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CASE STUDY

EVALUATING THE INTEGRATED MEASUREMENT AND EVALUATION SYSTEM IMES: A SUCCESS STORY

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ABSTRACT

This case study serves to illustrate an integrated and practical methodology for evaluating advanced information database systems. The goal of the integration is to create a top-down evaluation process that reduces user and data requirements to a standard evaluation structure. In this framework, the evaluation of the Integrated Measurement and Evaluation System IMES was implemented by the Energy Policy Unit of the National Technical University of Athens. Evaluation team members successfully followed the proposed evaluation methodology.

Keywords: evaluation, measurement, IMES, database systems

I. INTRODUCTION

In the 1990's, many projects were implemented to provide technical assistance to countries that moved from centrally planned to market economies. Originally, the technical assistance was developed with just one country in mind, the Soviet Union, but in 1991 a period of uncertainty followed the break-up of the Soviet Union. The Baltic States and many New Independent States (NIS) formerly part of the Soviet Union had to determine their own reform policies. The European Union (and other political organisations) recognised that economic reform initiatives are important in promoting peace and stability and established strong relationships with each of the new states. Today, technical assistance concerns mainly countries of Central and Eastern Europe previously under Soviet control (Poland, Romania, Bulgaria, Russia, Ukraine, Belarus, Moldova, Armenia, Georgia, Kazakhstan, etc.). The pace and the degree of success of the transition that these economies and, most important, their societies are undergoing will certainly impact the global economy, politics, social security, democracy and peace.

The monitoring and evaluation (M&E) exercise described in this paper exercise aims to help these technical assistance projects in achieving their objectives. The system provides management information on project implementation, so that structured management decisions can be taken. M&E teams, which consists of external experts working to pre-agreed terms of reference, carry out systematic on-the-ground monitoring and evaluation of the Technical Assistance Programme's projects [European Commission, 1995a]. Their basic aim is to improve project performance by providing timely relevant information and recommendations to the Technical Assistance Programmes' management. These assistance programs go under such names as Tacis, Phare, and USAID. [European Commission, 1995b]. In this framework, the necessity for creating an integrated M&E information system emerged.

II. THE IMES SYSTEM: AN OVERVIEW

2.1. IMES OBJECTIVES

IMES is a dynamic integrated monitoring & evaluation system. It was developed to meet the following needs of the European Commission:

- Close management of the Tacis Programme (that is, the technical assistance programme for the NIS & Mongolia)
- Monthly assessment of Tacis results
- Statistical support to Tacis decision making.

- Support to future planning of further Tacis activities in the NIS and Mongolia

Its operation is focused on the M&E exercise implemented in the NIS. The main objectives are (1) to improve management reporting on Tacis progress and results and (2) to provide support to the Tacis management decision making, in the direction of:

☑ Extraction of relevant information on project performance from the monitoring and evaluation reports

☑ Production of overall statistics at NIS level

Support to the Tacis management decision making involves mainly:

- launching future technical assistance projects,
- allocation of funds,
- maximization (or minimization) of the provision of technical assistance to specific regions/countries/sectors,
- measures related to specific problematic technical assistance projects [European Commission, 1995c].

IMES ARCHITECTURE

IMES is an integrated information system that incorporates Internet technologies to provide wide monitoring and evaluation capabilities. It consists of five individual, but interacting, subsystems that form a robust intranet information system. The structure of the system is presented in Figure 1.

