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## **FINAL REPORT**

# **Needs Assessment of Higher Education Information Systems at the Ministry of Education and Higher Education and Higher Education Institutions**

Funded by  
**USAID Mission to the West Bank and Gaza**

Submitted to the  
**Academy for Educational Development**

Submitted by  
**Massar Associates**

**January 2005**

**This publication was produced for review by the United States Agency for International Development. It was prepared by Massar Associates.**

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## **Acronyms**

AED	Academy for Educational Development
DNS	Data Name Server
HE	Higher Education
ICT	Information and Communications Technology
IS	Information System
ISA	Internet Security and Acceleration Server (Microsoft)
ISS	Institution-Side System
IT	Information Technology
MIS	Management Information System
MOEHE	Ministry of Education and Higher Education
MSS	Ministry-Side System
PDC	Primary Domain Controller
UPS	Uninterruptible Power Supply
USAID	United States Agency for International Development

## **Acknowledgments**

This project was made possible by the combined efforts of the Academy for Educational Development (AED), the USAID Mission to the West Bank and Gaza Agency for International Development (USAID), the Division of Higher Education at the Ministry of Education and Higher Education (MOEHE), and HE institutions and specialists in Palestine.

Massar Associates would like to extend its gratitude and appreciation to all those that helped in bringing this project to fruition. First and foremost, we would like to thank AED staff for giving us the opportunity to undertake this important project: our gratitude extends to Ms. Eliane Strite, Chief of Party, Ms. Jamileh Abed, Senior Academic Counselor, and Mr. Sami Abu Ikmeil, Senior IT Specialist at AED/Gaza. We would also like to thank Birzeit University and the Islamic University at Gaza for their help in testing the project's information gathering tools.

The Ministry's officials provided us with critical support and assistance, especially through the office of Dr. Fahoum Shalabi, Director of Scientific Research and Planning, and a member of the project management committee. We are also indebted to Mr. Abdallah Awad, from the World Bank, for keeping abreast of project developments and helping to bring the project to conclusion.

Lastly, we are deeply indebted to Ms. Elaine Strite at AED and Ms. Nadia Basel, AID Development Assistance Specialist (Higher Education) at USAID, for their careful review of our work and the valuable feedback that they provided.

Massar Project Team

## Introduction

HEMIS – the Higher Education Management Information System, was conceived by MOEHE and the World Bank in 2002, as a tool that was required to improve the overall efficiency of the HE sector in Palestine and build capacity therein.

The development and implementation of HEMIS is divided into three phases:

1. **Requirements Definition and Needs Assessment** is the first phase that aims to assess the information and technological requirements associated with HEMIS; generate a proto-design for the system architecture and topology; undertake a gap analysis to identify HE institutions' ability and MOEHE's needs with respect to the successful deployment of HEMIS.
2. **System Design** is Phase Two and focuses on extrapolating the proto-design for the system into a fully functional and executable information system, connecting MOEHE to HE institutions. This includes a refinement of the HEMIS information content.
3. **System Implementation** is the final Phase and focuses on the physical execution of the system, involving the procurement and installation of required technology at MOEHE and HE institutions; HEMIS deployment; training and capacity-building activities at MOEHE and HE institutions; and system monitoring.

In May 2004, Massar Associates was commissioned by the Academy for Educational Development to undertake Phase One – Requirements Definition and Needs Assessment. Funded by USAID, Massar completed the assignment in January 2005.

This report is a culmination of the work undertaken by Massar's team over a period of seven months, in which Massar proceeded to:

- Survey the IS and IT environments at the MOEHE
- Determine the HEMIS functional requirements
- Determine the HEMIS information contents
- Develop the HEMIS proto-design
- Develop Gap Analysis Tools (questionnaire)
- Undertake Gap Analysis:
  - Visit each Palestinian HE institution, survey current IS contents and structure and IT environment
  - Estimate the gap between current IT and IS capabilities at each HE institution, and IT and IS requirements based on full connectivity between the HE institution and HEMIS
- Derive recommendations for Phase II (System Design)

The submission of this report marks the successful conclusion of Phase One – Requirements Definition and Needs Assessment.

## Executive Summary

### **Introduction**

HEMIS (Higher Education Management Information System) was conceived by MOEHE and the World Bank in 2002 as a tool that was required to improve the overall efficiency of the HE sector in Palestine and build capacity therein.

The development and implementation of HEMIS is divided into three phases:

- *Phase One: Requirements Definition and Needs Assessment*
  - Determining HEMIS' functional and technical requirements
- *Phase Two: System Design*
  - Developing a comprehensive technical and functional design
- *Phase Three: System Implementation*
  - Implementing the design and deploying HEMIS

In May 2004, Massar Associated was commissioned by the Academy for Educational Development to undertake Phase One – Requirements Definition and Needs Assessment. Funded by USAID, Massar completed the assignment in January 2005.

The purpose of this report is to summarize the findings of Phase One; and provide the effective building-blocks (analysis and tools) for Phases Two and Three to donors that are interested in financing these subsequent phases.

### **Rationale**

HEMIS is an automated structure that performs three critical functions – collecting, storing, and reporting on, information related to Palestinian higher education. The key, basic functions of the systems will be to:

- Conduct data collection from HE institutions on a regular, timely basis
- Classify, clean and store data in a central location
- Report on data in a timely manner
- Generate customized reports to suit research needs

This allows HE stakeholders to obtain better-quality, standardized data on HE in a timely and continuous manner that can be used to plan and monitor Palestinian HE. In addition to significantly increasing the efficiency of planning and monitoring systems in HE, additional advantages of adopting HEMIS include:

- 1) Adopting an automated platform for information-exchange that is more efficient than the existing, partially-automated, system
- 2) Centralizing the location of HE information and reducing time involved in searching for alternative information sources
- 3) Introducing qualitative standards on the type of required data by ensuring that data is reported in a consistent, approved format from all HE institutions
- 4) Standardizing the frequency at which information is collected, ensuring that information is constantly updated
- 5) Providing quality data that is immediately accessible in the form of standardized and customized reports

### **Implementation**

Implementation followed the chronology presented below:

- ***Mobilization*** Formation of a Project Management Committee
- ***Survey of Ministry's IT Environment*** Review the current IT environment, assessing the employed server applications, networking capabilities, and system infrastructure; interview IT staff
- ***Requirements Definition*** Define the HEMIS requirements with respect to functionality, information, and reporting
- ***System Proto-Design*** Development of the data dictionary, database schema and schema diagrams
- ***Developing Information Gathering Tools*** Development and testing of questionnaire designed to obtain information from HE institutions on existing IT systems, hardware availability and type, data communication technology and systems, skills and availability of IT personnel, immediate and long term IT plans, data element availability and specifications, and data element discrepancies vis-à-vis elements in HEMIS
- ***Gap Analysis*** Undertook IT and data elements gap analysis, to measure the gap between HEMIS IT and data requirements, and HE institutions current IT and data collection capabilities
- ***Final Reporting and Recommendations*** Identification of best-fit solutions for HEMIS database architecture, data communications topology between HE Institutions and MOEHE, and data collection options for HE Institutions with limited or no MIS capabilities

### **Technical Output**

With the continuous supervision of project stake-holders, the consultancy team worked with MOEHE to develop the following HEMIS building blocks:

***Use Cases*** Nine key functions were identified, which HEMIS is required to perform. They are:

1. Find Report
2. Import Data
3. Import Institution Data
4. Login
5. Manage Institution Profile
6. Manage Reports
7. Save Report
8. Schedule (Data) Import Process
9. Send Report

The project team mapped out the requirements, making explicit workflow processes within each requirement.

***Reports*** 113 reports were identified that HEMIS is required to generate systematically. Reports are divided into seven categories:

1. Financial Reports
2. Institution Reports



3. Management And Governance Reports
4. Outcome Reports
5. Research Reports
6. Staff Reports
7. Student Reports

77 reports were identified as being high priority; 18 reports as intermediate priority and 18 reports as low priority.

**Data Dictionary** Five primary subject areas were identified:

1. Finance
2. Institution
3. Research
4. Staff
5. Student

In these five areas, data needs to be gathered directly from HE institutions. One additional subject area, entitled "Country Wide", is required to provide MOEHE with macro-educational and socioeconomic data.

Within the six subject areas, 401 raw data elements were identified that need to be included in HEMIS. These 401 elements are distributed across 122 entities (tables). Definitions have been provided for all raw data elements and tables.

**Database Schema** The consultancy team identified the required form, length, order, type, importance and independence of each raw data element and table.

**Schema Diagrams** These provide a visual representation of HEMIS, in which all tables and elements are recorded, in addition to entity-entity and entity-attribute relationships.

### **IT Gap Analysis**

Data collection – the gathering of information from HE institutions and feeding it into a central information system – is a key business process in HEMIS. Resultantly, institutions are required to collect non-subjective, real-time data by utilizing specialized university administration software applications.

For a fully-functioning HEMIS, the minimal infrastructure components that must be adopted by HE institutions (for data collection and transmission) include:

- Dedicated database server
- Dedicated administration PC clients (for administrative staff, i.e. not students)
- Software application (specialized modules for HE administration)
- IT staff with required technical skills to support the MIS systems at the institution
- High speed communication link - (128K or better) between institution and MOEHE

The analysis measured the gap between the actual state, and desired state, of hardware; database systems; software; connectivity; and IT staff at HE institutions.

The IT Gap Analysis Findings are:

***Overall IT Assessment***

- Hardware and Internet connectivity are the two areas in which HE institutions are close to meeting the HEMIS requirements
- Institutions need to adopt more advanced database software and software modules
- Training for IT staff is required – almost half (45%) of the required skills are not available

***Hardware***

- Universities and the Open University have the required hardware to support HEMIS
- Hardware upgrades are required for colleges and university-colleges

***Database Software***

- Universities and the Open University have the required database software to support HEMIS
- Colleges and university-colleges need to upgrade their database software in order to support HEMIS

***Software Modules***

- The technical team determined that HEMIS (a comprehensive institution administration software application) should comprise eight essential software modules:
  1. Administration
  2. Facilities and Services
  3. Finances
  4. IT Department
  5. Library
  6. Personnel
  7. Planning and Information
  8. Registration
- For a total of 41 institutions, the cumulative total of all software modules is 328. Of these 328, 169 modules (52%) are available (either ready or need customization) and 48% are not available. Of the available modules, 26% are ready, and 74% require customization. Almost all institutions are missing a "Planning Module" (88%) and most are also missing the "Facilities and Services Module" (76%). The "Student Registration Module" was the most readily available.

***Internet Connectivity***

- Universities and the Open University have the required connections to support HEMIS
- Colleges and university-colleges need to deploy better-standard communication technologies

***IT Staff***

- Universities and the Open University require a modest amount of training for their staff
- Colleges and university-colleges need substantial training and need to employ additional specialized staff

***Universities and Open University***

- Best equipped to connect with HEMIS, scoring full-marks in hardware, database software; and internet connectivity
- A modest amount of training is needed for their staff
- Customization of software modules is required

***Colleges and University-Colleges***

- Upgrades are required for hardware and internet connectivity
- Most need to adopt database software and software modules; a smaller number require substantial customization of existing database software and software modules
- Substantial training of IT staff is required, as well as additional recruitment

**Data Elements Gap Analysis**

Using the developed information system as a benchmark; the project team undertook a **data elements gap analysis** to measure the disparities in data element availability between what is required (as determined by the benchmark) and what is available (based on existing information sources at higher education institutions). The benchmark was based on HEMIS' data dictionary, focusing on five subject areas.

The Data Elements Gap Analysis Findings are:

***Subject Areas***

- Overall all data elements, and all subject areas, 72% of data elements are available
- Data elements are *most readily* available in Student Subject Area
- Data elements are *readily* available in the Staff Subject Area
- Data elements are *least* available in Research Subject Area
- Availability is less than 50% in the Institution and Finance Subject Areas
- More than 70% availability for all data elements in the Student Subject Area
- Less than 50% availability for all data elements in the Finance Subject Area
- Less than 20% availability for all data elements in the Research Subject Area

***All Institutions***

- Availability exceeded 60% for all four types of institutions
- 79% of data elements are available at universities
- 62% of data elements are available at Open University

***Universities***

- Highest availability: Student Subject Area
- Lowest availability: Research Subject Area
- Availability approximately 70% in Institution, Staff and Finance Subject Areas

***Colleges***

- Highest availability: Student Subject Area
- No availability: Research Subject Area
- Availability less than 50% in Institution, Staff and Finance Subject Areas

***University Colleges***

- Highest availability: Student and Staff Subject Area
- No availability: Research Subject Area
- Low availability in Institution and Finance Subject Areas

***Open University***

- Highest availability: Research Subject Area
- Least availability: Finance Subject Area
- Moderate availability: Student Subject Area; Staff Subject Area
- Low availability: Institution Subject Area

***All Subject Areas vs. Type of Institution***

- Overall, universities are most capable of providing data elements according to HEMIS' requirements
- Overall, the Open University is least capable of providing data elements according to HEMIS' requirements
- Universities are most capable of providing data elements in the Student, Institution and Finance Subject Areas
- Open University is most capable of providing data elements in the Research and Staff Subject Areas
- Colleges are least capable of providing data elements in the Staff, Institution and Finance Subject Areas
- The Open University is least capable of providing data elements in the Student Subject Area
- University-Colleges are least capable of providing data elements in the Research Subject Area

**HEMIS Architecture**

The project team used Service Oriented Architecture (SOA) to build HEMIS architecture. Essential services that HEMIS has to perform are data import process from the ISS to the MSS; and establishing connectivity with institutions with limited MIS capabilities and modules that need extensive customization. The complexity is borne out of the need to connect the MSS, with multiple ISS platforms at HE institutions. ISS are heterogeneous where each possesses its own characteristics, constraints, integration behavior, and communication channels.

