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EL SALVADOR MINISTRY OF EDUCATION
MANAGEMENT INFORMATION SYSTEM BASELINE STUDY

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EXECUTIVE SUMMARY

Among the problems which hamper the ability of Ministry of Education managers is an information management system inadequate to operational and managerial needs of collecting, processing, analyzing, and presenting data. Despite substantial investments in computer equipment, lack of compatibility of this equipment and computer staff limitations represent major obstacles to providing the El Salvador Ministry of Education with a coherent, useful tool for management improvements.

The MOE does not possess a serious information systems plan which details the overall philosophy, direction, and strategy of MIS activities in response to the information resource management needs of the MOE. Equipment procurement has been made with little regard to establishing and preserving a stable institutional environment for the MOE's MIS to develop in. "Inexpensive" solutions have been opted for which threaten to fall short of both MOE requirements and expectations.

The basic administrative functions served by the existing system are essential for MOE operation. On the other hand, the MIS is not currently conceptualized as a planning or strategic management tool.

The Computer Center performs essential data processing functions without which the MOE would collapse. Basic Education collects the information necessary for its own operation. The Statistical department depends on the goodwill of other units to actually collect the data, and is not really a user of the information. With no direct authority relationship to the data providers, Statistics can do little to improve data coverage or timely reporting. No material support or information feedback is ever received in return by the data provider.

The largest gains in MOE efficiency will be obtained by improvements in the administrative procedures employed by the MOE on a day-to-day basis. Longer-term gains will result from policy formulation and adjustment based upon the analysis of information captured through the operation of an affective method, for such management. It is essential to consolidate the MOE's capability to support administrative functions while capturing the result of the administrative activity.

The educational statistics system is operated by the Estadística department now located under the MOE's planning unit. Initial enrollment data are collected disaggregated by grade, age, and sex. This system requires a substantial amount of data collection effort, consolidation, and aggregation and suffers from substantial delays in data flow, incomplete coverage, and unknown data quality.

The Computer Center of the MOE has been located under the Administration Directorate, a reflection of its implicit priorities.

Even though a large number of computer applications currently exist, the principal problems are those of access and relation. Data extraction, consolidation, and presentation are important functions for strategic management, and these are currently poorly served by the existing system. The number of terminals and printers available are inadequate.

For the MOE to implement sustainable administrative improvements, it will be necessary to provide for their effective decentralization. Central information requirements must be met through regional information capture and flow up through the system. There should be completely compatible hardware, operating and software systems at all levels of the MOE. Currently, the MOE has a "mixed salad" of computers, peripherals, and software, and there is no effective support.

Data communications also form an important part of any computer decentralization plan. Communications infrastructure in El Salvador is currently poorly developed but a number of options exist which can be implemented such as leased-lines, radios, or wireless, modems, private microwave links. In any case, fall-back means of data exchange must be provided.

Regional and subregional offices will require both clean power and a reasonably clean environment: this means that uninterruptible power supplies and air conditioning be included for each site.

The essential support needs of the MOE must be met through a hardware and software environment which is of sufficient power, flexibility, reliability, and compatibility. No serious plan has yet been developed. The MOE must define the direction of MIS efforts.

Given the importance of an effective MIS for improving the effectiveness of MOE management and planning, and the difficulties of sustaining such an MIS within a Ministry environment, the argument for a unified hardware/software environment is strong.

With current equipment, however, the MOE's needs are not met. Effective decentralization requires computer support for four offices. Continued purchases of smaller personal computers do not address central MOE needs.

Hardware support should be provided for test development and scoring.

Communications systems are extremely important to support the decentralization of MIS functions. A study will require funding to select the most appropriate options for the MOE.

Efforts undertaken to date for the personnel system have suffered from the mechanization of deficient manual systems, which results in deficient automated systems. Recursos Humanos needs assistance in reorganizing its personnel procedures. What is needed for a successful effort at improving the efficiency of MOE personnel management is a combination of specific long-term technical assistance supported by a carefully selected and adapted full-function personnel software system.

A concentrated search needs to be conducted for a personnel system as part of the decision process for hardware selection.

Long-term specialized technical assistance in personnel management to the Recursos Humanos directorate should accompany the implementation of the new personnel software, and will have to develop a phased, multiyear plan for conversion to the system.

The most important conclusion to be drawn from this study is that the information problems of the MOE are of a larger scale than had been recognized to date. The MOE is a very large, complex organization with a weak information system, which has not been responsive to MOE management needs.

Combined with a limited personnel system is an educational statistics system best characterized as inflexible, seriously delayed, and of questionable coverage and quality.

A second problem area has been to assume that MIS personnel can solve the MOE's very large problems. Insufficient specialized technical assistance has been provided to guide the reworking of the MOE's procedures, and this compromises MIS impact.

A third weakness in the effort to strengthen the MIS of the MOE has been a propensity to apply "small" solutions to very large problems.

The foregoing findings suggest that the Mission should carefully consider its commitment to different MIS aspects under a future project. Substantial time and resources will have to be committed in a sustained manner. The priorities for this action are: personnel management inefficiency, the lack of timely and reliable educational statistical data, a software environment which will permit their combined analysis.

If student testing is to be supported at a nationwide level, specialized hardware and software will have to be procured to manage the large volumes of data. Specialized technical assistance should be provided for test development and operational planning.

For the personnel system, a search should be conducted for a full-function personnel system which can be adapted to the specific needs of the MOE.

The MOE's WANG VS-45 is virtually obsolete as equipped: it is insufficient to meet the current demand. A concerted effort must be made to define the future development of the MOE's computer environment.

USAID support for MIS must now address better means of assuring the institutional sustainability of the management tools necessary for the MOE to achieve educational quality and efficiency.

I. INTRODUCTION

The Ministry of Education (MOE) of El Salvador is a large (approximately 30,000 employees) organization operating more than 650 kindergarten, 3,500 primary, and 150 secondary schools throughout the country. In addition, the MOE has the responsibility of supervising over 1,000 schools from the private sector. More than 1,000,000 students are enrolled in grades 1-9, of whom over 85% attend MOE schools, and an additional 100,000 secondary students roughly split between public and private sector schools. Public, political, and teacher union pressures are placed on the MOE, and have resulted in a bureaucratic organization unparalleled in El Salvador. The MOE is, without question, the most difficult-to-manage and among the most poorly managed institutions in the country.