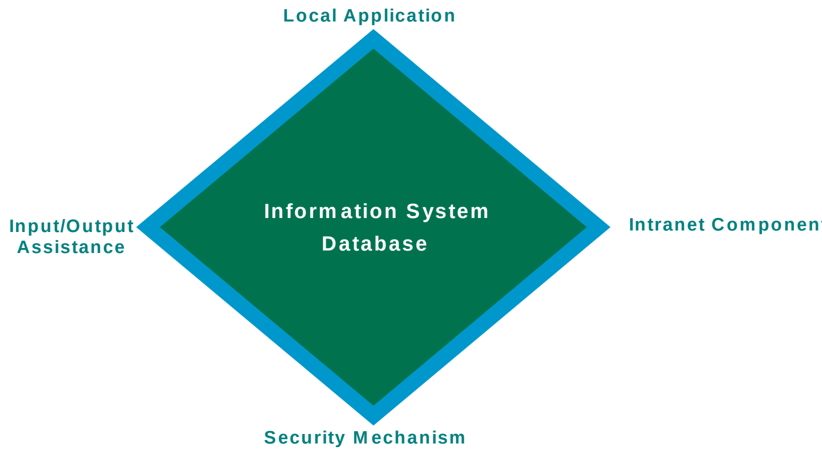

Figure 1. Structure of the System

1. *The Information System Database.* This database is the "back end" application used for storing all kinds of data. It is built in MS Access 7.0 and structured according to the relational model into entities and relationships. The entities used are listed in Table 1.

The Entities-Relationships (E-R) model of the Information System Database are shown in Figure 2. All the reports included in the IMES database were produced between March 1994 and March 1999 and were available in Word files.

2. *The Local Application.* This "front end" application was built in MS Visual Basic for controlling and managing the stored data. The application enables direct access to the system database through a friendly user interface. The interface offers an alternative database updating method, combined with extensive searching capabilities. It also acts as a control agent for the input and output assistants. Analytically, the operations that are supported by the local agent are:

Table 1. Entities Used in the Relational Model

Project	This entity stores the identity data of the Tacis projects including the Contract Number, Project Title, Sector, Sub-sector, Country, Location, EC Task Manager, Project Start & End Date, Status.
Inception Report	This entity contains the most important information from the Inception Report. It is joined with an “one to one” relation with the Project entity, because there is only one Inception Report in a project’s lifetime. This entity also stores data concerning the path and the name of each Inception Report document
Monitoring Report	This entity contains the most important information from the Monitoring Report. It is joined with an “one to many” relation with the Project entity, because there may be more than one Monitoring Reports in a project’s lifetime. This entity also stores data concerning the path and the name of each Monitoring Report document.
End of Project Assessment Report	This entity contains the most important information from the Assessment Report. It is joined with an “one to one” relation with the Project entity, because there is only one Assessment Report in a project’s lifetime. This entity also stores data concerning the path and the name of each Assessment Report document.
Comments on Contractor’s Report	This entity contains the most important information from the Comments on Contractor’s Report. It is joined with an “one to many” relation with the Project entity, because there may be more than one Comments on Contractor’s Reports in a project’s lifetime. This entity also stores data concerning the path and the name of each Comments on Contractor’s Report document.
Briefing Note	This entity contains the most important information from the Briefing Note. It is joined with an “one to many” relation with the Project entity, because there may be more than one Briefing Notes in a project’s lifetime. This entity also stores data concerning the path and the name of each Briefing Note document.
Kick-off Meeting Report	This entity contains the most important information from the Kick-off Meeting Report. It is joined with an “one to one” relation with the Project entity, because there is only one Kick-off Meeting Report in a project’s lifetime. This entity also stores data concerning the path and the name of each Kick-off Meeting Report document.