**HEMIS Architecture** is composed of the Ministry Side System (MSS) and the Institution Side System (ISS). Each IS contains modules – components within it that perform multiple diverse functions.

The MSS needs to include seven modules (components):

- *Institution Profile Manager* Defines ISS and entity with which data import will be executed, as well as the rules for communication and data exchange

- *Institution Service Invocation Manager* Invokes the connection between the Ministry and each institution
- *Authentication and Authorization* - Secures access to the ISS
- *Save Imported Data* Stores and saves data retrieved from the ISS
- *Import Data Manager* Executes the system's core function - data import
- *System Level Modules and Services* Technical modules that reflect the system architecture's needs from each ISS
- *Log Module* Logs and saves all the actions that are executed

Institutions use numerous different applications with varying backend Database Management Systems (DBMS). In addition, applications with the same functionality are implemented differently from one university to another. Since the MSS will interact with all ISS, it is recommended to 'wrap' the ISS locally (at the institution side) in one standard interface through which communications with the MSS will be facilitated.

The ISS needs to include four Modules (components):

- *Institution Profile Manager (IPM)* Defines the entities and rules that are required for communication and data exchange
- *Institution Systems Connection Manager* - Handles connections internally within the ISS
- *Institution Import Data Manager* Retrieves data from internal systems, converts them to MSS Data Standards, exports data to MSS
- *Log Module* Saves all executed actions

Based on the system architecture, important implications for HEMIS are:

- The ISS is primarily responsible for converting the migrated data to meet the Ministry Data Standard. The MSS is expected to interact with all ISSs in a standard way, guaranteeing its full separation from the ISS's internal platform-dependent restrictions.
- The ISS is required to wrap data-integration with internal systems, minimizing MSS's burden. This will minimize maintenance required for MSS.
- Internal changes at an ISS should not affect MSS' behavior, therefore web services should be used to build the architecture.

### **Technical Recommendations**

Due to the large volume of **data exchange**, and extensive modifications that may be required, it is strongly recommended that data exchange should utilize a standard framework, so that any type of information (message, workflow document) relayed across any type of technology (Application Program Interface, Web Application, Database Portal) can be searched, decoded, modified, displayed and stored consistently and correctly. Data Exchange Mechanisms are illustrated below:

Although a number of institutions already have permanent Internet connections installed, it is important that **security** is maximized during periods of connection between the MSS and ISS. The following options could be used to maximize connection security:

- A separate and more secure channel can be used specifically for ISS-MSS communications, for example ISDN dial on demand, or a separate leased line.
- VPN (Virtual Private Network) between the Ministry and institutions. Current, permanent Internet connections can be used to transfer data between ISSs and MSS by using a secure channel requiring the installation of either VPN Module or an IPsec Module on the ISS routers. This will allow for secure use of the current connection.

Building an ISS at different Palestinian HE institutions will be a costly and time consuming process. The project team recommends that for **data collection** two possible tracks can be pursued:

- For institutions with ISS (i.e. that have their own MIS), there ISS can be customized and upgraded (if need be) to meet the requirements of HEMIS
- For institutions with limited or no IT capabilities, as an alternative to implementing an application server solution for each, the **Application Service Provider (ASP)** model can be used for connectivity

ASP is a web-based ISS that contains all modules required by HEMIS. It is operated by a third party that leases the right of usage of its modules to institutions in return for a set fee. Institutions can access the ASP through a workstation that is connected to the Internet; and can download the modules; download upgrades to the modules; and post (dump) completed modules on the ASP, for MOEHE officials to retrieve later.

If HEMIS is to succeed, it is crucial for both the MOEHE and HE institutions to recruit and **train** specialized staff capable of supporting and maintaining the system. Key skill sets that are required include:

1. System Administration
2. Data Base Analysis
3. Business Analysis
4. Report Generation

HEMIS stakeholders need to develop a proactive country-wide training component for both MOEHE and HE institutions. The actual contents of the training will be made more explicit during the subsequent Design and Implementation Phases.

### **Non-Technical Recommendations**

Additional, non technical recommendations include:

- Establish a *Specialized Information Department* responsible for collection and dissemination of information on HE
- Develop a unified method across HE institutions to record and classify information on applicants' socio-economic status
- Support training programs in the fields of educational cost-management and facility management
- Enhance coordination and cooperation with PCBS, Ministry of Labor and other institutions that can provide useful information on HE
- Establish a HE standard-setting body comprising HE representatives and professionals, responsible for developing standards for HE monitoring, and reporting

## Rationale – the Need for HEMIS

In 1999, the predecessors of the MOEHE undertook a strategic planning process in order to effectively respond to the needs of the higher education sector in Palestine, namely, the need to meet increased demand for HE, and the need to move-away from outdated financial and managerial systems that rendered the sector inefficient and threatened its sustainability.

With the assistance of international donors, particularly the World Bank, MOEHE concluded that among its primary goals was the need to strengthen and build capacity at MOEHE itself and across HE institutions.<sup>1</sup> This centered upon the implementation of managerial and operational changes that included regulating accreditation and licensing, introducing sector-wide institutional management plans, and most importantly, *designing and deploying an IS specifically for Palestinian HE: namely HEMIS – the Higher Education Management Information System*

HEMIS is an automated structure that performs three critical functions – collecting, storing, and reporting on information related to Palestinian higher education. The key, basic functions of the systems will be to:

- Conduct data collection from HE institutions on a regular, timely basis
- Classify, clean and store data in a central location
- Report on data in a timely manner
- Generate customized reports to suit research needs

This allows HE stakeholders to obtain better-quality, standardized data on HE in a timely and continuous manner, that can be used to plan and monitor Palestinian HE. In addition to significantly increasing the efficiency of planning and monitoring systems in HE, additional advantages of adopting HEMIS include:

- 6) Adopting an automated platform for information-exchange that is more efficient than the existing, partially-automated, system
- 7) Centralizing the location of HE information and reducing time involved in searching for alternative information sources
- 8) Introducing qualitative standards on the type of required data by ensuring that data is reported in a consistent, approved format from all HE institutions
- 9) Standardizing the frequency at which information is collected, ensuring that information is constantly updated
- 10) Providing quality data that is immediately accessible in the form of standardized and customized reports

Realizing the full benefits of adopting HEMIS, MOEHE and donor organizations formulated an implementation plan for its realization that focused on three phases:

- 1) *Phase One: Requirements Definition and Needs Assessment*
  - Determining HEMIS functional and technical requirements
- 2) *Phase Two: System Design*
  - Developing a comprehensive technical and functional design

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<sup>1</sup> *Palestinian Higher Education Financing Strategy*, Ministry of Higher Education and Scientific Research and the World Bank, August 2002

3) *Phase Three: System Implementation*

- Implementing the design and deploying HEMIS

Donors' convergence on the contents and themes of support to MOEHE resulted in the commencement of work on HEMIS. In May 2004, with funding from USAID, AED commissioned Massar Associates to undertake Phase One – the Requirements Definition and Needs Assessment. This report marks the successful conclusion of that phase.

The purpose of this report is to summarize the findings of Phase One, and provide the effective building-blocks (analysis and tools) for Phases Two and Three to donors that are interested in financing these subsequent phases.



## Methodology

The methodology presented below follows in chronological order for the whole life-cycle of the project.

### ***Project Mobilization (May 2004)***

The project commenced with the formation of a Project Management Committee that included representatives from the main stakeholders in this project, namely MOEHE, AED; USAID, and the World Bank. Massar presented, and gained approval for the project team and work plan.

### ***Survey of Ministry's IT Environment (June 2004)***

The project team visited the Ministry to review the current IT environment, assessing the employed server applications, networking capabilities, and system infrastructure. The team also interviewed the two IT staff at the Ministry – the IT Manager and Technician, to gain an understanding of the Ministry's current IT needs and future plans.

Please see [Chapter One: Overview of Ministry's IT Environment](#) for an overview of MOEHE's current IT systems and capabilities.

### ***Requirements Definition (June 2004)***

Massar defined HEMIS requirements with respect to:

- Functionality
- Information
- Reporting

Please see [Chapter Two: Requirements Definition](#) for further details.

### ***Functional Requirements***

Massar used Use Case Modeling to determine the system's functional requirements. Use case modeling simulates interaction between a proposed IS (HEMIS in this case) and end-users, identifying users' requirements from the system e.g. load data; save data; print reports etc.

Please see [Annex B: Use Cases \(Functional Requirements\)](#) for an identification and description of each Use Case.

### ***Information Requirements***

Massar proceeded to identify the information requirements – namely, the indicators, formulae and data elements that needed to be included into the system. The project team worked with MOEHE staff to identify the type of information required by the systems' end-users. Massar interviewed numerous officials at the Ministry to understand their information needs, and identify the data that they needed to help

them in their work, particularly in planning and monitoring. The following MOEHE staff were interviewed:

- Fahoum Shalabi – Director of Scientific Planning and Research
- Hisham Kuheil – Deputy Minister
- Jamil Abu Sa`da – Director of Vocational Training
- Jamal Hussein – Director of University Education
- Abd Al-Karim Saghir – Financial Assistant to Minister
- Muafaq Al Khatib – Director of Student Loans

Massar's team also interviewed officials from Bir Zeit University, the Palestinian Central Bureau of Statistics, the Palestine Economic Policy Research Institute, UNESCO in Ramallah, private consultants and higher education specialists.

Additionally, Massar undertook desk research to find and review useful documented resources for identifying and cataloguing variables and formulas. The following resources were used:

- OECD, *OECD Handbook for Internationally Comparative Education Statistics – Concepts, Standards, Definitions and Classifications*, 2004
- Mahmoud El-Jafari and Dareen Lafi, *Matching Higher Education Graduates with Market Needs in the West Bank and Gaza Strip*, Palestine Economic Policy Research Institute, 2004
- Maher Hashweh and Mazen Hashweh, *An Assessment of Higher Education Needs in the West Bank and Gaza*, AED, 2003
- OECD, *Education at a Glance – OECD Indicators*, 2003
- The World Bank, *Palestinian Higher Education Financing Strategy*, 2002
- Abbas Bazargan, *Measuring Access to Higher Education and Higher Education Quality: A Case Study of the Islamic Republic of Iran*, 2000
- California State University, *Financial Information Record Management System Data Element Dictionary*, 1997
- UNESCO, *Policy Paper for Change and Development in Higher Education*, 1995

The definition of information requirements ended with the compilation of a report listing all the required indicators, variables and formulas. This report can be found at [Annex C: Indicators, Variables, Formulas \(Information Requirements\)](#)

### ***Report Requirements***

Massar and MOEHE identified the reports that are required by the Ministry in order to facilitate planning, monitoring and budgeting. The reports provide information on individual data elements, and analysis based on a comparison of two, or more, data elements.

Reports are classified into High Priority Reports (those that are essential to MOEHE); Intermediate Priority Reports (reports that are important, yet not crucial) and Low Priority Reports (additional reports that are not crucial to planning, but nonetheless provide useful insights on Palestinian HE).

Details on report titles, contents, and prioritization can be found in [Annex D: Reports \(Report Requirements\)](#).

### ***System Proto-Design (June – July 2004)***

Massar employed Physical Data Modeling (PDM) to design the HEMIS database, employing the process outlined below:

- *Identified entities* - the main data categories to be included in the system
- *Determined entity types* – the title and technical specifications for each entity
- *Identified attributes* – the raw data-elements within each entity
- *Determined attribute types* – form, length, and technical specifications for each attribute
- *Identified entity – entity and entity-attribute relationships* – identified data linkages
- *Assigned keys* – assigned identification keys to selective attributes within entities
- *Normalized data* – reviewed data to ensure consistency in terminology and reduce data redundancy by removing repetitions
- *Renormalized data* – repeated the above process

The resultant output included:

- *Database Schema* - Specifies system entities, attributes, and information hierarchy
- *Schema Diagrams* - Visual representation of the schema, demonstrating data linkages
- *Data Dictionary* - Definitions of entities and attributes

Please see [Chapter Three: HEMIS Proto-Design](#) for further details.

### ***Developing Information Gathering Tools (June 2004)***

Subsequently, Massar proceeded to develop the questionnaire: the information-gathering tool required to identify and analyze discrepancies (gaps) in data elements, between those available at HE institutions and those needed by MOEHE (as defined by HEMIS).

#### ***Compiled list of HE institutions***

Initial lists were provided by the Ministry; the project team validated contents

#### ***Classified Institutions According to Type***

Institutions were classified according to 1 of 4 types (based on the Ministry's definitions) - University, College, University College or Open University.

According to this classification, university-colleges are distinct from colleges in that they provide educational programs up to and including the Bachelors' level, while colleges provide post-secondary education below the Bachelors' level.

### ***Developed Questionnaire***

An initial questionnaire was developed to gather information from HE institutions in two main areas – IT systems and data collection. The questionnaire contained open-ended questions on types of technology used by an institution - current and planned IT systems, data communications and personnel - and identified the data elements in pre-selected databases.

The questionnaire provided the fieldworker with details on each data element – name, type, length, and form (based on the database schema). The fieldworker would locate the availability of each data element within these databases and record basic data. In instances where an observed element exactly complemented a HEMIS element, the fieldworkers could record this entry directly. If an observed element alluded to, but did not exactly complement, a HEMIS element, the fieldworker would record the entry, and its specifications, alongside the corresponding HEMIS element. Finally, the fieldworkers would record the elements (and their specifications) for all observed data elements that did not exactly complement or correspond to existing elements in HEMIS. All data elements within existing ISs at HE institutions was recorded; and compared to the corresponding elements in HEMIS.