Among the problems which hamper the ability of MOE managers is an information management system inadequate to operational and managerial needs for collecting, processing, analyzing, and presenting data. The current system is characterized by a series of partial and isolated solutions which have not addressed the procedural deficiencies underlying MOE operations. Despite substantial investments in computer equipment made under the APRE Project, lack of compatibility of this equipment and computer staff limitations represent major obstacles to providing the MOE with a coherent, useful tool for management improvements. Current and planned activities in the education sector will require support services beyond current capabilities.

II. OBJECTIVES

USAID/El Salvador has identified the need to improve the information resource management capabilities of the El Salvador Ministry of Education. Currently, the MOE does not have a complete system upon which to base policy development, and administrative inefficiency can be clearly linked to the lack of a reliable, up-to-date information base. The APRE Project developed applications for information management which have not been integrated with the overall MOE operations, and concern exists as to the MOE's ability to maintain and improve its administrative procedures. The purpose of the MIS study was to assess both limitations and opportunities for MIS improvement, and to recommend a line of action for future USAID support of MIS activity within the MOE.

The consultant's scope of work emphasized aspects of the MIS related to educational planning functions. Discussions with personnel from both USAID and the MOE, however, revealed broader concerns regarding the current fragmented nature of the MIS and of the unreliability of data within the MIS, and a focus on the efficiency of the educational system has made clear the need to strengthen the basic administrative functions of the system (especially regarding personnel systems) as a basis for improved management and planning capabilities. A renewed emphasis on decentralization of the educational system also required that this aspect be included in the present study. Given time constraints, this study is necessarily more of a general guidance document for the Mission rather than a specialized analysis of a narrow part of an educational MIS.

III. METHODOLOGY

The study consisted of the review of prior work on the MIS and interviews with USAID and MOE staff. Documents consulted included the APRE Midterm and Final Evaluations, the September 1988 "Improvements in Educational Efficiency for Basic Education" report by the Academy for Educational Development, planning documents and other reports prepared by the MOE, and system documentation. Interviews were conducted during the month of October with MOE personnel from a number of divisions, including the APRE office, with University of New Mexico current and past technical assistance personnel, with staff from the USAID Office of Education and Training (OET), and with other members of the Baseline Studies team. Additionally, the consultant participated in discussions with distributors of computer equipment. A total of 16 work days were spent in El Salvador by the consultant.

IV. BACKGROUND

Both the Midterm and Final Evaluations of the APRE Project were sharply critical of the isolated nature of MIS efforts supported under the project. Because of this isolation, for example, data processing on school inventories, teacher staffing, and supplies and equipment distribution were performed separately, and never coincided, leading to confusion and reduced credibility of all information sources. The project failed to build upon prior USAID investments in the General Directorate for Educational Information and Infrastructure (DIIE), but rather created applications within the project implementation unit and the technical assistance contractors offices on noncompatible equipment and without provision for information interchange.

It was not until virtually the end of the project that project resources were directed towards DIIE, consisting of some short-term training in the U.S. for three Computer Center staffers, and the turnover of two UNIX-based NCR super-micro systems originally placed in the UNM and RONCO offices. These systems are not compatible with the MOE's aging WANG VS-45 minicomputer system. Along with the closing down of the contractor's offices, a veritable mixed salad of computers and peripherals have been turned over to the MOE, and additional equipment (IBM-AT clones, image scanners, printers, etc.) is now arriving.

The problem with all of this is twofold. On the one hand, the MOE does not possess a serious information systems plan which details the overall philosophy, direction, and strategy of MIS activities in response to its information resource management needs.¹ On the other hand, equipment procurement has been made with little regard to establishing and preserving a stable institutional environment (hardware, operating and database systems, programming, and development languages) for the MOE's MIS to develop in. Technical assistance has, to date, not concentrated on this larger institutional issue. And "inexpensive" solutions have been opted for which threaten to fall short of both MOE requirements and expectations, resulting in the loss of credibility of MIS as an answer to the very real problems of the MOE. The

¹ The former UNM MIS Advisor prepared an important MIS plan for the MOE, but no awareness of its existence was detected during the interviews. Also, as part of their training at UNM, a document on regionalization of the MIS was prepared in September 1989 by three members of the DIIE Computer Center staff (Proyecto Regionalizacion del Sistema de Informatica). This document represents the MOE's attempt to include planning in their thinking about the MIS.

efforts to date, far from strengthening institutional capability, may in fact have weakened it.²

Another area of concern in attempting to improve MOE management lies in a surprisingly widely held assumption that providing inputs to MIS will "solve" the problems in the MOE's technical and administrative units. While MIS is likely a necessary condition for supporting efficiency improvements, technical assistance and training efforts should be directed towards the responsible MOE units themselves. MIS must first consolidate the day-to-day operational support applications solely to allow the MOE to function, but must begin serious development of needed management reports, and move towards the coherent integration of the system to provide the strategic-level information required by educational planners.

The Mission's CDSS places priority on the development of information profiles and related information systems to assist the GOES in improving its ability to develop effective educational policy, efficient program implementation, and streamlined administration. The MOE also has recognized the need to improve its existing information support system. The MOE has, over time, assembled a series of applications which remain largely unrelated. Moreover, these applications have operated only at the central level, providing neither feedback nor support for the decentralization effort begun in 1982. The new leadership in the MOE is focusing attention on ways to improve the efficiency of the administration of the educational system, and this attitude coincides with both the end of the current APRE Project and the design of a new project. This opportunity should be taken advantage of.

Although information is collected and processed manually by virtually all MOE units, the systematization of these information activities has taken place within the General Directorate of Administration in the Finance, Human Resources, and Infrastructure directorates. Until recently, the Education Infrastructure and Information division (DIIE), through its Computer Center, provided the computing services on a USAID-donated Wang VS-45 minicomputer. Personnel, payroll, accounting, inventory and educational statistics systems were developed using COBOL and WANG-based query and report facilities. A staff of 12 programmer-analysts, programmers, and data entry operators are in charge of the operation of the system. Terminals and data entry operators are

² This is not a comment on the support APRE received in its functions. It is meant to indicate that the isolation problems suffered by the APRE Project also apply to MIS. A search for meaningful gains in MIS development for the MOE, independent of APRE, yields relatively little more than limited training.

located in the Human Resources, Finances, Construction and Maintenance, and Infrastructure divisions.