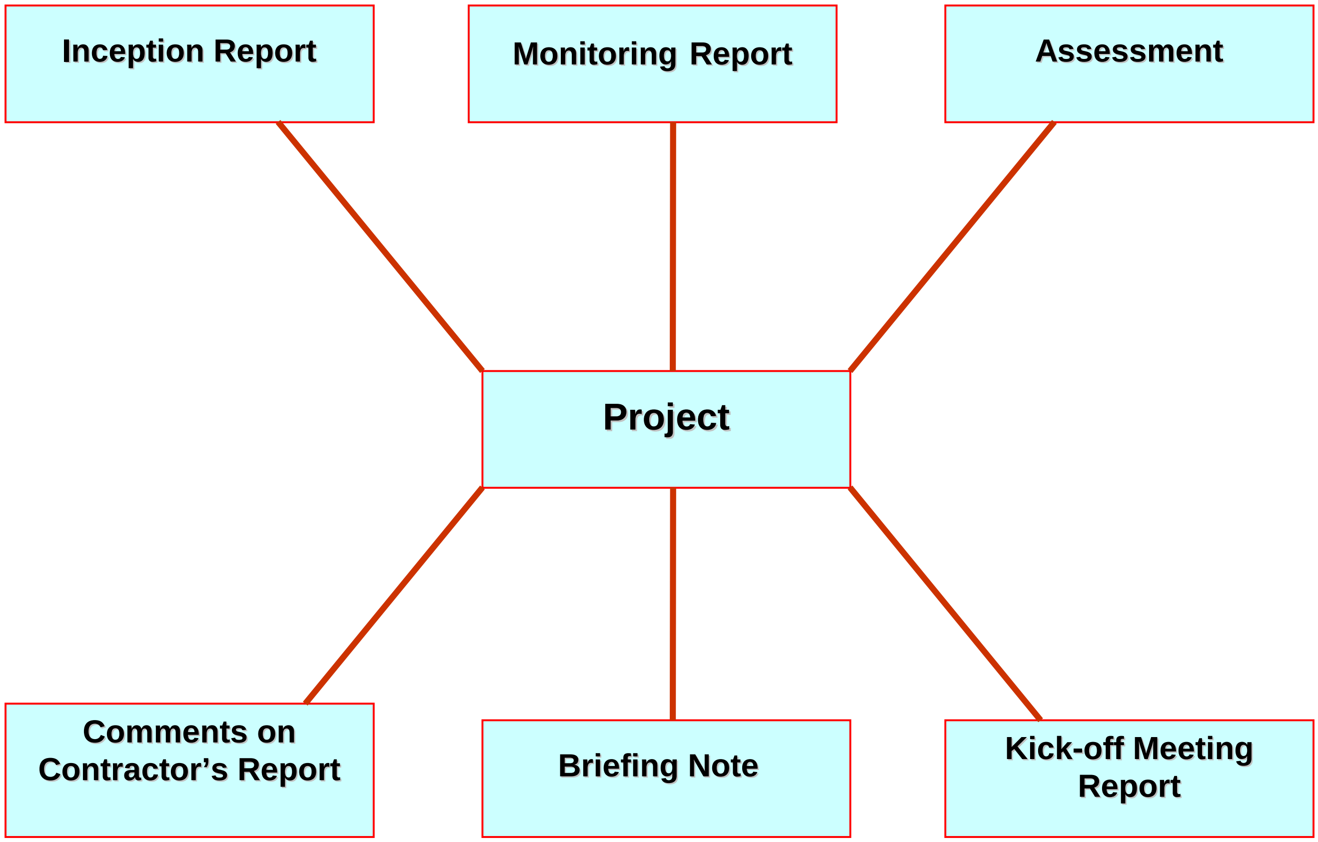

Figure 2. E-R Model of the System Database

- File manager capabilities for storing the M&E reports.
- Searching and browsing the M&E reports.
- Ability to insert, delete and update the stored data.
- Provision of an interface for querying the database.
- Interaction with Microsoft office applications to provide specific reports.
- Control of the Input and Output Assistants.
- Ability to compact and maintain the Database.

3. Input / Output Assistants. The Input Assistant is a separate tool for loading data from the M&E reports to the system database. Since all the M&E reports have been written in MS Word templates, Active-X Controls (together with OLE technology) was used in MS Word templates to enable automatic data entry procedures.

The Output Assistant interacts with MS Office applications to provide specific reports, combining data from the M&E reports. The provided reports are easy to maintain, since they are exported to common office applications, like MS Word and MS Excel. The Output Assistant includes the report generator, a tool for preparing statistical reports. The report generator is developed in MS Access and provides extended querying and reporting capabilities through an easy interface.

4. The Intranet Component. The intranet component is located on the network Web Server, enabling authorised Internet users to access the system database. It consists of parameter queries executed from common Web Pages. These Web pages can be accessed from the network server IP address, using the http protocol. The VB Script language, which creates these Web pages, submits calls to the system database using ODBC driver technologies. The system database receives the calls, executes the appropriate queries and exports the results in html format.

