis to ascertain which HMIS (system developed by MHIN and paper-based approach) maximizes the benefits lower costs for epidemiological surveillance data, collection and reporting.

However, it does not constitute an easy task, because it is generally difficult to monetize healthy benefits. Traditionally, a decision on whether an investment is feasible was taken based on the return on investment calculations. However, these calculations tend to value both benefits and costs only in monetary terms. But since many benefits accruing from health care interventions cannot always be valued in monetary terms, there was a need to develop an alternative tool that could make it possible to compare different program interventions. That additional tool is cost-effectiveness analysis (Disease Control Priority Project, 2008).

Cost-Effectiveness Analysis (CEA) is a method of financial evaluation that has gained prominence within the academic and policy communities in the last 20 years. It compares the costs and health effects (outcomes) of an intervention to assess whether it is worthwhile from an economic perspective (Phillips and Thompson, 2001).

In cost-effectiveness analysis it is necessary to distinguish between independent interventions and mutually-exclusive interventions. Independent interventions are those where the costs and effects of one intervention are not affected by the introduction or otherwise of other interventions, and mutually exclusive interventions refer to where implementing one intervention means that another cannot be implemented, or where the implementation of one intervention results in changes to the costs and effects of another. For example, for independent interventions, average cost-effectiveness ratios are enough to compare the programs, whereas for the mutually-exclusive interventions it is essential to use incremental cost-effectiveness ratios if the objective is to maximize health care benefits given the resources available.
Additionally, it is also important to specify which costs are included in the computation of the CEA: whether they are the direct costs of intervention - such as medical drugs, staff salary, costs of capital and equipments, transport; or indirect costs - such as production losses, pain, suffering, adverse effects, and other uses of time. Moreover, it is important to define the nature of the benefits. The health benefit might be reducing the risk of a health problem, reducing the severity or duration of an illness or disability, or preventing death.

This study uses a measure of effectiveness based on the costs per form. Cost per form is used when measuring the cost-benefits of a system on the overall functioning of the system. On the other hand, if the aim is to evaluate the overall impact of a specific treatment/program on overall disease reduction, cost per patient would be more adequate (Kumaranayke et al, 2006). The reasons behind the choice of cost per form as an outcome measure are twofold. First, cost per form allows standard comparison across different health information systems (e.g. either the system is paper-based or computer based (PDA)). Second, the use of cost per patient rather than cost per form poses a challenge in terms of the analytical ground since different patients often may report different diseases in the same form, which means that we would be required to measure the costs per patient and by disease type, which is more complex and difficult to obtain.

Using CEA with independent programs requires that cost-effectiveness ratios (CERs) are calculated for each program and placed in rank order (Phillips et al, 2001):

\[
\text{CER} = \frac{\text{Total costs of intervention}}{\text{Total Outcome}}
\]

The total outcome refers to the benefits such as reduction in costs per HIS form used.

In the case of mutually exclusive situations, incremental cost-effectiveness ratios (ICERs) are used. The ICER allows measuring the joint effect of additional benefits to be gained from a new program/intervention in combination, taking into account the costs incurred. The ICER is calculated as follows (Phillips et al, 2001):

\[
\text{ICER} = \frac{\text{Difference in costs between programmes P1 and P2}}{\text{Difference in Outcomes between programmes P1 and P2}}
\]
The ICER values are calculated for each of the different programs/interventions. After calculating the ICERs these are ranked, the low ICER for a certain program P1 against P2 means that by adopting P1 rather than P2 there is an improvement in terms of benefits and a reduction of costs.

In economic modeling, the estimated results are largely dependent on the level of confidence/uncertainty in various factors, such as the methodology used in constructing the model. For example, a reviewer of a model might suspect that one particular value (for example, the probability of a treatment being successful) is too high in the model. In this case, the reviewer may wish to know the likely impact of using an alternative value (Taylor, 1996).

Sensitivity analysis is used to determine how “sensitive” a model is to changes in the value of the parameters of the model and to changes in the structure of the model (Breierova and Choudhari, 1996; Taylor, 1996). It allows the modeler to determine what level of accuracy is necessary for a parameter to make the model sufficiently useful and valid. If the tests reveal that the model is insensitive, then it may be possible to use an estimate rather than a value with greater precision. In this study, it is performed a sensitivity analysis to test for the robustness of the results when the parameter used for determining the cost-effectiveness are changed.  

According to Dixon and Lunden (2004) the advantages of using CEA are:

- It supports objective decision making since it compares options in an objective way
- CEA evaluates options in similar terms to avoid comparing “apples to oranges”
- Allows for strategic review of organizations since it might justify some centers operating at a loss to increase overall return on investment, employee health, or both.

According to Drummond et al (1987), CEA analysis may suffer some limitations. For example, costs often depend on how long a programme has been operating. It may also be inappropriate to compare costs per patient in widely different regional and socio-cultural health facilities. Nevertheless, an overall comparison of cost per SIS form yields some useful insights into the efficiency of various modes of Health Information Systems. Such a comparison may be beneficial in weighing broad policy considerations, and even for guiding allocations for specific projects.

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6 For more details on the sensitivity analysis see section 5.1.5
5. Methodology

This section outlines the methodology that will be used in conducting the cost-effectiveness analysis of the MHIS for epidemiological surveillance. It presents the techniques needed to perform both quantitative and qualitative analysis in the study.

5.1. Quantitative Analysis

5.1.1. Data Collection

The Epidemiological Surveillance System developed by the project has been deployed in 11 provinces and 43 districts of Gaza, Inhambane and Zambézia province. The cost-effectiveness analysis will cover a sample of 13 SDSMAS in the provinces of Gaza (6) and Inhambane (7), as well as Provincial Departments and Headquarters.7

The main methods of data collection consisted of interviews. The interviews are expected to take about one week. Prior to the survey, the team visited the epidemiological surveillance systems laboratory at the project office in Maputo, to get a better understanding of the system’s functioning. This demonstration helped identifying key elements in designing the questionnaire for data collection for the assessment of cost-effectiveness of MHIN in the Mozambique’s HMIS.8

The sources of data include information sought through record/document review at the district and MoH headquarters and interviews with users of at the SDSMAS. The study units are epidemiological surveillance centers.

The collected data will be classified into costs, effectiveness measures, benefits measures and utilities. The cost data include the cost of the system developed by MHIN and the cost of ingredients in the HIMS. All cost items will be annualized with the corresponding conversion factors. The effectiveness measure includes the proportion/number of SDSMAS that submitted complete returns since the system became operational or timely. The benefits measures include

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7 See Table A1 in the Appendix for the list of SDSMAS visited. Zambézia was excluded due to limited budget and high costs constraint.

8 See Appendix 2 for questionnaire.
respondent’s score of accuracy, timeless and other perceived benefits of PDA. The cost-effectiveness measures the effectiveness of an alternative by its costs. This is expressed by means of a cost-effectiveness ratio.

5.1.2. Data Analysis

The basic technique used to link the effectiveness and costs allocated to a government program (for example, education) is the ingredients approach. The ingredients approach was developed to provide a systematic way to evaluate the costs of social interventions in cost estimation, it entails three distinct phases, namely: i) identification of ingredients; ii) determination of the value or cost of the ingredients and the overall costs of an intervention; and iii) an analysis of the costs in an appropriate decision-oriented framework (Levin, 1995). This subsection describes the methods used to measure and estimate cost, effectiveness and cost-effectiveness.

This study focuses on data collection for both the paper-based and system developed by MHIN. Additionally, it performs a cost-effectiveness analysis of MHIN system and paper-based system for epidemiology surveillance. The primary outcome measure is the total cost per form for a 12 month period for each district. The model was framed from the perspective of the health care organization, and the reference strategy was the traditional paper-based medical record. All costs and benefits were converted to September 2009 U.S. dollars using an exchange rate of 37MZN. The database was created using Microsoft Excel, and data analysis is performed in STATA 10.0 and/or Excel.

5.1.3. Cost Estimation

The total cost of the intervention can be expressed as the sum of each ingredient, defined in Murindwa et al (2004). All cost items will be annualized with the corresponding conversion factors. Total costs will result from the sum of recurrent costs plus capital costs. The former include salaries and benefits; office supplies; transport costs; and water, electricity and communications. Capital costs consist of buildings, equipment, vehicles, and start-up and

---

9 The equations derived in this sections are based on the methodology defined in Murindwa et al (2004).
training costs. For joint costs the weight will be the share of the particular form in total aggregated forms at the district health office level. Table 1 presents the methods used for measuring, identifying and valuing the costs of both HMIS.

Table 1: Methods Used for Identifying and Valuing Costs of HMIS

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Identification Categories</th>
<th>Measuring</th>
<th>Valuation Method</th>
<th>Sources of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Recurrent</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Personnel</td>
<td>Aggregation and transcription of paper and MHIS forms</td>
<td>Time spent on this activities</td>
<td>Average salary per hour of health personnel</td>
<td>Ministry of Finance Salary decree</td>
</tr>
<tr>
<td>Office Supply</td>
<td>Paper, Forms, filters, binder, internet, rent</td>
<td>Quantity consumed</td>
<td>Interview at SDSMAS</td>
<td>Market prices</td>
</tr>
<tr>
<td>Transportation</td>
<td>Vehicle running costs</td>
<td>Number of Kilometers travelled</td>
<td>Interview at SDSMAS</td>
<td>Actual expenditure on oil, gasoline and maintenance</td>
</tr>
<tr>
<td>Buildings operations and maintenance</td>
<td>Water, electricity and Telephone</td>
<td>Average costs of each item per month</td>
<td>Interview at SDSMAS</td>
<td>Actual expenditure</td>
</tr>
</tbody>
</table>

**Capital**

<table>
<thead>
<tr>
<th>Type of Cost</th>
<th>Identification Categories</th>
<th>Measuring</th>
<th>Valuation Method</th>
<th>Sources of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buildings</td>
<td>Office</td>
<td>Acquisition Value</td>
<td>Interview at SDSMAS</td>
<td>Replacement Price</td>
</tr>
<tr>
<td>Equipment</td>
<td>Furniture, Solar panel</td>
<td>Acquisition Value</td>
<td>Interview at SDSMAS</td>
<td>Replacement Price</td>
</tr>
<tr>
<td>Vehicles</td>
<td>Vehicles used to transport from SDSMAS to DPS</td>
<td>Acquisition Value</td>
<td>Interview at SDSMAS</td>
<td>Replacement Price</td>
</tr>
<tr>
<td>Training</td>
<td>Training initiative took place in this SDSMAS</td>
<td>A verage cost of at least 1 training initiative</td>
<td>Actual costs</td>
<td>Actual expenditure</td>
</tr>
</tbody>
</table>

Source: Adapted from Kumaranayka et al (2006)
a) Estimation of Personnel Costs

The estimation of the average salary of personnel responsible for filling out and transcribing the paper forms and MHIN system uses the following formula:

$$W_j = \sum_i^n \alpha_j T_j w_j ; \quad (1)$$

With $i=1, 2... 13$ (SDSMAS) and $j=activity$ (e.g. filling up paper vs MHIN forms)

Where:

- $\alpha_j$ = share of weekly/monthly HMIS forms “f” on total forms filled out/aggregated at SDSMAS;
- $T_j$ = time required to fill up/aggregate/ or transcribe a particular HMIS form “f”; and
- $w_j$ = average salary per hour of the health personnel responsible for filling up or transcribing the HMIS form “f” at the health unit/district health office. $W_j$: Total wage bill of filling up or transcribing SIS form “f”.

b) Estimation of Office Supply Costs

General office equipment costs from expenditure book records at the district health directorate will be estimated for each aggregated HMIS form using the following formula:

$$GOE_j = \sum_i^n \alpha_j OE_k \quad (2)$$

With $i=1, 2... n$ (district health office) and $k=office$ equipment (e.g. stationery, paper, forms, binders).

Where:

- $\alpha_j$ = share of weekly/monthly HMIS forms “f” on total forms filled out/aggregated at health facility/district health office;
- $GOE_j$ = Total annual office equipment costs per SIS form “f”
\[ OE_k = \text{annual cost of office equipment } "k". \]

c) Estimation of Transport Operation Costs

Vehicle operation and maintenance costs include expenditures with gasoline, oil, and tune-ups (e.g. Filters, plugs, belts). Using expenditure book records from the district directorate of the health financial office we will attempt to estimate travel costs per month and per SIS form “f”, using the following formula:

\[ TC_f = \sum_{i} \alpha_i (GAS_i + OIL_i + SP_i); \]  

(3)

Where:

\[ TC_f = \text{total costs of transport operation per SIS form } "f"; \]
\[ \alpha_i = \text{share of aggregated weekly/monthly HMIS forms } "f" \text{ on total forms filled out/aggregated in a period (month since the system become operational) at district health office}; \]
\[ GAS_i = \text{total costs of gasoline [e.g. (km travelled per month/km per liter) x cost per liter]}; \]
\[ OIL_i = \text{total costs of oil (e.g. 15% x annual expenditure on gasoline)}; \]
\[ SP_i = \text{total spare parts costs (e.g. 24% x purchase price of vehicle)}. \]

d) Estimation of Buildings Operations and Maintenance

Buildings operations and maintenance costs like water, electricity, gas, and telephone that are not incurred directly in the process of filling up paper forms, will be computed using the average costs of the items for at least six months of expenditure data prior to the survey. An average over time will avoid using a month when expenditures were much higher or lower than normal.

In case where a monthly expenditure series is not available, then we will adopt the approach suggested by Janowitz and Bratt (1994:27), which consists of using 2% to 4% of building
investment as the cost of utilities and maintenance combined. Therefore, the formula for computing buildings operations and maintenance costs will be the following:

\[ MSC_f = \sum_{i} \alpha_i (WATER_i + ELECT_i + PHONE_i); \]  

With \( i = 1, 2...13 \) (SDSMAS)

Where:

- \( MSC_f \) = total buildings operations and maintenance costs per SIS form “f”;
- \( \alpha_i \) = share of aggregated weekly/monthly SIS forms “f” on total forms filled out/aggregated in a period (month or year) at district health office;
- \( WATER_i \) = average costs in water for at least six months prior to the survey;
- \( ELECT_i \) = average electricity costs for the last six months prior to the survey;
- \( PHONE_i \) = average telephone costs for the last six months prior to the survey.

e) Estimation of Annual Capital Costs

Capital costs often are not used only for one year of project operation and in most cases their utility spans beyond the lifetime of the project. However, for the purpose of this study, there is a need to estimate the intrinsic capital costs that correspond to a specific year of project operation. The technique we will use to estimate capital costs is called “annualization”. Essentially, we will calculate the amount of the good that is used up (depreciated) in the period of time corresponding to the cost study. Depreciation is only one part of the annual cost of a capital good. The other part is an allowance that represents the interest that could have been earned if the programme had invested the funds used to purchase the item. This component is usually referred to as the “opportunity costs of capital”.

To estimate annual capital costs of buildings, equipment, vehicles, training and start-up costs, three components are required:
1) Estimate of the replacement cost of the item (e.g. current cost of purchasing the item - total amortization).

2) Estimate of the useful life of the good. In this study we will assume the following useful lives for the items: (i) 20 years for buildings; (ii) 5 years for vehicles; (iii) 5 years for training costs and other start-up costs; (iv) 5 years for electronic equipment like computers; and (v) 5 years for other office equipment like chairs, desks. It is important to note that in cases where detailed cost information is not available from the financial record books, then the World Health Organization and World Bank\(^{10}\) propose the following approximations of annual replacement costs of equipment operation and maintenance: (a) 5% of the original investment cost for furniture and general office equipment; (b) 10% of the original cost for audio-visual and office equipment; (c) 10% to 20% of the original cost of technical/medical equipment. Thus, we may use this approach as a last resort.

3) Estimate of a discount rate in order to take into account the opportunity cost of capital. In annualizing all capital costs we will assume a discount rate of 10% (e.g. 20.99% annual nominal interest rate - 10.35% year-on-year average inflation rate. Therefore, and following Janowitz and Bratt (1994:31), the annual cost of capital good “k” at health facility “i” will be estimated as follows:

\[
ACC_i^k = RC_i^k \times \frac{\left(1 + r\right)^n - 1}{r\left(1 + r\right)^n} 
\]

Where: ACC - Annual Cost of Capital

RC - Replacement cost of the item

n - Life expectancy of the item (in years)

r - Discount rate

k - Capital good

i - SDSMAS (1, 2... 13)

\(^{10}\) See Janowitz and Bratt (1994:28): “Methods of Costing Family Planning Services”.\四大洲
Using the procedure mentioned above, to arrive at an estimate of annual capital costs per SIS form “f” aggregated at district level; one uses the following formula:

\[
TACC_f = \sum_{i=1}^{n} \sum_{k=1}^{m} \alpha_f ACC^i_k, \quad (6)
\]

With \(i=SDSMAS\); and \(k=capital\ good\)

Where:

\(TACC_f = total\ annual\ capital\ costs\ per\ SIS\ form\ “f”\ at\ district\ health\ office\ level;\ \alpha_f = share\ of\ SIS\ forms\ “f”\ on\ total\ forms\ filled\ out\ in\ a\ period\ (month\ or\ year)\ at\ district\ health\ office;\)

\(ACC^i_k = Annual\ capital\ cost\ of\ good\ item\ “k”\ at\ SDSMAS\ “i”\ in\ the\ district.\)

### 5.1.4. Cost-Effectiveness Ratio

Using the ingredients presented above, now we can arrive at the proposed outcome measure by simply taking the sum of all ingredients associated with a specific form and aggregated at district level, and divide it by the total number of forms that were successfully filled up at district health office level. The resulting ratio will give us an estimate of the associated cost of the paper based health information system per aggregated SIS form and by district level. Putting this in mathematical terms, we have:

\[
CER^d_f = \frac{\sum_d (W_f + GOE_f + TC_f + MSC_f + TACC_f)}{TSISF^d_f} = \frac{TC^d_f}{TSISF^d_f} \quad (7)
\]

Where:

“f”=SIS form;
“d”=district directorate of health;
\(W_f\)=salary costs; \(GOE_f\)=general office supplies;
\(TC_f\)=transport costs;
\[ MSC_f = \text{buildings operations and maintenance costs}; \]
\[ TACC_f = \text{total annual capital costs}; \]
\[ TC_f^d = \text{total costs per SIS form “f” from the district “d”}; \]
\[ TSISF_f^d = \text{total number of HMIS form returns received by the MoH from the District health offices/total number of monthly HMIS form returns submitted by 28th of next month to MoH from the SDSMAS}. \]

5.1.5. Sensitivity Analysis

In this section we will investigate the degree of robustness of the CER estimates given unexpected changes in terms of the parameters. Most specifically, this section aims to test which SIS forms are sensitive to changes in their basic parameters. For example, it will examine the robustness of an SIS form when there is an unexpected increase in the number of forms filled out due to a sudden outbreak of a deadly disease (this will be assessed by estimating the marginal impact on costs as a result of an increase in the number of SIS form).