The basic administrative functions served by the existing system are, in fact, essential for MOE operation, and their importance should not be underestimated. On the other hand, the MIS is not currently conceptualized as a planning or strategic management tool. This has led to efforts to relocate the Computer Center under the Office of Planning (ODEPOR), which is attached to the Office of the Minister and Vice Minister. ODEPOR wields considerable power within the MOE, and technical directorates resist ODEPOR's involvement in their operations. Outside of Administration, the Computer Center provides virtually no services to the MOE. For example, the Basic Education directorate uses its own educational statistics system, which is a totally manual process involving consolidation at each administrative level--school, nucleo, subregion, and region. Given the close ties of Basic Education with these administrative units, compliance in reporting is considerably better than that experienced by the Statistics Department of what has been the DIIE. The data collected by Basic Education, however, are not readily available for analytic use: the data tend to be used only for the production of Basic Education's Memoria de Labores. The Computer Center, of course, maintains personnel records; it is not possible to "merge" these records with Basic Education's data, and, since the Statistics Department data are neither timely, trusted, nor relevant to the administrative control structure, personnel planners and managers do not have easy access to a combined view of both resources and demand.

It is tempting to suggest that the Computer Center, or the centralized data functions which comprise it, are at fault. On closer examination, the Computer Center performs essential **data processing** functions without which the MOE would collapse. Basic Education collects the information it believes necessary for its own operation, and fears dependence on data collected by others. The Statistics department, on the other hand, depends on the goodwill of other units to actually collect the data, and is, in itself, not really a user of the information. With no direct authority relationship to the data providers, Statistics can do little to improve data coverage or timely reporting. And, of course, the data provider sees little or no benefit which results from information sent to the Statistics department--no material support or information feedback is ever received in return.

As an information resource management device, then, the MIS is inoperative. It tends to function as a sophisticated accounting machine incapable of drawing together information from different sources and levels of detail to permit analytical conclusions to be drawn. The challenges to fostering such use of the data processed by the MOE while ensuring competent and effective processing are formidable indeed. "Decentralizing" information

processing and use within the central MOE places data integrity at risk; centralizing such processing in a single facility removes the responsibility of data capture from the generators of the information. And finally, the data generators do not make analytic use of the information, and the would-be analysts in the Planning Office do not have ready access to the data at levels of aggregation useful to them.

The largest gains in MOE efficiency will be obtained by improvements in the administrative procedures employed by the MOE on a day-to-day basis. Longer-term gains will result from policy formulation and adjustment based upon the analysis of information captured through the operation of an effective method for such management. It is essential, therefore, to consolidate the MOE's capability to support administrative functions while capturing the result of the administrative activity. While in no manner ignoring the value of the collection of educational statistics, the MOE's policy-makers and management staff have little control over much beyond the MOE personnel, and thus the most important MIS improvement efforts should begin with the personnel system. If nothing else is accomplished, any achievement in this area will have the greatest potential impact on educational access and quality of all MIS activities.³ The MIS support to personnel systems development must provide line supervisors with the information necessary to perform their supervisory functions effectively. From a strategic point of view, the next most essential information set is clearly from the demand side: enrollment data. MOE supervisory personnel must learn to allocate resources (mostly human) in accordance with real demand: this requires reliable up-to-date information on teacher assignments, enrollments, and resource availability.

³ The September 1988 "Efficiency" report by AED emphasizes the inefficiencies currently caused by personnel actions and underscores the substantial impact on both quality and efficiency which could be gained if improvement is achieved in this area. In fact, the personnel issue is unmanageable at present because of the volume of personnel actions processed. Mechanization efforts in Recursos Humanos continue to be stymied by the day-to-day load.

V. CURRENT COMPUTER EQUIPMENT

The flagship of the Computer Center continues to be a WANG VS-45 minicomputer which was acquired in 1984 with USAID assistance. This system is now moving into obsolescence, but continues to support the principal computing functions for the MOE. The WANG equipment consists of:

- Multi-user CPU with 1.0 MB of RAM
- Two removable-media disc drives, 300 MB each
- Magnetic (reel) tape drive, 800/1600 bpi
- A 600 line-per-minute line printer, 132 columns wide
- One 360 kB diskette drive
- Eight WANG full-function terminals.

This minimal equipment is distributed insofar as possible: two terminals each are located in the Human Resources and Finance directorates; an additional terminal is located in the Construction and Maintenance directorate. Educational statistics and inventory functions (including data entry) are served by two terminals in the Computer Center, and the system console occupies the eighth. System development and maintenance activities are fit in on the three centrally located terminals as data entry loads permit. The lack of remote printers and additional terminals has severely limited the effectiveness of the WANG system. It is significant that the MOE has never lapsed in keeping the WANG equipment under maintenance, and Computer Center staff report satisfaction with both the service received and the overall reliability of the WANG equipment.

The Computer Center has a budgeted staff of 12 persons:

- 1 Department Chief
- 4 System Programmer-Analysts
- 3 Programmers
- 3 Data Entry Operators
- 1 System Operator.

Because of low MOE salaries, however, two of the most experienced programmer-analysts left the Ministry for more attractive jobs during 1989. Salary levels for the programmer-analysts are about C.1,800 per month, and not much can likely be done to improve this situation for Computer Center staff. The vacated positions have not yet been filled. Additional personnel in the user directorates operate their respective applications. The Computer Center staff can best be characterized as serious and competent, even though they recognize their own limitations. Three staff members recently returned from a three-month training course at UNM, but otherwise, little formal training has been received.

Software development on the WANG has been very traditional but effective given the limitations of the WANG VS-45 system: rather

isolated applications were developed using the WANG menu system, COBOL programming language, and simple, flat-file, access methods. The VS-45 system will not efficiently support the PACE (Professional Application Creation Environment) package, available from WANG, which provides an excellent environment for developing integrated systems around a mature, relational database management system. Given the probability of continued personnel turnover, a stable software systems development environment is much needed.

