Education Management Information System (EMIS): Integrated Data and Information Systems and Their Implications In Educational Management[1]

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Abstract

Successful management of today's education systems requires effective policy-making and system monitoring through data and information. To this end, countries around the world have invested significant resources into collecting, processing, and managing more and better data through education management information systems (EMIS). However, all too often EMIS design and development has been limited to information technology enhancements, and/or data storage and maintenance, with insufficient attention paid to the management environment in which EMIS operates and data utilization for policy decisions. This paper will examine the technical, organizational, and institutional conditions that must be met in order to enable information-based decision-making for effective system management. It will highlight the fact that technical capacity building must be accompanied by the creation of the demand for information and the nurturing of a culture of open communication, information sharing, and information use.

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1. Introduction

There is no doubt that education contributes to the advancement and enrichment in cultural, social and economic development in all societies by endowing individuals with the means to improve their health, skills, knowledge, and capacity for productive work. Many years of research have provided clear evidence that education is a key factor to the growth in development. However, how to maximize student learning in educational systems with limited resources remains one of the greatest educational challenges. This requires a constant monitoring and evaluation of the learning system in education by collecting and examining data and information used in the process of educational decision making.

Information-based decision making in the management of the education system has as its goal increased access, efficiency, effectiveness, equity, and quality of education through effective systems of monitoring and evaluation, budgeting and planning, policy research and analysis. Education management information systems (EMIS) enable these informed decisions to be made by providing necessary data and information and by fostering an environment in which the demand for this information drives its use. Integrated data and information systems are at the very core of EMIS development in their support of the educational management functions throughout the education system.

The production of educational data and information is a critical cornerstone on which this information-based decision-making framework is built. Deficiencies or inadequacies in its availability, utility, or quality have far-reaching implications. This article will examine the production and use of education information in the EMIS framework.

2. Managing Education System Data & Information (EMIS Development Framework)

"Perhaps for the first time in history, humankind has the capacity to create far more information than anyone can absorb, to foster greater interdependency than anyone can manage, and to accelerate change faster than anyone's ability to keep pace." (Peter Senge 1990)[i] An EMIS is designed to manage this wealth of information in the education system and put it to use to enact meaningful changes in education, while highlighting the interdependencies that exist within different elements of the education system, as well as between education and other aspects of society.

2.1 Definition of EMIS

An EMIS is an institutional service unit producing, managing, and disseminating educational data and information, usually within a national Ministry or Department of Education. The management functions of EMIS include collecting, storing, integrating, processing, organizing, outputting, and marketing educational data and statistics in a timely and reliable fashion. These specific tasks serve the needs of educational management, resource allocation, and policy formulation, such as planning and budgeting, policy research and analysis, monitoring and evaluation, allocating school supplies, and domestic and global communication and collaboration.

An EMIS is also a set of formalized and integrated operational processes, procedures, and cooperative agreements by which data and information about schools and schooling, such as facilities, teachers, students, learning activities, and evaluative outputs, are regularly shared, integrated, analyzed, and disseminated for educational decision use at each level of the educational hierarchy.

Lastly, EMIS is an institutional culture that perpetually advocates data and information use and seeks to ensure it through the creation of an environment which permits information systems to flourish (requiring institutional and organizational commitments), while creating and sustaining demand for information products.

2.2 Three Key Measures of EMIS Success

An EMIS's success depends upon three factors:

- Timely and Reliable Production of Data and Information
- Data Integration and Data Sharing among Departments
- Effective Use of Data and Information for Educational Policy Decisions

2.2.1 Timely and Reliable Production of Data and Information

Timely production of data and information requires that there be a shared understanding of the following by all potential data and information producers, users, or clients:

1) EMIS data produced regularly must meet the needs of overall educational planning and budgeting cycle.

2) EMIS data produced regularly must meet the needs of educational services, such as the Logistics Unit and other units of school supplies.

3) EMIS data produced regularly must meet the needs of educational monitoring and evaluation, and policy research and guidance in a timely fashion.

4) EMIS data produced regularly must meet the needs of international collaboration and communication.