Incremental costs analysis will be performed to measure change in costs and effects from the SDSMAS to MoH headquarters, and in respect to all aggregated HMIS forms. The mathematical expression of ICER which measures the difference in costs between intervention “f2” against “f1” divided by the difference in outcomes can be expressed as follows:

\[
ICER_{f1,2}^d = \frac{TC_{f2}^d - TC_{f1}^d}{TSISF_{f2}^d - TSISF_{f1}^d}
\]

(8)

In this situation, the alternative interventions are ranked according to their effectiveness – on the basis of securing maximum effect rather than considering costs. If an ICER for a certain aggregated SIS form “f2” against “f1” is negative, then it means that as we move from filling up “f1” to “f2” there is an improvement in health information services – e.g. reduction in costs per SIS form filled up.
Marginal effects of an unexpected increase in the number of forms filled can be assessed by simulating the potential change in cost ingredients as a result of an increase in total forms. In mathematical terms, this corresponds to computing the following partial derivative:

\[
\frac{\partial CER_f^d}{\partial TSISF_f^d} = \sum_d (\Delta W_f + \Delta GOE_f + \Delta TC_f + \Delta MSC_f + \Delta TACC_f) / \Delta TSISF_f^d
\]  

(9)

The lower the marginal cost the better the results, since, it implies less sensitivity of the total costs of a specific form. Therefore, a low ratio is preferred given that the higher it is the more sensitive it is thus more expensive when exposed to shocks.
5.2. Qualitative Analysis

5.2.1. Measuring Benefits

Although this study focuses on cost-effectiveness analysis, measuring benefits from HMIS system may provide us with additional information from the new system. The benefits from each HMIS are measured in two ways: i) asking health workers using each HMIS to rank/score the perceived benefit and ii) measuring the money saved by using each HMIS.

The qualitative assessment for this study will draw heavily on the approach adopted in Dolan et al (1995)\textsuperscript{11} and Routh and Khouda (1999)\textsuperscript{12}. The approach consists of estimating the health information system State Utility Index, taking into account health information system attributes and the corresponding multiplicative factors. The Health Utility Index (HUI) is a methodology used to evaluate the benefits of a specific health program in terms of the cost associated. Using this methodology, different health care programs could be compared with respect to the amount of health improvement produced as well as their cost, to determine their relative cost-effectiveness.

In this study, HUI was used to measure and compare perceived gains that result from the use of each HMIS (paper-based and computer based). After a summation of all the scales selected, the system produced a single utility value for the state of each health information system. The standard scale adopted for the information system was rated on average as one (for good) or zero (bad). After obtaining the utility index, the cost-utility ratio of each of the health information systems under comparison was computed by dividing the total incurred costs of HMIS by the respective value of utility index. The lower the cost-utility value, the better the HMIS.

The multiplicative factor allows for preference interaction among attributes. The general form for the multiplicative form is as follows (Feeny et al, 2002):

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\[ u(x) = \left( \frac{1}{x} \right) \left[ \prod_{j=1}^{n} \left( 1 + k_j u_j(x_j) \right) - 1 \right] \]  \hspace{1cm} (10)

Where:

\[ u(x) = \] is the utility function for attribute \( j \)

\( k \) and \( k_j \) = model parameters

\( \prod \) = is the multiplication sign with \( j=1 \), through \( n \) (i.e.: \( n=10 \))

The study defines 10 attributes deriving from the potential benefits of using each of the HMIS systems (paper-based and MHIS system), with three levels for each attribute. The attributes of either HMIS include: precision, timeliness, completeness and reliability, conflict, pain/discomfort, training, supervision, prestige, motivation, and safety. Each attribute has the corresponding multiplicative factor that essentially measures the weight with which the attribute impacts the utility index. The higher the utility score level, the greater the perceived benefits of using a particular HMIS system at health unit or district level.

The utility score is computed using the following formula:\(^{13}\)

\[ u_{z} = 1.85(m_1 \times m_2 \times m_3 \times m_4 \times m_5 \times m_6 \times m_7 \times m_8 \times m_9 \times m_{10}) - 0.25 \]  \hspace{1cm} (11)

Where:

\[ u_{z} = \] health utility index for both paper and PDA

\( m_i \) = multiplicative factor measuring the weight of the level chosen

0.25 = model error of \( u \)

The above formula produces a single utility value for each health information system on the standard scale where HMIS state is rated from one (good) to zero (bad), and is based on the ten-attribute HMIS state classification system with further subdivisions into a number of levels having corresponding multiplicative utility factors (Torrance et al., 1982).

\(^{13}\) The calculation of weights was obtained using the methodology defined in Torrance et al (1982).
Assuming that the MoH has limited resources to invest in either health information system, we can calculate the cost-utility ratio (CUR), which is the corresponding measures of effectiveness as follows:

\[ CUR = \frac{\text{Costs}}{\text{Utility}} \]  \hspace{1cm} (12)

Where:
- CUR - Cost-utility ratio
- Costs - Total costs
- Utility - Perceived utility (for Paper and/or MHIN system)

For practical purposes, total utility index for each health information system will be computed using the data from the questionnaire (Appendix A). The algebra for the computation of health information system utility index is as follows:

\[ U_i = \frac{\sum_{j=1}^{5} u_{ij}}{13} \]  \hspace{1cm} (13)

Where:
- \( I \) - number of health information systems (Paper-based; MHIN System);
- \( j \) - number of HMIS respondents (\( j=1; \ldots, 13 \))
- \( u \) - perceived utility of health information system “\( i \)” attributed by respondent “\( j \)”
  (calculated using formula 11)

The CUR shows the relationship between the total cost and benefits of a program/initiative. The lower the ratio the better is the program/initiative, since it indicates that this option yields higher utility levels with lower costs.
5.2.2. Qualitative Evaluation of the Efficiency of the MHIN System

This section provides a qualitative evaluation of the efficiency of the MHIN for disease surveillance data gathering and reporting compared to approaches currently used by MoH. For that three research questions were developed:

1) Under what conditions the MHIN system is most likely to result in efficiency and quality-of-care improvements?
2) What experiences and lessons were drawn from the implementation of the MHIN system?
3) What evidences exists that MHIN system improved the efficiency and quality-of-healthcare?

Evaluating the efficiency is a complex issue, as it involves the relationship between the committed resources and the produced goods and services (Rochet, Bout-Colonna & Keramidas, 2005). The complexity is in measuring how far the output of a given production unit is from the maximum output. Evans, et al (2001) and Rochet, Bout-Colonna & Keramidas (2005), define efficiency as the ratio of the observed level of attainment of a goal to the maximum that could have been achieved (output/results) with the committed observed resources (inputs/means) being such process occurred at the lowest cost.

This implies that to have an efficient systems it is required to reduce the costs, the execution times, and improve the benefits. Rochet, Bout-Colonna & Keramidas (2005) used the work of Malleret to identify the key issues on measurements efficiency related to:

- Information concerning the inputs;
- Information concerning the means or resources;
- Information concerning the outputs or achievements;
- Information concerning the outcomes or impacts.

The evaluation will be a contribution to understand the similarities and the differences in approaches employed to implement the HMIS, and it helps to establish the potential benefits and drawbacks of policies and frameworks affecting the structure, design, implementation and outcomes of the MHIN project.
Research methods

The current evaluation is a case study about efficiency of the MHIN system, following a qualitative and interpretative approach (Patton, 2002, and Oates, 2005). By using a qualitative evaluation allowed us to conduct in-depth exploration of the phenomenon in study. The evaluation focused on gathering information about HMIS related to inputs, processes, means or resources, outputs and outcomes as the key issues for measuring efficiency (Rochet, Bout-Colonna & Keramidas, 2005).

All data collection and analysis will be used to trace the implementation process and resources, the value and benefits of the MHIN system within the MHIN Project.

Data Collection

Data collection (Table 17 in Appendix C) was based on semi-structured interviews to staff working at the epidemiology surveillance department at SDSMAS, DPS and MoH. The interviewees were data collection staff, data entry staff, data analysts and report writing staff, decision makers (at district, province and national level) and the HMIS project developers.

The interview questions were prepared based on key issues on measurements efficiency (Table 18 in Appendix C). The questions were also developed based on the specifics of each target group. Some questions were repeated to different target groups in order to get as much information about the issue in analysis.

Data Analysis

The final research findings are presented as descriptive and an interpretative study of a quality evaluation of the efficiency (Patton, 2002; and Denzin & Lincoln, 2005). The description presents the information of the key issues on measurements efficiency like information concerning the inputs, the means or resources, the outputs or achievements and the outcomes or impacts (experiences). Based on this, the analysis obeyed a checking the endogenous and exogenous factors that effected the translations of the HMIS project against the project outputs and results achieved up the date of the evaluation (Rochet, Bout-Colonna & Keramidas, 2005). Also, were identified the realized benefits and verified how they have improved the management and planning of health programmes interventions at all levels of the health services. From the
description of the entire process, the users’ experiences and the analysis of realized benefits are
drawn conclusions effectiveness and efficiency of the MHIN system.

In resume, using interpretative approach we will measure how things have changed and assess
whether the outcomes match the originally stated goals and objectives to define the efficiency of
the MHIN system.
6. Results

This section summarizes the main descriptive results of the data collected for CEA. The objectives of this section are the following: i) data collection and sample methodology; ii) highlight the main characteristics of the respondents; and iii) present and discuss the cost estimates, CER, CUR and sensitivity analysis of the model.

6.1. Data Collection and Sample Methodology

The main method of data collection was one-on-one interviews. These interviews were performed by a group of four field workers. They received training prior to the trip, which included visiting the epidemiological surveillance systems laboratory at the AED-SATELLITE office in Maputo, to get a better understanding of the functioning of the system. The paper-based method interviews took place in August 2010 and lasted for about one week. The field-workers were divided into groups of two by province, and each was allocated half of the SDSMAS in the respective province.

The Mozambican Health Information System was deployed in 43 districts and 11 provinces. However, the Cost-effectiveness study of the MHIS covered a sample of 13 SDSMAS, corresponding to about 30 percent of the entire population. The sample SDSMAS were selected from a list of systems that were easily accessible and relatively far along in the implementation process. The sample was collected across two provinces in Mozambique, namely Gaza and Inhambane. Due to budget constraints, it was not possible to visit Zambézia province. Across the provinces, we visited 6 SDSMAS in Gaza, namely: Manjacaze, Chockwe, Mabalane, Bilene/Macia, Chibuto and Xai-Xai. The 7 SDSMAS visited in Inhambane were Vilanculo, Massinga, Morrumbene, Homoine, Zavala, Inharrime and Maxixe.
6.2. Descriptive Analysis

The questionnaire for the study covered a sample of 14 individuals, working with either or both the HIS at the SDSMAS. Only 13 interviews were completed representing 92.8 percent of respondents that could be contacted. The contact information of the respondents was obtained from the list of people that received training on the new system, by AED-SATELLIFE.

In general, the successfullness of a health information system (paper-based or electronic), is highly dependent on human capital. Therefore, by looking at the basic characteristics of the respondents, we were able to infer their effectiveness on the job. Table 2 provides a distribution of the general characteristics of respondents.

Currently, the MHIS is mostly operated by men; about 77% of the responds are male.

The sample is composed of relatively young people. The average sample age is 29 years, varying from 25 to 40 years. This finding is congruent with the age distribution of the Mozambican population, which is relatively young (INE, 2010). A relative young health workforce at SDSMAS suggests, consequently, an easy adoption of information technology for collecting, reporting and storing of health data.

The average respondent has some kind of professional training, indicating some ability to efficiently perform tasks.

HMIS officers, records assistants, clinical officers and vaccinators were represented in the study. A large proportion of the individuals operating the HMIS system are clinic officers and vaccinators.

On average the respondents have worked for about 3 years in their station. Although they have been working for longer with the traditional HIS, they have also been working with the HMIS since it was deployed about 2 months before the interviews took place.

Table 2 includes a summary of responses to questions about the use of HMIS by respondents. The results indicate that in general respondents use the HMIS frequently.
Table 2: Characteristics of Respondents

<table>
<thead>
<tr>
<th>Demographic Characteristics</th>
<th>Sample Statistic</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Gender (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Female</td>
<td>23.08</td>
</tr>
<tr>
<td>Male</td>
<td>76.92</td>
</tr>
<tr>
<td><strong>2. Age</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>13</td>
</tr>
<tr>
<td>Mean</td>
<td>29</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>4.01</td>
</tr>
<tr>
<td>Minimum</td>
<td>25</td>
</tr>
<tr>
<td>Maximum</td>
<td>40</td>
</tr>
<tr>
<td><strong>3. Education (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Primary (1st - 7th Grade)</td>
<td>0</td>
</tr>
<tr>
<td>Secondary (8th - 10th Grade)</td>
<td>30.77</td>
</tr>
<tr>
<td>High School (11th-12th Grade)</td>
<td>30.77</td>
</tr>
<tr>
<td>Vocational Training (Institute)</td>
<td>38.43</td>
</tr>
<tr>
<td>Higher Education (University)</td>
<td>0</td>
</tr>
<tr>
<td><strong>4. Occupation (%)</strong></td>
<td></td>
</tr>
<tr>
<td>HMIS officer</td>
<td>46.15</td>
</tr>
<tr>
<td>Records assistant</td>
<td>15.38</td>
</tr>
<tr>
<td>Other (Specify)</td>
<td>38.46</td>
</tr>
<tr>
<td><strong>5. Time of Work (in months)</strong></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td>13</td>
</tr>
<tr>
<td>Mean</td>
<td>37.15</td>
</tr>
<tr>
<td>Std Deviation</td>
<td>27.46</td>
</tr>
<tr>
<td>Minimum</td>
<td>2</td>
</tr>
<tr>
<td>Maximum</td>
<td>84</td>
</tr>
<tr>
<td><strong>6. Main Task (%)</strong></td>
<td></td>
</tr>
<tr>
<td>Filling up the forms</td>
<td>23.08</td>
</tr>
<tr>
<td>Transcribing the forms into PDA/Computers</td>
<td>38.46</td>
</tr>
<tr>
<td>Other (Specify)</td>
<td>38.46</td>
</tr>
<tr>
<td><strong>7. Last Time used HMIS (proportion of people)</strong></td>
<td></td>
</tr>
<tr>
<td>Days ago</td>
<td>61.54</td>
</tr>
<tr>
<td>Weeks ago</td>
<td>7.69</td>
</tr>
<tr>
<td>Months ago</td>
<td>23.08</td>
</tr>
<tr>
<td>Years ago</td>
<td>7.69</td>
</tr>
</tbody>
</table>
6.3. Quantitative Analysis

This section presents the results for the cost-effectiveness analysis of the MHIS, following the methodology presented in section 5.2.1. The results of the cost-effectiveness analysis show which of the data collection and reporting approaches yield high benefits at the lowest cost. The underlying assumption of the analysis is that each HMIS is associated with different costs and results. The analysis of the quantitative results looks at the cost estimation of the different ingredients and evaluates which items have the lowest cost. Analyzing the Cost-Effectiveness ratios ultimately determines that the HMIS that can use resources more effectively than the paper-based version.

6.4. Quantitative Analysis

This section presents the results for the cost-effectiveness analysis of the MHIS, following the methodology presented in section 5.2.1. The results of the cost-effectiveness analysis show which of the data collection and reporting approaches yield high benefits at the lowest cost. The underlying assumption of the analysis is that each HMIS is associated with different costs and results. The analysis of the quantitative results looks at the cost estimation of the different ingredients and evaluates which items have the lowest cost. Analyzing the Cost-Effectiveness ratios ultimately determines that the HMIS that can use resources more effectively than the paper-based version.

6.4.1. Cost Analysis

a) Personnel Costs

Summary of findings: The MHIN approach results in 66% savings in personnel expenses compared to paper based approach. This translates to approximately 102.81MZN savings per year per district (about US $2.78/year/district).
The evaluation of personnel was performed based on equation (1) presented in section 5.1.3. It aims to compute and compare the average salary of personnel working with the paper and MHIN systems.

The personnel costs are computed as follows:

- The average hourly wage is about 31.15MZN per month. THIS figure was obtained from MISAU, calculated based on the monthly salary paid to workers at SDSMAS, responsible for aggregating forms and transcribing them to the PDA/Computer.\textsuperscript{14} The total number of monthly working hours is 160. The salary range did not differ substantially across the different occupations, since according to the classification of professional careers in the public health sector, all the respondents fall under the same category, the difference being the time period they have been working in the institution. Therefore, the remuneration is not very different across the survey’s respondents, ranging from 4,799MZN to 5,352MZN (Ministry of Finance, 2010).\textsuperscript{15} The figure obtained should be used for the paper-based as well as MHMIS.
- Cost of aggregation/transcription is calculated by multiplying the hourly wage rate by the total number of monthly hours to aggregate forms from health units and/or transcribe into the PDA/PC.
- The annual personnel cost equals monthly personnel costs multiplied by 12 months.
- Annual personnel costs per form are calculated by dividing the annual personnel cost by the total (annual) number of forms.

A closer look at the gathered information related to personnel costs shows that under the paper based system, health workers take on average 23 hours in a month per district to aggregate all the forms received from the different health units, prepare the respective SDSMAS weekly report, and forward it to the DPS. The results show a positive correlation between the time spent on aggregating forms and the number of health units. The larger the number of health units, the longer it will take to aggregate the information for the respective districts. Consequently, the

\textsuperscript{14} The analysis in MHIS paper was done using an exchange rate of $1 to 37 MZN, unless otherwise stated.
\textsuperscript{15} Note that the remuneration values represent the base level of salary for health worker. That is, it does not include any fringe benefits and/or benefits
higher the personnel costs incurred. On the other hand, for the MHIS system, it takes on average 32min to transcribe the forms into the computer and elaborate the monthly report.

Table 3 presents the estimated annual personnel cost for Paper-Based and MHIN system.

<table>
<thead>
<tr>
<th>Personnel Cost Item</th>
<th>Paper</th>
<th>PDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Monthly Wage</td>
<td>64,801.00</td>
<td>64,801.00</td>
</tr>
<tr>
<td>Hourly Wage</td>
<td>405.01</td>
<td>405.01</td>
</tr>
<tr>
<td>Monthly Time to aggregate/Transcribe in hours</td>
<td>300.00</td>
<td>81.6</td>
</tr>
<tr>
<td>Cost for aggregation/transcription</td>
<td>10,125.16</td>
<td>2,754.04</td>
</tr>
<tr>
<td>Number of form</td>
<td>780.00</td>
<td>624.00</td>
</tr>
<tr>
<td>Annual Personnel Cost</td>
<td>121,501.88</td>
<td>33,048.51</td>
</tr>
<tr>
<td>Annual personnel Cost per form</td>
<td>155.77</td>
<td>52.96</td>
</tr>
</tbody>
</table>

The personnel cost for MHIN system is smaller in comparison with the paper-based system. The total personnel cost for paper-based system is about three times (155.65MZN) larger than the personnel costs for the MHIN system (55.54MZN). It is clear from this finding that PDAs are a cost-saving alternative in terms of personnel costs. This result can be explained by the following:

- On average, the MHIN system is a time-saving mechanism. The MHIN takes less time to perform a similar task than on the paper-based form. Therefore, saving about 72.8% of the total time spent working with the HMIS per district per month, hence, allowing workers to perform other task. Consequently reducing the average cost per hour for transcribing data from paper to PDA/computer.