With the phasing-out of the APRE Project, computer equipment acquired under that project has been turned over to the MOE. Key among this equipment are two UNIX-based, multi-user NCR computers. The configurations are as follows:

NCR Tower 32/650:

- CPU with 4 MB RAM
- Fixed disc drive with 170 MB capacity
- Fixed disc drive with 380 MB capacity
- Cartridge tape drive with 150 MB capacity
- Magnetic (reel) tape drive, 1600/3200 bpi
- Diskette drive, 5.25", 360 kB
- Dot matrix printer, 420 cps, 132 columns
- 10 WYSE serial terminals
- Uninterruptible power supply, 3.5 kVA

NCR Mini-Tower:

- CPU with 2 MB RAM
- Fixed disc drive with 380 MB capacity
- Cartridge tape drive with 150 MB capacity
- Magnetic (reel) tape drive, 1600/3200 bpi
- Diskette drive, 5.25", 360 kB
- Dot matrix printer, 420 cps, 132 columns
- 10 WYSE serial terminals
- Uninterruptible power supply, 3.5 kVA

These systems are equipped with the UNIX multi-user operating systems, the C compiler, and the INGRES development environment centered around a relational database system. At the time of this baseline study, no central MOE applications had been developed by DIIE on the NCR, and data had not been transferred to or from the WANG VS-45 to the NCR 32/650. In effect, the NCR equipment is not being used. UNIX systems are still not well known in El Salvador, and there is a strong reluctance among the Computer Center staff to migrate from the WANG system: they were not involved in the decision to acquire this equipment. No support arrangement has yet

been established with the local NCR dealer, as the equipment was procured directly from the U.S. by USAID/UNM/RONCO.⁴

A mix of microcomputers, including IBM and "clone" (Zenith, WYSE, etc.) PCs, XTs and ATs, and an equally wide range of printers (dot matrix and laser) have been donated by different projects and are scattered around the MOE. These machines are "stand-alone" machines, not linked to either the WANG VS-45, the NCRs, or each other. No distribution or support policy has been developed to deal with the mix of existing equipment, nor to guide the selection of additional computer equipment.

⁴ An initial maintenance offer was received by the MOE on October 20. The 32/650, including the 380 MB disc, 150 MB tape cartridge, and SCSI controllers cost US\$519/month; the Mini-Tower with 380 MB disc, and SCSI controllers cost US\$467/month. Unspecified software support was offered for the UNIX operating system and COBOL-85 compiler at a cost of US\$160/month.

VI. REVIEW OF THE STATISTICS SYSTEM

The educational statistics system is operated by the Estadística department now located under ODEPOR, the MOE's planning unit. This system is similar to most such information systems throughout Central America: initial enrollment data are collected disaggregated by grade, sex, age, and repetition status, and an end-year data collection effort determines final enrollment and promotion results by grade and sex. This system requires a substantial amount of data collection, consolidation, and aggregation at the school level, and suffers from substantial delays in data flow, incomplete coverage, and unknown data quality.

How bad are the data? The APRE Project final evaluation team reported statements regarding available data which ranged from "dispersed" to "way behind schedule" to "not useful for anything", and that the "duplication and multiplicity of statistics [results] in total confusion and inconsistency of information". In October 1989, the initial enrollment data from April 1988 had not yet been processed, because only 82% of schools had reported.⁵ And even these data are considered suspect. Although the Statistics department keeps track of schools which have not reported, there are no effective internal checks which highlight suspect enrollment figures, missing grades, etc. No direct supervision is performed, and no coverage adjustments are made (nor is coverage reported) to the figures produced for the annual Memoria de Labores.

The origin of most of these problems relates to the data collection strategy itself, complicated by an inappropriate relationship between data collection responsibility and lines of authority within the MOE. No study has yet been performed, for example, to determine how teachers or school directors actually maintain the student data required to fill out the forms. The system is designed such that each school director must consolidate information provided by individual teachers, a simple task in smaller schools, but a very difficult job when multiple teachers report at a given school. This is because grade/sex/age disaggregated data for enrollment, for example, must be summed together for each section for each cell of a nine-grade, two sexes, 19-age categories spreadsheet. This matrix thus contains some 684 cells.⁶ In a school with four sections, therefore, up to 2,736 summing operations are required for initial enrollment data alone.

⁵ The Statistics department reports that compliance in data reporting is better among schools from the private sector than from the MOE's own schools.

⁶ Actually, the matrix is not quite this large. While there may be over-age students in all grades, it is impossible to have, for example, seven-year-old students in grades 3-9.

Repetition data (enrolled students reported to be repeating a given grade) represent an equal arithmetic exercise. Data entry (performed centrally) also faces these very large data entry matrices.

The simple solution to this problem is to require each teacher to report directly on the students he or she teaches by section. An additional benefit to the MOE would be to allow better control of teacher activities, a basis for improved supervision. A system such as this would virtually eliminate transferring and adding errors and reduce noncompliance by school directors. The cost would be an increase in the data entry requirements (from 4,300 schools to approximately 30,000 sections for grades 1-9), although this increase would be tempered by a reduction of form complexity, from nine grades to one. Use of codes for teachers and educational centers would allow the generation of appropriate statistics and efficiency indicators for loads at all levels, and permit a feedback mechanism to be established from regional managements to nucleo and school directors. School directors would contribute to the system by reporting teacher section assignments. In addition, this would represent a step towards the implementation of student-level registration in the future.

Decentralized data processing equipment should form a part of this system. This capability directly addresses the issues of data entry and correction, assurance of coverage, and provides a much-needed feedback mechanism for the regions. Currently, the computerized information system provides no support for regional or lower-level management.