### ***Tested and Finalized Questionnaire (Model Visits)***

Two model visits were undertaken at the Islamic University in Gaza and Birzeit University in the West Bank. In these visits, senior fieldworkers tested the questionnaire by completing it with university officials. The required information was collected from these institutions and the questionnaire improved based on the recommendations of the field workers.

Please see [Annex H: Completed Questionnaire \(Model\)](#) for example for a sample of a completed questionnaire.

### ***Fieldwork (July – September 2004)***

Two teams of fieldworkers were mobilized to undertake the fieldwork, comprising five fieldworkers in the West Bank / Jerusalem and two in Gaza.

#### ***Mobilization***

Mobilization provided orientation to the fieldworkers on the project and the fieldwork requirements, introduced the project schedule, specified responsibilities, and simulated interviews with university officials. Fieldworkers practiced 'completing' the questionnaire.

#### ***Implementation***

Over a period of two months, fieldworkers gathered data on all 41 HE institutions in the West Bank, Gaza and Jerusalem. This involved on-site visits to 39 HE institutions, ranging from one to three day visits per institution, depending on the sophistication of IT systems and IS at the institution. Two institutions were interviewed remotely (fax and email).

The output: 41 completed institution-specific questionnaires, providing information on:

1. Existing IT systems
2. Hardware availability and type
3. Data communication technology and systems
4. Skills and availability of IT personnel
5. Immediate and long term IT plans
6. Data element availability and specifications
7. Data element discrepancies vis-à-vis elements in HEMIS

### ***Data Entry and Cleaning***

Keyed data into appropriate software

### ***Gap Analysis (September 2004)***

Massar performed a Gap Analysis to identify the differences between HEMIS target architecture and data dictionary, and the multiple systems at HE institutions. Gap assessments were generated for each institution on IT systems and data element availability.

### ***IT Gap Analysis***

The analysis measured the gap between the actual state and desired state of five categories:

1. Hardware
2. Database Systems
3. Software
4. Connectivity
5. Staff

The gap assessments relied on assigning scores to each of the five categories. An institution would score 100% (the maximum in each category) if its existing systems exactly matched those required by HEMIS; a score of less than 100% if its system complemented HEMIS' requirements to an extent; and 0% if no system existed to meet HEMIS' requirements.

Within each category, the point allocation was weighted as follows:

Hardware:

- 50% allocated to the availability and state of dedicated servers for hosting database system
- 50% allocated to number of PC's dedicated to administration and PC-administrative staff ratio

Database:

- 100% allocated to having a database system regardless of type (Oracle, SQL Server, Access), otherwise 0%

Software:

- Based on the availability of specialized software module for management and administration of each of 8 departments:
  1. Administration
  2. Facilities
  3. Financial
  4. Library
  5. Personnel
  6. Planning
  7. Registration
  8. IT
- Modules can be ready; or need customization; or are not available
- In the gap analysis, each module is assigned an equal weight:
  - If the module is ready, it receives a score of 12.5%
  - If the module needs customization, it receives a score of between 0 and 12.5%, depending on the extent of customization required
  - If the module is not available, receives a score of 0%
- The aggregate score for the software gap analysis is the sum of the scores received for each of the eight modules

Internet Connectivity:

- 100% allocated to fast fixed Internet lines (128K+)
- 75% allocated to fixed line internet connectivity less than the (128K)
- 50% allocated to dialup connections

Staff:

- Measured in "Software Category" as part of "IT Department Module"

Gap Assessments were generated for:

- Each individual institution (41 assessments)
- All Universities – by aggregating results for all universities
- All University Colleges - by aggregating results for all university colleges
- All Colleges - by aggregating results for all colleges
- Open University (only one Open University in Palestine)
- All HE institutions, by aggregating the findings of all individual-institution assessments

Please see Chapter Four: IT Gap Analysis for the findings of this component.

***Data Elements Gap Analysis***

Using the data dictionary as the standard, the project team undertook a gap analysis to measure data element availability, and discrepancies in data-element forms, based on HEMIS requirements. Using the data elements in HEMIS as the benchmark (the required standard), a checklist of all data elements required by HEMIS was generated. If a particular data element existed in an institution's MIS, the entry would be recorded as being available, and vice versa. All data elements were assigned equal weights i.e. equally important. Institutions were then allocated an aggregate score that

specified the percentage of HEMIS data elements that were already available in their existing MIS.

In generating aggregate gap assessments for all institutions and across all types of institutions, additional weights were employed based on enrollment sizes at institutions (student and staff number).

Gap Assessments were generated for:

- Each individual institution (41 assessments)
- All Universities – by aggregating results for all universities
- All University Colleges - by aggregating results for all university colleges
- All Colleges - by aggregating results for all colleges
- Open University (Only one Open University in Palestine)
- All HE institutions, by aggregating the findings of all individual-institution assessments

Please see Chapter Five: Data Elements Gap Analysis for the findings of this component.

***Final Reporting and Recommendations (October 2004 – January 2005)***

The final stage of the project involved documenting the results (tools, data, and analysis) – as presented by this report.

Additionally, recommendations are made on:

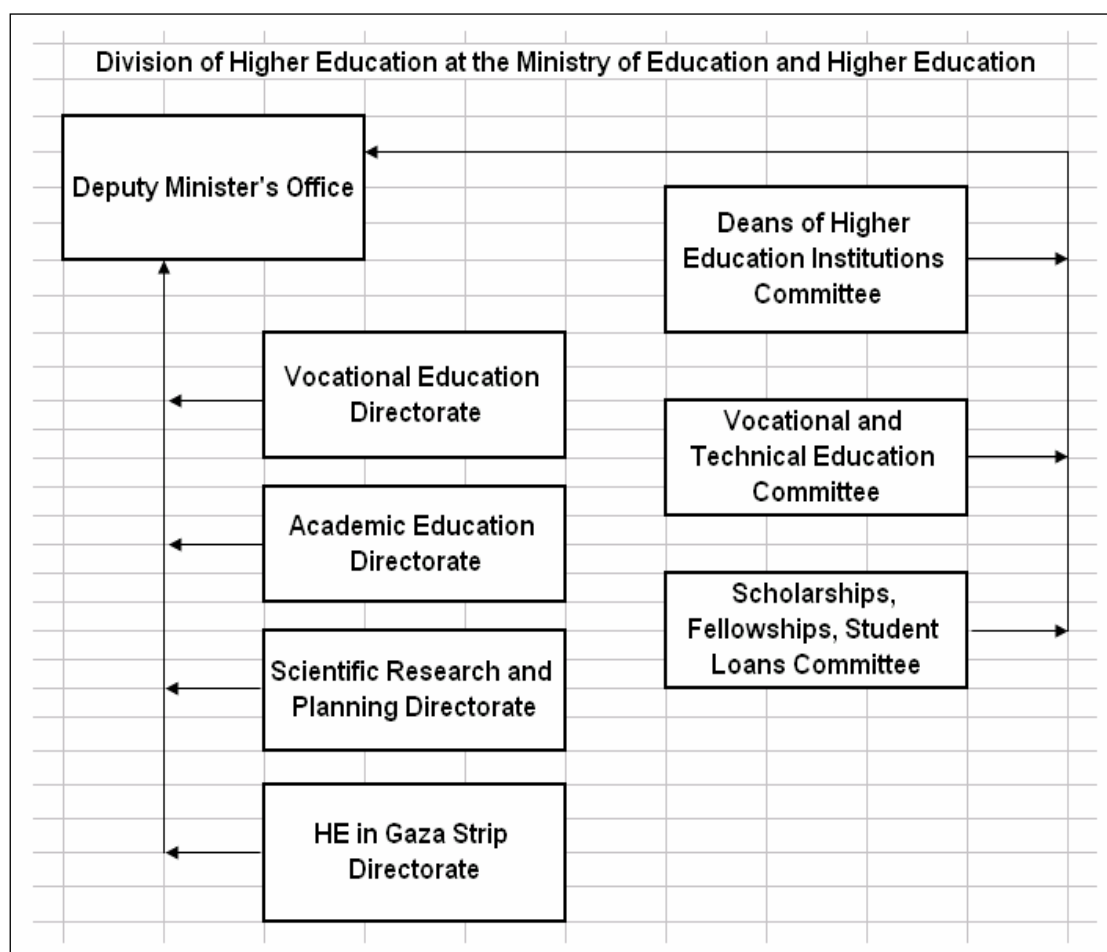
- HEMIS database architecture
- Data communications topology between HE institutions and MOEHE
- Data collection options for HE institutions with limited or no MIS capabilities

## Role Players in Palestinian Higher Education

### The Division of Higher Education at MOEHE

The diagram below illustrates the structure of the Division of Higher Education at the Ministry.

**Figure 1: Structure of Division of HE at MOEHE**



The Deputy Minister is directly responsible for Palestinian HE. Four departments (directorates) in the Ministry report directly to the Deputy Minister, complemented by three working committees that include representatives from the Ministry as well as prominent individuals and professionals in the HE sector.

MOEHE is currently engaged in building up and strengthening its internal capacity, and capacity within the HE sector overall; in automating its internal working processes; in administering loans to HE students; and in supporting the development of a few selected high priority fields of study.

The Ministry's current internal operations are focused on:



*Capacity Building* Delivering training to high and middle level staff in MOEHE and for personnel from HE institutions; applying more rigid staff recruitment procedures

*Automation* Developing an advanced Higher Education Management Information System (HEMIS) to link the Ministry with HE institutions

*Financial Restructuring* Implementing financial reforms to increase efficiency and minimize costs

The three fields guiding the Ministry's internal work are a strong reflection of MOEHE's primary needs: to build capacity, to automate and modernize working processes, and enhance financial systems.

### Higher Education Institutions in Palestine

There are 41 HE institutions in Palestine, of which 11 are located in Gaza; 29 are located in Jerusalem and the West Bank, and one Open University which operates campuses across urban locations in both the West Bank and Gaza.

Of the 41 institutions, ten are universities that provide full undergraduate education, and postgraduate education to the Masters level. Ten university-colleges provide a full undergraduate education; and twenty colleges provide undergraduate educational programs below the Bachelor's level.

The following table shows the distribution of types of institutions across urban locations in Palestine.

Type of Institution	Gaza					West Bank										Jerusalem	Overall
	Gaza	Rafah	Deir Al Balah	Khan Yunis	GAZA TOTAL	Ramallah	Birzeit	Bethlehem	Hebron	Nablus	Jenin	Tulkarem	Qalqilia	W/B TOTAL			
U	3				3		1	1	2	1	1			6	1	10	
U-C	1		1	2	4	3		1				1	1	6		10	
C	3	1			4	4		2	3	4				13	3	20	
<b>TOTALS</b>	<b>7</b>	<b>1</b>	<b>1</b>	<b>2</b>	<b>11</b>	<b>7</b>	<b>1</b>	<b>4</b>	<b>5</b>	<b>5</b>	<b>1</b>	<b>1</b>	<b>1</b>	<b>25</b>	<b>4</b>	<b>40</b>	
Open U	Operates branches countrywide														1		
<b>Overall Total</b>															<b>41</b>		

(U = Universities, U-C = university-colleges, C = Colleges, Open U = Open University)

In 2001/2, approximately 85,000 to 90,000 students were enrolled in some form of higher education<sup>2</sup>. High population growth has seen the number of high-school graduates increase at a rate of 9% annually. At the start of the 2005/6 academic year, it is estimated that the number of new entrants to higher education (i.e. high-school graduates) will reach 40,000 individuals. The total number of students in HE is expected to double between the 1999/2000 and 2005/6 academic years.<sup>3</sup>

Building capacity within the HE sector is of key importance so that HE institutions will be able to accommodate the increased demand, without comprising the quality of educational services provided.

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<sup>2</sup> *An Assessment of Higher Education Needs in the West Bank and Gaza*, Maher Hashweh, Mazen Hashweh, Sue Berryman, USAID/AED, September 2003. Page 6

<sup>3</sup> *Ibid*, Page 5

## Chapter One: Assessment of Ministry's IT Systems

### *Introduction*

The Division of Higher Education at MOEHE has its own stand-alone Local Area Network (LAN), independent of the Ministry's network. The LAN is composed of two servers, router, switches, patch panel, and infrastructure cabinets. Sixty Six (66) PC clients are attached to the network. Internet access is available through a **128 Kb/s WAN** link with the Government Computer Center (GCC).

Use of the network is limited to providing basic services:

- E-mail
- Office applications
- File and print share
- Internet access

Correspondence between employees is through paper memos only. There are two types of memos, one used for general communication amongst employees, the other used for communication between managers.

The network administrators at MOEHE communicate electronically using the NetSend program.

The Ministry is currently collecting some data from HE institutions using Excel-based templates. Institutions have the option to either enter the data directly into the excel workbooks and e-mail the files back to the Ministry, or receive and complete hard copies of the templates which are returned to the Ministry in hard-copy format.

Some of the important limitations of the current process include:

- The method is labor-intensive and requires duplicated effort: data is received in multiple formats and has to be re-integrated into one central location for reporting and analysis. Since the processing component is manual, the amount of analysis that is provided on the data is limited.
- Excel templates are limited, and do not provide the comparative and dynamic features of an industrial strength database engine.
- Universities are required to provide calculated information rather than raw data. Universities determine their own definitions and reporting methodology rather than following a Ministry-set standard.
- Through using the Excel template-based system, HE institutions do not feel compelled to adopt MIS software applications and modules.