- Using the MHIN system does not involve any aggregation costs, since this is implicitly incurred into the form transcription.

- The MHIN system provides automatic generation of reports. Once again, no additional costs are incurred by this activity.

The personnel costs are subject to a test of significance of differences in means of personnel costs for the paper-based and MHIN system. This test allows us to check if the average personnel cost per HMIS are significantly different from each other, by means of a statistical test. Table 4
presets the summary statistics for the test of mean differences between Personnel Costs for Paper and MHIN system.

**Table 4: Testing for Mean differences between Personnel Cost for Paper and MHIN system**

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>SE</th>
<th>Std Dev</th>
<th>95% Confidence Interval</th>
<th>t-value</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paper</td>
<td>156.0</td>
<td>17.76</td>
<td>64.07</td>
<td>117.32 - 194.74</td>
<td>4.447</td>
<td>&lt;0</td>
</tr>
<tr>
<td>PDA</td>
<td>52.5</td>
<td>17.73</td>
<td>63.09</td>
<td>13.91 - 91.19</td>
<td>0.999</td>
<td>0.0004</td>
</tr>
</tbody>
</table>

Looking at the results presented above, the mean values fall within the 95% confidence interval. THIS means that if we had to repeat this experiment 100 times, we would obtain a mean within this interval 95 times out of the 100.

The means between personnel costs are significantly different for the paper-based and MHIN system. The null hypothesis states that the average personnel cost for the paper-based and MHIN systems are equal. At a 5 % level of significance, this hypothesis is rejected. In other words, the average personnel cost for the paper-based system is statistically significantly different from that for PDA.

**b) Office Supply Costs**

**Summary of findings**: The MHIN approach results in 62.85% savings in office supply costs compared to paper based approach. This translates to approximately 4,246.57MZN savings per year per district (about US $114.77 per year/district).

Office supply costs include all the items needed to run the district health office. Some of these costs include: paper, SIS forms, archive files, internet, maintenance, internet, printing and fax. The annual office supply cost was calculated based on equation 2, defined in section 5.1.3, and the respective results are presented in Table 5.

The annual office supply costs for the Paper-based system are more than those for the MHIN system. On average, it costs about 6,756.68MZN to run the paper-base system, while the MHIN system costs about 2,510.01MZN per annum of office supplies. Thus, by adopting the MHIN system, the SDSMAS is likely to reduce its expenditure on office supplies.
Once again, a significance test for differences in mean annual office supply cost for paper forms and MHIN system forms was completed to test for differences and for the robustness of the estimated costs. The results for the t-test show that the p-value equals to 0.0000, which is significant at a 5% level of significance. Therefore, the null hypothesis can be rejected in favor of the alternative. That is, the average annual costs for paper-based is statistically different from that for paper-based. Once again, this supporting our initial finding that the MHIN system is cost-saving in terms of office supplies when compared to the paper-based system.

### c) Transportation Costs

**Summary of findings:** Transportation costs play a major role in increasing the total cost of the paper-based approach. The paper-based HMIN solution incurs a total cost of about 5,796.06MZN (US $156.65) which is not incurred under the MHIN solution.

Transport costs are those incurred by the SDSMAS to transport forms from the SDSMAS to the DPS. They are only incurred by the paper system, since the information is automatically
uploaded to the DPS and MISAU servers using the MHIN system. The transport cost was calculated using equation 3, defined in section 5.1.3.

The transportation costs included the expenditure on gasoline, oil and vehicle maintenance. Respondents were not able to distinguish between transport costs for other uses/purposes and for forms transfers. Therefore, the calculated costs include a lump-sum for all activities undertaken by the DPS. Consequently, the estimated costs for this item are likely to be over-estimated. Table 6 presents the estimated annual transportation cost from SDSMAS to DPS.

Table 6: Annual Transportation Cost from SDSMAS to DPS

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper Annual Cost</th>
<th>Paper Forms</th>
<th>Cost per form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gasoline</td>
<td>3,926,649.60</td>
<td>780.00</td>
<td>5,034.17</td>
</tr>
<tr>
<td>Oil</td>
<td>588,997.44</td>
<td>780.00</td>
<td>755.12</td>
</tr>
<tr>
<td>Spear Parts</td>
<td>5,280.00</td>
<td>780.00</td>
<td>6.77</td>
</tr>
<tr>
<td><strong>Total cost per form</strong></td>
<td>5,796.06</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

According to the results presented above, transportation costs represent a relatively high proportion of total costs incurred by SDSMAS. Although it was not possible to isolate the transportation costs associated with forms transfer in the paper-based system, it can still be said that this cost item will be substantially reduced under the MHIN, since the latter system does not incur any transportation costs.

In addition, several externalities can be derived such as the reduction in constant delays of forms submission due to vehicle breakdowns. Once again, the MHIN solution proves to be superior to paper-based system, in terms of expenditure cut.
*Summary of findings:* The MHIN approach results in 11.56% savings in buildings operations and maintenance costs such as water, electricity, and telephone compared to paper based approach. This translates to approximately 2,358.72MZN savings per form year/district (about US $6.45 per form per year/district).

Buildings operations and maintenance costs refer to the costs of water, electricity, and telephone service factor into the costs of running the health facilities. Whether or not the health facilities operate a HMIS, these costs are incurred. These buildings operations and maintenance costs are computed using equation 4, defined in section 5.1.3. Once again, it is difficult to disaggregate the costs across the two HMIS. The estimated results for annual buildings operations and maintenance costs are presented in Table 7.

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper Annual Cost</th>
<th>Paper Cost per Form</th>
<th>PDA Annual Cost</th>
<th>PDA Cost per Form</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>126,372</td>
<td>162.02</td>
<td>126,372</td>
<td>202.52</td>
</tr>
<tr>
<td>Electricity</td>
<td>766,970</td>
<td>983.30</td>
<td>766,970</td>
<td>1229.12</td>
</tr>
<tr>
<td>Telephone</td>
<td>717,848</td>
<td>920.32</td>
<td>246,648</td>
<td>395.27</td>
</tr>
<tr>
<td>Total</td>
<td>2,065.63</td>
<td></td>
<td>1,826.91</td>
<td></td>
</tr>
</tbody>
</table>

Note: The DDS was not able to differentiate the above costs, between the two HMIS system.

As shown in Table 7, under the paper-based system, on average the SDSMAS undertakes higher costs under the paper-based system in comparison with the MHIN system. It costs about 2,065.63MZN (US $55.83) for the paper-based system in comparison with 1,826.91MZN (US $19.34) with the MHIN system. This discrepancy in results is caused by the average cost of telephones, which tends to be relatively higher when using the paper-based system. Health workers sometimes have to send information via Short Message Service (SMS) from the cellular network with the
respective weekly reports, or even call the DPS to provide them with additional information. However, this cost item is substantially reduced with the MHIN system, since all the information is transcribed at the SDSMAS and uploaded in the serves.

The t test results support the above findings, once again showing that the MHIN system is a better option in term of cost-saving for health information data capturing and storage.

e) Capital Costs

Summary of findings: The Paper-based approach results in 53.25% savings in capital costs compared to MHIN system. This translates to approximately 3,868.29MZN savings per form, per year per district (about US $104.55 per form per year/district).

Capital costs, including the opportunity costs of capital, were estimated using equation 5, defined in section 5.1.3. Table 8 presents the estimates for annual capital costs of Paper and MHIN system.

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper PDA</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Annual Cost</td>
<td>Forms</td>
<td>Cost per form</td>
<td>Annual Cost</td>
<td>Forms</td>
<td>Cost per form</td>
</tr>
<tr>
<td>Buildings</td>
<td>85,963.6</td>
<td>780</td>
<td>110.21</td>
<td>85,963.60</td>
<td>624</td>
<td>137.76</td>
</tr>
<tr>
<td>Vehicles</td>
<td>896,420.00</td>
<td>780</td>
<td>1,149.26</td>
<td>896,420.00</td>
<td>624</td>
<td>1,436.57</td>
</tr>
<tr>
<td>Training</td>
<td>75,420.00</td>
<td>624</td>
<td>120.87</td>
<td>75,420.00</td>
<td>624</td>
<td>120.87</td>
</tr>
<tr>
<td>Programming Costs</td>
<td>115,187.50</td>
<td>780</td>
<td>147.68</td>
<td>115,187.50</td>
<td>624</td>
<td>184.60</td>
</tr>
<tr>
<td>Chairs</td>
<td>192,700.00</td>
<td>780</td>
<td>247.05</td>
<td>192,700.00</td>
<td>624</td>
<td>308.81</td>
</tr>
<tr>
<td>Tables</td>
<td>338,770.00</td>
<td>780</td>
<td>434.32</td>
<td>338,770.00</td>
<td>624</td>
<td>542.90</td>
</tr>
<tr>
<td>Cabinets/Shelves</td>
<td>406,044.25</td>
<td>780</td>
<td>520.57</td>
<td>406,044.25</td>
<td>624</td>
<td>650.71</td>
</tr>
<tr>
<td>Computers</td>
<td>255,600.00</td>
<td>780</td>
<td>327.69</td>
<td>255,600.00</td>
<td>624</td>
<td>409.62</td>
</tr>
<tr>
<td>Printer</td>
<td>97,650.00</td>
<td>780</td>
<td>125.19</td>
<td>97,650.00</td>
<td>624</td>
<td>156.49</td>
</tr>
<tr>
<td>Solar Panel</td>
<td>108,000.00</td>
<td>780</td>
<td>138.46</td>
<td>108,000.00</td>
<td>624</td>
<td>173.08</td>
</tr>
<tr>
<td>Other Computer Accessories</td>
<td>55,260.00</td>
<td>780</td>
<td>70.85</td>
<td>55,260.00</td>
<td>624</td>
<td>88.56</td>
</tr>
<tr>
<td>UPS</td>
<td>96,900.00</td>
<td>780</td>
<td>124.23</td>
<td>96,900.00</td>
<td>624</td>
<td>155.29</td>
</tr>
<tr>
<td>Other Costs Equipment (PDAs with SD cards, Servers)</td>
<td>1,206,295.50</td>
<td>624</td>
<td>1,933.17</td>
<td>1,206,295.50</td>
<td>624</td>
<td>1,933.17</td>
</tr>
<tr>
<td></td>
<td>602,400.00</td>
<td>624</td>
<td>965.38</td>
<td>602,400.00</td>
<td>624</td>
<td>965.38</td>
</tr>
<tr>
<td></td>
<td>3,395.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>7,263.80</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
The MHIN system solution for epidemiologic surveillance presents higher (7,263.80MZN) capital costs than the paper-based solution (3,395.51MZN). The capital cost for operating the MHIN system is about 48% more expensive than the paper system. THIS is explained by the fact that the equipment investment costs for the MHIN system are high (i.e.: PDAs, AAPs, Servers, Internet Connection), and training that was provided for all health workers operating the MHIN incurred costs as well. However, these are likely once-off investments and with a medium-term life span of about 6 years, it will be a while before the equipment requires a replacement.

The above results are supported by the t test for mean differences between the estimates. The null hypothesis that average capital costs for the paper-based and MHIN systems are not different is rejected, with a p-value of 0.0000 which is smaller than the 5 % level of significance. Hence, the MHIN system incurs higher capital costs than the paper-based system. Nevertheless, the overall advantages of an electronic system (timely and accurate information) still deem it to be a better option for disease surveillance system.

6.4.2. Cost-Effectiveness Ratio

| Summary of findings: | The Cost-Effectiveness Ratio for MHIN system is lower than those for paper-based system, suggesting that the former is less costly and more efficient than the latter. The paper-based solution costs are up 20% above those of the MHIN. |

The cost-effectiveness ratio (CER) is calculated based on equation 7, defined in section 5.1.3. The CER gives us a measure of the relationship between total cost and the number of completed forms, per SDSMAS. The lower the ratio, the more efficient and less costly the HMIS system. The results are presented in Table 9.

The costs for the paper-based system are on average larger in comparison with the MHIN system, showing that the MHIN system for collecting, recording and storing health information incurs fewer costs than the traditional paper-based forms. That is, the MHIN system is on average 20% cost-saving in comparison with the paper-based system.
Table 9: Cost-Effectiveness Ratios

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper</th>
<th>PDA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>155.77</td>
<td>52.37</td>
</tr>
<tr>
<td>Office</td>
<td>6,756.68</td>
<td>2,510.00</td>
</tr>
<tr>
<td>Buildings</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operations and</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Maintenance</td>
<td>2,065.63</td>
<td>1,826.91</td>
</tr>
<tr>
<td>Transport</td>
<td>5,796.06</td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>3,395.51</td>
<td>7,263.80</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>18,169.65</td>
<td>11,653.08</td>
</tr>
<tr>
<td>Nbr of Forms</td>
<td>780</td>
<td>624</td>
</tr>
<tr>
<td><strong>CER</strong></td>
<td>23.29</td>
<td>18.67</td>
</tr>
</tbody>
</table>

The costs for the paper-based system are on average larger in comparison with the MHIN system, showing that the MHIN system for collecting, recording and storing health information incurs fewer costs than the traditional paper-based forms. The cost of running the MHIN are 80% that of the paper-based system. That is, MISAU can save as much as much as 20% in HMIN under the MHIN system in comparison with the paper-based system.

This finding shows that the electronic health information system reduces the average cost of operating the system and simultaneously maximizes efficiency in the collection, analysis and storage of health information data. By implementing this system, the MoH will improve their decision-making, monitoring and evaluation of policies.

6.4.3. Sensitivity Analysis

The sensitivity analysis is performed based on equations 8 and 9, defined in section 5.1.3. This technique allows us to test the robustness of the model, by allowing for change in some variables.
and quantifying the possible impact of the change in the model. For the cost-effectiveness study, we are particularly interested in analyzing the following scenario:

1. An unexpected increase in the number of SIS forms filled up due to sudden outbreak of an epidemiology - in this unfortunate situation, the general operation of health facilities in the entire health system will be affected by additional variable costs. Fixed costs (i.e. capital) are unlikely to be unaffected since they do not change in the short-run. On the other hand, variables costs such as personnel, transportation, office supply and buildings operations and maintenance cost, are highly likely to increase due to an increase in the volume of work. Therefore, it will be interesting to see what will be the impact on the over CER in both HMIS. The results for this scenario are presented in Table 10.

### Table 10: Sensitive Analysis - Computing ICER Index

<table>
<thead>
<tr>
<th>Item</th>
<th>Paper</th>
<th>Change</th>
<th>New</th>
<th>Original</th>
<th>Change</th>
<th>New</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personnel</td>
<td>155.77</td>
<td>77.885</td>
<td>233.66</td>
<td>52.37</td>
<td>26.19</td>
<td>78.56</td>
</tr>
<tr>
<td>Office</td>
<td>6,756.68</td>
<td>3378.34</td>
<td>10,135.02</td>
<td>2,510.00</td>
<td>1,255.00</td>
<td>3,765.00</td>
</tr>
<tr>
<td>Buildings Operations and Maintenance</td>
<td>2,065.63</td>
<td>1032.815</td>
<td>3,098.45</td>
<td>1,826.91</td>
<td>913.46</td>
<td>2,740.37</td>
</tr>
<tr>
<td>Transport</td>
<td>5,796.06</td>
<td>2898.03</td>
<td>8,694.09</td>
<td>7,263.80</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Capital</td>
<td>3,395.51</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
<td>18,169.65</td>
<td>7,387.07</td>
<td>22,161.21</td>
<td>11,653.08</td>
<td>2,194.64</td>
<td>6,583.92</td>
</tr>
<tr>
<td><strong>No of Forms</strong></td>
<td>780</td>
<td>390</td>
<td>1,170</td>
<td>624</td>
<td>312</td>
<td>936</td>
</tr>
<tr>
<td><strong>ICER</strong></td>
<td>18.94</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>7.03</td>
</tr>
<tr>
<td><strong>Marginal Cost Effect</strong></td>
<td>40.66</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>18.83</td>
</tr>
</tbody>
</table>

The Incremental Cost-Effective Ratio (ICER) is a measure of marginal cost due to a 50% increase in the number of forms, due to an outbreak of a disease. According to Table 10 the ICER index for the MHIN system is lower than the paper-based system. Lower marginal costs imply less sensitivity of the total costs of a specific form to shock, therefore, this finding suggests that in the unfortunate situation of an outbreak of a disease, the additional cost for operating the HMIS is larger in the paper-based system than MHIN system. For the paper-based system, an additional form increases the average cost for operating the entire HMIS and hence,
reduce the efficiency of works. The marginal cost of an additional form increases the average cost for operating the electronic HMIS in the MHIN system as well, but at a lower proportion than the paper system. The MHIN system has a higher absorption capacity to shocks (disease outbreak) than the paper-based system. The MoH in Mozambique should strongly consider the electronic HMIS over the paper-based since it is more effective in handling shocks.

A 50% increase in the number of forms collected leads to a less than proportional change in the total cost for each type of form. A comparison of the two systems reveals that the paper-based HMIS incurs proportionately more costs than the MHIN system. The costs for the paper HMIS increase by about 40.66%, the costs for the MHIN system increased by about 18.83%. Therefore, the MHIN system provides cost saving of about 54% in total cost in a situation of a diseases outbreak. This marked difference in the change in the cost by the two HMIS is largely because of the transport costs. The paper-based HMIS will require more empty forms and transport to take them to health facilities while MHIN system does not incur such costs.
6.5. Qualitative Analysis

This section presents the results for the qualitative analysis of the MHIS. In addition to the descriptive analysis of the attribute factors for each of the HIS, it also presents the health utility scores and the respective multiplicative factors for the benefit analysis of the MHIS, and the estimates for the cost utility ratio.

6.5.1. Descriptive Analysis

The respondents were asked to indicate the benefits of using each of the HMIS. The attributes of either HMIS include: the accuracy of the data; timeliness and vertical integration; completeness and reliability; degree of conflict with usual activities; supervision; prestige; motivation; need for training for better skills; and the degree of safety of retrieval of information. A descriptive analysis of the attributes across the three levels is presented in Table C1 in Appendix C.

In terms of data precision, the MHIS is more accurate than the paper-based system. All the respondents reported that the MHIS always provides accurate and precise data, while about 76.92% of the respondents stated that the paper-based system often registers problems with data accuracy.

On timeliness and vertical integration, the reporting process for the MHIS is fully integrated with the headquarters (MISAU). However, 92% of the respondents declared that the reporting process is only integrated with the Provincial health office, while 8% stated that it is very slow.

The MHIN reporting and capturing system provides more complete and reliable information. For the paper-based system, about 53.83% of the respondents stated that the forms often miss relevant information while 30.77% of the respondents have a similar opinion about the MHIN system.