Another problem involves the products of the massive enrollment and promotion data collection effort. Tables are produced which not only are out-of-date, but are without regard to use of the data. For example, it is known that repetition is a serious problem, especially in first and second grades.⁷ One of the likely causes of high repetition rates, especially in first grade, is the lack of student maturity. Yet while tables are produced for repetition by sex and grade for each department, no examination of even global patterns of repetition by age is performed, despite the existence of such data. There is a strong tendency to produce voluminous "dead" statistics for the Memoria de Labores, rather than focusing on specific problems. As the

⁷ The official data on repetition, based upon identification and reporting of repeaters enrolled in each grade, is known to seriously underestimate the true number of children repeating a grade. Thus, the MOE estimates that some 18% of first graders are repeaters, but application of the Schieffelbein method using the STEP model suggests that this figure is closer to 49%. Simple examination of enrollment numbers in first and second grades indicates the presence of a large "bottleneck" in student flows.

author of another of the baseline studies expressed, the statistics system would appear to be used solely by foreign consultants. Within the MOE, there is no real use of the system for evaluation or planning purposes: statistics are used for "how much we did" rather than "what needs to be done" questions. At lower levels of MOE management, there is even less use of the data.

As indicated, one of the causes of poor data timeliness, quality, and coverage is the lack of an identified "owner" of the data. The Statistics department has no real authority over regional, subregional, nucleo, or school personnel. These MOE staffers are constantly bombarded with requests and requirements for information from a number of different sources, and do not see the statistics system as serving any useful purpose. It is certainly clear that the data requests they receive are because the centralized system has not made available the information being requested.⁸ Another logical inconsistency of the data collection system is the whole section on teaching staff: if the MOE has to ask directors what teachers are assigned to the school through a questionnaire, of what use is the personnel system?

A short discussion of the Basic Education directorate's statistics system is in order. Basic Education uses 17 forms to collect its data, and these forms are considerably more complex because they depend on manual consolidation at each level up from the school. Thus, Basic Education's forms record data disaggregated by sector (public, private, parochial, and municipal) and/or by urban/rural status. Obviously, a given school fits a single category; the purpose of this structuring is at the consolidation level. The data collected include:

- Number of educational centers and staff.
- Names, ownership, rents, and functional status of schools.
- Section counts, average grades, maximum and final enrollment, dropouts, promoted students.
- Teaching staff by class, career step, and sex.
- Administrative staff by post, urban/rural, and salary scheme.
- Section counts, average grades, maximum and final enrollment, dropouts, promoted students, by grade.
- Kindergarten and special education sections, average grades, enrollments.
- Supervision visits.
- Teacher absences, authorized and not.
- School finances, including parents' contributions.
- Preschool population served.

⁸ Some questionnaires actually suggest that a copy be retained at the school level in order to respond to requests for the same information.

- School feeding program.
- "Active School" project for grades 1-3.

This is a lot of data, and represents an enormous collection and processing effort. Yet this entire system is performed manually, and results in Basic Education's Memoria de Labores, produced yearly. The 1988 report was published in May 1989. The Memoria contains effectively the same forms used in the field, consolidated at the national level. The enrollment data do not, predictably, coincide with those of the educational statistics system, but this is hard to track down--the MOE's Memoria de Labores, published in late July 1989, contains only **projections** of initial enrollments for 1988.

How good are the data? Although there is no question that Basic Education obtains better compliance in terms of the timeliness and coverage, there is also a sense that, because of the difficulty of managing the number and complexity of the forms, considerable "cooking" and/or copying of prior years' data occurs at different levels of the consolidation process. And at the very least, there is considerable opportunity for undetected errors to occur during the consolidation process.

Why can't these two data systems be unified? They could, in fact, and should be, although inter-directorate rivalries must be resolved. Basic Education has a legitimate interest in the data, and, to date, have been unable to acquire it in a timely fashion through any other means. At the same time, the Statistics and Documentation departments have played a traditional role in this basic reporting activity. Certainly, a meeting of minds regarding data sources is necessary. As indicated elsewhere, it is illogical that the MOE does not, through its personnel system, know where teachers are assigned, and must determine this through a survey instrument. There are small areas where Basic Education and the Statistics Department seem to differ: the concept of "initial" versus "maximum" enrollments, the timing of data collection (Statistics performs data collection twice a year, the Basic Education system is at the end of the school year), and there are areas where greater detail is required by one than the other. But these are easily resolvable issues. Questions of data quality should be addressed through data checks and supervision of the data collection process. And the merging of the systems would force the production of synthetic reports back down the data collection chain.

VII. NEEDS FOR IMPROVEMENT IN THE ADMINISTRATIVE MIS

The Computer Center of the MOE has been located under the Administration directorate, a reflection of its implicit priorities. Most of the computer applications developed since 1984 are oriented towards essential MOE functions: personnel, payroll, and finance. Developed on the WANG VS-45 system in COBOL, these applications constitute the fundamental activity of the MOE's computer facility. Additional applications have been developed for educational statistics, inventory, and construction and maintenance.⁹ As the September 1988 AED report on efficiency indicates, there are seven areas in which MIS support should exist in a Ministry of Education:

1. **Curriculum:** content, delivery, and quality control.
2. **Students:** enrollments, tracking, and certification.
3. **Teachers:** hiring, payroll, promotion, transfer, discipline, and release.
4. **Finances:** budget, accounting, expenditures, payroll.
5. **Supplies:** equipment, supplies, distribution.
6. **Construction:** planning, building, and supervision, financing.
7. **Planning:** information, evaluation, projections for budget purposes, quality review.

To be integrated, these seven activity areas need an effective MIS. While the El Salvador MOE of course generates manual or automated data (at the operational level) from each of the activities, there is currently no real integration of the data. Different levels of data collection and analysis, incompatible formats and coding, varying coverage, frequency, and timing all contribute to the difficulties MOE managers face in evaluating and making information-based decisions to guide the MOE's operations.

Even though a large number of computer applications currently exist, the principal problems are those of access and relation. This is due, in large part, to the storage methods employed: the Computer Center uses sequential flat files with minimum indexing; no database technology is in use. Regardless of efficiency considerations, a relational database makes it possible to develop queries of information in the database in continually changing ways in response to needs, thus requiring development of far fewer specific applications. Data extraction, consolidation, and

⁹ Many applications were developed by UNM to support the APRE Project, but these have not been integrated into the overall MOE information system. If the MOE begins migration to the NCR computers, these may form an important base for future MIS development efforts. More discussion of this issue is presented in other sections of this report.

presentation are all important functions for strategic management, and these are currently poorly served by existing systems which tend to produce volumes of output instead of key indicators. Relational technology will go a long way towards improving the responsiveness of the MIS.