5. The Security Mechanism. The system database is isolated from everyone except the IMES Administrator. The local application has a “built-in” security mechanism, which provides safety to the stored data and documents. The security system supports specific users groups to which all the authorised users belong. Each user group has specific permissions for browsing the stored data. Internet users have read-only access to the System Database, while only the official IMES Administrator is able to delete data.

IMES OUTPUTS

IMES provides the authorised Internet users with four important functions/outputs, as shown in Table 2.

Apart from the Commission services, the main outputs recipients are:

- Task managers of SCR A3 & A6
- The Evaluation Unit
- EC Delegations in the region
- Monitoring Teams (Moscow, Kiev, Almaty, Tbilisi).

Table 2. IMES Functions and Outputs

Functions	Outputs
Statistics Production	Monthly Statistics for Total Tacis Monthly Statistics per country/sector Cumulative Statistics for Total Tacis List of Problematic Tacis Projects Monitored Monitoring Scores per Indicator for each type of Monitoring Report Monthly Performance Indicators per region, country, sector Cumulative Performance Indicators per region, country, sector
Projects Searching	All Tacis projects implemented in the NIS
Documents Searching & Downloading	All Monitoring Reports (of any kind) produced from March '94 till March '99
Documents Browsing & Downloading	All Evaluation Reports and other Reports

III. EVALUATION APPROACH

The evaluation took place during the nine-week period from 4 January to11 March 1999 and focused on system operation. The Evaluation Team consisted of four information technology consultants of the Energy Policy Unit of the National Technical University of Athens (EPU-NTUA), supported by the members of the IMES project team. The purpose of the evaluation was to inform the European Commission about the technical functions, results and effects of the IMES system.

METHODOLOGY

The basic stages of the methodology used by the evaluation team to test the over-all IMES performance is shown in Figure 3.

Figure 3. Basic Stages of Methodology

The evaluation steps were identified by the Evaluation Team taking into consideration the basic rule "the evaluation steps must follow the natural design process of a system to be evaluated".

Therefore, during the first stage, the team collected and studied the requirements of the system as defined by the main client (European Commission) and set the key evaluation questions. Then, the usability evaluation and the system performance evaluation (technical evaluation) were implemented, giving specific evaluation results related to the key evaluation questions. Finally, recommendations and conclusions were reported to increase the effectiveness and the over-all relevance of the system.

To assess relevance, the evaluation team used the criteria in Table 3. The principal evaluation questions, set by the Evaluation Team, were:

- Does the system actually meet users' needs?
- Is IMES a reliable M&E Information System?
- How complete is the system database?
- Is the system well designed ?
- Is it easy to search, display and derive information from the database?
- How good are the instruction manuals for using IMES ?
- Is IMES actually a high-quality product ?
- What comments arise from this evaluation on the future operation and use of IMES?