Neither the MHIN nor the paper-based system interferes with the performance of other activities. However, while 46.15% of the respondents declared to have some problems and/or interference with other activities when working with the paper-based system, only 15.38% had the same opinion about the MHIN.
Working with the MHIN system causes no pain or discomfort. However, 69.23% of the respondents feel moderate pain and/or discomfort after filling the paper-based forms.

Working with MHIN system appears to be simpler than paper-based system. More respondents claimed to need some additional training for the paper-based (46.15 %) than the MHIN (23.07 %).

According to 84.62 % of the responses, the supervision process is faster under the MHIN system. Meanwhile, 61.54 % of the respondents find the paper-based system supervision process to be sometimes deficient.

The attribute prestige, measures the extent to which each HMIS is able to successful achieve its intended objectives. About 76.92% of respondents find that the MHIN system is a very prestigious, in comparison with 53.85% who find that the paper-based system is reasonable prestigious.

The MHIN system is more motivating for staff than the paper-based system. The results show that 23.08% of staff find that the paper-based system does not motivate staff to work on it, while for the MHIN system 84.62% finds it to be very motivating system to work.

Although computer virus infections are a major threat to the successful implementation and operation of the MHIN, 76.92% of respondents state that the HMIS is easy to retrieve information from, while 61.53% state that the MHIN ensures reasonable safety due to technical/jack failures.

In general, respondents gain more benefits from using the MHIN system than the paper-based system. The MHIN system provides more precise, reliable and timely information than the paper-based system. On the other hand, it is very vulnerable to technology related threats such as computer viruses and hardware malfunctions, in which case the data can be easily lost. In addition, the respondents also feel like there is a need for additional training in order to maximize the efficiency of working with the electronic HMIS.
6.5.2. Health Utility Index

The study adopted the Health Utilities Index (HUI) because of its use of the multi-attribute utility theory for the estimation of the utility formula. It is used to measure the overall benefits associated with using either of the Mozambican HMIS. It provides a more robust estimation of the benefits associated with the paper and/or MHIN system.

The HUI is computed using equation 11, for each SDSMAS visited in the two provinces. It is based on the 10 attributes listed above (section 5.2) and the respective multiplicative factors. The results of the computed HUI are presented in Table 14 in APPENDIX C.

According to the results presented, HUI for the paper-based system is low (0.1820) in comparison with the HUI for MHIN system (0.4240). This suggests that the respondents believe they derive more benefits and higher utility from the MHIN system than the paper-based system.

A test of significance of the difference in the means of HUI for each HMIS supports the above finding. Testing the null hypothesis that the HUIs for the paper and MHIN system are not different is rejected at a 5% level of significance, with a p-value of 0.0000. Therefore, there is in fact a significant difference in the benefits derived from each of the HMIS, with MHIN system providing more benefits than the paper-based system.

6.5.3. Cost Utility Ratio

The cost utility ratio (CUR) gives us an overview of the benefits derived from each HMIS in terms of its respective costs. It was computed based on Equation 10, presented in section 5.2.1. The CUR allows us to identify the least costly and more beneficial HMIS option.

In developing countries, limited and scarce financial resources constitute the main constraint for the implementation of many government programs. In the Mozambican economy, the government allocated about 16% of the budget to the health sector. From the total budget allocated to the provinces, about 9% is allocated to Gaza SDSMAS and 5% to Inhambane SDSMAS (MF, 2010). Assuming that the latter value is equivalent to the total cost to operate the SDSMAS in the year 2010/2011, this value is then used to estimate the CUR. Table 11 presents the results of the computation of CUR, by province.
### Table 11: Computation of Cost-Utility Ratio

<table>
<thead>
<tr>
<th></th>
<th>HMIS</th>
<th>HUI</th>
<th>MHIN Budget (MZN)</th>
<th>CUR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Combined</strong></td>
<td>Paper</td>
<td>0.1840</td>
<td>94,670,446</td>
<td>514,513,293</td>
</tr>
<tr>
<td></td>
<td>PDA</td>
<td>0.4208</td>
<td>94,670,446</td>
<td>224,977,296</td>
</tr>
<tr>
<td><strong>Gaza</strong></td>
<td>Paper</td>
<td>0.1748</td>
<td>72,911,476</td>
<td>417,113,707</td>
</tr>
<tr>
<td></td>
<td>PDA</td>
<td>0.4346</td>
<td>72,911,476</td>
<td>167,766,857</td>
</tr>
<tr>
<td><strong>Inhambane</strong></td>
<td>Paper</td>
<td>0.1919</td>
<td>21,758,970</td>
<td>113,387,024</td>
</tr>
<tr>
<td></td>
<td>PDA</td>
<td>0.4090</td>
<td>21,758,970</td>
<td>53,200,416</td>
</tr>
</tbody>
</table>

Source: Ministry of Finance, 2009/2010 Budget

In general, the CUR for the MHIN system is lower (514,513,293MZN) than that of the paper-based system (224,977,296MZN). Looking at the CUR across the two provinces, the calculated ratio remains lower for the MHIN system (167,766,857MZN and 53,200,416MZN) in comparison with the paper-based system (417,113,707MZN and 113,387,024MZN) for the Gaza and Inhambane province, respectively. Therefore, the MHIN system provides more benefits at a lower cost, than the paper-based system for epidemiological control, in both provinces.

The above result holds for the combined provinces also. In short, where it takes about 514,513,293MZN to run the paper-based HMIS, the MHIN system only incurs an average total cost of about 224,977,196MZN to perform a similar task but also achieving a greater level of utility. Therefore, if the MoH had a limited budget allocated to SDSMAS of about 94,670,446MZN, it will save about 53.7% in using the MHIN for epidemiology disease surveillance.
7. Discussion, Conclusions and Recommendations

This section provides a discussion of the results presented above, makes some conclusions and proposes policy recommendations. The Mozambican Health Information Network (MHIN) was implemented with the aim of providing a less costly and highly efficient alternative for data collection, transmission, analysis and storage of epidemic-prone diseases, which will improve the decision-making procedure of the Ministry of Health.

This study reveals that the HMIS system is mostly operated by HMIS officers, although other types of workers also performed HMIS related activities. During the deploying of the MHIN system, technical training was provided to health workers to enhance performance in the operation of the new HMIS system. At least two health workers received training in each of the SDSMAS, DPS and MoH (central level).

Under the MHIN system, it takes less time to aggregate and transcribe the forms than on the paper-based form. On average the MHIN saves about 72.8% of the total time spent working with the HMIS per district per month. Under the MHIN system, health workers have more flexibility to perform other activities and responsibilities. For instance, the new system skips the aggregation of forms, since this is done automatically electronically. Thus, the costs related to the aggregation of forms are eliminated. Therefore, the MHIN at this phase provides an opportunity to cut cost and improve efficiency of health workers.

The paper-based system requires more average personnel costs than the MHIN system. The MHIN approach results in 34% savings in personnel expenses compared to paper based approach. This translates to approximately 102.1MZN savings per year per district. The significance test for differences in mean personnel costs supports this finding by allowing to reject the null hypothesis that the average personnel cost are not significantly different in the MHIN system and paper-based system. Therefore, with the electronic HMIS, health workers save time in dealing with data capturing of epidemic-prone diseases, and may have more time for data analysis, report writing, and other activities.

The MHIN approach results in 11.56% savings in buildings operations and maintenance costs such as water, electricity and telephone compared to paper based approach. The MHIS offers a solution to the Mozambican Government for savings and reallocation of financial resources,
from unnecessary expenditure related with traditional epidemiological surveillance system to finance activities that will further enhance the effectiveness of the electronic system. For instance, the acquisition of proper computer and PC related items will further improve the efficiency of the MHIN system.

Transportation costs are the second largest element of the total cost of the paper-based system, corresponding to about 32% of total cost. On average, SDSMAS spent about 5,796.06M ZM per form per year on total transportation costs. The MHIS system may result in a substantial reduction or complete elimination of these costs, once again freeing up money for savings and/or reallocation, since it does not incur such costs.

In terms of capital costs, MHIN incurs higher costs compared to the paper-based system. The Paper-based approach results in 53.25% savings in capital costs compared to MHIN system. The MHIN requires an initial high investment in equipment (i.e.: PDA, 3GSM card, AAPs) to quick start the operation of the system. However, these are once-off investments, with a medium-term life span of about 6 years before a replacement is required.

The computed Cost-Effectiveness Ratio (CER) shows that the MHIS system is more cost-effective than the paper-based. The CER for MHIN system is lower than those for paper-based system, suggesting that the former is less costly and more efficient than the latter. The cost of running the MHIN are 80% that of the paper-based system. That is, MISAU can save as much as much as 20% in HMIN under the MHIN system in comparison with the paper-based system. This finding shows that the electronic health information system reduces the average cost of operating the system and simultaneously maximizes efficiency in the collection, analysis and storage of health information data. By implementing this system, the MoH will improve their decision-making, monitoring and evaluation of policies.

The qualitative analysis supports the initial finding derived from the quantitative analysis. The Health Utility Index (HUI) indicates a preference of the MHIN system over the paper-based system. The HUI for the paper-based system is low (0.1820) in comparison with the HUI for MHIN system (0.4240). This suggests that the respondents believe they derive more benefits and higher utility from the MHIN system than the paper-based system. This finding suggests that on average respondents have more benefits from the paper-based and at a lower cost.
In general, the CUR for the MHIN system is lower (514,513,293 MZN) than that of the paper-based system (224,977,296 MZN). Under the condition of limited budget allocation for SDSMAS, the MHIN system provides a 53.7% cost-saving alternative for epidemiology disease surveillance, in comparison with the paper-based system.

Sensitive analysis results show that in the unfortunate situation of a disease epidemic, the MHIN system is a better option than the paper-based system. In a situation of 50 percent increase of total forms saves more costs in comparison with the paper-based system, while simultaneously keeping a high rate of effectiveness for health workers. For the Mozambican Government, this will provide them with a rapid and reliable response in a situation of a cholera outbreak, especially in rural and less developed provinces. Therefore, it is recommended that MISAU considers the option of expanding the electronic HIS throughout the country.

The qualitative evaluation of the MHIN supports the findings from the quantitative and benefit analysis. It shows that the MHIN is superior to the paper-based system. On average, the MHIN is time and cost savings on data collection, enables processing and sharing of information, facilitating clinical decision making, and enables communication and collaborative practice, quality and safety of the epidemiological data.

The results from the qualitative evaluation of the efficiency of the MHIN for disease surveillance data gathering and reporting compared to approaches currently used by MoH, shows that by relating the outputs or achievements observed from the PDA based HMIS against the inputs and means or resources we can say that the project goals has been met. The evidences of that can be resumed in the following benefits observed.

- **Time and Cost Savings on Data Collection, Processing and Sharing.** The new system reduced the four week reporting delay when using paper based system to one week reporting delay with PDA based HMIS. The SDSMAS, DPS and MISAU is able to access the weekly reports at the same time upon the upload of data by SDSMAS epidemiological staff.

- **Facilitating Clinical Decision Making.** The reduction to one week and the possibility to have data being feed daily to the database allows the decision makers at any level of the
health administration hierarchy to make attempt decision. Also the possibility to have access to the epidemiological electronic database with allows heath practitioners to compose graphics to make comparisons, track back and see the evolutionary a certain disease.

- **Enabling Communication and Collaborative Practice.** SDSMAS and DPS established faster and functional networks for communication and collaborative working with the Health Units and the affiliated health departments or agencies. An example is the permanent and prompt communication between the health units and SDSMAS and the cooperation with between the SDSMAS and Town Council of Health in Chibuto Municipality.

- **Quality and Safety of the Epidemiological Data.** All data is stored in an electronic data based and it is done regular backups. Remote access to the database is granted by using specific and individual credentials that are advised to not be shared with others. The accuracy of data entered in the system is regularly checked during the monthly statistical meeting. Also at the moment of data entry if is observed uncommon data are made mobile calls to the heath units verify data specific data.

In conclusion, the MHIN provides a less costly and highly efficient alterative for data capturing, analysis and storage of epidemiological surveillance data. In addition, it provides timely and accurate data, which reduces risks and also speeds up the process for rapid response. The new HMIS represents an improvement in the overall functioning of the SIS, removing unnecessary barriers to efficient functioning and improving the reporting and feedback system of health information and surveillance.

Therefore, the MHIS system is recommended to the Ministry of Health in Mozambique for epidemiology surveillance. Certainly, the MHIN is a tool that provides support to policy-makers with priorities in the health sector, resource allocation, and monitoring and evaluating the impact of health programs towards goals.

Therefore, following the above discussion and conclusion, the following recommendations are proposed:
i) The new electronic system developed under the Mozambique Health Information Network is highly recommended to the Government of Mozambique. It provides a less costly and more efficient solution for epidemiological surveillance, hence maximizing evidence-based decision making and policy evaluation in the area of Integrated Disease Surveillance and Response (IDSR).

ii) Additional training of health professionals is required. Ongoing on the job-training, regular supervision and monitoring of health worker activities are needed at all levels, should be done and emphasize basic computer skills. The training will improve efficiency, enhance the performance of health professionals, ensure high data quality and readily to be used for decision-making.

iii) There were no specific evidences regarding the use of the system during disease outbreaks because no disease outbreaks happened until date of the project evaluation. Therefore, prior to scaling up and rolling out to more districts, a second evaluation would then be recommended to assess the efficiency of the system in such conditions.

iv) Ensure that all stations have access to a functional computer, with at least the minimal requirements to run the MHIN.

v) Since the MHIN has a high replacement of capital cost, the use of lower cost but highly efficient technology in the HMIS is suggested. This can be achieved by the use of cellular telephones. Hence, the overall initial capital cost can be significantly reduced, while keeping the same level of effectiveness of the electronic HMIS.
8. Reference


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Kennedy School of Government (2001) “e-health in Developing Countries: The future of health care?” Organized by the information technology group at the center for international development with digital National Consortium

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OECD (2003) “Poverty and Health in Developing Countries: Key Actions” Policy Brief


APPENDIX A: List of District Health Posts Visited

Table 12: List of District Health Posts Visited

<table>
<thead>
<tr>
<th>Province</th>
<th>District Health Office</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gaza</td>
<td>Manjacaze</td>
</tr>
<tr>
<td></td>
<td>Chockwe</td>
</tr>
<tr>
<td></td>
<td>Mabalane</td>
</tr>
<tr>
<td></td>
<td>Bilene/Macia</td>
</tr>
<tr>
<td></td>
<td>Chibuto</td>
</tr>
<tr>
<td></td>
<td>Xai-Xai</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Vilanculo</td>
</tr>
<tr>
<td></td>
<td>Massinga</td>
</tr>
<tr>
<td></td>
<td>Morrumbene</td>
</tr>
<tr>
<td></td>
<td>Homoine</td>
</tr>
<tr>
<td></td>
<td>Zavala</td>
</tr>
<tr>
<td></td>
<td>Inharrime</td>
</tr>
<tr>
<td></td>
<td>Maxixe</td>
</tr>
</tbody>
</table>
APPENDIX B: Consent Form and Questionnaire

THE EVALUATION OF THE MOZAMBIQUE HEALTH INFORMATION SYSTEM

Dear Sir/Madam

My name is ______________________ I am part of the team from the Eduardo Mondlane’s University leaded by Dr. Leopoldo Nhampossa, in charge of evaluating the cost-effectiveness of the health information system in Mozambique. I am therefore requesting you to kindly answer some few questions concerning the paper-based and the MHIN system health information system for epidemiology surveillance. The information you provide is expected to contribute to a better understanding of the functioning of both health information systems and will be a great input in deciding and planning their future improvement.

You are free to express your opinions and provide any information you think is important. The information provided will be kept very confidential. The time for the interview will be only 30 minutes.

Thank you very much for your cooperation.
Cost-Effectiveness Assessment of Mozambican Health Information System

Name of Interviewed Person: _____________________________

District Health Office of: _____________________________ Code: __________

Province: _____________________________ Code: __________

Address: _____________________________ Telephone: _____________________________

Cell phone: _____________________________

**PART I: BACKGROUND CHARACTERISTICS**

<table>
<thead>
<tr>
<th>Questions</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q01 Gender</td>
<td>1. Male&lt;br&gt;2. Female</td>
</tr>
<tr>
<td>Q02 Age of respondent (in years)</td>
<td></td>
</tr>
<tr>
<td>Q03 Education level (Complete)</td>
<td>1. Primary (1st - 7th Grade)&lt;br&gt;2. Secondary (8th - 10th Grade)&lt;br&gt;3. High School (11th-12th Grade)&lt;br&gt;4. Vocational Training (Institute)&lt;br&gt;5. Higher Education (University)</td>
</tr>
<tr>
<td>Q04 Occupation</td>
<td>1. HMIS officer&lt;br&gt;2. Records assistant&lt;br&gt;3. Other (Specify)</td>
</tr>
<tr>
<td>Q05 How long have you been working in this institutions? (in years)?</td>
<td></td>
</tr>
<tr>
<td>Q06 What is your main task? (Note: Check consistency with the responses to Q04. Multiple answers accepted)</td>
<td>1. Filling up the forms&lt;br&gt;2. Transcribing the forms into PDA/Computers&lt;br&gt;3. Other (Specify)</td>
</tr>
<tr>
<td>Q07 When did you last handle the paper-based health information forms? (Note: Verify answer with last BES)</td>
<td>1. Days ago&lt;br&gt;2. Weeks ago&lt;br&gt;3. Months ago&lt;br&gt;4. Years ago</td>
</tr>
</tbody>
</table>
### PARTE II: Use of Paper-Based and PDA/Computer based System

This section aims at obtaining brief information about the usage of paper-based system and PDA / computer to collect information within the SDSMAS.

**Q08** What is the epidemiological surveillance system that is installed in this SDSMAS? *(Verify by observation)*
- 1. PDA
- 2. Computador (3G Internet)
- 3. Computador e PDA

**Q09** How long have you been using the new epidemiology surveillance system?
- 1. Some days
- 2. Weeks
- 3. Months

**Q09a** If Q08 is (1), how many days?

**Q09b** If Q08 is (2), how many weeks?

**Q09c** If Q08 is (3), how many months?

**Q09d** When did you use the epidemiology surveillance system for the first time?

**Q10** How many times per week works in:
- 1. Fill in weekly report using paper-based method
- 2. Transcribe from paper-forms to PDA/PC

**Q11** In a week, when do use the PDA/Computer to capture health information?
- 1. Simultaneously with other day-to-day activities?
- 2. Some hour in a day?
- 3. Some days?
- 4. Any hour of the day?