## *Network Configuration*

### *Network and Data Storage*

The infrastructure of the communications is composed of a proxy server, PDC<sup>4</sup> server, router, switches, patch panel, and others as cabinets.

### *Logical Network Layout*

The Ministry of Higher Education network has no partitions. It has two servers, a proxy server and a PDC server. The user should go through the ISA firewall for access outside the network.

### *Web Services*

MOEHE does not have a web server, it has an outsourced hosting of its website, <http://www.mohe.gov.ps> and an intranet page which is currently being developed.

### *Physical Network Layout*

The LAN consists of 66 client desktops. It has two servers, a proxy server and a PDC server. The proxy server has a real IP address from the Government Computer Center (GCC), and MOEHE is connected to the Internet through a **128 Kb/s WAN** link with GCC.

### *Services Layout*

MOEHE uses a Windows 2000 active directory to provide services to users. Inside the active directory is the **Home Server Operations Master**. This performs the main functions of the PDC. The PDC also serves as a backup server and for DNS and email. The Home server also holds the users' profiles and the users' home directories.

The proxy server serves as an Internet gateway, with a real IP taken from GCC. It has two network cards or IPs – one real, and one virtual - each with its own IP address. The Virtual IP is used for the LAN.

### *Network Security*

The Ministry of Higher Education uses basic Windows Operating Systems based security to control privileges and access resources. Security levels are defined by classifying users into groups.

### *Backup System and UPS*

- MOEHE network uses CDs for backing up the data.
- There is no archiving system
- There is no UPS

### *Minor Branches*

MOEHE is headquartered in Ramallah, with additional branch offices in 17 locations. There is no information about the network infrastructure in these branches, or their connectivity to Ramallah HQ.

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<sup>4</sup> PDC: Primary Domain Controller

*Hardware / Software Configuration**Home Server (PDC)*

The PDC works as a backup server and DNS. It hosts the operations master and active directory. Its configurations are as follows:

<b>Table 2: System Summary for PDC Server</b>	
<b>Item</b>	<b>Specifications</b>
<b>OS Name</b>	Microsoft Windows 2000 Server.
<b>Version</b>	5.0.2195 Service Pack 3 Build 2195
<b>OS Manufacturer</b>	Microsoft Corporation
<b>System Name</b>	MOHER-DOMAIN
<b>System Manufacturer</b>	Dell Computer Corporation
<b>System Model</b>	PowerEdge 2500
<b>System Type</b>	X86-based PC
<b>Processor</b>	x86 Family 6 Model 11 Stepping 1 GenuineIntel ~1263 MHz
<b>Processor</b>	x86 Family 6 Model 11 Stepping 1 GenuineIntel ~1263 MHz
<b>BIOS Version</b>	Phoenix ROM BIOS PLUS Version 1.10 A04 Intel P4
<b>Hard Disk</b>	SCSI 15 GB
<b>Tape Driver</b>	
<b>Windows Directory</b>	C:\WINNT
<b>System Directory</b>	C:\WINNT\system32
<b>Boot Devices</b>	Device\Harddisk0\Partition2
<b>Locale</b>	USA
<b>User Name</b>	MHE-DOMAIN\administrator
<b>Total Physical Memory</b>	1,048,048 KB
<b>Total Virtual Memory</b>	2,098,264 KB
<b>Page File Space</b>	1,050,216 KB
<b>Page File</b>	C:\pagefile.sys

*Software Versions*

- Microsoft Windows 2000 Server, Version 5.0.2195 Service Pack 3 Build 2195
- ArcServer is the software used for the data backup (version 7, licensed)
- Remote Administrator version 7.2.1, not licensed
- Norton Antivirus version 60505h, licensed

*ISA or Proxy Sever*

The ISA server acts as a proxy server for MOEHE staff who request Internet access. The ISA server uses the leased-line connection as the domain controller server. The ISA server runs Norton antivirus to reduce the load on the domain controller when staff update their antivirus software.

<b>Table 3: System Summary for ISA Server</b>	
<b>Items</b>	<b>Specifications</b>
<b>OS Name</b>	Microsoft Windows 2000 Server.
<b>Version</b>	5.0.2195 Service Pack 4 Build 2195
<b>OS Manufacturer</b>	Microsoft Corporation.
<b>System Name</b>	MOHE.
<b>System Manufacturer</b>	VIA Technologies, Inc.
<b>System Model</b>	VT8653-8233
<b>System Type</b>	X86-based PC.
<b>Processor</b>	x86 Family 6 Model 11 Stepping 1 GenuineIntel ~1263 MHz

<b>BIOS Version</b>	Award Modular BIOS v6.00PG
<b>Hard Disk</b>	SCSI 40 GB
<b>Windows Directory</b>	C:\WINNT
<b>System Directory</b>	C:\WINNT\system32
<b>Boot Devices</b>	Device\Harddisk0\Partition1
<b>Locale</b>	USA
<b>User Name</b>	MOHE\Administrator
<b>Total Physical Memory</b>	523,760 KB
<b>Total Virtual Memory</b>	1,089,640 KB
<b>Page File Space</b>	1,277,968 KB
<b>Page File</b>	C:\pagefile.sys

*Software Versions*

- Microsoft Windows 2000 Server. Version: 5.0.2195 Service Pack 4 Build 2195
- Norton Antivirus version 60505h, licensed. User managed by server
- ISA Server 2000 Enterprise version (caching, reporting firewall)
- Cyber Gage for monitoring the leased-line (not licensed)

*Routers, Switches and Cabinet*

<b>Items</b>	<b>Description</b>	<b>Quantity</b>	<b>Notes</b>
Routers	CISCO 2500 series, has two serials ports and two Ethernets ports	1	
Switches	3com daemon switches: 24 ports 10bax T/100base TX auto sensing switch with simple SNMP module (manageable)	6	3 additional unmanaged switches will be added
Cabinets	Which holds the router and the switches and the patch panel, which consists of 24 ports, inside the cabinets	4	There are 3 cabinets that will come in the future.
Patch Panel	24 ports	4	3 additional are necessary; will come in the future
Database Server	For database objective	1	Future addition

*Software Applications*

- MS Office
- Norton Client
- Acrobat Reader 5.0 or 6.0, not licensed
- Oracle (based on a project operated by ATS)
- WinZip

*IT Personnel*

The Division of Higher Education at MOEHE employs two IT staff.

1. Head of Information Systems Department

- *Education:* B.Sc. Computer Systems Engineering
- *Training:* MSCE; A+; 3D MAX; Photoshop; Corel Draw
- *Qualifications:*
  - Networking Support and Administration, for Hardware (PC and Server), MSCE
  - Networking Support/Administration, for Software (Operating System), Graphic Design, Databases
  - Communications (Leased Line, Dialup)
  - Database Administration (Access)
  - Reporting (Access Data Reports)
  - Data Analysis: Database analysis and software systems analysis.
  - End User Technical Support

2. Networking and Maintenance Chief Officer

- *Education:* B.Sc. Computer Systems' Engineering
- *Training:* MSCE 2003; A+; Access
- *Qualifications:*
  - Networking Support and Administration for Hardware (PC and Server)
  - Networking Support and Administration for Software (Operating System); Win XP and Windows 2003
  - Communications (Leased Line, Dialup)
  - Database Administration: Access
  - Reporting Tools: Access Data Reports
  - End User Technical Support

In order to support HEMIS, it is evident that the Ministry will have to recruit additional specialized IT personnel.

## Chapter Two: Requirements Definition

The requirements definition defines HEMIS functional, information and reporting requirements.

*Functional Requirements* are the functions that HEMIS is required to perform to enable users to utilize the system

*Information Requirements* lists the indicators, variables and formulas on higher education from which data elements can be extracted

*Report Requirements* lists the reports that HEMIS is required to generate. Reports can either be static, referring to a particular data element, or comparative i.e. comparing two or more data elements simultaneously

### 1. Functional Requirements

The diagram on the next page illustrates HEMIS functional requirements.

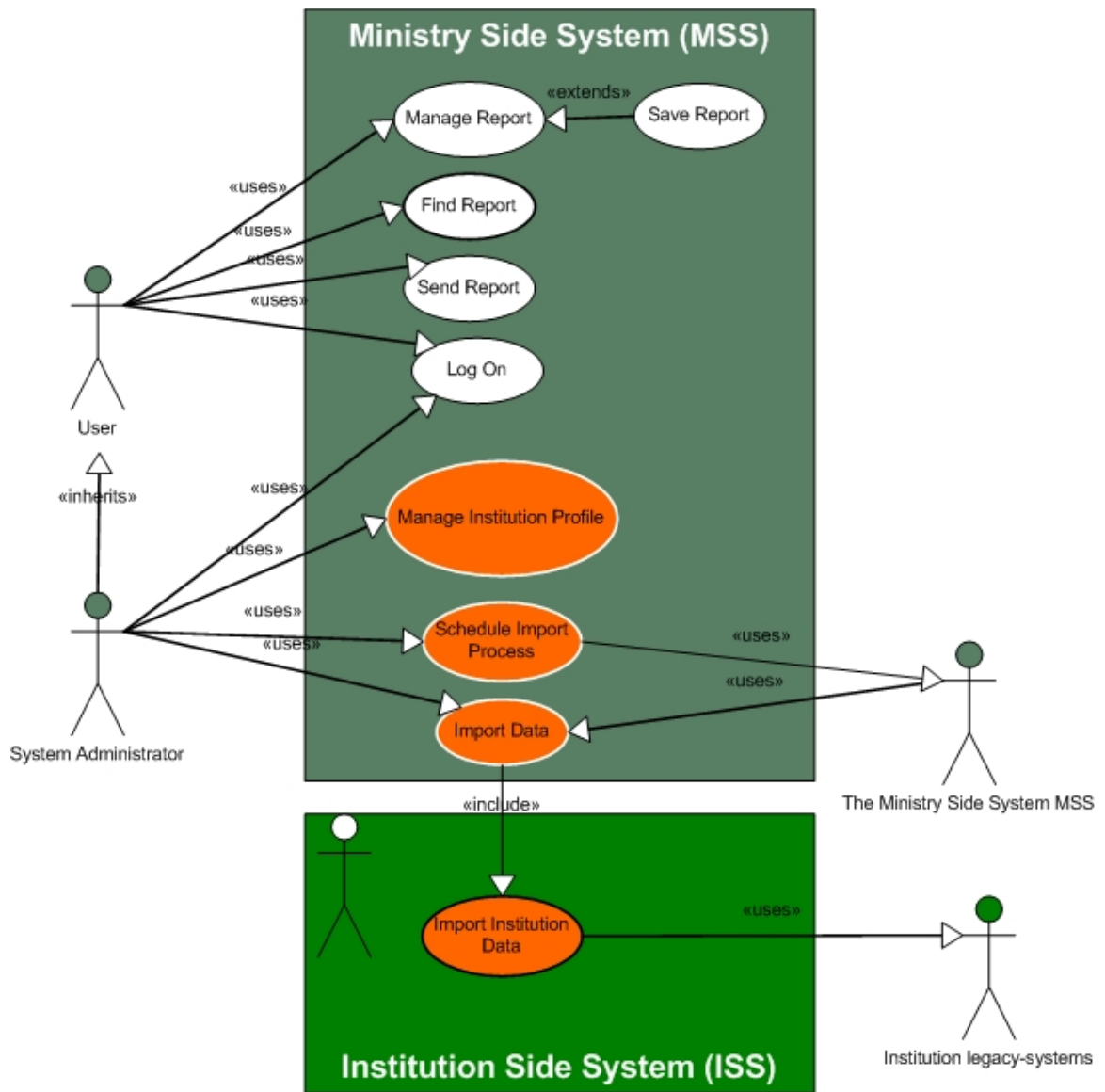
At the MSS, users and administrators interact directly with the system through logging onto the system, managing reports, finding reports, saving reports, sending reports and managing institution profiles.

At the ISS, users (administrators at HE institutions) interact directly with the interface by importing data to the ISS on the institution.

The ISS and MSS interact in order to import institution-specific data, with data migrating from the ISS to the MSS. End users at the MSS schedule import processes from ISSs.



Figure 2: Functional Requirements



Nine Use Cases were identified, as listed below

<b>Table 5: Use Case Descriptions</b>	
<b>Use Case</b>	<b>Description</b>
Find Report	Process for finding a report (search)
Manage Reports	Processes required for creating, saving, deleting, printing, exiting, and displaying reports
Schedule Import Process	Process required to build a schedule (timetable) for imminent data-import operations from ISSs (institutions) to the MSS (Ministry)
Send Report	Process required for sending a report to a person or a group of persons
Save Report	Process required to save reports
Import Data	Mechanism in which the data is imported from ISSs (institutions), and saved to the MSS (Ministry)
Import Institution Data	Internal ISS mechanism by which data is collected, packaged and sent to the Ministry
Login	Allows the operator or administrator or searcher to log onto the system
Manage Institution Profile	Functions required to manage, create, edit, and delete a profile for a HE institution

Please see [Annex B: Use Cases \(Functional Requirements\)](#) for an identification and description of each Use Case.

## **2. Information Requirements**

Massar proceeded to identify the information requirements – namely, the indicators, formulae and data elements that needed to be included into the system.

The project team worked with MOEHE staff to identify the type of information that they required and undertook additional desk research to extract variables and formulas from resources on HE.

The project team identified 225 variables, formulas and reports, divided into eight categories:

- Student Indicators
- Staff Indicators
- Financial Indicators
- Research Indicators
- Outcome Indicators
- Management / Governance Indicators
- Institution Indicators
- Country Wide Indicators

Please see [Annex C: Indicators, Variables, Formulas \(Information Requirements\)](#)

### 3. Report Requirements

Massar and MOEHE identified the reports that are required by the Ministry in order to facilitate planning, monitoring and budgeting.