The timeliness of meeting these needs within the Ministry of Education is critically important for the success of EMIS development. Obsolete data, even after produced, may not have much value for use, resulting in missed intervention opportunities and a pervasive distrust from information clients within or outside the organization. To guarantee timely production of data and information to meet these needs, the process of data collection, data entry, data processing, data integration, data analysis, and data reporting should be short, efficient, and productive. This can be often achieved by increasing the level of effort, beginning preparations earlier, proposing and reinforcing

task deadlines, institutionalizing EMIS as a routine management process, and strengthening the coordinating capacity of EMIS data-related activities.

The reliable production of data suggests that EMIS data, once produced, must reliably report a "current reality or status" or "trend of change" of educational development of the country, district, or school. It means that policy makers, planners, budget makers, field educational officers, principals, teachers, parents, and students can trust the data and data sources. To win such a trust, data collection must be treated as a scientific process of fact finding. Variables must be indicative, meaningfully measuring certain elements of the educational system or sub-systems. Regardless of whether data collection is routine or ad hoc, data collectors must be well-trained and prepared to follow scientifically rigid steps. They should not be left with much flexibility in interpretation of methodology or with freedom to change the course of data collection. The level of data reliability can be affected by almost all elements of data and information production procedures, which include the design of data collection instruments, clarity of question items, field data collection methods, educational and ethical level of respondents, design of computer database applications, data entry procedures, data aggregation methods, data integration procedures, and analytical and data processing capacity. To boost the reliability of data, the overall design of the data collection process, data instrument development, and design and development of computer database application must be carefully crafted. No amount of technological innovation can enhance data and information that is of poor quality from the outset. The maxim "garbage in, garbage out" is as true in data and information management as it is in computer programming.

Both timeliness and reliability can affect the level of *information user confidence and trust* in the data. Delay in data production and/or production of unreliable data can easily lead to lack of data use and management frustration, resulting in ineffective planning and budgeting, monitoring and evaluation, policy analysis, and policy-making. When data and information users (e.g., policy makers, analysts) lose faith in EMIS's ability or credibility, they often *discourage* support for maintaining, strengthening, and upgrading the EMIS system. In turn, data and information production capacity becomes even worsened or diminished, further jeopardizing the ability to produce timely and reliable data. This vicious cycle that permeates some educational systems must be eradicated. A healthy culture of information-based decision-making and management, enabled and supported by an information-user-demand-driven EMIS, must be nurtured and developed.

2.2.2 Data Integration and Data Sharing among Departments

Data integration is one of the most important EMIS development strategies. It means that data from multiple sources (payroll, achievement, school census), multiple years, and multiple levels (student, teacher, or school level) can be linked, integrated, or merged. Data integration is intended to add value to the data that are already collected and available in variously scattered places within the same system. Data integration is a must occur before an educational policy analyst or planner can conduct a high-level and high-quality policy analysis or planning exercise. It is common to see multiple units within a Ministry of Education collect and manage large databases and not share them with each

other. These various sets of data are collected to describe certain elements of the system. For example, in a Ministry of Education, data on student achievement are often collected, managed, and available at an examination unit; data on teacher qualification and salary are at a payroll office; data on enrollment and school inputs are at a statistics unit, and data on supplies of textbooks, classroom hardware, and other teaching resources are often at a supply office. These offices often have separate databases for their own task planning and management and they rarely share them with other offices. These multiple sets of data are often designed in varying database applications, organized in different platforms, and coded with self-developed identification code. As a result, the data cannot readily be integrated or used integratively unless a data integration strategy is implemented. Without coordinated management, there cannot be a monitoring and evaluation system, a planning and policy analysis system, or an EMIS system that is effective and policy-relevant. Without such systems, there would be no answers to policy inquiries such as: How much do teacher qualification and salary contribute to student learning achievement, given that the school environment and resource allocation are identical? What is the impact of a new teacher-training program or a new curriculum (or any new educational investment project) on student learning achievement? Clearly, we must integrate the data from multiple sources so that we can conduct the right data analysis to answer the right policy questions. Multi-level data from multiple sources and years, once centrally integrated and organized, could have a tremendous value for policy-relevant research and analysis and improvement in education management.