Finally, the number of terminals and printers available on the WANG system are simply inadequate. Two terminals and no printer at the service of one of the largest personnel operations in El Salvador draws to mind the image of moving a mountain with a teaspoon. The functionality of even the existing systems at the MOE are seriously threatened by the limitations of the current WANG system.

VIII. REGIONALIZATION ISSUES

For the MOE to implement sustainable administrative improvements, it will be necessary to provide for their effective decentralization. This means that central information requirements must be met through regional information capture and flow up through the system. Whatever form of support system is adopted, the task of maintaining and modifying system applications over time will fall upon the centrally based information systems personnel. It is for this reason that USAID (assuming USAID participation in addressing MIS problems in the new education project) should acquire completely compatible hardware, operating, and software systems at all levels of the MOE. Currently, the MOE has a veritable "mixed salad" of computers, peripherals, and software, and there is no effective support. It is not appropriate to suggest that this collection of equipment can be made to function: the objective of any computerized support is for sustained and consistent operation of the system to be as unobtrusive and easy for the end-users as possible. The introduction of such a wide variety of hardware and software into a Ministry environment during the APRE Project is almost unforgivable, and was especially inappropriate to the magnitude and complexity of the tasks at hand. The strategy of any MIS support effort must err on the conservative side, using existing proven technology with local support and expertise, if the MIS effort is not to lose credibility.

This approach will require that USAID provide support for the acquisition of scalable versions of central-level hardware and software capable of running identical program applications without limitations or modifications. The central computer staff should strengthen their support role, and be provided with necessary communications, transportation, and per diem. It is important that the Mission not view investments in information systems as "nonsustainable." As long as recurrent operating costs are covered by the MOE, information systems investments are effectively one-time costs, if a careful selection of hardware and software is made.

Data communications also form an important part of any computer decentralization plan. Communications infrastructure in El Salvador is currently poorly developed and cannot be considered reliable, but a number of options exist which can be implemented. Leased-lines are the least expensive of all options, but are subject to the availability of dedicated, quality signal lines from ANTEL, the national telephone utility. All telephone lines are subject to terrorist attacks throughout the country. Another option suggested by hardware vendors is radio, or wireless, modems. Private microwave communications links are clearly a higher priced solution, and require substantial investment. Hardware vendors should be required to propose and support communications systems capable of handling distributed data processing as part of their

offers. In any case, fall-back means of data exchange must be provided: there are many inexpensive options for this which are capable of large volume data transfers, including tape cartridge, Bernoulli boxes, and removable sealed disc drives. Diskettes are not an appropriate medium because of their limited (up to 1.44 MB) capacity and relatively low reliability.

Finally, regional and subregional offices will require both clean power and a reasonably clean environment in order to enhance reliability and equipment life. This means that uninterruptible power supplies and air conditioning must be included for each site. Assuming some modifications are required for adapting and equipping each site, the cost of preparing regional offices may be estimated at US\$10,000 each.

IX. COMPUTER EQUIPMENT REQUIREMENTS

The essential support needs of the MOE must be met through a hardware and software environment which is of sufficient power, flexibility, reliability, and compatibility for both user interface and communications. Although no serious plan has yet been developed, the MOE must define the direction of its MIS efforts. Currently, the MOE is examining an offer to upgrade its WANG VS-45, which is verging on obsolescence. This offer includes trade-in credits for the VS-45 and the newer NCRs. A second alternative is to concentrate development on the NCRs. And a third alternative would establish communication between the existing WANG, the NCRs, and some of the microcomputers.

Given the importance of an effective MIS for improving the effectiveness of MOE management and planning, and the difficulties of sustaining such an MIS within a Ministry environment, the argument for a unified hardware/software environment is strong. This would reduce the alternatives to two: remain with WANG equipment, or make a complete commitment to the NCR/UNIX option. Cost considerations aside, the WANG option represents a conservative approach favored by the Computer Center staff, in part because of past support received from the WANG distributor.

Certainly, WANG offers what is needed: a single operating environment fully functional in complete systems, ranging from US\$20,000 and up, integrated system development software, full compatibility, usability of most existing peripherals,¹⁰ assurance of an expansion growth path, support for word processing and automated text and graphics retrieval, and a track record with the MOE of competent support. The NCR option provides flexibility in that the UNIX operating system is available for a wide range of equipment (UNIX equivalents run on 80386 microcomputers, for example), a base from which to start (the two NCR machines and terminals), and relatively inexpensive growth capabilities.

With current equipment, however, the MOE's needs are not met. What other needs exist? Effective decentralization must be an integral part of the MOE's MIS development plans. This, at a minimum, requires computer support to four offices: the central MOE and the three regional offices (Central, Oriente, and Occidente). The subregions in Sonsonate, Chalatenango, and San Vicente also should receive support, either through their own compatible equipment or through functional communications links to

¹⁰ Certainly at the central level, the 600 line-per-minute printer is a necessary peripheral. The NCRs are equipped with character printers not appropriate for the print loads typical of the central MOE. The WANG terminals, disc drives, and tape unit also represent significant investments which can be retained if an upgrade to a WANG VS-5000 system is chosen.

their respective regional offices. Thus, despite the recent donation of two NCR computers, the MOE is short at least two more. It must be reiterated that continued purchases of smaller personal computers do not address central MOE needs, and that lower prices on "mini" and "super-micro" computers allows integrated solutions to be proposed even to the level of the subregion.

The central MOE offices and those of the central region require systems costing about US\$60,000 each, while the Eastern and Western regional offices could be equipped with smaller versions (four to six users) costing in the range of US\$25,000 each. If the WANG option were chosen, costs would run around US\$175,000-\$200,000. If the NCR option were chosen, the smaller of the two existing machines is appropriate for either the Eastern or Western region, and thus perhaps an additional US\$100,000 of NCR equipment would be required. Given the higher maintenance costs charged by NCR, the difference in costs is not great over a seven-year expected equipment life. If the WANG option were chosen, the existing NCR equipment could be donated to MOE secondary institutes or traded in or sold (although the complexities of these latter transactions is recognized). If the NCR option is chosen, the MOE must upgrade its computer personnel, both in training and pay level, to support the UNIX environment.