**Q11a** If 2 above (in question Q11), state the hours

**Q11b** If 3 above (in question Q11), state the days

**Q12** Since you began to use the PDA/Computer, was there registered any cholera outbreak?
- 1. Yes (go to Q12a)
- 2. No (go to Q13)

**Q12a** How many outbreaks have been registered until now?

**Q12b** When was the outbreak registered? (State the epidemiological Week)

**Q12c** Besides Cholera, was there any other outbreak registered? *Yes* [ ] *No* [ ]
PARTE III: INFORMATION ABOUT THE OPERATING COSTS OF SDSMAS
This section aims at collecting data for the various costs of operation of the SDSMAS

a) Personnel Costs
Please indicate the occupation of respondent:
(Note: Only Applicable is Q06=1 or 2)

Q13 On average, how long do you take to:
1. Fill in weekly report using paper-based method
2. Transcribe from paper-forms to PDA/PC
(Verify answer by requesting a demonstration)

Q14 On average, in a month how many forms:
1. Fill in manually
2. Transcribe from paper-forms to PDA/PC
(Verify with MISAU or HR of SDSMAS)

Q16 On average, how many hours do you work monthly?
1. Fill in weekly report using paper-based method
2. Transcribe from paper-forms to PDA/PC
3. Total number of Hours (sum 1+2)

Q17 Average hourly salary
(To be calculated using MISAU information)

Q18 Total monthly salary for filling in forms calculated (= Q13xQ14xQ17)

b) Office Supply and Buildings Operations and Maintenance Costs:
Q19 Please indicate the cost of the items below:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Quantities (per month)</th>
<th>Total Value (per Month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Paper</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2. SIS Forms</td>
<td></td>
<td></td>
</tr>
<tr>
<td>3. Files</td>
<td></td>
<td></td>
</tr>
<tr>
<td>4. Binders</td>
<td></td>
<td></td>
</tr>
<tr>
<td>5. Water</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6. Electricity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>7. Telephone</td>
<td></td>
<td></td>
</tr>
<tr>
<td>8. Internet</td>
<td></td>
<td></td>
</tr>
<tr>
<td>9. Maintenance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10. Other (i.e. Rent)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Cost-Effectiveness Study of the Mozambique Health Information System

c) Transport Operational Costs: Expenses incurred from SDSMAS to DPS

Q20 Please provide us with the following information:

- **Average Kilometers traveled per month (average):**
- **Total Petrol Costs = 15% x of monthly expenditure including petrol**

- **Average amount of liter spent per month:**
- **Costs of spare parts = 24% x purchase price of vehicles**

Costs per liter

Note: The value must be specified. This information must be recheck with the SDSMAS finance responsible

d) Annual Capital Costs

Q21 Please indicate the cost of the items below:

<table>
<thead>
<tr>
<th>Ingredient</th>
<th>Purchase Value</th>
<th>Life Expectancy of the good</th>
<th>Annual Replacement Costs (Depreciation)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Buildings</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>2. Vehicles †</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>3. Training ‡</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>4. Chairs</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>5. Tables</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>6. Cabinets/Shelves</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>7. Computers</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
<tr>
<td>8. Printer</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>9. Solar Panel</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>10. Other Computer Accessories</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>11. UPS</td>
<td></td>
<td></td>
<td>10%</td>
</tr>
<tr>
<td>12. Other Costs</td>
<td></td>
<td></td>
<td>5%</td>
</tr>
</tbody>
</table>

Note: † Vehicles refer only to those used for transporting forms for DPS  ‡ SDSMAS Please indicate the average cost of at least one training initiative that took place in this SDSMAS
PART IV: BENEFITS FROM THE UTILIZATION OF EACH OF THE HEALTH INFORMATION SYSTEMS

This section aims to capture qualitative information about the benefits from the utilization of each of the health information system by its users.

Q22 In your opinion, what are the advantages of using the PDA/Computer vis-a-vis the paper-base system to communicate health information?

Q23 Evaluate the paper-base vs PDA/Computer based health information system, as a mechanism to communicate health information:

<table>
<thead>
<tr>
<th>A. Precision of Data</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Timeliness and Vertical Integration</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Level</strong></td>
</tr>
<tr>
<td>1</td>
</tr>
<tr>
<td>2</td>
</tr>
<tr>
<td>3</td>
</tr>
</tbody>
</table>
### C. Completeness and Reliability

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>C1</td>
<td>Forms are always complete and reliable</td>
</tr>
<tr>
<td>2</td>
<td>C2</td>
<td>Forms often miss relevant information</td>
</tr>
<tr>
<td>3</td>
<td>C3</td>
<td>Forms are always reported with missing information (i.e. Drugs prescription, death reasons in case of pregnant women, etc)</td>
</tr>
</tbody>
</table>

### D. Conflict with usual activities

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>D1</td>
<td>No problems with performing usual activities (i.e. Attending patients, assisting other personnel, on-job-training)</td>
</tr>
<tr>
<td>2</td>
<td>D2</td>
<td>Some problems with performing usual activities</td>
</tr>
<tr>
<td>3</td>
<td>D3</td>
<td>Unable to perform usual activities</td>
</tr>
</tbody>
</table>

### E. Pain/Discomfort

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>E1</td>
<td>No pain or discomfort</td>
</tr>
<tr>
<td>2</td>
<td>E2</td>
<td>Moderate pain or discomfort</td>
</tr>
<tr>
<td>3</td>
<td>E3</td>
<td>Often feel extreme or discomfort after filling the forms</td>
</tr>
</tbody>
</table>

### F. Need for additional training or advanced skills required

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>F1</td>
<td>Forms are very easy to fill in</td>
</tr>
<tr>
<td>2</td>
<td>F2</td>
<td>Sometimes there is a need for assistance in filling the forms</td>
</tr>
<tr>
<td>3</td>
<td>F3</td>
<td>There is a strong need for technical assistance or advanced skills</td>
</tr>
</tbody>
</table>

### G. Supervision

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>G1</td>
<td>Supervision process is easier under this HMIS system</td>
</tr>
<tr>
<td>2</td>
<td>G2</td>
<td>Sometimes supervision is deficient</td>
</tr>
<tr>
<td>3</td>
<td>G3</td>
<td>There is almost ineffective in this HMIS system</td>
</tr>
</tbody>
</table>

### H. Prestige

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>H1</td>
<td>The nature of the HMIS system is very prestigious</td>
</tr>
<tr>
<td>2</td>
<td>H2</td>
<td>The HMIS system is reasonable</td>
</tr>
<tr>
<td>3</td>
<td>H3</td>
<td>The nature of the HMIS system is not prestigious at all</td>
</tr>
</tbody>
</table>
### I. Motivation

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>I1</td>
<td>This HMIS system is quite motivating</td>
</tr>
<tr>
<td>2</td>
<td>I2</td>
<td>The system is reasonable</td>
</tr>
<tr>
<td>3</td>
<td>I3</td>
<td>This system does not motivate staff to work on it at all</td>
</tr>
</tbody>
</table>

### J. Degree of safety of retrieved information and failures

<table>
<thead>
<tr>
<th>Level</th>
<th>Code</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>J1</td>
<td>This HMIS ensures that health information is retrieved safely for long period of time and does not admit failures</td>
</tr>
<tr>
<td>2</td>
<td>J2</td>
<td>The HMIS ensures reasonable safety and there may occur failures (e.g. technical failures, jack failures, etc)</td>
</tr>
<tr>
<td>3</td>
<td>J3</td>
<td>The HMIS is not safe and always reports equipment failures</td>
</tr>
</tbody>
</table>
### APPENDIX C: Tables

#### Table 13: Descriptive Analysis of HIS Attributes

<table>
<thead>
<tr>
<th>Attributes</th>
<th>Paper</th>
<th>PDA</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Freq</td>
<td>Percent</td>
</tr>
<tr>
<td><strong>A. Precision of Data</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Data is always accurate and precise</td>
<td>1.00</td>
<td>7.69</td>
</tr>
<tr>
<td>Often there are problems with data accuracy</td>
<td>10.00</td>
<td>76.92</td>
</tr>
<tr>
<td>Always have problems with data accuracy</td>
<td>2.00</td>
<td>15.38</td>
</tr>
<tr>
<td><strong>B. Timeliness and Vertical Integration</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reporting process is fully integrated with MoH Headquarters, and is fast</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td>Reporting process is fully integrated with Provincial Headquarters, and is fast</td>
<td>12.00</td>
<td>92.00</td>
</tr>
<tr>
<td>Reporting process is only integrated with District Health Offices and is very slow (i.e. Sometimes it takes 2 to 3 months to send the forms from the health facility to the district health office)</td>
<td>1.00</td>
<td>8.00</td>
</tr>
<tr>
<td><strong>C. Completeness and Reliability</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forms are always complete and reliable</td>
<td>4.00</td>
<td>30.77</td>
</tr>
<tr>
<td>Forms often miss relevant information</td>
<td>7.00</td>
<td>53.85</td>
</tr>
<tr>
<td>Forms are always reported with missing information (i.e. Drugs prescription, death reasons in case of pregnant women, etc)</td>
<td>2.00</td>
<td>15.38</td>
</tr>
<tr>
<td><strong>D. Conflict with usual activities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No problems with performing usual activities (i.e. Attending patients, assisting other personnel, on-job-training)</td>
<td>7.00</td>
<td>53.85</td>
</tr>
<tr>
<td>Some problems with performing usual activities</td>
<td>6.00</td>
<td>46.15</td>
</tr>
<tr>
<td>Unable to perform usual activities</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td><strong>E. Pain/Discomfort</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No pain or discomfort</td>
<td>3.00</td>
<td>23.08</td>
</tr>
<tr>
<td>Moderate pain or discomfort</td>
<td>9.00</td>
<td>69.23</td>
</tr>
<tr>
<td>Often feel extreme or discomfort after filling the forms</td>
<td>1.00</td>
<td>7.69</td>
</tr>
<tr>
<td><strong>F. Need for additional training or advanced skills required</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Forms are very easy to fill in</td>
<td>7.00</td>
<td>53.85</td>
</tr>
<tr>
<td>Sometimes there is a need for assistance in filling the forms</td>
<td>6.00</td>
<td>46.15</td>
</tr>
<tr>
<td>There is a strong need for technical assistance or advanced skills</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td><strong>G. Supervision</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Supervision process is easier under this HMIS system</td>
<td>5.00</td>
<td>38.46</td>
</tr>
<tr>
<td>Sometimes supervision is deficient</td>
<td>8.00</td>
<td>61.54</td>
</tr>
<tr>
<td>There is almost ineffective in this HMIS system</td>
<td>.</td>
<td>.</td>
</tr>
<tr>
<td><strong>H. Prestige</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>The nature of the HMIS system is very prestigious</td>
<td>2.00</td>
<td>15.38</td>
</tr>
<tr>
<td>The HMIS system is reasonable</td>
<td>7.00</td>
<td>53.85</td>
</tr>
</tbody>
</table>
## I. Motivation

<table>
<thead>
<tr>
<th>Description</th>
<th>Rating</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>This HMIS system is quite motivating</td>
<td>1.00</td>
<td>7.69</td>
<td>11.00</td>
<td>84.62</td>
</tr>
<tr>
<td>The system is reasonable</td>
<td>9.00</td>
<td>69.23</td>
<td>2.00</td>
<td>15.38</td>
</tr>
<tr>
<td>This system does not motivate staff to work on it at all</td>
<td>3.00</td>
<td>23.08</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>

## J. Degree of safety of retrieved information and failures

<table>
<thead>
<tr>
<th>Description</th>
<th>Rating</th>
<th>Mean</th>
<th>Median</th>
<th>Mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>This HMIS ensures that health information is retrieved safely for long period of time and does not admit failures</td>
<td>5.00</td>
<td>38.46</td>
<td>10.00</td>
<td>76.92</td>
</tr>
<tr>
<td>The HMIS ensures reasonable safety and there may occur failures (e.g. technical failures, jack failures, etc)</td>
<td>6.00</td>
<td>46.15</td>
<td>3.00</td>
<td>23.08</td>
</tr>
<tr>
<td>The HMIS is not safe and always reports equipment failures</td>
<td>2.00</td>
<td>15.38</td>
<td>.</td>
<td>.</td>
</tr>
</tbody>
</table>
Table 14: Multiplicative Factor for Paper and MHIN system

<table>
<thead>
<tr>
<th>SDSMAS</th>
<th>Precision</th>
<th>Timeliness</th>
<th>Completeness and Reliability</th>
<th>Conflict</th>
<th>Pain/Discomfort</th>
<th>Training</th>
<th>Supervision</th>
<th>Prestige</th>
<th>Motivation</th>
<th>Safety</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manjacaze</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Chockwe</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Mabalane</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Bilene/Macia</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Chibuto</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Xai-Xai</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.81</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Vilanculo</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Massinga</td>
<td>1</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Morrumbene</td>
<td>0.91</td>
<td>1</td>
<td>0.77</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Homoine</td>
<td>0.77</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.96</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.83</td>
<td>1</td>
</tr>
<tr>
<td>Zavala</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>0.81</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.76</td>
<td>1</td>
</tr>
<tr>
<td>Inharrime</td>
<td>0.77</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.95</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Maxixe</td>
<td>0.91</td>
<td>1</td>
<td>0.86</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0.95</td>
<td>0.95</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 15: Computation of HUI for both Paper and MHIN System

<table>
<thead>
<tr>
<th>Province</th>
<th>District</th>
<th>Paper-based</th>
<th></th>
<th>PDA</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Constant</td>
<td>MF</td>
<td>Error Estimate</td>
<td>Constant</td>
</tr>
<tr>
<td>Gaza</td>
<td>Manjacaze</td>
<td>1.85</td>
<td>0.2794</td>
<td>0.25</td>
<td>0.1292</td>
</tr>
<tr>
<td>Gaza</td>
<td>Chockwe</td>
<td>1.85</td>
<td>0.2956</td>
<td>0.25</td>
<td>0.1367</td>
</tr>
<tr>
<td>Gaza</td>
<td>Mabalane</td>
<td>1.85</td>
<td>0.3302</td>
<td>0.25</td>
<td>0.1527</td>
</tr>
<tr>
<td>Gaza</td>
<td>Bilene/Macia</td>
<td>1.85</td>
<td>0.5072</td>
<td>0.25</td>
<td>0.2346</td>
</tr>
<tr>
<td>Gaza</td>
<td>Chibuto</td>
<td>1.85</td>
<td>0.4804</td>
<td>0.25</td>
<td>0.2222</td>
</tr>
<tr>
<td>Gaza</td>
<td>Xai-Xai</td>
<td>1.85</td>
<td>0.3747</td>
<td>0.25</td>
<td>0.1733</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Vilanculo</td>
<td>1.85</td>
<td>0.3987</td>
<td>0.25</td>
<td>0.1844</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Massinga</td>
<td>1.85</td>
<td>0.5924</td>
<td>0.25</td>
<td>0.2740</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Morrumbene</td>
<td>1.85</td>
<td>0.3070</td>
<td>0.25</td>
<td>0.1420</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Homoine</td>
<td>1.85</td>
<td>0.2626</td>
<td>0.25</td>
<td>0.1215</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Zavala</td>
<td>1.85</td>
<td>0.3431</td>
<td>0.25</td>
<td>0.1587</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Inharrime</td>
<td>1.85</td>
<td>0.5182</td>
<td>0.25</td>
<td>0.2397</td>
</tr>
<tr>
<td>Inhambane</td>
<td>Maxixe</td>
<td>1.85</td>
<td>0.4818</td>
<td>0.25</td>
<td>0.2228</td>
</tr>
</tbody>
</table>

Total 2.3918 Total 5.4709

HUI 0.1840 HUI 0.4208

Table 16: Data collection guide

<table>
<thead>
<tr>
<th>Target interviewee</th>
<th># RQ*</th>
<th>Level of Heath Administration</th>
<th>Major variables to be covered</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data collection staff and data entry staff</td>
<td>RQ 1</td>
<td>District</td>
<td>• inputs&lt;br&gt;• means or resources</td>
</tr>
<tr>
<td>Data analysts and report writing staff</td>
<td>RQ2 &amp; RQ3</td>
<td>District Provincial National</td>
<td>• means or resources&lt;br&gt;• outputs or achievements&lt;br&gt;• outcomes or impacts</td>
</tr>
<tr>
<td>Decision makers</td>
<td>RQ2 &amp; RQ3</td>
<td>District Provincial National</td>
<td>• means or resources&lt;br&gt;• outputs or achievements&lt;br&gt;• outcomes or impacts</td>
</tr>
<tr>
<td>HIS project developers/coordinators</td>
<td>RQ 1</td>
<td>National</td>
<td>• inputs&lt;br&gt;• means or resources</td>
</tr>
</tbody>
</table>

* RQ = Research Question
Table 17: Definition of the key issues for measuring efficiency

<table>
<thead>
<tr>
<th>Information concerning</th>
<th>Definition</th>
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</thead>
<tbody>
<tr>
<td>Inputs</td>
<td>The state of activities and capital required for production or before a process is carried out.</td>
</tr>
<tr>
<td>means or resources</td>
<td>Supplies, materials, equipment, or skill that is necessary for the operation of the PDA based HMIS.</td>
</tr>
<tr>
<td>outputs or achievements</td>
<td>Activities and resources resulting from a PDA based HMIS process.</td>
</tr>
<tr>
<td>outcomes or impacts</td>
<td>Changes and greater effects that occur among the beneficiaries or the environment the HMIS intervene</td>
</tr>
</tbody>
</table>
Ministério da Saúde (MISAU)

REDE MOÇAMBICANA DE INFORMAÇÃO PARA SÁUDE (RMIS)

O projecto RMIS é uma parceria da Academia para o Desenvolvimento Educacional (AED), MISAU e Ministério da Ciencia e Tecnologia.

Manual de Descarga, sincronização e migração de dados para a base de dados distrital (MB:SIS)
(Destinado aos Pontos Focais Distritais)

AED
Academy for Educational Development
Connecting People > Creating Change

Projecto da AED Número: 3746-01

Este trabalho foi realizado com a ajuda de fundos concedidos pelo Centro de Pesquisa para o Desenvolvimento Internacional em Ottawa, Canada (International Research Centre, IDRC).

As actividades do projecto foram realizadas com o apoio financeiro do Governo Canadiano através da Agência Canadiense de Desenvolvimento Internacional (Canadian International Development Agency, CIDA).
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Introdução

O Projecto RMIS (Rede Moçambicana de Informação para Saúde), é um projecto que visa essencialmente informatizar o sistema de recolha de dados de Saúde usando Computadores de Mão, vulgo PDA.

Actualmente o projecto está implantado em cinco distritos, nomeadamente Chókwe, Manjacaze, Morrumbene, Nicoadala e Namacurra.

No presente “manual” mostramos como baixar os dados recolhidos nas unidades sanitárias da periferia das sedes distritais armazenados no computador servidor para o computador localizado na sede distrital de saúde, além da sincronização destes mesmos dados para a base de dados. E destina-se exclusivamente ao Ponto Focal que é o responsável do NEP no distrito.
Apresentação do aplicativo Core FTP Lite

O programa Core FTP Lite, é o aplicativo que usualmente será usado para descarregar, baixar, ou mesmo fazer download (baixar ou descarregar em inglês) os dados armazenados no computador central (Servidor) localizado no MISAU. Os dados armazenados no Servidor foram recolhidos através de PDAs e enviados para o Servidor através do Ponto de Acesso Africano (AAP).

Para aceder ao aplicativo Core FTP Lite, no desktop do seu computador, dê dois cliques consecutivos no ícone .