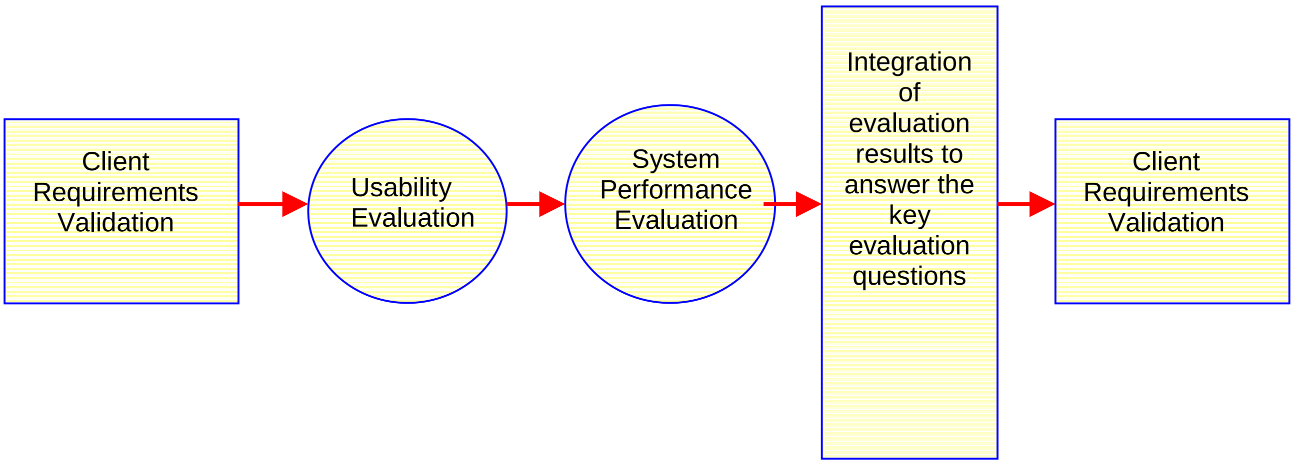

Figure 3. Basic Stages of Methodology

Table 3. Evaluation Terminology and Criteria

Relevance	Term reserved for the overall judgment by the evaluators on the performance of the system against all evaluation criteria.
Efficiency	The degree to which the system realises the planned outputs within the context of the requirements set by the client
System Search Features	Implementation in accordance with the operational requirements set by the client.
Accuracy	The degree of precision of both the data stored in the database and the system's outputs.
Reliability	The extent to which the clients can trust the system and its services
Fullness of Database	The degree to which the system database has been populated with M&E data.
Accessibility	The degree to which the system database is easy to be accessed by the users.
Ease to use	The extent to which the users can "navigate" in the system database and use its services.
Integration	The degree of connection of multiple design disciplines on multiple hardware platforms.
Documentation	The degree of adequate help offered to all the system's users.

During the Evaluation different sources and types of information were used, including:

- Existing documents including both system documentation and IMES project reports.
- “Interview” notes, taken by the IMES Project Team after their visits to the Monitoring Teams in the region (NIS).
- Specific data reports (lists of produced Monitoring reports, etc.) supplied by the Monitoring Teams.
- Remarks made by the EC officials during the presentations of the system.

The relevance of IMES, the ultimate reason for the evaluation, was seen as the sum of the findings relative to the preceding questions. As is the case of all technical evaluations, relevance cannot be measured quantitatively. The result was arrived at by summing the different parts and their relative tendencies towards an over-all negative/positive or neutral judgement.

IV. CLIENT’S REQUIREMENTS VALIDATION

CONCEPTUAL FRAMEWORK

The first stage of the evaluation approach was the client’s requirements validation, which the Evaluation Team used to study and analyse the client’s requirements. Two basic questions were posed relating to the client’s requirements:

1. Which are the main requirements specified by the client?
2. Will this set of requirements, if implemented well, result in a system that will meet the users’ needs?

The requirements validation conceptual framework is presented in Table 4.

Table 4. Requirements Validation Conceptual Framework

Goal Requirements	Task Requirements	Functional Requirements	System Requirements
System objectives and users' needs	Task activities to achieve goal requirements	General system functions for helping users achieve their task requirements	What the system needs to do to implement required tasks and achieve the task and goal requirements

REQUIREMENTS ANALYSIS

When the Evaluation Team studied and analysed the client's requirements according to the conceptual framework, the following results were obtained:

Goal Requirements:

- Improve management reporting on Tacis progress and results.
- Improve the management of the monitoring contracts.
- Future planning of further Tacis activities in the NIS.

Task Requirements:

- Study relevant information on Tacis projects' performance
- Analyze over-all statistics at NIS level
- Study specific information (e.g., countries' profiles, important sectors,) in the NIS.

Functional Requirements:

- Provide relevant information and data on Tacis projects' performance from the monitoring reports
- Provide overall statistics at NIS level

System Requirements:

- The user can search for monitoring reports
- The user can search for monitored Tacis projects
- Produce specific statistical information at NIS level

- Provide the user with the ability to find Evaluation Reports and Sectoral Reports

V. USABILITY EVALUATION

BASIC PRINCIPLES

The following principles are fundamental to the design and implementation of effective interfaces, either for traditional GUI environments or the Web. The Evaluation Team took these principles into consideration in evaluating IMES:

- Effective interfaces are visually apparent, instilling in their users a sense of control; users quickly see the breadth of their options, grasp how to achieve their goals and do their work.
- Effective interfaces do not concern the user with the inner workings of the system.
- Effective applications perform a maximum of work, while requiring a minimum of information from users.
- Interfaces are user-centered designed
- To most users, the interface is the system.