The automation of personnel records continues to spark a great deal of interest around the MOE. In efforts of this nature, personnel records traditionally have been placed on a micro-storage media, such as microfilm or microfiche, and indexed with computer programs to assist in retrieval. Technological advances now replace the somewhat cumbersome microfilming process with computerized image scanning. These images are stored on either traditional magnetic (disc) media or on high-capacity optical discs, and provide a rapid access method for retrieval of document images to either terminals or printers. With remnants of APRE Project funds, the UNM advisor ordered an image scanner and optical disc unit for attachment to a personal computer. The scanner itself is a bottom-of-the-line, manually fed unit, with a rated scanning speed of 21 seconds per page. With hand feeding and normal system overhead (including data compression), it will probably take about two minutes per page to scan an average document. Assuming that the 40,000+ personnel files contain some 20 pages each, there are perhaps 800,000 pages to be scanned, representing perhaps 14 years of eight hour-per-day, five day-per-week scanning. The personnel office probably generates somewhere around 80,000¹¹ additional pages of documentation per year, which

¹¹ The September 1988 "efficiency" report by AED suggests that transaction rates range from 3,000 per day in March to as high as 9,000 per day in June, the busiest month of the year for Recursos Humanos. Many of these transactions, however, are mechanized and would not require image scanning.

would require about a year and a quarter of scanning at the same level of effort.

Scanning speed is just one problem, however. Although the UNM advisor suggested that each scanned page would require about 6,000 bytes after data compression, WANG literature indicates a typical compressed size of some 50,000 bytes per page. Thus the capacity of the optical disc ordered (600 MB) ranges from 100,000 to as few as 12,000. Given that the optical disc unit is a single drive, to have the MOE's personnel records on-line (necessary for effective access of given personnel files in a multi-user environment) would require anywhere from 8 to 67 units such as that ordered, plus an additional 1 to 8 additional units per year. With these volumes, schemes requiring operator intervention to "change" discs are simply not feasible and should not be considered.

An additional problem is that no multi-user storage, indexing, or retrieval software has been identified to drive this system. WANG does offer full support for image storage and retrieval as an integrated part of its PACE development environment, and also supports high-speed (500 pages per hour with a trained operator) scanners and optical disc "juke boxes" capable of handling up to 4,000,000 pages each. Image-capable terminals are required for on-line display, and laser printers are strongly recommended for hard copy output of image data.

As the September 1988 AED study suggested, this type of effort requires a careful and detailed plan. It may well be that much of the information proposed to be image-scanned would be better entered into a database, rather than kept in image form. There are probably certain documents which are of use only in image form, but these are likely to be fewer than one might expect. A reliable employee database system probably would solve the majority of the personnel department's needs without the heavy investments an image-based system implies.

Another area in which hardware support should be provided is a realistic system for test development and scoring. An image scanner identical to the one described above was also purchased under the APRE Project for this purpose, but is another case of the wrong equipment for the job. An image scanner is appropriate for moving graphics into computers, but is not an optical scoring device (a widely used technology in the U.S.), which senses responses off multiple choice answer forms. The scanner which was purchased is thus neither appropriate nor has the speed for scoring either the 9,000 pilot test results nor the estimated 900,000 test forms expected to be applied annually.

Options should be investigated for purchasing test scanners of sufficient velocity to handle the expected loads, and coordinated with the hardware environment chosen by the MOE. Assuming the existence of sufficient computer capability, a high-

speed, test sheet scoring device will cost approximately US\$35,000-\$40,000. Test scoring does not stop there: scoring software systems must be set up for each test type developed. Finally, as in other areas, test development, management and operations are specialized activities which require technical assistance inputs if the activity is to be successful when undertaken nationwide. Technical assistance support for testing could cost in the neighborhood of US\$250,000.

Communications systems are extremely important if distributed systems are to effectively support the decentralization of MIS functions. A study will need funding to select the most appropriate options for the MOE, which may include leased-line, microwave, or "radio modem" networks. Of course, independent computational power combined with compatible media exchange (such as tape cartridges or removable discs) will always be required as a backup to any communications links which may be developed. Currently in El Salvador there are virtually no distributed systems established, and communications facilities are unreliable for anything beyond simple terminal capabilities.

X. SELECTING A PERSONNEL SYSTEM

It has been expressed above that much of the considerable effort undertaken to date for the personnel system has suffered from the mechanization of deficient manual systems, which results in deficient automated systems. Personnel management is a highly specialized area in which great attention has been paid to process optimization and information systems design. Recursos Humanos needs assistance in reorganizing its personnel procedures, and this type of assistance is not appropriately provided by Computer Center staff. Care also should be taken to avoid contracting with a software shop which offers to mechanize the personnel system as it currently exists. What is needed for a successful effort at improving the efficiency of MOE personnel management is a combination of specific long-term technical assistance to the Recursos Humanos directorate, supported by a carefully selected and adapted full-function personnel software system. The alternative of designing and implementing a full-function software system in-house is simply not viable, given the complexity of software requirements and available MOE staff.

A concentrated search needs to be conducted for a personnel system as part of the decision process for hardware selection. While it is clear that such a system should be either WANG or UNIX based and be modularly developed in a fourth generation language (4GL) for ease of modification and maintenance, careful comparison of features will be crucial if a good base is to be established for what is effectively the reorganization of the MOE's personnel department. It is equally important that the manufacturer of the software system be able to provide on-site adaptation and modification of the system to the specific needs of the MOE. A serious software system with the capabilities needed will cost approximately US\$40,000-\$50,000. The on-site services, which will also serve as training for the Computer Center staff, will probably cost another US\$50,000.

A software purchase of this magnitude is a major investment, subject to the risk that the system will be inappropriate for the needs at hand, is too inefficient to handle expected loads, cannot easily be modified to meet the specific legal and procedural requirements of the MOE, or simply cannot realistically be implemented in a progressive, phased manner. Any of these faults will lead to the abandonment of the system and a failed attempt at personnel management reform. Software package review should be professionally conducted, and include both contact (preferably site visits) with existing users of the system and review of the actual software itself.