A apresentamos a seguir a janela principal e os botões que usará com muita frequência. Não apresentamos as funcionalidade de todos os botões porque o objectivo nosso, ao usarmos o aplicativo Core FTP Lite é de fazer o download de dados somente:

- Computador do distrito - esta é a área de trabalho do computador de distrito, aqui poderemos ver os ficheiro que baixaram para o computador do distrito. Podemos ver também se algum dado foi sincronizado com sucesso ou não.
- **Servidor** – esta é a área de trabalho do Servidor. Aqui podemos visualizar todos os dados do distrito que foram recolhidos nas unidades sanitárias através de PDA e enviados através dos AAP.

- **Botão Reconnect** – permite que o computador do distrito re-estabeleça a comunicação com o computador servidor após um corte de conexão.

- **Botão Disconnect** – permite que o computador do distrito corte a comunicação com o Servidor após executar as tarefas de download.

- **Botão Break** – interrompe a tarefa de download que está sendo executada pelo Core FTP Lite no momento.

- **Botão Refresh** – permite que na área de trabalho do Servidor, se execute uma tarefa que por qualquer eventualidade tenha sido congelado. Permite também a visualização do resultado após a execução da tarefa de HotSync. Este resultado pode ser de que a sincronização decorreu com sucesso ou não, na área de trabalho do computador do distrito. Mostraremos mais adiante como podemos concluir que a sincronização decorreu com sucesso ou não.

- **Botão Download** – executa a tarefa de download após a selecção do ficheiro a fazer download.

- **Botão Sair** – permite que se termine e se feche o aplicativo Core FTP Lite. Este botão deve ser pressionado somente se tiver terminado de realizar todas as tarefas.

**O processo de Download e sincronização de dados**
Após esta breve apresentação do aplicativo Core FTP Lite, a seguir mostraremos os passos a seguir para executar o download de dados e sincronização, desde o acesso ao aplicativo até a sincronização dos dados.

**Download de dados**

Siga os seguintes passos para fazer download de dados:

1º Passo: Aceda ao aplicativo Core FTP Lite clicando no ícone duas vez consecutivas ou através do botão Start – all programs – Core FTP – Core FTP Lite.

2º Passo: Na janela que se segue, selecione o nome do seu distrito e em seguida pressione o botão connect.

3º Passo: Aguarde até que a conexão com o Servidor esteja estabelecida. Como certeza de que a conexão foi estabelecida, verás na área de trabalho do Servidor as pastas.
4º Passo: Abra a pasta New, clicando duas vezes de forma rápida sobre ela.

5º Passo: Os ficheiros que contêm dados são os zipados e que contém Pdf como parte integrante do nome do ficheiro. Por exemplo: 000010009020_Pdf-MnhbA_76.zip. Selecione o ficheiro que quer fazer download dando um clique sobre ele.
6º Passo: Clique o botão Download. E aguarde até que o ficheiro selecionado passe para a área de trabalho do Computador do distrito. Conforme mostra a figura abaixo.

![Imagem do Core FTP Lite](image)

7º Passo: Assim o ficheiro ora baixado e estando na área de trabalho do computador do distrito, significa que já está pronto para ser sincronizado. Devido a performace e de modo a reduzir o número de falhas no acto da sincronização, aconselhamos que faça a sincronização ficheiro por ficheiro, isto é, após o download de um determinado ficheiro, execute a sincronização. Minimize (**não feche**) a janela do aplicativo Core FTP.

**Sincronização de dados**

Uma vez feito o download do ficheiro desejado, na área de trabalho do computador do distrito ele fica armazenado na pasta Working. Após a sincronização passam para a pasta complete. Não interessa aprofundar sobre essa passagem.

Entende-se como sincronização de dados, a passagem de dados o aplicativo Core FTP Lite para a base de dados.
Até o momento os dados ficarão na base de dados Pendragon (linguagem de desenho dos formulários) e futuramente, estes dados serão migrados para a base de dados Módulo Básico em uso em todos distritos.

Passemos então aos passos de sincronização de dados:

1º Passo: Suponhamos que queremos fazer sincronização do dados contidos no ficheiro [081011230360_Pdf-MinhD_56.zip].

2º Passo: Abra o ícone de nome disponível no desktop do seu monitor clicando duas vezes sobre ela. E aguarde até que o processo de hotSync inicialize. A seguinte janela será visualizada. Aguarde de modo a introduzir o utilizador por PDUp quando for solicitado.
3º Passo: Clique no círculo correspondente a select an existing user account. E em seguida clique no botão ok. Aguarde até que termine o processo de HotSync. O processo termina quando a janela seguinte fecha automaticamente.

4º Passo: Assim processo de HotSync está terminado. Te recordas que minimizaste a janela do aplicativo Core FTP Lite? Então, de modo a garantir que o processo terminou com sucesso, maximizamos a janela do aplicativo Core FTP Lite.
5º Passo: Clique uma vez no botão Refresh da área de trabalho do Computador do distrito. A pós isso, se não constar o ficheiro 081011230380_Pdf-MnhD_56.zip o qual fizemos a sincronização, significa que a sincronização decorreu com sucesso e os dados já estão na Base de dados Pendragon, prontos para serem visualizados como relatórios do distrito.
NOTA: Até aqui fizemos download e sincronização de somente alguns dados. Voltamos agora ao passo quinto passo (5º passo) de download de dados e continuamos com o processo de download e sincronização para cada ficheiro que contém dados.

6º Passo: Após a conclusão do processo de download e sincronização de todos os dados. De modo a fechar o aplicativo Core FTP Lite, clique no **Botão Disconnect** da área de trabalho do Servidor de modo a cortar a comunicação entre o Servidor e o Computador de Serviço. A seguinte mensagem aparecerá:

Clique o botão **Yes**.

7º Passo: Clique no **Botão Close**.
Ministério da Saúde (MISAU)

REDE MOÇAMBICANA DE INFORMAÇÃO PARA SÁUDE (RMIS)

O projecto RMIS é uma parceria da Academia para o Desenvolvimento Educacional (AED), MISAU e Ministério da Ciencia e Tecnologia.

MANUAL DE CONFIGURAÇÃO DO PDA E INSTALAÇÃO DE APLICATIVOS NOS PDAs (Destinado aos Pontos Focais Distritais)

Este trabalho foi realizado com a ajuda de fundos concedidos pelo Centro de Pesquisa para o Desenvolvimento Internacional em Ottawa, Canada (International Research Centre, IDRC).

As actividades do projecto foram realizadas com o apoio financeiro do Governo Canadiano através da Agencia Canadiana de Desenvolvimento Internacional (Canadian International Development Agency, CIDA).

Projecto da AED Número: 3746-01
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Introdução

O projecto RMIS (Rede Moçambicana de Informação de Saúde), é um projecto do Ministério da Saúde (MISAU) em parceria com o Ministério da Ciência e Tecnologia (MCT) e a Academia para o Desenvolvimento Educacional (AED-SATELLIFE), financiado pelo Centro de Pesquisa para o Desenvolvimento Internacional (IDRC) que, pretende equipar o MISAU a vários níveis, com ferramentas de recolha e transmissão de dados para a melhoria do sistema de Informação para a Saúde. Este projecto consistirá na utilização de PDA’s e AAP’s.

Na presente brochura iremos mostrar como configurar o PDA de modo a permitir que este possa enviar e receber emails. E esta brochura é destinada aos Pontos Focais do Projecto RMIS nos distritos contemplados pelo mesmo.
Configuração do PDA e do Versamail para o envio de emails

Entende-se por configurar o PDA como prepará-lo de modo a poder desempenhar ou executar uma determinada acção.
Versamail é o aplicativo que permite a recepção e o envio de mensagens electrónicas (emails) usando o PDA.
Mostaremos em seguida, como configurar o PDA e o aplicativo Versamail de modo que possa receber e enviar email.

Configuração do PDA

A seguir os passos de configuração do PDA:

1º HotSync

Aceda ao HotSync através do seu respectivo ícone visível no seu visor.

- Pressione em “Local”, oposto ao Modem (localizado acima do botão de HotSync no visor);
- A baixo do botão de HotSync, através do sinal de seta para baixo, pressione nela e seleccione o método “IR to a PC/Handheld”; 
- Verifique o nome localizado no canto superior direito e grave na mente ou em papel.

➢ LANSync Prefs

- Na página do “HotSync”, aceda a barra de menu pressionando em HotSync no canto superior esquerdo;
- Selecione “LAN Sync Prefs”;
- Pressione em "LAN Sync" localizado no lado oposto de “Local HotSync”;
- Volte para casa.

2º Prefs

Uma vez estando em casa, pressione no ícone “Pref”.

➢ Pref – Conexão

- Na página do Prefs, selecione “Comunicação” – “Conexão”;
- Na página seguinte, selecione “IR para PC/Comp.mão”;
- Pressione Ok.

➢ Pref – Rede

- De modo a configurar PPP, selecione “Comunicação” – “Rede”;
  - Serviço: pressione a seta do lado esquerdo da palavra serviço, listará um conjunto de serviços. Selecione “Unix”;
  - Usuário: introduza o nome ora gravado no canto superior direito da página do HotSync;
  - Senha: Introduza a senha, que usualmente coincide com o nome introduzido acima;
  - Conexão: através de seta, selecione “IR para PC/Comp.mão”;
  - Pressione o botão Detalhes e na página seguinte:
    - **Tipo de conexão**: através da seta, selecione PPP;
    - **Tempo limite**: se não estiver em 1 minuto, através da seta, selecione 1 minuto;
    - **Consultar DNS**: por defeito, já aparece com um certinho no quadrinhinho, mas se não aparecer, pressione o quadrinhinho de modo a aparecer;
Endereço IP: por defeito, já aparece com um certinho no quadradinho, mas se não aparecer, pressione o quadradinho de modo a aparecer;

- Pressione o botão Script…: se houver alguma especificação do script, logo na primeira seta que encontrares, pressione nela e selecione Fim.
- Pressione ok;
- Pressione ok;
- Pressione ok;
- Volte para casa.

Configuração do Versamail

Uma vez estando em casa, aceda ao aplicativo Versamail.

- Pressione a barra de menu, no canto superior esquerdo
  - Seleccione “Accounts”;
  - Seleccione “Account Setup”;
  - Na página seguinte, seleccione o “Versamail”;
  - Pressione o botão “Edit…”;
    - Account Name: por defeito aparece Versamail;
    - Mail Service: pressione a seta e selecione “Other”;
    - Protocol: pressione a seta e selecione “POP”;
    - Synchronize Only Account: por defeito aparece sem o certinho;
- Pressione “Next”
  - Username & Password:
    - Username: introduza o nome gravado no canto superior direito da página do HotSync;
    - Password: introduza outra vez o nome introduzido acima;
- Pressione “Next”
  - Email Address: a seguir ao sinal “@” acrescente “rmis.org.mz”;
  - Incoming Mail Server: introduza “192.168.1.1” (sem aspa);
**Outgoing Mail Server:** introduza “192.168.1.1” (sem aspas);
- Pressione “Next”
- Pressione “Next”
  - **Delete messages on the server when they are deleted in Versamail:** pressione o quadrinho correspondente de modo que este tenha o certinho;
  - **Leave mail on server (e.g. to view on desktop later.):** pressionando no quadrinho correspondente, retire o certinho de modo que o quadrinho esteja vazio.
- **Maximum Message Size:** introduza 2048. Este é o limite máximo de uma mensagem permitido pelo PDA.
  - Pressione “Next”
  - Pressione “Next”
  - Pressione “Next”
  - Pressione “Done”

Deste modo o PDA, já está configurado para poder enviar e receber emails.

**Sincronização directa no PC**

A sincronização directa no PC, para além de permitir a transferência de dados do PDA para a base de dados PenDragon, ela permite que vídeos, fotos, contactos e outros sejam transferidos para o PC. Além disso, faz uma cópia de toda informação contida no PDA para o computador.

Este modo de transferência de dados é somente permitido aos pontos focais nas sedes distritais, e deverá ser feito em caso de a rede não estiver a funcionar perfeitamente, ou seja, em caso de não ser possível transmitir os dados através do AAP.

Em seguida mostraremos como fazer a sincronização.

**1º Passo:**
Conecte o cabo de sincronização contido no conjunto de acessórios disponível na caixa do seu PDA (veja o cabo abaixo). A parte USB conecte numa porta USB do computador, e a outra parte que contém botão, conecte no PDA.

2º Passo: Uma vez conectado o cabo no computador e no PDA, conforme mostra a figura, pressione o botão contido no cabo. O processo de sincronização iniciará. Ou,

Estando na página inicial do seu PDA (em casa), aceda ao HotSync. Certifique se o modo de comunicação é via Base/Cabo. Feito isto, pressione o botão de sincronização. Assim o processo começa:

3º Passo: Terminado o processo, a seguinte mensagem aparecerá:

Pressione em Ok.
Instalação de aplicativo .prc no PDA

Os aplicativos .prc são aplicativos aceitáveis e executados em PDAs. Para o caso de nossos PDAs temos os seguintes aplicativos .prc: BeamPro, os nossos formulários, Mobipocket, e mais.
O principal aplicativo para a instalação dos aplicativos .prc num PDA, é o aplicativo PalmOne Quick Install disponível em todos os computadores distritais. Mostraremos a seguir, como instalar um aplicativo .prc.

1º Aceda o aplicativo PalmOne Quick Install, indo primeiramente ao botão start do seu computador, pressione em all programs, em seguida, pressione em PalmOne, e finalmente pressione em PalmOne Quick Install. A seguinte janela aparecerá.
Pressione no User conforme mostra a seta acima e selecione o nome do PDA no qual deseja instalar o aplicativo. Para o nosso caso queremos instalar no PDA RMIS082.

2º Vá até onde se encontra o ficheiro .prc de instalação do aplicativo desejado. Para o nosso exemplo, mostraremos usando o aplicativo mobireader.prc. Clique duas vezes consecutivas por cima do ficheiro mobireader.prc. O ficheiro irá automaticamente para o programa PalmOne Quick Install conforme mostra a figura seguinte:

3º Execute a operação de Hotsync usando o PDA onde quer instalar o aplicativo. Para o nosso caso usamos o PDA RMIS082. No final da operação do HotSync, pressione no botão ok.
Assim, o aplicativo mobireader.prc já está instalado no PDA. Para certificação, na janela principal do seu PDA, procure o ícone **Mobipocket**, que é o ícone do aplicativo instalado.

O mesmo procedimento usa-se para instalar o aplicativo BeamPro e todos os outros com extensão .prc.
### Suporte técnico

<table>
<thead>
<tr>
<th>Contactos para assistência técnica:</th>
<th>RMIS</th>
</tr>
</thead>
<tbody>
<tr>
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<td></td>
</tr>
<tr>
<td>Fixo: 21418712</td>
<td></td>
</tr>
<tr>
<td>Fax: 21418712</td>
<td></td>
</tr>
<tr>
<td>Email: <a href="mailto:rmis082@rmis.org.mz">rmis082@rmis.org.mz</a></td>
<td></td>
</tr>
</tbody>
</table>

| Telefone ao supervisor do Distrito | Qualquer funcionário treinado para fazer supervisão a nível do Distrito |
MINISTÉRIO DA SAÚDE (MISAU)

REDE MOÇAMBICANA DE INFORMAÇAO PARA SÁUDE (RMIS)

O projecto RMIS é uma parceria da Academia para o Desenvolvimento Educacional (AED), MISAU e Ministério da Ciencia e Tecnologia.

MANUAL DO UTILIZADOR DO PDA
(Destinado aos técnicos de saúde)

Academy for Educational Development
Connecting People • Creating Change

Projecto da AED Número: 3746-01

Este trabalho foi realizado com a ajuda de fundos concedidos pelo Centro de Pesquisa para o Desenvolvimento Internacional em Ottawa, Canadá (International Research Centre, IDRC).

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Introdução

O projecto RMIS (Rede Moçambicana de Informação de Saúde), é um projecto do Ministério da Saúde (MISAU) em parceria com o Ministério da Ciência e Tecnologia (MCT) e a Academia para o Desenvolvimento Educacional (AED-SATELLIFE), financiado pelo Centro de Pesquisa para o Desenvolvimento Internacional (IDRC) que, pretende equipar o MISAU a vários níveis, com ferramentas de recolha e transmissão de dados para a melhoria do sistema de Informação para a Saúde. Este projecto consiste na utilização de PDA’s e Pontos de Acesso Africano (AAP).

PDAs também são conhecidos como Computadores de Bolso ou Computadores de Mão. Os PDA’s têm várias utilidades: como calculadora, relógio, calendário, contém jogos para diversão, acesso a Internet (para envio e/ou recepção de E-mails). Estes possuem uma tela de cor e capacidades de áudio, podendo ainda, serem usados para visualizar e ou armazenar vídeos e fotografias, servindo ainda como um rádio ou aparelho de som.
Familiarizando-se com o PDA

Informação detalhada sobre o uso e cuidados a ter com o PDA, poderás encontrar no catálogo que vem como acessório na caixa do PDA. Aconselhamos que leia cuidadosamente o catálogo. Este manual dá informação básica de que precisas para preencheres alguns formulários de saúde.

Recomendamos que leia este manual com o PDA na mão e verás que ele é protegido com uma cobertura plástica.

- **Visor, Ecrã ou Tela de toque** – permite a visualização das aplicações e da informação contida no PDA. Este visor é sensível ao toque;

- **Stylus** – É um utensílio de escrita, semelhante a uma caneta ou esferográfica moderna. Permite inserir informações no PDA. A interacção é feita ao pressionar-se sobre o visor (ecrã), para activar botões ou fazer escolhas de menu, usar um teclado virtual, onde teclado é mostrado na tela de toque. Para usar o stylus, remova-o do orifício e segure-o como se fosse uma caneta ou um lápis. Pode-se usar a ponta do dedo no lugar do stylus, mas não use a unha, uma caneta real ou qualquer outro objecto pontiagudo para tocar na tela. Sempre se deve repor o Stylus no orifício de onde o retirou depois ser utilizado, pois este pode ser facilmente perdido.

- **Botão de ligar/desligar (Botão de energia)** – Este botão serve para ligar e/ou desligar o PDA e ainda desbloquear a tela (caso a função esteja activada). Tem uma linha verde sobre ela. O PDA funciona com base numa bateria recarregável, por isso aconselhamos a desligar o PDA imediatamente após o uso para evitar a perda de carga.
Mais para a parte inferior do visor encontra quatro figuras circulares, uma de casa que é a primeira vista do visor do PDA, a lista de menus, a estrela para sincronização ou Hot Sync e mais a lupa para localizar algo no PDA.

Existem outros botões adicionais na parte mais inferior do PDA da esquerda para a direita, shortcut para o calendário, contactos, tarefas e notas. Vais-te familiarizar com estas e mais funções do PDA através de práticas. É preciso praticar sempre para ter domínio do PDA.