113 reports were identified, across seven categories:

- Financial Reports
- Institution Reports
- Management And Governance Reports
- Outcome Reports
- Research Reports
- Staff Reports
- Student Reports

Reports are classified into High Priority Reports (those that are essential to MOEHE); Intermediate Priority Reports (reports that are important, yet not crucial) and Low Priority Reports (additional reports that are not crucial to planning, but nonetheless provide useful insights on Palestinian HE). The following table catalogues the distribution of reports by High, Intermediate, and Low Priority status across the seven main categories.

<b>Table 6: Report Prioritization</b>				
<b>Area</b>	<b>Number of Reports that are:</b>			<b>Total # of Reports</b>
	<b>High Priority</b>	<b>Intermediate Priority</b>	<b>Low Priority</b>	
Student Reports	35	7	10	<b>52</b>
Staff Reports	10	1	3	<b>14</b>
Financial Reports	14			<b>14</b>
Research Reports	2		2	<b>4</b>
Outcome Reports	3		2	<b>5</b>
Management / Governance Reports	1	1		<b>2</b>
Institution Reports	12	9	1	<b>22</b>
<b>Grand Total</b>	<b>77</b>	<b>18</b>	<b>18</b>	<b>113</b>

Details on report titles, contents, and prioritization can be found in Annex D: Reports (Report Requirements).

## Chapter Three: HEMIS Proto-Design

The proto-design phase developed three primary tools:

### *Database Dictionary*

Five primary subject areas were identified:

1. Finance
2. Institution
3. Research
4. Staff
5. Student

In these five areas, data needs to be gathered directly from HE institutions. One additional subject area, entitled "Country Wide", is required to provide MOEHE with macro-educational and socioeconomic data.

Within the six subject areas, 401 raw data elements were identified, that need to be included in HEMIS. These 401 elements are distributed across 122 entities (tables). Definitions have been provided for all raw data elements and tables.

Please see [Annex E: Data Dictionary](#) to review definitions.

### *Database Schema*

- Includes six subject areas (as listed above)
- Identifies 122 entities (tables) for all six subject areas
- Records 401 attributes (data elements) within the 122 entities
- Specifies type, form, content, length, and importance of each entity and the attributes within it

Please see [Annex F: Database Schema](#) to review the schema.

### *Schema Diagrams*

Seven diagrams are provided:

- *HEMIS Overall* containing all subject areas, their entities and attributes
- *Student Subject Area* containing all entities and attributes related to students
- *Staff Subject Area* containing all entities and attributes related to staff
- *Institution Subject Area* containing all entities and attributes related to institutions
- *Finance Subject Area* containing all entities and attributes related to finance
- *Research Subject Area* containing all entities and attributes related to research
- *Country Wide Subject Area* containing additional entities and attributes related to countrywide data e.g. GNP, population statistics and unemployment rates

The diagrams also identify entity-entity and entity-attribute relationships; and 'rank data within each entity'.

Please see [Annex G: Schema Diagrams](#) to review the diagrams.

## Chapter Four: IT Gap Analysis

### Methodology for IT Gap Analysis

Data collection – the gathering of information from HE institutions and feeding it into a central information system – is a key business process in HEMIS. Resultantly, institutions are required to collect non-subjective, real-time data by utilizing specialized university administration software applications.

Such software applications are designed to provide data that is non-subjective (based on automated calculations and not on manual data estimation and entry) and real-time (continuously updated). Usually, these applications comprise data modules in which raw data is entered, and a legacy system (backend database) that gathers data, generates calculations, and provides reports.

Therefore the utilization of such software applications for data collection and transmission purposes is of prime-importance to HE institutions and HEMIS. These sophisticated systems need to be supported by highly-specialized personnel and backend infrastructure components.

For a fully-functioning HEMIS, the minimal infrastructure components that must be adopted by HE institutions (for data collection and transmission) include:

- Dedicated database server
- Dedicated administration PC clients (for administrative staff, i.e. not students)
- Software application (specialized modules for HE administration)
- IT staff with required technical skills to support the MIS systems at the institution
- High speed communication link - (128K or better) between institution and MOEHE

The goal of the IT gap analysis was to measure each individual institution's ability to provide data to HEMIS through an automated process. The IT gap assessment aimed to generate answers to these key questions regarding each HE institution:

- Does the institution have the necessary modules that can facilitate connectivity to, and exchange data with, HEMIS?
- Are these modules integrated or integrate-able through a backend database system?
- Does the institution have the necessary bandwidth (high-speed connections) to transmit the data to the MOEHE?
- Most crucially, does the institution have the skilled IT staff to operate and support these systems?

The analysis measured the gap between the actual state, and desired state, of five categories:

- Hardware
- Database Systems
- Software
- Connectivity
- Staff

The gap assessments relied on assigning scores to each of the five categories. An institution would score 100% (the maximum in each category) if its existing systems exactly matched those required by HEMIS; a score of less than 100% if its system complemented HEMIS requirements to an extent; and 0% if no system existed to meet HEMIS requirements.

Within each category, the point allocation was weighted as follows:

**Hardware:**

- 50% allocated to the availability and state of dedicated servers for hosting database system
- 50% allocated to number of PC's dedicated to administration; and PC-administrative staff ratio

**Database:**

- 100% allocated to having a Database system regardless of type (Oracle, SQL Server, Access), otherwise 0%

**Software:**

- Based on the availability of specialized software module for management and administration of each of 8 departments:
  1. Administration
  2. Facilities and Services
  3. Finances
  4. IT Department
  5. Library
  6. Personnel
  7. Planning and Information
  8. Registration
- Modules can be ready; or need customization; or are not available
- In the gap analysis, each module is assigned an equal weight:
  - If the module is ready, it receives a score of 12.5%
  - If the module needs customization, it receives a score of between 0 and 12.5%, depending on the extent of customization required
  - If the module is not available, receives a score of 0%
- The aggregate score for the software gap analysis is the sum of the scores received for each of the eight modules

**Internet Connectivity:**

- 100% allocated to fast fixed Internet lines (128K+)
- 75% allocated to fixed line internet connectivity less than the (128K)
- 50% allocated to dialup connections

**Staff:**

- Measured in "Software Category" as part of "IT Department Module"

## Country Wide IT Gap Analysis Findings

The table below illustrates the percentage scores for type of HE institution, based on the Analysis Components defined above.

IT Gap Analysis Component	Score (%)				
	Overall	Universities	University Colleges	Colleges	Open University
<b>Hardware</b>	72	100	73	56	100
<b>Database Software</b>	68	100	60	55	100
<b>Software Modules</b>	48	71	26	42	76
<b>Internet Connectivity</b>	78	100	60	75	100
<b>IT Staff</b>	55	83	40	46	90

### *Overall*

- Hardware and Internet connectivity are the two areas in which HE institutions are close to meeting HEMIS' requirements
- Institutions need to adopt more advanced database software and software modules
- Training for IT staff is required – almost half (45%) of the required skills are not available

### *Hardware*

- Universities and the Open University have the required hardware to support HEMIS
- Hardware upgrades are required for colleges and university-colleges

### *Database Software*

- Universities and the Open University have the required database software to support HEMIS
- Colleges and university-colleges need to upgrade their database software in order to support HEMIS

### *Software Modules*

- Universities and the Open University need to upgrade their software modules in order to match HEMIS' requirements
- Colleges and university colleges need to adopt software modules into their IT systems



***Internet Connectivity***

- Universities and the Open University have the required connections to support HEMIS
- Colleges and university-colleges need to deploy better standard communication technologies

***IT Staff***

- Universities and the Open University require a modest amount of training for their staff
- Colleges and university-colleges need substantial training and need to employ additional specialized staff

***Universities and Open University***

- Best equipped to connect with HEMIS, scoring full-marks in hardware, database software, and internet connectivity
- A modest amount of training is needed for their staff
- Customization of software modules is required

***Colleges and University-Colleges***

- Upgrades are required for hardware and internet connectivity
- Most need to adopt database software and software modules; a smaller number require substantial customization of existing database software and software modules
- Substantial training of IT staff is required, as well as additional recruitment

***Status of Software Modules***

The technical team determined that a comprehensive Institution Administration Software Application should comprise eight essential software modules:

1. Administration
2. Facilities and Services
3. Finances
4. IT Department
5. Library
6. Personnel
7. Planning and Information
8. Registration

**Table 8: Overall Status of IT Software Modules**

Module Status	Software Modules								Totals
	IT Department	Registration	Finances	Personnel	Administration	Library	Facilities and Services	Planning and Information	
<b>Ready</b>	17	2	7	1	0	13	3	1	44
<b>Customizable</b>	6	31	18	22	25	12	7	4	125
<b>Not Available</b>	18	8	16	18	16	16	31	36	159
<b>TOTAL</b>	41	41	41	41	41	41	41	41	328

The table above provides data on the availability of specific software modules. For a total of 41 institutions, the cumulative total of all software modules is 328. Of these 328, 169 modules (52%) are available (either ready or need customization) and 48% are not available. Of the available modules, 26% are ready, and 74% require customization.

Almost all institutions are missing a "Planning Module" (88%) and most are also missing the "Facilities and Services Module" (76%). The "Registration Module" was the most readily available.

See [Annex I: Status of IT Software Module by Institution](#) to review the performance of each institution.

### **Planned IT Implementations over the next 12 months**

As far as applicable IT implementations and upgrades at HE institutions, the following was noted:

- One institution plans to purchase and implement a student registration module
- One institution plans to purchase and implement a library management module
- Six institutions plan to migrate their data to a database backend system

## Chapter Five: Data Elements Gap Analysis

### Methodology for IT Gap Analysis

Using the developed information system as a benchmark, the project team undertook a *gap analysis* to measure the disparities in data element availability between what is required (as determined by the benchmark) and what is available (based on existing information sources at higher education institutions).

The gap analysis was conducted within five subject areas, based on three levels of information hierarchy:

- *Subject Areas*: The macro-topics in the information system.
- *Entities*: Information sub-categories within each subject area
- *Attributes*: Individual data elements in each entity

The gap analysis was based on five subject areas:

- Finance
- Institution
- Research
- Staff
- Student

The "Country-Wide" subject area was excluded from the gap analysis, as the data elements therein need to be collected from sources that are not HE institutions e.g. Ministry of Labor, Bureau of Statistics and others.

The table below records the tables (entities) and attributes that were used in the Gap Analysis for the Institution Subject Area.

<b>Table 9: Entities and Attributes in Institution Subject Area</b>	
<b>Tables (Entities)</b>	<b>Attributes</b>
Institution	<ol style="list-style-type: none"> <li>1. Institution Name</li> <li>2. Institution District</li> <li>3. Institution President</li> <li>4. Institution Establishment Year</li> <li>5. Institution PO Box</li> <li>6. Institution Telephone</li> <li>7. Institution Fax</li> <li>8. Institution Type</li> <li>9. Institution Governing Authorities</li> <li>10. Institution Enforcement Accreditation Procedures</li> <li>11. Institution System-wide Institutional MIS</li> <li>12. Institution Financial Reporting Budgeting Systems</li> <li>13. Institution Documented Annual Plans</li> <li>14. Institution Documented Staff Development Plans</li> <li>15. Institution Equity Groups Gender Policy</li> <li>16. Institution Official Complaints Number</li> <li>17. Institution Written Mission Statements</li> </ol>

	18. Institution Inform Staff Employee Mission Statement 19. Institution Goals And Objectives Written
Boards	20. Boards Type Of Board 21. Regular Meetings Number 22. Actual Meetings Number 23. Provide Financial Oversight
Boards Members	24. Boards Members Name 25. Board Type 26. Members Position 27. Members Qualifications
Campuses	28. Campus Name 29. Description 30. Building Area 31. Campus Location 32. Campus Total Area Of All University Property 33. Campus Forecasted Increase In Construction And Buildings 34. Campus Planned Increase In Construction And Buildings
Buildings	35. Buildings Name 36. Location 37. District 38. Campus 39. Number Of Floors 40. Floors Area 41. Class Room Number 42. Total Area Of Normal Class Rooms 43. Number Of Administration Offices 44. Total Area Of Administration Offices
Academic Facilities	45. Academic Facilities Name 46. Building Name 47. Facilities Type 48. Users 49. Location 50. Description 51. Total Area 52. Capacity
Non Academic Facilities	53. Non Academic Facilities Name 54. Non Academic Facilities Building Name 55. Non Academic Facilities Type 56. Non Academic Facilities Location 57. Non Academic Facilities Description 58. Non Academic Facilities Area 59. Non Academic Facilities Capacity
Accommodation	60. Accommodation Name 61. Target Group 62. Personnel Capacity 63. Bedrooms Number 64. Total Area 65. Facilities Total Area
Library	66. Library Number Of Seats In Library

	67. Library Number Of Borrowed Books 68. Library Number Of Borrowers 69. Library Electronic System 70. Library Working Hours 71. Library Specialized Non Specialized Staff
Library Resources	72. Library Resources Type 73. Library Resources Title 74. Library Resources Number Of Copies 75. Library Resources Language
Non Academic Departments	76. Non Academic Department Name 77. Non Academic Department Type 78. Non Academic Department Normal Employee Load
Faculty	79. Faculty Name
Academic Departments	80. Academic Department Name 81. Normal Employee Load
Programs	82. Program Name 83. Program Description 84. Program Faculty 85. Program Academic Department 86. Program Credit hours 87. Program Degree 88. Program Number Of years 89. Program Non Degree Programs 90. Program Hour Fees Per Program 91. Program Typical Age 92. Program Starting Date 93. Program Accreditation 94. Program Lowest Admission Score 95. Courses ID
Courses	96. Courses Names 97. Courses Number 98. Course Faculty 99. Course Department 100. Course Program 101. Course Credit Hours 102. Course Nominal Hours 103. Course Class Hours 104. Course Lab Hours 105. Course Lecture Hours 106. Course Teaching Time

The table below records the tables (entities) and attributes that were used in the Gap Analysis for the Finance Subject Area.