User contact is important to determine the following:

- Overall level of satisfaction with the system.

- How transactions are entered/processed.
- Completeness/appropriateness of output.
- Transaction volume (average, peak) handled.
- Size of files handled, growth rate.
- Integrity of data: Have data ever been lost? What recovery procedures exist and did they work?
- What additional hardware was required for the system?
- Software problems encountered.
- Experience in modifying the package to user needs.
- Operator complaints.
- Efficiency of use of machine resources.

Professional review of the software itself should look at the following:

- Content and quality of programming.
- Program flows, controls and system interactions.
- Input, output, and file structures.
- Run-time tests and safeguards.
- Flexibility and expandability.
- Quality and completeness of documentation.
- Modular system design; structured programming techniques.
- Maintenance guidance.

Initial software identification may begin with a request to NCR and WANG hardware distributors, key software suppliers for minicomputers, review of trade journals, and inquiries to management consulting firms with experience in Latin America. Most major U.S. software developers have conversion/translation counterparts in Latin America, and should be able to provide input for the software identification phase. The software review phase should be possible to complete in approximately three months, and should be conducted jointly by a personnel management specialist and an MIS specialist.

Long-term specialized technical assistance in personnel management to the Recursos Humanos directorate should accompany the implementation of the new personnel software, and will first have to develop a phased, multiyear plan for conversion to the system. Three years of focused technical assistance in personnel management systems is recommended. Local in-service training and observation visits are also recommended for Recursos Humanos staff to assist in the transition from existing manual procedures to the new system.

XI. CONCLUSIONS AND RECOMMENDATIONS

The most important conclusion to be drawn from this study is that the information problems of the MOE are of a larger scale than was recognized. The MOE is a very large, complex organization attempting to balance three sets of forces: teachers, students, and classrooms. It has a weak information system, fraught with flaws, which has not been responsive to MOE management needs. Computer Center staff are dedicated and competent individuals who have attempted to address administrative needs with rather limited resources. Although they have developed a number of systems to support the personnel department, these are too limited and rigid. The personnel department itself is overwhelmed by the volume of daily transactions, and has not been able to use even those computerized functions available to it.

Combining with a limited personnel system is an educational statistics system best characterized as inflexible, seriously delayed, and of questionable coverage and quality. The output of this system is used for the Memoria de Labores, foreign consultants, and little else. No feedback mechanisms support regional or nucleo administrators, and there are no links with other information systems, such as personnel. Classroom-level data are equally sparse and out-of-date (on the MOE's system), or do not form part of the system (as with the APRE systems). In sum, sufficient attention has not been paid to developing integrated systems within the "permanent" structure of the MOE.

A second problem area has been to assume that MIS personnel can solve the MOE's very large problems. Thus far, most MIS efforts have simply mechanized deficient manual systems, rather than supported improvement in these systems. Insufficient specialized technical assistance has been provided to guide the reworking of the MOE's procedures, and this, combined with the relatively small leverage MIS has over the MOE's technical and administrative units, compromises MIS impact.

A third weakness in the effort to strengthen the MIS of the MOE has been a propensity to apply "small" solutions to very large problems. This has resulted in some inappropriate "band-aid" approaches to what should be serious efforts. Included in this category are the computer-imaging of personnel documents and the totally insufficient equipment ordered for the test development and scoring activities. The cost of having to drop these approaches when they inevitably prove inadequate has not been taken into account. An additional threat to project success has come from the proliferation of different equipment often incompatible with existing hardware and software. The MOE personnel should not be stressed by having to cope with such a variety of equipment and software. Technical assistance resources should be used to develop

more careful and appropriate approaches to such problems, prior to beginning implementation.

The future of most of the applications developed for APRE under the past project is limited. Greater effort should be made to incorporate these applications into the overall MOE software library, and certainly project data should be merged with those of the MOE to build upon the project data collection effort. If the MOE chooses to migrate to the NCR UNIX environment, then some of these applications may serve as a basis for new system development. At this time, however, there are no signs of such a migration.

The foregoing findings suggest that the Mission should carefully consider its commitment to different MIS aspects under a future project. Recognizing the size and complexity of the MOE, substantial time and resources will have to be committed in a sustained manner, supported by specialized technical assistance. The priorities for this action are relatively clear: personnel management is at the core of current MOE inefficiency on the supply side, and the lack of timely and reliable educational statistical data on the demand side. The implementation of these systems must take place in a software environment which will permit their combined analysis.

Following in priority are school-level inventories of equipment, teaching materials, and supplies and an enhanced budget and finance system to permit evaluation of programs in conjunction with personnel and student data. If student testing is to be supported at a nationwide level, specialized hardware and software will have to be procured to manage the large volumes of data this type of effort will represent. Specialized technical assistance should be provided for test development and operational planning.

For the personnel system, it is highly recommended that a search be conducted for a full-function personnel system which can be adapted, by the software manufacturer, to the specific needs of the MOE. The level of effort involved in designing and implementing a fully functional system clearly exceeds the capability and availability of the Computer Center's limited staff. Moreover, a properly designed personnel system may be the only way for specialized technical assistance to guide Recursos Humanos towards improved personnel management procedures.

The MOE's WANG VS-45 is virtually obsolete, and, as equipped, is insufficient to meet the current demands placed on it. This means that a concerted effort must be made to define the future development of the MOE's computer environment. These choices must take into account the opportunity to decentralize many of the administrative functions of the MOE to the regions, but the hardware which will have to be purchased for the regions must be completely compatible at the operating system and software level, and proper provision for communications made. Both NCR and WANG

offer scalable equipment capable of assuring such software compatibility, and thus the major considerations have to do with hardware and communications support and the development environment the MOE programmers will have to work in. In this regard, WANG would appear to have an edge, and is preferred over NCR by MOE personnel.

In the same way that the Mission's focus has broadened into educational quality and efficiency issues, USAID support for MIS must now address better means of assuring the institutional sustainability of the management tools necessary for the MOE to achieve those goals.