2.2.3 Effective Use of Data & Information for Policy Decisions

One of the most critical factors that contributes to the success of the EMIS development is an institutional culture of making policy decisions based on data and information. This culture is a user-demand-enabling environment under which the policy research and analysis capacity can be built, strengthened, and further developed. Policy makers, planners, policy analysts, and other high stakeholders are the users of the data and information. The demand for using data and information should stimulate and nurture the healthy development of an information-based decision-making culture and the EMIS system. Often, the institutional demand for use of data and information is translated into or demonstrated by the capacity of the Monitoring and Evaluation Unit, Policy Research and Analysis Unit, and Budgeting and Planning Unit within the Ministry. A weak capacity in any of these management units would exert a negative impact on EMIS development.

EMIS activities can often be misconstrued as information technology (IT) activities. It should be noted that IT efforts represent the technical elements of a larger information management capacity. IT development will not automatically bring about healthy data flow, data sharing, information production, or information use for policy decisions. Some people even firmly believe that the "productivity" can be significantly improved and organizational "business benefits" can be extensively materialized once IT is introduced. This perception gets exacerbated as people work farther away from the central level (such as district offices) or in lower management positions. This perception is not correct.

EMIS development should concentrate on data and information use and institutional behavior change for modern management. Even without IT, there should be a system or culture of data and information use for management. An IT development should be designed to provide a technical enhancement to facilitate the capacity of data and information production and use. There is a saying "manage your business, not your applications." In short, we must examine the key functions of the EMIS Unit and how it can help to improve the integration and productivity of "educational business and management" within a Ministry of Education.

2.3 Summing Up

To enable and build an effective EMIS system and capacity, and to create a strong demand for using EMIS data and information, organizational capacity must be strengthened, specifically the capacities of budgeting, planning, monitoring, evaluating, and policy research and analysis, and policy formulation. To assess whether an EMIS is effective or not, one must determine whether it accomplishes the following in a timely and reliable fashion:

- define, collect, and process educational data and statistics;
- integrate data from multiple sources, multiple years, and multiple educational levels within and outside the Ministry of Education;
- systematically store and manage databases and quickly retrieve them when requested.
- produce an annual statistical report on the current conditions of the education system and meet ad-hoc data and statistical requests from the senior management of the Ministry of Education, as well as all other education information users.
- respond to and support inquiries and requests by educational policy researchers, analysts, planners, and other management personnel for supporting activities such as indicator development, statistical analysis, budgeting and planning, enrollment projection, studies of educational effectiveness, and other quantitative system analysis and monitoring and evaluation.

3. Data Integration – Enabling the Creation of Policy-Relevant Information

Integrating data, as mentioned earlier, means that data from multiple sources (payroll, achievement, school census), multiple years, and multiple levels (student, teacher, or school level) can be linked, integrated, or merged. Data integration is intended to add value to the data that are already collected and available in variously scattered places within the same system. Data integration is a prerequisite before an educational policy analyst or planner can conduct a high-quality policy analysis or planning exercise.

Data integration, procedurally, is the "tailpiece" to data collection and the "prelude" to data utilization. It not only helps manage data in a more effective and consistent manner, it also contributes to a readiness for more useful policy-oriented analysis, planning, budgeting, and monitoring. Data integration does not necessarily mean having all data physically integrated in one location, or dynamically linked at any given time. Data sources can still be decentralized. The key to data integration is the process of standardizing data structures, types, formats, and coding schemes, as well as creating institutional agreements to share and mine data for policy-making purposes, including monitoring the present, evaluating the past, and projecting the future needs of the education system.

3.1 Data Integration Strategy – The Technical Elements

Despite the need to distinguish information management from information technology, information management enabled by data integration does entail a certain amount of technical consideration. As developments in IT permit larger volumes of more diverse data to be collected from a growing number of sources (both within and outside of the traditional education sector) and managed more easily, these technical considerations become increasingly important to facilitate data integration for the creation of meaningful indicators.

In simple terms, data must be made "integrateable" by understanding 1) the unique identification codes used to identify various system elements, e.g. schools, students, test subjects, etc.; 2) the structure of the contents of the data, along with variable code values; and 3) the context from which the data is derived.

3.1.1 Coding

To maintain accurate and consistent records that permit longitudinal and cross-sectional analyses, unique identification codes must be assigned to every level of the education system for which data is collected (schools, teachers, students) and into which this data can be grouped and compared (e.g., political units, system level). As separate data and information systems develop in Ministries of Education, they often do so independently of one another, resulting in different sets of codes being used as unique identifiers for every level of evaluation (e.g., district, school, classroom, student, test subject). This environment of disparate codes makes comparison of data from different sources and accurate integration impossible. This challenge is dealt with in nearly every EMIS at one point or another.