<b>Table 10: Entities and Attributes in Finance Subject Area</b>	
<b>Tables (Entities)</b>	<b>Attributes</b>
Expenditures	1. Expenditures Salaries Full Time Academic Educational 2. Salaries Of Part-Time Academic Educational 3. Expenditure Salaries Of Full-Time Academic Administrative

	<ol style="list-style-type: none"> <li>4. Expenditure Salaries Of Part-Time Academic Administrative</li> <li>5. Expenditure Salaries Of Full-Time Academic Research</li> <li>6. Expenditure Salaries Of Part-Time Academic Research</li> <li>7. Expenditure Salaries Of Clerical</li> <li>8. Expenditure Salaries Of Research Educational Assistant</li> <li>9. Expenditure Salaries Of Professional</li> <li>10. Expenditure Salaries Of Technical</li> <li>11. Expenditure Salaries Of Unskilled</li> <li>12. Expenditure Salaries Of Professors</li> <li>13. Expenditure Salaries Of Assistant Professors</li> <li>14. Expenditure Salaries Of Participant Professors</li> <li>15. Expenditure Salaries Of Lecturers</li> <li>16. Expenditure Salaries Of Teachers</li> <li>17. Expenditure Salaries Of Graduate Assistants</li> <li>18. Expenditure Total Salary</li> <li>19. Expenditure Salaries Related Expenses</li> <li>20. Expenditure Exempt Of Student Fees</li> <li>21. Expenditure Procurement Of Books</li> <li>22. Expenditure Procurement Of LabTools</li> <li>23. Expenditure Academic Support And Student Services Expenses</li> <li>24. Expenditure Auxiliary Services Expenses</li> <li>25. Expenditure Community Units Expenses</li> <li>26. Expenditure General Management And Administrative Expenses</li> <li>27. Expenditure Library Expenses</li> <li>28. Expenditure Health Insurances Expenses</li> <li>29. Expenditure Other Insurances Expenses</li> <li>30. Expenditure Expenses Of Rented Facilities And buildings</li> <li>31. Expenditure Taxes</li> <li>32. Expenditure Total Operating Expenditure</li> <li>33. Expenditure Capital Investment</li> <li>34. Expenditure Capital Building</li> <li>35. Expenditure Capital Facilities Labs</li> <li>36. Expenditure Capital Facilities Library</li> <li>37. Expenditure Capital Teaching Equipments Furniture</li> <li>38. Expenditure Total Capital Expenditure</li> <li>39. Expenditure Total Expenditure</li> </ol>
Revenues	<ol style="list-style-type: none"> <li>40. Revenue Student Fees Full-Time</li> <li>41. Revenue Student Fees Part-Time</li> <li>42. Revenue Student Loans</li> <li>43. Revenue Sales Of Good And Services</li> <li>44. Revenue Research Fees</li> <li>45. Revenue Consultation Fees</li> <li>46. Revenue Total Operation Revenue</li> <li>47. Revenue Public Subsidies</li> <li>48. Revenue Donor Grants</li> <li>49. Revenue Donation Private</li> <li>50. Revenue Donation Public</li> </ol>

	51. Revenue Transfers 52. Revenue Scholarships 53. Revenue Institution Loans 54. Revenue From Investment 55. Revenue Total Non Operating Revenue 56. Revenue Total Revenue 57. Revenue Public Expenditure For Infrastructure 58. Revenue Public Expenditure For Wages
Diversified Sources of Funding	59. Diversified Source Of Funding Source Of Funding 60. Diversified Source Of Funding Amount
Financial Sustainability and Planning	61. Financial Sustainability Having Control Expenditure procedures 62. Financial Sustainability Having Internal Auditors 63. Financial Sustainability Total Budget 64. Financial Sustainability Recurrent Budget 65. Financial Sustainability Financial Gap 66. Financial Sustainability Average Student Cost 67. Financial Sustainability Have Annual Budget Projections 68. Financial Sustainability Follow These Budget Projections 69. Financial Sustainability Monitor Budgets And Spending Regularly 70. Financial Sustainability Have Strategy For Funding Diversification 71. Financial Sustainability Have An Income Generating Plan

The table below records the tables (entities) and attributes that were used in the Gap Analysis for the Student Subject Area.

<b>Table 11: Entities and Attributes in Student Subject Area</b>	
<b>Tables (Entities)</b>	<b>Attributes</b>
Student	1. Student Registration Number 2. Student First Name 3. Student Father Name 4. Student Grand father Name 5. Student Family Name 6. Student Date Of Birth 7. Student Gender 8. Student Minorities 9. Student Disabled 10. Student Place Of Origin 11. Student Nationality 12. Student So_Ec Total Household Income Per Month 13. Student So_Ec Number Of Individuals In Household 14. Student So_Ec Income Earner Educational Attainment 15. Student So_Ec Income-earner's Type Of Employment 16. Student So_Ec Mother Educational Attainments 17. Student So_Ec Mother Type Of Employment 18. Student So_Ec Ownership Of Place Of Residence 19. Student District 20. Student District Types

	21. Student High School Source 22. Student High School Location 23. Student High School Year Of Graduation 24. Student High School Average Score 25. Student High School Branches 26. Student Destination Of Applicants HE Institution 27. Student Destination Of Applicants Faculty 28. Student Destination Of Applicants Program 29. Student Accepted 30. Student Destination Of Acceptance HE Institution 31. Student Destination Of Acceptance Faculty 32. Student Destination Of Acceptance Program 33. Student Social Status 34. Student Application Date 35. Student Acceptance Date 36. Student Institution Code
Student Enrollment	37. Student Enrollment Year 38. Student Enrollment Student ID 39. Student Enrollment Semester 40. Student Enrollment Type 41. Student Enrollment Model 42. Student Enrollment Faculty 43. Student Enrollment Major Program 44. Student Enrollment Minor Program 45. Student Enrollment Intended Attainment 46. Student Enrollment Typical Enrollment Load 47. Student Enrollment Level 48. Student Enrollment Accumulated Credit Hours 49. Student Enrollment Accumulated Average 50. Student Enrollment Status 51. Student Enrollment Full Part time
Student Enrollment Details	52. Student Enrollment Details Year 53. Student Enrollment Details Semester 54. Student Enrollment Details Student ID 55. Student Enrollment Details Course ID 56. Student Enrollment Details Class ID 57. Student Enrollment Details Score 58. Student Enrollment Details Course Status 59. Student Enrollment Details Course Type
Student Duration and Planning	60. Student Duration Number Of Enrolled Students At Beginning Of Current Year 61. Student Duration Number Of Enrolled Students At End Of Current Year 62. Student Duration Number Of Student In Their First Year 63. Student Duration Number Of student Leavers In Current Year 64. Student Duration Forecasted increase In Student Body 65. Student Duration Planned increase In Student Body
Student Enrollment Financing	66. Student Enrollment Financing Student ID 67. Student Enrollment Financing Year



	68. Student Enrollment Financing Semester 69. Student Enrollment Financing Fixed Charges 70. Student Enrollment Financing Student Fees Per Hour 71. Student Enrollment Financing Normal 72. Student Enrollment Financing Grant 73. Student Enrollment Financing Scholarships 74. Student Enrollment Financing Student Loans 75. Student Enrollment Financing Aid Student Enrollment Financing Exempt Fees
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The table below records the tables (entities) and attributes that were used in the Gap Analysis for the Staff Subject Area.

<b>Table 12: Entities and Attributes in Staff Subject Area</b>	
<b>Tables (Entities)</b>	<b>Attributes</b>
Staff	1. Staff First Name 2. Staff Father Name 3. Staff Grand father Name 4. Staff Family Name 5. Staff Gender 6. Staff Date Of Birth 7. Staff Nationality 8. Staff District 9. Staff Social Status 10. Staff Minorities 11. Staff Disabled 12. Staff Place Of Origin 13. Staff Education Attainments 14. Staff Specialization 15. Staff Graduation Country 16. Staff Graduation HE Institution 17. Staff Graduation Year 18. Staff Experience 19. Staff Enrolled College 20. Staff Enrolled Department 21. Staff Enrolled Program 22. Staff Staff Classification 23. Staff Position 24. Staff Contract Type 25. Staff Hire Date 26. Staff Academic Classification
Staff Employment	27. Staff Enrollment Staff ID 28. Staff Enrollment Year 29. Staff Enrollment Semester 30. Staff Enrollment Full Part Time 31. Staff Enrollment Working Status 32. Staff Enrollment Total Staff Load 33. Staff Enrollment Academic Load 34. Staff Enrollment Administrative Load 35. Staff Enrollment Research Load

	<ul style="list-style-type: none"> <li>36. Staff Enrollment Instruction Load</li> <li>37. Staff Enrollment Community Load</li> <li>38. Staff Enrollment Salaries</li> <li>39. Staff Enrollment Salary Related</li> <li>40. Staff Enrollment Training In Management And Leadership</li> <li>41. Staff Enrollment Training In General Areas Of Training</li> <li>42. Staff Enrollment Training In Educational Planning and economics</li> <li>43. Staff Enrollment Training In Educational Administration</li> <li>44. Staff Enrollment Training In General Pedagogy</li> </ul>
Staff Enrollment Details	<ul style="list-style-type: none"> <li>45. Staff Enrollment Details Course ID</li> <li>46. Staff Enrollment Details Staff ID</li> <li>47. Staff Enrollment Details Class ID</li> <li>48. Staff Enrollment Details Good teaching Course Evaluation Percentage</li> <li>49. Staff Enrollment Details Skills Gained Course Evaluation Percentage</li> </ul>

The table below records the tables (entities) and attributes that were used in the Gap Analysis for the Research Subject Area.

<b>Table 13: Entities and Attributes in Research Subject Area</b>	
<b>Tables (Entities)</b>	<b>Attributes</b>
Research	<ul style="list-style-type: none"> <li>1. Research ID</li> <li>2. Research Name</li> <li>3. Research Type</li> <li>4. Research Book Chapters</li> <li>5. Research Total Income Derived</li> <li>6. Research Field Of specialization</li> <li>7. Research Degree</li> <li>8. Research Status</li> <li>9. Research Research Fees</li> <li>10. Research Sponsored Fees</li> <li>11. Research Publisher</li> <li>12. Research Publishing Year</li> <li>13. Research Publisher Type</li> <li>14. Research Publisher Address</li> </ul>
Researchers	<ul style="list-style-type: none"> <li>15. Researcher First Name</li> <li>16. Researcher Father Name</li> <li>17. Researcher Grand father Name</li> <li>18. Researcher Family Name</li> <li>19. Researcher Gender</li> <li>20. Researcher Nationality</li> <li>21. Researcher District</li> <li>22. Researcher Place Of Origin</li> <li>23. Researcher Education Attainments</li> <li>24. Researcher Specialization</li> <li>25. Researcher Department</li> <li>26. Researcher Program</li> <li>27. Researcher Research Name And ID</li> </ul>

Given a high level of variance in the size of HE institutions (based on student and staff numbers), aggregated results were generated by using the following weights:

- Data elements in Institution, Finance, and Research Subject Areas are weighted equally across all institutions
- Data elements in Student Subject Area is weighted by the number of enrolled students at each institution
- Data elements in Staff Subject Area is weighted by the number of staff at each institution

For institution-specific reports, all data elements are weighted equally.

## Country Wide Data Elements Gap Analysis Findings

The matrix below provides a comprehensive summary of the findings of the data elements gap analysis.

Subject Area	Tables (Entities)	HE Institution - %age of Available Data Elements				
		U	C	U-C	Open U	Totals
<b>All</b>		<b>79</b>	<b>72</b>	<b>63</b>	<b>62</b>	<b>72</b>
<b>Staff</b>	<b>All Entities</b>	<b>70</b>	<b>48</b>	<b>63</b>	<b>76</b>	<b>68</b>
	Staff Enrollment Details	77	59	42	100	73
	Staff Enrollment	53	34	51	56	51
	Staff	81	43	76	85	79
<b>Student</b>	<b>All Entities</b>	<b>79</b>	<b>73</b>	<b>63</b>	<b>62</b>	<b>72</b>
	Student Duration and Planning	81	76	57	67	75
	Student Enrollment Details	97	89	77	88	92
	Student Enrollment Financing	94	78	63	73	85
	Student Enrollment	85	75	68	53	73
	Student	68	67	59	56	64
<b>Institution</b>	<b>All Entities</b>	<b>68</b>	<b>35</b>	<b>52</b>	<b>55</b>	<b>48</b>
	Institution	25	57	37	53	62
	Programs	22	42	44	29	55
	Courses	12	49	44	18	61
	Buildings	35	25	46	100	41
	Academic Facilities	45	24	51	0	40
	Campuses	34	21	49	43	40
	Non Academic Facilities	50	5	50	0	29
	Accommodations	82	0	82	100	9
	Library	45	39	60	83	43
	Boards	43	21	55	0	38
	Boards Members	18	34	50	0	51
	Library Resources	3	64	23	50	75
	Non Academic Departments	27	35	63	100	44
	Academic Departments	25	30	40	100	48
	Faculty	0	30	60	100	49
<b>Finance</b>	<b>All Entities</b>	<b>71</b>	<b>30</b>	<b>35</b>	<b>34</b>	<b>42</b>
	Expenditures	67	27	34	31	39
	Revenues	74	32	38	37	44
	Financial Sustainability and Planning	75	36	39	45	46
	Diversified Sources of Funding	90	40	20	0	46
<b>Research</b>	<b>All Entities</b>	<b>31</b>	<b>3</b>	<b>0</b>	<b>89</b>	<b>11</b>
	Research	33	4	0	79	12
	Researchers	29	2	0	100	11

(U = Universities, U-C = university-colleges, C = Colleges, Open U = Open University)

To review gap analyses for individual institutions, please see Annex K: [Institution Specific Gap Analysis Reports](#).