The approach followed was a combination of heuristic evaluation [Nielson, 1993] and usability testing. This model was proved cost-benefit since the “obvious” usability problems were immediately identified through heuristic evaluation and cleaned-up while the “hidden” problems were picked up by usability testing. For the usability evaluation four evaluators were used, taking into consideration the basic curve (Figure 4) showing the proportion of usability problems in an interface found by heuristic evaluation using various numbers of evaluators [Nielson,1994].

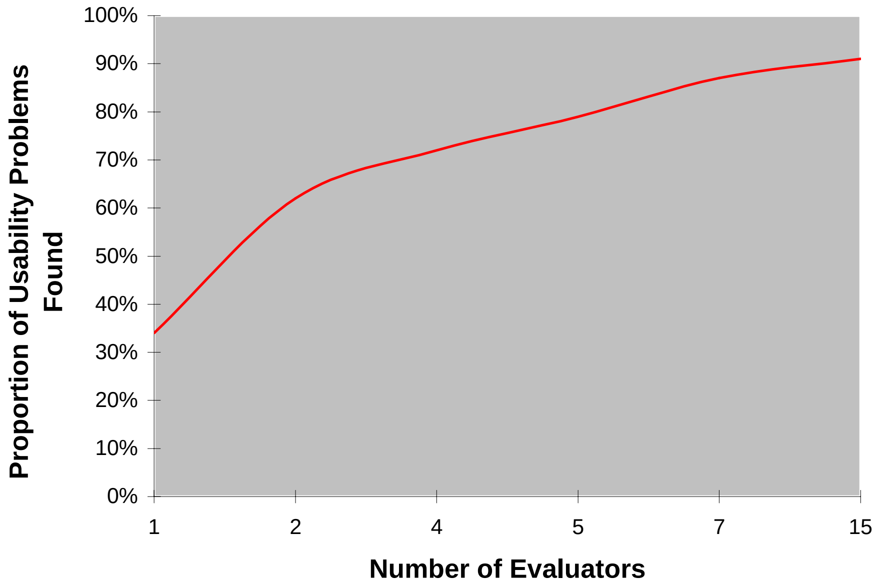

Figure 4. Proportion Of Usability Problems In An Interface Found By Heuristic Evaluation Using Various Numbers Of Evaluators

During the usability evaluation of IMES, the criteria shown in Table 5 were used.

Severity ratings were used by the Evaluation Team to assess the most serious problems and to provide a rough estimate of the need for additional usability efforts. The severity of a usability problem is a combination of three factors:

- The *frequency* with which the problem occurs: Is it common or rare ?
- The *impact* of the problem if it occurs.
- The *persistence* of the problem: Is the problem that users must overcome one-time or are users bothered repeatedly by the problem?

Table 5. Criteria for the IMES Evaluation Criteria

☑ **Visibility of database status**

The system should always keep users informed about what is going on (updating, maintenance, etc.) through appropriate feedback. The two most important things users need to know at a website is *"Where am I?"* and *"Where can I go next?"*.

☑ **Match between system and the real world**

The system should speak the users' language, with words and phrases familiar to the user, rather than system-oriented terms.

☑ **User control and freedom**

Because users often choose system functions by mistake; there should be support to "undo" and "redo".

☑ **Aesthetic design**

Special attention should be given to fonts, size, colours, screen widths, etc.

☑ **Consistency**

Users should not have to wonder whether different words, situations or actions mean the same thing. The most important consistency is consistency with user's expectations.

☑ **Efficiency of use**

Since people cost a lot more than machines, judging the efficiency of a system is something more than judging the efficiency of the machine.

☑ **Readability**

Text, which must be read, should have high contrast and appropriate size.

☑ **Help and documentation**

Even though it is better if the system can be used without documentation, it may be necessary to provide help and documentation (not too large).