Inicalizando o PDA

Sempre que inicializas o PDA, há que considerar os passos seguintes: abrir a cobertura, ligar através do botão ligar/desligar e retirar o Stylus. Quando ligas o PDA, verificarás no visor alguns ícones ou figuras, esta vista é chamada de casa. Cada ícone representa uma função que pode ser executada no PDA, incluindo a calculadora, calendário e uma lista de tarefas.

Fichas inseridas no PDA

Numa primeira fase as fichas convertidas ao formato electrónico são apenas algumas do SIS (Sistema de Informação para Saúde - MISAU), tendo estes sido agrupados por categoria, como se pode ver referidos abaixo:

**Mod. SIS A**
- A01 – Registo Diário do PAV – BCG/PÓLIO/DTP/SARAMPO
- A02 – Registo Diário do PAV – VACINA ANTI-TETÂNICA
- A03-A – Resumo Mensal PAV-BCG, DTP –HepB, Pólio e Sarampo
- A03-B – Resumo do PAV - VAT

**Mod. SIS B**
- B01 – Livro de Registo da Maternidade
- B02 – SMI – Registo das Consultas Pré-Natais/Pos-Parto / PF
- B03 – SMI – Registo das Consultas 0-4 Anos/Vigilâncias Nutricional 0-35 Meses
- B04 – Resumo Mensal de SMI/Vigilância Nutricional para Unidades Sanitárias

**Mod. SIS C**
- C01 – Livro de Registos de Consultas Externas
- C02 – Ficha de Contagem de Novos Casos de Doenças de Notificação Obrigatória
- C04 – PME – Resumo Mensal de Consultas Externas e do Stock Medicamentos de Kit A – Posto de Saúde
• C05 - PME - Resumo Mensal de Consultas Externas e do Stock de Medicamentos de Kit B – Centro de Saúde.

Mod. SIS D
• D01 - Livro de Registos de Internamentos
• D02 - Livro de Registos de Internamentos Cirúrgico

Mod. SIS H
• H01: Recepção do Hospital Dia
• H02: Consultas do Hospital de Dia
• H04: Movimentos (Resumo mensal)
• H04: Subcategoria de doentes no HDD (Resumo Mensal)
• H04: TARV

Modo de preenchimento

Notas importante:

➢ Em todos os campos a vermelho, o preenchimento é de carácter obrigatório, pois, caso não preencha, não poderá seguir à página seguinte.

➢ Os campos escritos as Verde os valores são calculados automaticamente, isto é, não precisa se preocupar em preencher.

➢ Em todas as fichas que correspondam a resumos, é necessário ter bastante atenção, de forma a ter resultados correctos; os campos Distrito, Unidade Sanitária, Mês e Ano devem corresponder exactamente aos mesmos das Fichas que os alimentam.

➢ Os botões Fim, Anterior e Seguinte, tem como significado respectivamente, Fim (ao clicar neste botão estará a terminar com o preenchimento da ficha), Anterior (ao clicar neste botão estará a voltar a página precedente, o que normalmente se faz quando se pretende fazer algum tipo de correção) e Seguinte (ao clicar neste botão estará a prosseguir com o preenchimento para a página seguinte).

➢ Nunca podem existir duas Fichas com a mesma data, isto é, não pode existir uma Ficha com o mesmo Mês, Ano, e Semana (no caso dos registos diário), e mesmo Mês e Ano (no caso dos resumos mensais); caso isso aconteça receberá sempre uma mensagem de erro. Sempre que quiser editar, reescrever ou corrigir um registo, deverá clicar no Botão Rever, como será explicado a diante.
Passos a seguir para o preenchimento

1º Usando seu Stylus, aceda a ficha desejada indo até a tela inicial, pressione em , a seguir pressione no ícone do modelo da ficha desejada, sendo os modelos representados como mostra a imagem destacada na figura 1.

![Fig. 1 Acessando à ficha](image)

2º Uma vez selecionado o modelo desejado, terá acesso a todas as fichas desse modelo usado nas unidades sanitárias. Usando o stylus, selecione a ficha desejada e sobre ela aparecerá uma barra azul como mostra a figura 2. Em seguida pressione no botão **Novo** que se encontra na parte inferior esquerda do visor. O que significa que está a criar um novo registo.

![Fig. 2 Barra azul na ficha selecionada](image)

3º A página (fig.3) que aparece corresponde a descrição da ficha, para aceder a página seguinte, pressione em **Seguinte**.

![Fig. 3 Descrição da ficha](image)

4º A seguir temos os campos cujo preenchimento é de carácter obrigatório, o nome do distrito e da unidade sanitária. Através do botão **Procurar** terás acesso a lista dos distritos onde escolherás o distrito desejado. O mesmo processo é feito para o nome
da unidade sanitária. Em seguida, pressione em **Seguinte** para ter acesso a páginas seguintes.

5º Nos campos mês e ano, os dados devem ser introduzidos a partir do teclado numérico que já se encontra disponível no visor. Para preencher **Semana de**, e para **A**, deve pressionar respectivamente em **-Acertar data-**. Aparecerá um calendário onde poderá pressionar em **Hoje** se for a data corrente, ou deverá escolher o ano pressionando na seta da esquerda para o ano anterior ou na seta da direita para o ano seguinte. No que respeita ao mês, escolha na tabela o mês pretendido e o dia correspondente. Em seguida pressionar em **Seguinte/Next**.

6º Sempre que um paciente é atendido que vá ser administrado uma determinada vacina, se escolherá a vacina a administrar (podendo ser BCG, Pólio primário, Pólio 1ª, etc.). Para escolher a vacina a administrar pressione no botão **Anterior/Seguinte**. Logo que encontrada a vacina desejada, poderá escolher a faixa etária (**0-11 meses** ou **12 meses e +**). Em seguida pressione no botão **Adicionar**, na página seguinte pressione o botão **Registrar**. Uma vez vacinada, pressione respectivamente no botão **Seguinte** e **Fim**. Aparecerá em seguida uma caixa de texto com a seguinte mensagem “**Excluindo este registo**” onde deverá pressionar no botão **Ok**. Aparecerá no visor uma nova página que estará registada a hora da vacinação, onde deverá pressionar no botão **terminado** para retornar a página inicial de onde poderá escolher as novas vacinas a administrar.

Caso pretenda continuar a registar a mesma vacina, pressione no botão **Adicionar** e prossiga com o processo acima descrito.
7º O **número de doses nos frascos abertos** para cada vacina deve ser introduzido através do teclado numérico visível no visor, o **Nº de Doses Aplicadas** e o **Nº de Doses Desperdiçadas** são gerados automaticamente. Não se preocupe com o resultado que visualiza logo a primeira. O resultado que será guardado é o correcto. Exemplo: Para o caso do A01, devemos introduzir manualmente o número de doses nos frascos abertos para uma determinada vacina, em seguida teremos automaticamente o número de doses desperdiçadas.

8º Em alguns campos a introdução de dados é por escolha (**sim** ou **não**), que se deve escolher pressionando sobre o quadradinho que se encontra ao lado da opção desejada.

9º Em casos de campos com perguntas abertas (cuja resposta é necessária escrever), abre-se o teclado virtual pressionando nas letras ABC que se encontra no canto inferior esquerdo da área de escrita do PDA.
Revisão e correção de dados

Em princípio todas as fichas podem ser revistas e actualizadas. Em seguida será descrito o modo de proceder para cada caso.

1º Para aceder a ficha desejada, vá a tela inicial pressionando em , e pressione o ícone do modelo da ficha desejada (podendo ser MOD. SIS A, Mod. SIS B, Mod. SIS C ou Mod. SIS D).

2º Selecione a ficha desejada, sobre ela aparecerá uma barra azul (como mostra a figura 5). A seguir pressione no botão Rever que se encontra na área inferior (entre o botão Novo e Excluir…) do visor. Na página a seguir, escolha o registo que pretende rever. Depois de rever, vai pressionando os botões Seguinte e vai alterando onde achar necessário.

3º Para corrigir qualquer dado, aceda a ficha desejada seguindo os passos partindo do modelo da ficha como anteriormente explicamos, pressionar no botão Rever, e ir seguindo na ficha até onde deseja alterar e introduzindo novo registo. Como pode ver na figura abaixo, se desejar alterar a hora, pressione apenas sobre o rectângulo da que se refere a hora. O mesmo procedimento é válido para a data ou para qualquer outro campo da ficha.
Apagando um registo

1º Para apagar um registo completo da ficha, correspondente a uma semana ou mês (em caso de resumo mensal) deve proceder do mesmo modo para aceder a ficha desejada como vimos anteriormente. Contudo, desta vez terá que pressionar no botão **Excluir** localizado na parte inferior direita do visor, na página seguinte escolher o registo desejado, em seguida pressionar em **Delele/Excluir** situado do lado direito do botão **Record/Registo**. Uma mensagem com o texto “Excluindo este registo” aparecerá. Pressione em **OK** se desejar apagar e, **Cancel** se decidir não apagar.

2º Se desejar apagar algum registo das sub-fichas (como é o caso das vacinas) prossegue-se do seguinte modo:

- Primeiramente deve chegar na vacina desejada (BCG, Pólio primário, etc...);
- Escolha o grupo etário (*0 – 11 meses ou 12 meses e mais*) cujo registo pretende apagar;
- Escolha a hora do registo que lhe levará à página correspondente ao registo. Pressione o botão de **Menu** – pressionando na Barra Azul que se encontra na parte superior esquerda do visor, ou use o botão do **Menu** que se encontra na área de escrita do **PDA**;
- Ao aceder ao **Menu**, pressione em **Record**;
- Escolha a opção **Delete/Cancel**;
- Pressione em **Yes**, e assim terá o registo apagado;
- Para finalizar pressione em **Done**.

11
Ponto de Acesso Afiricano ou African Access Point (AAP)

Ponto de Acesso Africano ou mesmo African Access Point (em inglês), é um dispositivo usado para transmitir dados através de um cartão GSM. PDAs e outros telemóveis podem conectar-se ao AAP via Infra Vermelho (Infra Red), Wireless, Bluetooth (que não se encontra activo nesta versão que estamos a usar). Mais documentos sobre AAP pode ser encontrado em http://wiki.openwrt.org/.

Para o nosso caso, o AAP será usado para transmitir os dados recolhidos nas unidades sanitárias através do PDA e emails. Os dados ora recolhidos, são transmitidos para o AAP como será mostrado a seguir, via Infra Vermelho. De acordo com o horário estabelecido, o AAP efectua chamadas de transmissão de dados ao computador servidor localizado no MISAU onde todos dados recolhidos nas unidades sanitárias são armazenados.

Como enviar os dados para o African Access Point (AAP)?

O envio de dados para o Servidor é feito através do African Access Point (AAP) conforme foi dito anteriormente. Numa primeira fase iremos mostrar como configurar o seu PDA para poder enviar dados.

Passos de configuração do BeamPro

1º Usando seu Stylus, vá a janela inicial pressionando em , a seguir aceda ao aplicativo BeamPRO seleccionando o ícone relativo BeamPRO.
1º Usando seu Stylus, vá a janela inicial pressionando em , a seguir aceda ao aplicativo BeamPRO selecionando o ícone relativo BeamPRO.

2º No canto superior direito, pressione a seta localizada ao lado da palavra All, e selecione Creator ID Filter. Uma mensagem contendo Only show this Creator ID aparecerá. Pressione a seta localizado abaixo desta mensagem, e selecione MmhA. Em seguida clique no botão Ok. Assim serão visualizados todos os ficheiros do Mod. SIS A.

3º Assim, clique na barra de menu BeamPRO e selecione a opção Select All.

4º Através do botão de navegação, vá até a parte inferior do visor do PDA. Através da caneta, tire os certinhos nos quadradinhas correspondentes aos ficheiros com a denominações Mod.SIS A e Mod.SIS A_ptBR.

5º Uma vez selecionados todos os ficheiros, posicione o PDA de modo que a Porta de Infra-Vermelho esteja frente a frente com a porta de Infra-Vermelho do AAP, de tal forma que a distância que separa o AAP e o PDA não seja superior a 1 metro, conforme mostra a figura abaixo. E aguarde pelo sinal de reconhecimento do PDA no painel do AAP.

Assim, enquanto não se mudarem estas configurações, o PDA já está pronto para poder enviar dados para o AAP. A seguir mostraremos os passos de selecção e envio de dados.

Enviando dados

Aqui mostraremos como enviar os dados das fichas dos modelos Mod. SIS A, Mod. SIS B, Mod. SIS C e Mod. SIS D. Para cada modelo de ficha, os ficheiros relativos tem respectivamente a terminologia MmhA, MmhB, MmhC e MmhD. Enviamos todos os ficheiros de um modelo por cada vez. Vejamos a seguir os passos:

2º Na página seguinte, na parte inferior, ao lado do botão Send, pressione na seta virada para baixo ao lado da palavra “To” e escolha Other.

3º Mais para o lado direito, ao lado da palavra “VIA”, pressione na seta virada para baixo e selecione Infrared.

Assim, enquanto não se mudarem estas configurações, o PDA já está pronto para poder enviar dados para o AAP. A seguir mostraremos os passos de selecção e envio de dados.
Após o reconhecimento do seu PDA, uma mensagem contendo o texto **“Beam Content or Sync mail now”** aparecerá na parte inferior do visor do AAP. Assim já podes enviar os ficheiros. Clica o botão **Send** do BeamPro, localizado canto inferior esquerdo do visor.

Uma vez clicado no botão Send, as seguintes mensagens aparecerão consecutivamente no visor do seu PDA: **“Preparando: Selected Files”**, **“Pesquisando...”**, **“Enviando: Selected Files”** respectivamente. Aguarde até que a mensagem **“Enviando: Selected files”** desapareça do seu visor, e o mapa de África reapareça no visor do AAP.

Siga os mesmos passos para enviar os outros ficheiros (M mhB, M mhC e M mhD).

### Recebendo Conteúdos do AAP

#### Modo de envio e recepção de Emails

O Versamail é o aplicativo que é usado nos PDA’s para o envio de emails. Através do email podes enviar textos sem limitação do número de caracteres receber outros emails contendo alguns anexos (attachment). Estes anexos podem ser música, outros documentos, imagens, vídeos, etc.

**Enviando um email**

1º Usando seu Stylus, aceda ao aplicativo Versamail indo até a tela inicial pressione em , a seguir pressione no ícone do aplicativo.

2º Em seguida pressione o botão **New**. Na parte superior esquerda do visor, em **To**, introduza o endereço do email do destinatário, ex: rmis182@rmis.gov.mz, ou exemplo@gmail.com, e em **Subj** que significa assunto, introduza o assunto do conteúdo da sua mensagem. Não se esqueça que para introduzir um texto alfanumérico, é necessário introduzir o teclado através de **ABC** e **123** localizado na parte inferior do visor. Para escrever a mensagem do email, posicione o cursor na parte imediatamente inferior a **Subj** no visor e através do teclado alfanumérico, introduza o seu texto.

3º Uma vez terminada a introdução do texto da mensagem, posicione o PDA de modo que a Porta de Infra-Vermelho esteja frente a frente com a porta de Infra-Vermelho do AAP, de tal forma que a distância que separa o AAP e o PDA não seja superior a 1 metro. E aguarde pelo sinal de reconhecimento do PDA no painel do AAP. Em seguida pressione o botão **Send**. O envio é inicializado e as seguintes mensagens aparecerão
consecutivamente: “Connecting to ISP…”, “Iniciando a Sessão”, “Estabelecido”, “Connecting to Mail Server”, “connecting to SMTP Server” respectivamente. Aguarde até que esta última mensagem despareça do visor do seu PDA e o mapa de África reapareça no visor do AAP.

Recebendo um email

1º Usando seu Stylus, aceda ao aplicativo VersaMail indo até a tela inicial pressione em , a seguir pressione no ícone do aplicativo.

2º Na página que aparece, tens três botões (New, Get Mail e Display), pressione Get Mail. Em seguida aparecerá a janela cujo cabeçalho é Get Mail Option.

3º Se a opção Messages não estiver seleccionada, selecione esta opção Messages na parte imediatamente inferior ao cabeçalho.

4º Posicione o PDA como foste ensinado para o envio de dados no AAP, de forma que a porta de Infra-vermelho do PDA esteja frente a frente, não a uma distância superior a 1 metro do AAP. Em seguida pressione o botão OK. O andamento da sessão é inicializada e as seguintes mensagens serão visualizadas consecutivamente no visor do seu PDA: “Connecting to ISP…”, “Iniciando a Sessão”, “Estabelecido”, “Connecting to Mail Server”, “connecting to SMTP Server” respectivamente. Se tiveres alguma mensagem, a seguinte mensagem será visualizada no seu PDA: “You have # new messages”, onde # é o numero de mensagens nova que recebeste. Se não houver nenhuma mensagem, será visualizada a seguinte mensagem no visor do seu PDA: “No new messages”.

5º Para visualizares (leres) um email, no visor do VersaMail, selecione o email que desejás ler, e em seguida ele abrirá dando-te a possibilidade de leres. E em seguida pressione o botão Ok.

Solução de alguns problemas comuns

Muitas vezes, para a solução de problemas do PDA, recorremos a reinicialização do PDA. A seguir mostraremos duas formas de reinicializar o PDA, o Soft RESET e o Hard Reset.

Execução de uma reinicialização a quente (Soft RESET)
Para executar uma reinicialização a quente:
Use a ponta do stylus ou um clipe de papel desdobrado (ou objecto semelhante não pontiagudo) para pressionar cuidadosamente o botão de reinicialização (RESET) no orifício localizado no painel posterior do PDA.
Execução de uma reinicialização a frio (Hard RESET)

Na reinicialização a frio, todos os registos e entradas do PDA são apagados. Até mesmo alguns aplicativos instalados, tal é o caso dos Formulários que usualmente usamos para colecta de dados na unidade sanitária, BeamPro, Versamail, Jogos e mais.
Só execute uma reinicialização a frio se a reinicialização a quente não solucionar o problema.

Para executar uma reinicialização a frio:
1. Manter pressionado o botão ligar/desligar (Power) do PDA.
2. Em simultâneo que mantén o botão de ligar/desligar pressionado, use a ponta do stylus ou um clipe de papel desdobrado (ou objecto semelhante não pontiagudo) para pressionar cuidadosamente, durante pelo menos 5 segundos. Solte o botão de reinicialização (RESET).
3. Aguarde até ver o logotipo Palm Powered™; em seguida, solte o botão de energia.
5. Quando uma mensagem for exibida na tela do PDA avisando que todos os dados nele armazenados serão apagados, siga um destes procedimentos:
   – Pressione a seta para cima no navegador para concluir a reinicialização a frio e exibir a tela Digitalizador.
   – Pressione qualquer outro botão para executar uma reinicialização a quente.

Obs: Na reinicialização a frio, a data e a hora actuais serão mantidas. As preferências de formatos e outras configurações serão restauradas segundo as configurações padrão de fábrica.

1. Não se vê nada na tela do PDA
   - Pressione um botão de aplicativo para verificar se o PDA está ligado;
   - Carregue o PDA;
   - Execute uma reinicialização a quente. Se, mesmo assim, o PDA não ligar, execute uma reinicialização a frio.