**Type A Observations – Subject Areas**

The following observations record the aggregate findings of the gap analysis.

***All Subject Areas***

- Data elements are *most readily* available in Student Subject Area
- Data elements are *readily* available in the Staff Subject Area
- Data elements are *least* available in Research Subject Area
- Availability is less than 50% in the Institution and Finance Subject Areas

***Student Subject Area***

- More than 70% availability for all tables (Entities)
- *Highest availability*: Student Enrollment Details and Student Enrollment Financing Tables
- *Moderate availability*: Student Duration and Planning and Student Enrollment Tables
- *Least available*: Student Table
- *Neglected areas*: information on applicants, students' socio-economic background

***Staff Subject Area***

- *Highest availability*: Staff Table
- *Moderate availability*: Staff Enrollment Details Table
- *Least available*: Staff Enrollment Table
- *Neglected areas*: information on staff training; staff performance evaluations

***Institution Subject Area***

- *Highest availability*: Library Resources, Institution Profile, Courses, Programs, and Boards Members Tables
- *Moderate availability*: Academic Departments, Non Academic Departments, Library, Buildings, Campuses, Academic Facilities, and Boards Tables
- *Least available*: Non Academic Facilities, and Accommodations Tables

***Finance Subject Area***

- Less than 50% availability in all tables

***Research Subject Area***

- Less than 20% availability for both tables

**Type B Observations - Institutions**

***All Institutions***

- Availability exceeded 60% for all 4 types of institutions
- 79% of data elements are available at universities
- 62% of data elements are available at Open University

***Universities***

- Highest availability: Student Subject Area
- Lowest availability: Research Subject Area
- Availability approximately 70% in Institution, Staff and Finance Subject Areas

**Colleges**

- Highest availability: Student Subject Area
- No availability: Research Subject Area
- Availability less than 50% in Institution, Staff and Finance Subject Areas

**University Colleges**

- Highest availability: Student and Staff Subject Area
- No availability: Research Subject Area
- Low availability: Institution and Finance Subject Areas

**Open University**

- Highest availability: Research Subject Area
- Least availability: Finance Subject Area
- Moderate availability: Student, Staff Subject Areas
- Low availability: Institution Subject Area

Type B observations are summarized in the table below:

<b>Table 15: Summary – Type B Findings</b>						
<b>Subject Area</b>	<b>Tables (Entities)</b>	<b>HE Institution</b>				<b>Totals</b>
		<b>U</b>	<b>C</b>	<b>U-C</b>	<b>Open U</b>	
<b>All</b>		H	H	M	M	H
<b>Staff</b>	<b>All Entities</b>	H	L	M	H	M
<b>Student</b>	<b>All Entities</b>	H	H	M	M	H
<b>Institution</b>	<b>All Entities</b>	M	L	L	L	L
<b>Finance</b>	<b>All Entities</b>	H	L	L	L	L
<b>Research</b>	<b>All Entities</b>	L	P	N	H	P
<b>Where:</b>						
<ul style="list-style-type: none"> <li>▪ H = High Availability (70%+)</li> <li>▪ M = Moderate Availability (61% - 69%)</li> <li>▪ L = Low Availability (30% to 60%)</li> <li>▪ P = Poor Availability (1% to 29%)</li> <li>▪ N = 0% Available</li> </ul>						

(U = Universities, U-C = university-colleges, C = Colleges, Open U = Open University)

**Type A vs. Type B**

The table below ranks the availability of data elements in subject areas **across** types of institutions. The type of institution that gathers the most data elements in a particular subject area is assigned the value 1 while the type of institution that gathers the least data elements in a particular subject area is assigned the value 4.

<b>Table 16: Data Elements Availability Across Types of Institutions</b>					
<b>Subject Area</b>	<b>Tables (Entities)</b>	<b>HE Institution</b>			
		<b>U</b>	<b>C</b>	<b>U-C</b>	<b>Open U</b>
<b>All</b>		1	2	3	4
<b>Staff</b>	<b>All Entities</b>	2	4	3	1
<b>Student</b>	<b>All Entities</b>	1	2	3	4
<b>Institution</b>	<b>All Entities</b>	1	4	3	2
<b>Finance</b>	<b>All Entities</b>	1	4	2	3
<b>Research</b>	<b>All Entities</b>	2	3	4	1

(U = Universities, U-C = university-colleges, C = Colleges, Open U = Open University)

- Overall, universities are most capable of providing data elements according to HEMIS' requirements
- Overall, the Open University is least capable of providing data elements according to HEMIS' requirements
- Universities are most capable of providing data elements in the Student, Institution and Finance Subject Areas
- Open University is most capable of providing data elements in the Research and Staff Subject Areas
- Colleges are least capable of providing data elements in the Staff, Institution and Finance Subject Areas
- The Open University is least capable of providing data elements in the Student Subject Area
- University-Colleges are least capable of providing data elements in the Research Subject Area

**Type B vs. Type A**

The table below ranks the availability of data elements in subject areas **within** types of institutions. For each type of institution, the subject area with the highest availability of data elements is ranked 1; lowest availability is ranked 5. Otherwise, subject areas are assigned the intermediate values 2 (second-highest availability) or 3 (third highest availability) or 4.

<b>Table 17: Data Elements Availability Within Types of Institutions</b>						
		<b>HE Institution</b>				
<b>Subject Area</b>	<b>Tables (Entities)</b>	<b>U</b>	<b>C</b>	<b>U-C</b>	<b>Open U</b>	<b>Totals</b>
<b>Staff</b>	<b>All Entities</b>	3	2	1(1) *	2	2
<b>Student</b>	<b>All Entities</b>	1	1	1(2) *	3	1
<b>Institution</b>	<b>All Entities</b>	4	3	3	4	3
<b>Finance</b>	<b>All Entities</b>	2	4	4	5	4
<b>Research</b>	<b>All Entities</b>	5	5	5	1	5

(U = Universities, U-C = university-colleges, C = Colleges, Open U = Open University)

\* Identical score – both share first place

Please see [Annex J: Data Element Availability by Institution](#) to review the performance of individual institutions.

## Recommendations

### HEMIS System Architecture

In this report, we provide recommendations for a high-level architectural design of the Higher Education Management Information System (HEMIS), composed of the Ministry Side System (MSS) and the Institution Side System (ISS). In addition we outline essential services that the system has to be able to perform, namely - Data Import Process from the ISS to the MSS; and Establishing Connectivity with institutions with limited MIS capabilities and modules that need extensive customization.

#### Important Definitions

*Electronic Data Interchange (EDI)* is the computer-to-computer exchange of structured information through agreed-upon communication standards. The exchange is done electronically with minimum human intervention.

*Enterprise Application Integration (EAI)* is the use of software to allow applications within an enterprise, or across multiple enterprises, to communicate with one another. EAI utilizes middleware technologies such as Message Oriented Middleware (MOM), data representation technologies (XML), and older EDI technologies.

*Institution Side System (ISS)* is the HE institution-side component of HEMIS. The ISS will collect and relay data to MOEHE.

*Legacy System* is a database management systems (DBMS) running on mainframes or minicomputers. Typically, institutions that adapt this technology invest considerable time and money in its utilization. New software products that are purchased by the institution need to be compatible with the legacy application, or at least be able to import data from there.

*Ministry Side System (MSS)* is the Ministry's side of HEMIS

*Module* A self-contained component of a system, highly structured in communicating with other components

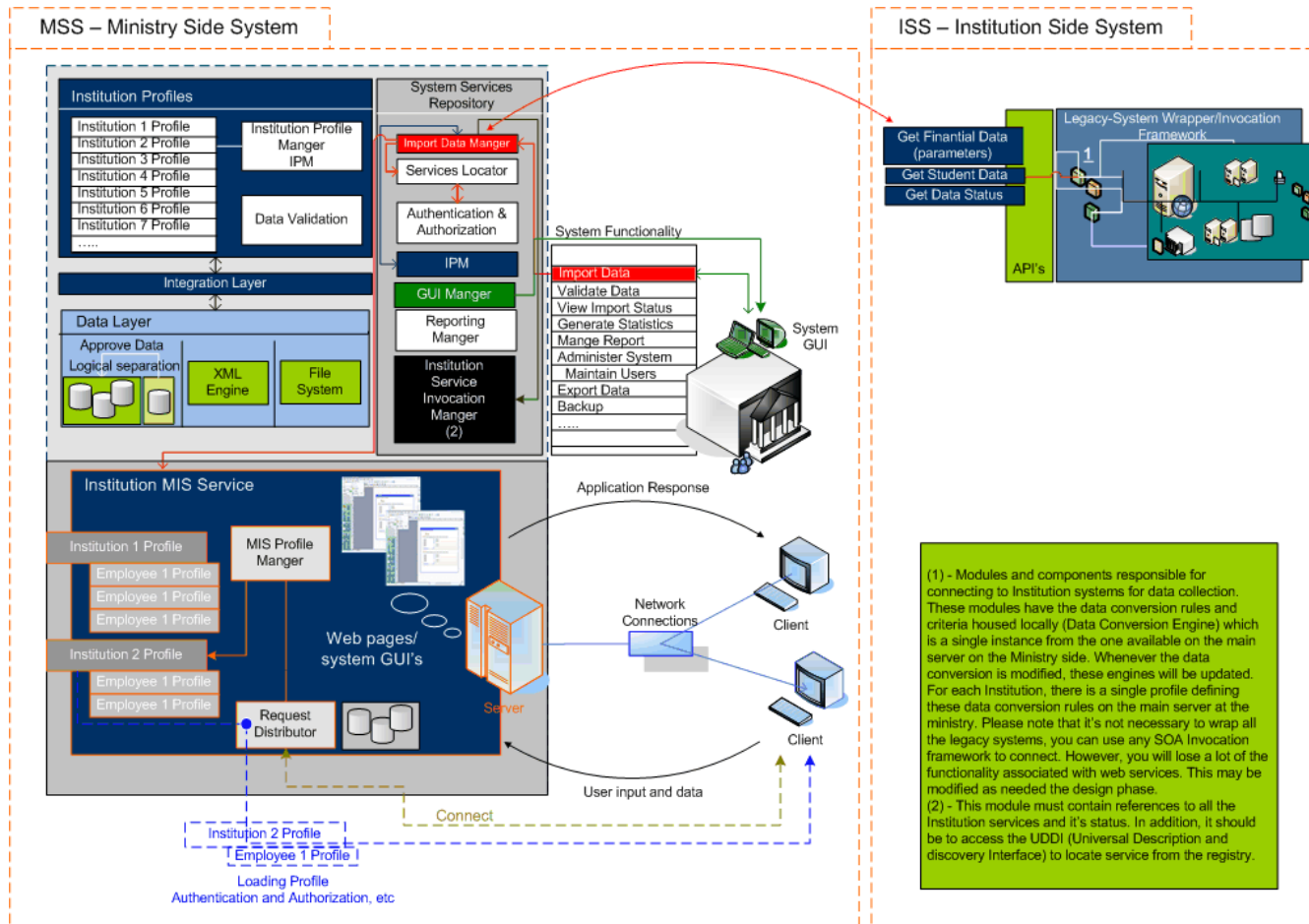
*Service Oriented Architecture (SOA)* is an architectural concept that defines services (functions) that a system must provide to meet business requirements. In an SOA, access to services is standardized for all users. It is possible to implement SOA using any service-based technology.

*Extensible Markup Language (XML)* is a W3C recommendation for creating special-purpose markup languages. It is a simplified subset of SGML, capable of describing many different kinds of data. Its primary purpose is to facilitate the sharing of structured text and information across the Internet. Languages based on XML (for example, RDF, SMIL, MathML, XSIL and SVG) are themselves described in a formal way, allowing programs to modify and validate documents in these languages without prior knowledge of their form.



The figure below illustrates HEMIS' Target Infrastructure

Figure 3: HEMIS Target Infrastructure



## ISS and MSS Main Modules and Components

Data migration is the most complex, yet most crucial requirement in HEMIS. Its complexity is born out of the need to connect the MSS with multiple ISS platforms at HE institutions. ISS are heterogeneous where each possesses its own characteristics, constraints, integration behavior, and communication channels.

Using Information-Oriented Integration will be the most effective mechanism for handling this environment. Alternative options include using Process-Oriented Integration, or Service -Oriented Integration.

### ***MSS – Modules and Components***

#### *Module 1 - Institution Profile Manager IPM*

Defines entity with which Data Import will be executed, as well as the rules for communication and data exchange. Components in this module are:

- Institution Identification e.g. unique ID, name, address etc.
- University Connection Manager (ISS connectivity Parameters e.g. target server location, IP, Connection Type)
- Data Migration Manager (defines data migration and data mapping needs, ensures seamless interchange of data meeting MSS' requirements)

#### *Module 2 – Institution Service Invocation Manager*

Invokes the connection between the Ministry and each institution; invokes the APIs defined at the ISS; interacts with the Service Locator at run-time to retrieve service definitions e.g. Private UDDI (Universal Description Discovery and Integration)

#### *Module 3 - Authentication and Authorization*

Secures access to the ISS, while limiting access to the ISS APIs exclusively to the MSS

#### *Module 4 - Save Imported Data*

Responsible for storing and saving the data retrieved from the ISS. It is also responsible for performing calculations where applicable. The data is stored in temporary tables, where it can be verified before posting on the main database. This verification process is fully automated, where a simple verification engine checks the data based on pre-defined rules and constraints. Manual data handling and manipulation are avoided at all times.