The following 0 to 4 rating scale was used to assess the severity of usability problems:

0 No usability problem at all
1 Cosmetic problems only: need not be fixed
2 Minor usability problems: fixing this should be given low priority
3 Major usability problems: important to be fixed, high priority
4 Usability catastrophe: imperative to be fixed

USABILITY EVALUATION RESULTS

The results of the usability evaluation are shown in Table 6.

Table 6. Usability Evaluation

Rating / Criterion	0	1	2	3	4
Visibility of database status	✔				
Match between system and the real world	✔				
User control and freedom		✔			
Aesthetic design	✔				
Consistency			✔		
Efficiency of use	✔				
Readability	✔				
Help and Documentation				✔	

VI. IMES PERFORMANCE EVALUATION

METHODOLOGY

The main methods of system performance evaluation are shown in Table 7.

Table 7. Methods of System Performance Evaluation

Subjectively-Based	Interviews: domain experts and/or potential users judgments
	Focus groups
	Questionnaires
Empirically-Based	Benchmark testing and simulation
	Test cases
	Task analysis walkthroughs
	Experiments (laboratory and field)

The Evaluation Team implemented test cases, taking into account the results of interviews of potential users, who were not experienced in using information systems, and questionnaires designed by the IMES Project Team. The evaluators tested the IMES Database and the system's functions and outputs using 10 typical usage scenarios, listing the various steps needed to perform a sample set of realistic tasks.

IMES DATABASE EVALUATION

The IMES database is the most important component of the information system. It is a relational database and contains:

1. 3816 monitoring contracts,
2. 2003 Tacis projects, and
3. 5637 reports.

Figure 5 presents the distribution of report types found in the system's database.

All reports included in the system's database were produced between March1994 and March 1999. Figure 6 presents the number of reports produced per year of production included in the IMES database.

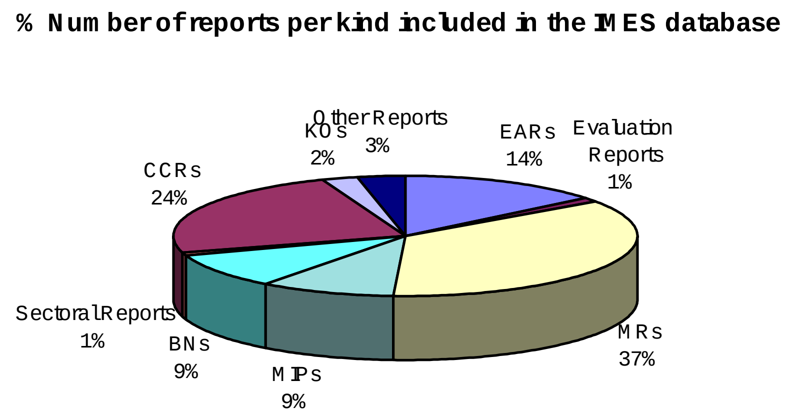

Figure 5. Reports Included in the IMES Database[1]