2. O PDA congelou (Encravou / Não reage)
   - Se uma conexão de rede tiver sido encerrada inadequadamente, o PDA poderá parecer congelado por até 30 segundos. Se ela permanecer congelada após 30 segundos, execute uma reinicialização a frio.

3. Quando se pressiona nos botões ou nos ícones da tela, o PDA activa o recurso errado
   - Vá a Pref e a seguir clique em Tela de Toque, e depois, cuidadosamente, calibre o ecrã clicando pressionando com o ponta do stylus no ponto central das espirais que aparecerem na tela.

4. O ecrã do PDA não acende ao ligar-se o Botão de ligar/desligar o PDA
- Conecte o PDA ao carregador para carregar por pelo menos 3 horas, e tente ligar novamente.

5. O PDA não emite nenhum som
   - Verifique as configurações de som do sistema, do alarme e dos jogos.

6. Toquei no botão ‘Hoje’, mas ele não mostra a data correcta
   - O PDA não está definido para a data actual. Verifique se a caixa Definir data na tela Preferências – Data e hora exibe a data actual.

7. Não consigo realizar uma operação de HotSync
   - Verifique se a base/cabo do HotSync está conectado correctamente.

7.1 Não consigo executar uma operação de HotSync por infravermelho
   - Verifique se a porta de infravermelho do computador de mão está alinhada directamente à frente, e afastada alguns centímetros, do dispositivo de infravermelho do dispositivo com que se pretende comunicar.
   - As operações de HotSync por infravermelho não funcionam depois que for emitido um aviso de bateria fraca. Verifique a carga da bateria do PDA. Recarregue a bateria interna.

8. Não consigo transferir dados para outro dispositivo com porta de infravermelho
   - Se a transferência estiver sendo feita para outro PDA Palm, verifique se a distância entre os aparelhos se situa entre dez centímetros e um metro e se o espaço entre eles está livre de obstáculos. A distância de transferência para outros dispositivos com porta de infravermelho pode ser diferente. Aproxime o PDA do dispositivo de recebimento.
   - Certifique-se as configurações do BeamPro estão correctas, se a via de transmissão é Infrared e se é To Other.

   - Certifique-se de que a comunicação Bluetooth está activada tanto no PDA quanto no outro dispositivo.
   - Certifique-se de que o dispositivo de recebimento tem um aplicativo instalado compatível activado para Bluetooth.
Conclusão

Para melhor ter domínio do seu PDA, suas funcionalidades e outras aplicações é necessário que pratique sempre. Não só podes usar o seu PDA para preencher os formulários integrados nele ou que aprendeste durante a formação, podes usar também para cálculos através da calculadora, podes fazer anotações, e programas para que o PDA te recorde ou na hora ou mesmo dias antes da data prevista.

Em caso de dúvida, no seu distrito estará sempre um supervisor formado para o efeito o qual poderás contacta-lo. Futuramente teremos uma linha verde a qual poderás contactar em caso de qualquer dúvida.

Recomendamos que carregue o seu PDA todos os dias no final do dia ou mesmo a noite durante 15 a 30 minutos, digo todos os dias. Não espere que o PDA não tenha carga para poder recarregar.

Aconselhamos que em caso de perda do Stylus, uso o dedo seco ou mesmo esferográfica mas sem a ponta pontiaguda. Para limpeza do visor do seu PDA, uso um pano macio e não deixe o seu aparelho em locais empoeirados.

Para terminar, faça bom proveito do seu PDA, nós aguardamos pelos dados por vós enviados no final de cada mês e regularmente voltaremos para supervisionar.
### Suporte técnico

<table>
<thead>
<tr>
<th>Contactos para assistência técnica:</th>
<th>RMIS 820418712 <a href="mailto:rmis082@rmis.org.mz">rmis082@rmis.org.mz</a></th>
</tr>
</thead>
<tbody>
<tr>
<td>Telefone ao supervisor do Distrito</td>
<td>Qualquer funcionário treinado para fazer supervisão a nível do Distrito</td>
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</tbody>
</table>
Étude de cas: le Réseau du Mozambique d’informations sur la santé (RMIS)

Henk Boshoff, S-Curve Technologies (Afrique du Sud)
Victorino Nhabangue, AED-RMIS (Mozambique)
Berhane Gebru, AED-SATELLIFE (États-Unis)

L’étude de cas du RMIS a été choisie pour cette trousse de ressources car celui-ci illustre comment certains points sont essentiels pour faire évoluer un prototype au stade de projet pilote, et finalement aboutir à un déploiement durable :

1) L’application d’une solution technologique innovante et abordable qui utilise les réseaux mobiles et des assistants personnels numériques (PDA) avec des personnes peu familiarisées avec les TIC, dans le cas présent le personnel médical, souvent relativement âgé et opposant donc plus de résistance envers l’adoption des nouvelles technologies.

2) Un engagement du gouvernement envers l’offre de meilleurs services pour les communautés, tout en tirant profit de la disponibilité de données médicales plus fiables provenant du terrain.

3) Des économies et une productivité accrue en termes de collecte de données dans les districts, avec notamment un suivi utilisant un système de collecte de données numérique plutôt que sur papier.

4) La généralisation graduelle d’un projet de développement grâce à un partenariat entre une ONG (AED-Satellite) et le ministère de la Santé du Mozambique.
Des réseaux de mobiles pour un échange de données à bas coût : le Réseau du Mozambique d'informations sur la santé (RMIS)

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L’étude de cas du RMIS a été choisie pour cette trousse de ressources car celui-ci illustre comment certains points sont essentiels pour faire évoluer un prototype au stade de projet pilote, et finalement aboutir à un déploiement durable :

1) L’application d’une solution technologique innovante et abordable qui utilise les réseaux mobiles et des assistants personnels numériques (PDA) avec des personnes peu familiarisées avec les TIC, dans le cas présent le personnel médical, souvent relativement âgé et opposant donc plus de résistance envers l’adoption des nouvelles technologies.

2) Un engagement du gouvernement envers l’offre de meilleurs services pour les communautés, tout en tirant profit de la disponibilité de données médicales plus fiables provenant du terrain.

3) Des économies et une productivité accrue en termes de collecte de données dans les districts, avec notamment un suivi utilisant un système de collecte de données numérique plutôt que sur papier.

4) La généralisation graduelle d’un projet de développement grâce à un partenariat entre une ONG (AED-Satellife) et le ministère de la Santé du Mozambique.

Origines et contexte


Tableau 1 : Sélection de statistiques médicales pour 2005

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
</tr>
</thead>
<tbody>
<tr>
<td>Docteurs par habitants</td>
<td>1/22 000</td>
</tr>
<tr>
<td>Infirmières par habitant</td>
<td>1/3 000</td>
</tr>
<tr>
<td>Espérance de vie H/F</td>
<td>44/46 ans</td>
</tr>
<tr>
<td>Mortalité infantile H/F pour 1 000</td>
<td>110,67/104,97</td>
</tr>
<tr>
<td>Cas de malaria</td>
<td>5 087 865</td>
</tr>
<tr>
<td>Morts dues à la malaria</td>
<td>3 569</td>
</tr>
<tr>
<td>Personnes atteintes du HIV/sida</td>
<td>1 300 000</td>
</tr>
</tbody>
</table>

1 Institut national de statistiques, 2007.
2 Ministère des statistiques médicales, 2005
Presque l’ensemble des infrastructures et des ressources se trouvent à Maputo, la capitale, située dans le sud du pays, ce qui constitue un obstacle important en raison de la géographie du pays, qui s’étend sur une longue bande étroite et dont les capitales de provinces sont très distantes les unes des autres. La mauvaise infrastructure routière et de télécommunications – la densité des lignes fixes n’est que de seize téléphones pour 1000 habitants – exacerbe encore plus la situation. La couverture mobile s’étend malgré tout sur 45 % du pays, ce qui offre de nouvelles possibilités pour améliorer les communications, même si ces services sont encore trop onéreux pour une majorité de la population.

Dans ces conditions, et avec la faiblesse et le manque de fiabilité de la collecte de données médicales actuellement en vigueur, le ministère de la Santé du Mozambique (MISAU) et d’autres décideurs ont été dans l’impossibilité de concevoir des politiques adéquates pour l’offre de services médicaux, notamment dans les zones rurales mal desservies. Cela les a également empêchés d’allouer des ressources là où elles font le plus défaut.

En 2005, le gouvernement du Mozambique a indiqué que l’un de ses objectifs les plus importants serait l’amélioration du service de santé en milieu rural, afin de réduire le poids de la maladie. Il s’avérait donc indispensable pour le MISAU de mieux comprendre la situation de la maladie dans le pays, au travers de l’analyse de données médicales recueillies dans les cliniques rurales de l’ensemble du pays. La collecte de données s’est donc avérée cruciale, si bien que le MISAU a créé un Service d’informations médicales chargé de gérer le processus de collecte des données et d’en effectuer l’analyse.

L’un des défis les plus importants du MISAU à l’époque, et aujourd’hui encore, est sa capacité à allouer des ressources médicales adéquates dans l’ensemble du pays pour analyser des données médicales fiables et en temps réel.

Le Réseau du Mozambique d’informations de santé (RMIS) est un projet qui vise à renforcer la capacité du MISAU à collecter, transmettre et gérer les données médicales au travers des technologies de l’information et de la communication (TIC) à faible coût. Le projet est mis en œuvre conjointement par l’Academy for Educational Development (AED), le Centre des technologies et des informations de santé SATELLIFE, le MISAU, et le ministère des Sciences et Technologies du Mozambique (MCT), avec le financement du Centre de recherches pour le développement international (CRDI) du Canada et l’Agence canadienne de développement international (ACDI). Des acteurs de ce secteur venant d’Afrique du Sud, S-Curve Technologies cc et Thalamic Systems cc, apportent leur soutien technique selon des contrats sans but lucratif. Lancé en 2007, le projet fonctionne actuellement dans 68 centres de santé situés dans cinq districts du Mozambique.

Les systèmes conçus pour ce projet RMIS avaient les principaux objectifs suivants :

1) Remplacer le processus de collecte de données médicales sur papier par des systèmes informatiques pour la collecte, le rapport et l’analyse de données médicales numérisées
2) Rendre plus fluide le report de données médicales entre les centres médicaux ruraux et le MISAU
3) Améliorer la fiabilité des données médicales publiques communiquées
4) Améliorer la diffusion des informations médicales publiques et cliniques au sein des cliniques rurales
5) Former des techniciens dans le MISAU pour gérer et élargir le projet RMIS, et assurer la viabilité de ce système.

Pour réussir à améliorer la collecte, la transmission et la gestion des données médicales du MISAU, le projet RMIS a déployé un système innovant qui achemine les données dans les deux sens, ce qui permet la mise à jour et la synchronisation des données entre les centres de santé et la base centrale de données. Un serveur fixe standard se trouve au MISAU. Quant au serveur du RMIS, il est accessible par internet, permet de télécharger des données au niveau national ou de district ; le MISAU y introduit également des ressources (informations et données) qui pourront être diffusées dans les cliniques rurales.

Tous les travailleurs de la santé qui participent au projet ont été munis d'appareils mobiles souvent appelés PDA (assistants numériques personnels). Les formulaires sur papier du MISAU ont été convertis au format PDA, si bien que les travailleurs de la santé y entrent leurs données socio-médicales et les y sauvegardent. Il s'agit notamment des régimes de vaccination pour la polio et la rougeole, les traitements de la malaria et les informations néonatales.

La technologie utilisée

**Le point d’accès africain (AAP)**

Un AAP (Point d’accès africain) est un appareil informatique qui communique avec un ordinateur de poche (PDA) par liaison infrarouge. Outre les données médicales, l’AAP peut acheminer des paquets de données sur un réseau de cellulaire GSM (global system for mobile) vers et depuis le serveur du RMIS.

**Logiciel AAP**

Pour assurer la stabilité de la plateforme, l’AAP fonctionne selon le système encastré Linux 2.6 avec le moins possible de paramètres modifiables par les utilisateurs. Ceux-ci peuvent se connecter à la fois au serveur et aux autres appareils clients au travers de l’interface web, qui leur permet d’entrer du contenu et d’envoyer des courriers électroniques dans l’ensemble du système. Il est possible d’utiliser la même interface pour entrer des données destinées à la diffusion vers les appareils clients. Les formulaires pour la collecte de données ont été conçus de façon à éviter que les travailleurs de la santé puissent sauter des questions.

Les AAP se trouvent dans les cliniques rurales couvertes par le réseau GSM, qui peuvent ensuite les partager avec les installations médicales proches n'ayant pas accès au GSM. Les AAP sont programmés pour effectuer leurs appels de données GSM/GPRS (general packet radio service) pendant les heures creuses du réseau GSM afin de téléverser et télécharger les données dans le serveur.

Le partage de chaque AAP et l’unique transfert de données permet de réduire les dépenses en télécommunications. Actuellement, avec des appareils qui ne sont pas encore utilisés au maximum de leur capacité, les coûts mensuels du RMIS en télécommunications s’élèvent à 7 dollars US par AAP.

**Flux des données dans le réseau**
Les données médicales ou non provenant des cliniques rurales entrent dans les AAP par infrarouge. Suivant la programmation quotidienne de connexion GSM/GPRS, l’AAP entre les données dans le serveur du MISAU, où un PC client a accès à toutes les données FTP (protocole de transfert des fichiers) des cliniques – alors que les capitales de district n’ont accès qu’aux données concernant les cliniques de leur district respectif (voir la figure 1).

**Figure 1 : Flux des données du réseau**

GPRS  
AAP  
Contenu  
Centre médical  
IR  
PDA

GPRS  
AAP  
Contenu  
Centre médical  
IR  
PDA

Serveur  
GPRS  
Internet  
FTP  
FTP  
FTP

Email  
FTP  
FTP  
FTP  
FTP

District Database  
MON Database

**Répercussions et bénéficiaires du projet**

Les patients seront les plus grands bénéficiaires de ce projet, puisque cette amélioration des politiques et des allocations en ressources leur permettront de recevoir de meilleurs soins de santé. Les premières études montrent qu’en comparaison avec les systèmes papier, la collecte de données du RMIS s’avère plus fiable et plus juste, et réduit considérablement le temps de compilation, de gestion et de report de ces données.

Un processus de suivi et d’évaluation est en cours afin de déterminer et répertorier les répercussions de ces modifications, ainsi que de voir la viabilité du projet et sa rentabilité. Cependant, les témoignages des utilisateurs du réseau RMIS des zones rurales indiquent que malgré le travail supplémentaire requis par une collecte simultanément sur papier et sur ordinateur, les travailleurs de la santé reconnaissent les avantages du système numérique et en voient les bénéfices par rapport au système sur papier. Un travailleur de la santé rural témoigne par un courriel envoyé depuis son PDA (en portugais, suivi de la traduction en français) :

Date: 2008/9/24  
Subject: Vantagem do modulo basico usado pela RMIS
To: aed.rmis@gmail.com

A grande vantagem do modulo básico usado pela RMIS em comparação com o modulo básico actualmente usado no MISAU é que o da RMIS não precisamos de introduzir dados porque o processo é automático enquanto que o modulo básico usado pelo MISAU é necessario sentar para introduzir os dados no final do mês e pela quantidade de dados acumulados até ao fim do mês existe o risco de erro que esta digitador cometer falhas que irão alterar os dados, e é um processo muito cansativo, se fizermos uma comparação do tempo no sistema da RMIS usamos um terço do tempo que se usa actualmente no MISAU.

[Le grand avantage de la base de données du RMIS par rapport à la base de données actuellement utilisée par le MISAU est que pour celle du RMIS, on n'a pas besoin d'entrer manuellement les données accumulées dans les différents centres médicaux à la fin du mois, ce qui est très fatigant et comprend toujours un risque d'erreur qui affectera l'ensemble des données. Si on compare le temps que nécessite chaque procédé pour compiler les données médicales du district et imprimer les rapports, le système du RMIS est trois fois plus rapide que celui du MISAU utilisé actuellement.]

Figure 2 : Impression d’écran d’un courriel envoyé par un participant au RMIS
Aider les travailleurs de la santé à améliorer leur performance

Le réseau RMIS et les PDA des travailleurs de la santé ne sont pas utilisés exclusivement pour la collecte et la transmission de données médicales. Ils sont également utilisés pour échanger des courriels, recevoir et lire des bulletins d'informations comme les manuels de politiques et de procédures du MISAU, des manuels sur le traitement de la polio, de la rougeole et de la dysenterie, et des manuels pour la vaccination et le traitement de la malaria, qui les aident à offrir les meilleurs soins.

Les informations diffusées sur le réseau augmentent les connaissances des travailleurs de la santé ruraux qui peuvent apprendre par eux-mêmes, et acquièrent en outre de nouvelles compétences techniques. Tout cela donne lieu à une amélioration des services de santé dans les centres médicaux des communautés rurales.

Enfin, les projets comme le RMIS offre un accès aux TIC aux travailleurs de la santé des zones rurales pauvres et contribuent au développement des compétences en TIC des citoyens.

Collaboration entre le gouvernement et les employés du projet

Les bonnes relations établies entre AED-SATELLIFE, les employés du projet et les directeurs et personnel du MISAU et du MCT ont largement contribué au processus de sélection et de conversion des formulaires sur papier en formats d'ordinateur de poche, l'autorisation et l'obtention du matériel nécessaire au déploiement, et le travail en liaison avec les directions des centres médicaux provinciaux et de districts pour la formation des travailleurs de la santé. L'esprit d'équipe qui en a découlé a joué un rôle décisif au moment d'obtenir les résultats de la mise en œuvre du projet dans les centres les plus éloignés et dans ceux de tous les districts. Les partenaires ont cependant conscience que des améliorations sont souhaitables, notamment en ce qui concerne l’implication de l’ensemble des pouvoirs publics chargés de la gestion des systèmes d’informations de santé aux niveaux des provinces, des districts et des cliniques.

Le succès du déploiement du matériel et de la formation des travailleurs de la santé est entièrement dû à l’engagement solide de l’ensemble du personnel technique et des équipes de travail au cours de la configuration du matériel, de la préparation des manuels et outils de formation, et de la cartographie des données des PDA dans le système de gestion de la base de données médicales du MISAU.

Le futur du projet

Les études des retombées du projet et de ses bénéficiaires sont actuellement en cours, et ce sont elles qui prouveront (ou réfuteront) la viabilité financière et sociale du projet. AED-SATELLIFE et le MISAU se sont cependant déjà mis d’accord pour augmenter le nombre de formulaires à convertir au format PDA dans toutes les cliniques rurales participantes d’ici la fin de 2008.

Les résultats de l’évaluation de suivi et de l’étude de rentabilité devraient permettre au MISAU de décider s’il souhaite adopter ou non le projet et le reproduire dans l'ensemble du pays en utilisant des fonds du gouvernement ou d'autres mécanismes de financement.

L’utilisation de technologies innovantes adaptées par le RMIS montre le potentiel considérable qu’elles offrent aux pays pauvres et en développement qui disposent d'infrastructures limitées de télécommunications.