#### *Module 5 - Import Data Manager*

This module executes the system's core function - data import. It interacts with all other modules in this process. It is responsible for:

- Loading all the institutions' profiles at run time
- Retrieving data profiles

- Initializing the University Service Invocation Manager with the appropriate data profiles
- Activating USIM to establish a connection with the ISS
- Sending an Import Request to the ISS via secure channels, facilitating the Authentication and Authorization Module

#### *Module 6 - System Level Modules and Services*

These are a set of high and low level technical modules that reflect the system architecture's needs from each ISS. Such modules control the Process Thread Handler (communications with each ISS proceeds according to rules in pre-defined pool of threads), Data Encryption and Decryption, Firewall Management when communicating with ISS

#### *Module 7 - Log Module*

Logs and saves all the actions (import status, insert data, update data, user login, etc) that are executed

### ***ISS – Main Modules and Components***

Institutions use numerous different applications, with varying backend Database Management Systems (DBMS). In addition, applications with the same functionality are implemented differently from one university to another.

Since the MSS will interact with all ISS, it is recommended to 'wrap' the ISS locally (at the institution side) in one standard interface through which communications with the MSS will be facilitated.

#### *Module 1 - Institution Profile Manager IPM*

Defines the entities and rules that are required for communication and data exchange, this module should always be synchronized with the MSS's IPM – ideally required changes should be undertaken at the ISS, and not the MSS

#### *Module 2 - Institution Systems Connection Manager*

Handles connections internally within the ISS, including DBMS, Legacy-System, Packaged Applications

#### *Module 3 – Institution Import Data Manager*

Responsible for retrieving data from internal systems, converting them to MSS Data Standards, packaging and preparing for export to MSS via secure channels.

#### *Module 4 - Log Module*

Logs and saves all executed actions: import status, insert data, update data, user login, and errors. These files should be sent to MEOHE as an attachment to the imported-data.

## **Import Data Process Workflow**

1. The MSS data-import process start is triggered by the scheduler
2. The process starts when the MSS loads the institution profiles. Each profile includes the rules for connection to each individual ISS, general institution information, and data migration descriptions which define where each data item is located, how to reach it, and how to adapt it to the MSS data-standard if necessary. The same identical profile is available at the ISS (the two copies of the profile are synchronized - any change in one will automatically change the other).
3. The MSS initiates a connection with an ISS and sends an import request. The ISS accepts the request and initiates all system connections. Internally, the ISS begins to import data from its individual systems and modules, compressing the data and relaying it to the MSS. The MSS filters the data, ensures that data is consistent with pre-defined data standards, and undertakes required data calculations. Data is then sent to the main database at the MSS.

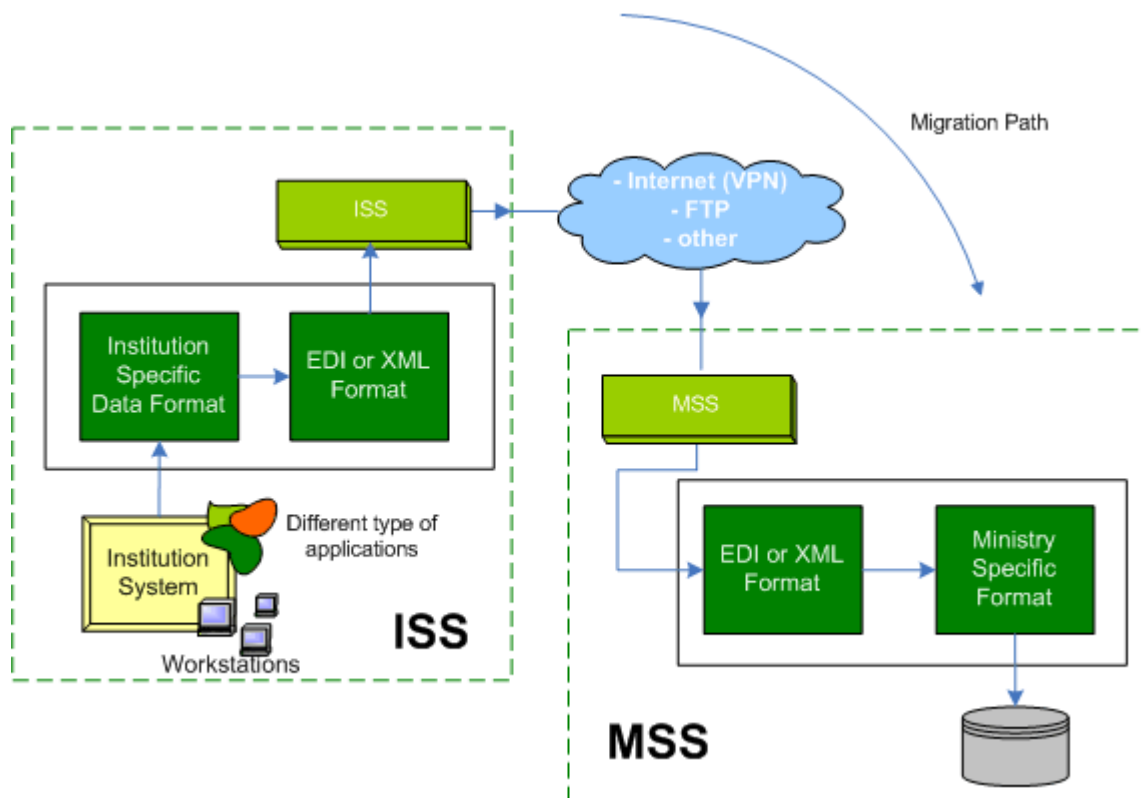
In order to undertake the process outlined above, the following key requirements need to be included in system:

- The ISS is primarily responsible for converting the migrated data to meet the Ministry Data Standard. The MSS is expected to interact with all ISSs in a standard way, guaranteeing its full separation from the ISS's internal platform-dependent restrictions.
- The ISS is required to wrap data-integration with internal systems, minimizing MSS's burden. This will minimize maintenance required for MSS.
- Internal changes at an ISS should not affect MSS' behavior, therefore web services should be used to build the architecture.

### Data Exchange Mechanisms – Using XML, EDI or XML/EDI

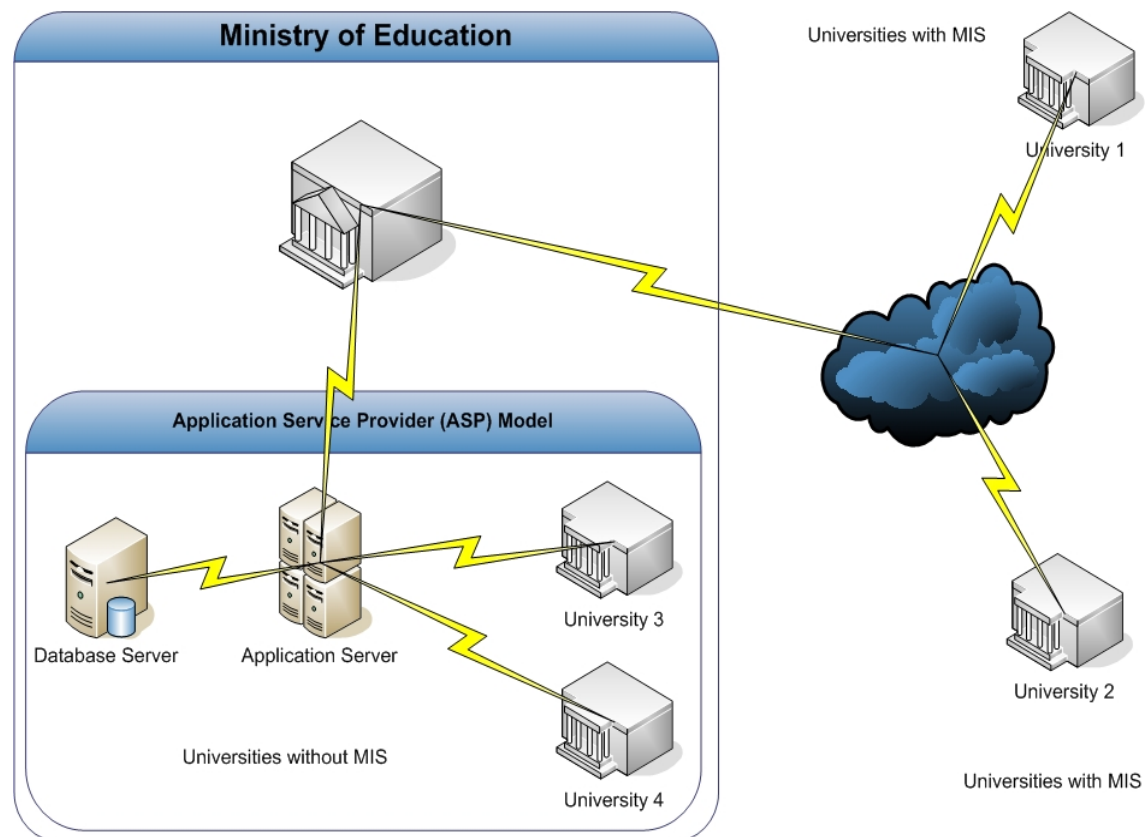
Due to the large quantities of data that will be exchanged and extensive modifications that may be required, it is strongly recommended that data exchange should utilize a standard framework, so that any type of information (message, workflow document) relayed across any type of technology (Application Program Interface, Web Application, Database Portal) can be searched, decoded, modified, displayed and stored consistently and correctly. Data Exchange Mechanisms are illustrated below:

**Figure 4: Data Exchange Mechanisms**



## Proposed Network Topology for Connecting Institutions to Ministry

Figure 5: Proposed Network Topology



The diagram above describes the proposed connection between HE institutions and MOEHE. The purpose of the connection is to facilitate data imports by MOEHE from HE institutions.

Although a number of institutions already have permanent Internet connections installed, it is important that a secure connection be used. The following options could be used to maximize connection security:

- A separate and more secure channel can be used specifically for ISS-MSS communications, for example ISDN dial on demand, or a separate leased line. The bandwidth required for this connection is 128 kb. For importing data, the MSS could dial into the ISS and request data. Since preparing the data will take a significant amount of time (i.e. hours or even up to a day), the connection will terminate after request. The ISS will dial into the MSS and upload data when it is ready.
- VPN (Virtual Private Network) between the Ministry and institutions. Current, permanent Internet connections can be used to transfer data between ISSs and MSS, by using a secure channel requiring the installation of either VPN Module or an IPsec Module on the ISS routers. This will allow for secure use of the current connection.

## **ASP Approach for Data Collection**

For HE institutions with no MIS and limited IT capabilities, as an alternative to implementing an application server solution for each institution, the Application Service Provider (ASP) model can be used for connectivity.

Under this model, a third party can host a full web-based suite of international-standard education administration applications, containing all modules required by HEMIS. Institutions can then lease one or more modules via the Internet. To access the modules (software), institutions can download the modules that they require from the ASP facility. Enhancements and updates can be made available on-line.

Institutions will not be required to purchase servers. The end-user only needs a workstation that connects to the Internet in order to access ASP applications

The ASP can initially offer a suite of core administration software, and add new models gradually. The costs for launching the ASP can be shared by higher education institutions throughout the country.

## **Additional System Recommendations**

### *Reporting*

HEMIS is required to generate 113 reports, and allow for the generation of customized reports on an ad-hoc basis. Implementation vendors will be required to include an industrial-strength reporting and analysis tool as an add-on to the HEMIS system.

### *Training*

If HEMIS is to succeed, it is crucial for both the MOEHE and HE institutions to employ specialized staff capable of supporting and maintaining the system. Key skill sets that are required include system administration, data base analysis, business analysis and report generation.

HEMIS stakeholders need to develop a proactive country-wide training component for both MOEHE and HE Institutions. The actual contents of the training will be made more explicit during the subsequent Design and Implementation Stages.

### **Additional - Non Technical Recommendations**

- Establish a *Specialized Information Department* responsible for collection and dissemination of information on HE
- Develop a unified method across HE institutions to record and classify information on applicants' socio-economic status
- Support training programs in the fields of educational cost-management and facility management
- Enhance coordination and cooperation with PCBS, Ministry of Labor and other institutions that can provide useful information on HE
- Establish a Higher Education standard-setting body comprising HE representatives and professionals, responsible for developing standards for HE monitoring, and reporting

### **Recommended Next Steps**

- Conduct two, one-day workshops in Gaza and the West Bank to present findings to MOEHE, donors and the HE Community in Palestine, to present the findings of Phase One: Needs Assessment and Gap Analysis.
- Prepare bid material and budget estimation for Phase Two: HEMIS Design



## **List of Annexes**

- Annex A: HE Institutions by Type and Contact Details
- Annex B: Use Cases (Functional Requirements)
- Annex C: Indicators, Variables, Formulae (Information Requirements)
- Annex D: Reports (Report Requirements)
- Annex E: Data Dictionary
- Annex F: Database Schema
- Annex G: Schema Diagrams
- Annex H: Model Questionnaire
- Annex I: Status of IT Software Modules by Institution
- Annex J: Data Element Availability by Table, by Institution
- Annex K: Institution-Specific Gap Analysis Reports