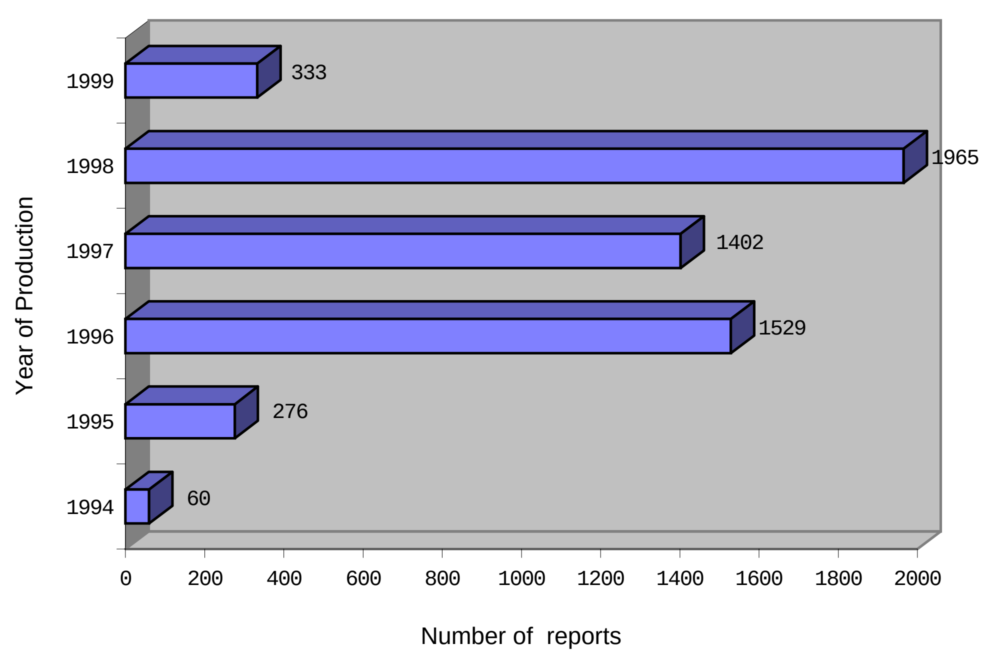

Figure 6. Number of Reports Produced

[1] Types of reports referred to in Figure 5: BN=Briefing note, CCR=Comments on contractor's report, EAR=End of project assessment, KO=Report following kick-off meeting, MIP=Monitoring inception phase, MR=Monitoring report,

The basic data about monitoring contracts/projects stored in the system's database tables are:

- Project number
- Project title
- Contractor
- Partner organisation
- Task manager
- Country
- Sector/Sub-sector
- Status
- Start date/End date

For the monitoring reports, the main data stored in the database tables are:

- Contract number
- Project number
- Type of report
- Date of production
- Report location
- Date of monitoring visit
- Scores

All this important information is divided and stored in 19 different tables, to create a practical and powerful database.

IMES OUTPUT EVALUATION

Using random sampling, all the mechanisms of IMES proved to be quick and accurate. The statistical data presented in the standard-format reports were correct and accurate in all cases (10 random tests per kind of statistical report). The search mechanisms proved to be easy to use and the Intranet component was very functional. The system's response times are short and appear reasonable to the user. The security mechanism (although not sufficieintly advanced) appears to be reliable and secure.

VII. CONCLUSIONS

The Evaluation Team found that IMES is a reliable M&E information system. Through careful design and successful development, the system met the client's needs and appears to be an efficient tool.

Table 8 assesses the overall performance of the IMES, using the standard evaluation criteria described in Section III.

Table 8. Over-All IMES Performance

	Evaluation Criteria Values		
Evaluation Criteria	*Excellent*	*Positive*	*Bad*
Efficiency	✔		
System search features		✔	
Accuracy	✔		
Reliability	✔		
Fullness of database	✔		
Accessibility	✔		
Ease to use	✔		
Integration		✔	
Documentation		✔	

Note: "Excellent" covers the outstanding system performance.
"Positive" means that the system performance is according to the plan (minor improvements are needed).
"Bad" means that the system performance is below the expectations (urgent action is needed).

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LIST OF ACRONYMS

EU	European Union
EC	European Commission
TA	Technical Assistance
NIS	New Independent States
M&E	Monitoring & Evaluation
SCR	Joint Relex Service
KO	Report following a Kick-off meeting
MIP	Monitoring Report on Inception Phase
MR	Monitoring Report
EAR	End of Project Assessment Report
CCR	Comments on Contractor’s Report
BN	Briefing Note

ABOUT THE AUTHORS

Kostas S. Metaxiotis is an Electrical & Computer Engineer and Researcher of the National Technical University of Athens (NTUA). He has wide experience in database systems & expert systems design and development, artificial intelligence, evaluation methods for information systems, object-oriented knowledge modeling, inference mechanisms, monitoring and evaluation of projects. Since 1996 he has participated in various EC projects within Tacis, Phare, Brite Programmes as an information technology expert.

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John E. Psarras is a Mechanical Engineer and Professor in the Department of Electrical and Computer Engineering of the National Technical University of Athens (NTUA). He has wide, international experience in energy policy analysis, national and regional development planning, project management and decision support systems. Since 1991 he has been involved in numerous activities in PECO and CIS Countries in energy planning, energy efficiency, energy technologies and monitoring and evaluation of energy projects.