There are two possible solutions to the identification coding issue, each with advantages and disadvantages. The first solution is to establish standardized codes accepted and implemented by all education data providers. In such a scenario, representatives from each unit or institution must come to agreement on, and begin using, unique identification codes for every element of the education system: political division, local education authority, school, teacher, student, test subject, etc. The advantage to such a solution is that all education databases are easily and quickly integratable, permitting a wider range

of personnel to perform integration procedures. This should expedite the creation of integrated indicators, and should facilitate the flow of information by alleviating the bottleneck caused by a limited number of individuals possessing the skills needed to perform such functions. However, the standardizing codes must be well-managed and coordinated. For example, new codes for schools or teachers must be applied from the Ministry's coding authority, often the EMIS database management unit. This is an on-going process and often requires high maintenance and institutional discipline.

The first challenge inherent in this solution is unwillingness of institutions to change codes. Each of the education institutions may feel that its coding system should be adopted by all other data sources as a matter of pride and of perceived greater importance in the education system. This is a symptom of the larger issue of lack of collaborative spirit and absence of shared vision for information use in education. Furthermore, institutions may claim that changing codes is too time-consuming and counterproductive, which is a either sign of a lack of understanding of the importance of data integration or proof that the institution does not see the value in such an exercise. In any event, institutional unwillingness to collaborate or compromise on common coding results in an inability to integrate data. This unwillingness is resolved through intensified sensitization of education information personnel to the importance of integration of data and the importance of the environment that must be created to enable such an undertaking.

The second challenge that adoption of common shared codes presents is the time and effort required by each institution to migrate their coding system. In a country with many schools, significant resources are needed to implement a new coding scheme at the school level, where each school name must be matched with a "new" code. This is exacerbated by lack of agreement or standardization of school names and/or definitions of schools. Limited alleviation may be offered by "technological wizardry," which may be used to assist in identifying matching schools using algorithms to find similarities in spelling, but there is no easy solution to this issue for existing schools. Newly-built schools can avoid this problem by institutions agreeing on their name and spelling.

Further complicating adoption of common codes is the issue of definition of schools, which is less frequent but more problematic. As Ministries of Education strive to improve education quality, efficiency, access, and effectiveness by constructing additional school buildings, it is not unusual for existing structures to be expanded. A 6-room school with one class per grade may become a 12-room school with two classes per grade. Some institutions may construe this as a second distinct school and others will view it as an extension of the same school. Within the same country, "expanded schools" may have one or two headmasters, may or may not have shared teaching staff, may have shared or distinct parent-teacher associations, among other complications. Lack of standardization in the definition of a school creates challenges when integrating data because of an inability to identify all of the assets of the school in all data sources. As with school names, agreeing upon the definition of a school (or any other asset to be given an identification code) will facilitate coding in the future, but will not have bearing on already-established schools.

The third challenge that adoption of common codes presents is the use of historical data. Once common codes are adopted and implemented, it becomes difficult to use historical data for longitudinal studies, due to the newly-created inability to match codes *within* the same institution. This necessitates either keeping records on two sets of codes, so that old and new codes may be matched to enable internal data merging, or changing all school codes in previous data files to reflect new codes. Either choice has implications for ease of data use.

The second solution to the issue of coding differences throughout the education system is the creation of a data file that can be used to "translate" between data sources. This translation file is a data file that lists the codes used by each institution, along with the name of the asset in question, i.e. school, district, region, etc. This file can be created only after complete lists of codes are provided by each institution to whoever will be responsible for the coordination of the integration initiative. Once provided, codes must be matched manually, facilitated by grouping and sorting methods that expedite the process. The benefit of this solution is that once created, the codebook permits any data from any data source *from any year* to be used in creating integrated information. However, using this file adds another technical skill to the list of those needed to integrate data, and may create an obstacle in the integration process due to limited technical expertise that may exist.

Regardless of which solution is implemented to overcome the coding problem, an initial investment of time and effort will be required to enable the integration of data. It is important to bear in mind that in addition to this considerable front-end work, ongoing effort must be spent to *maintain* the system used to integrate data. As new schools are constructed and old ones closed, common codes must be created or separate codes must be shared among partners and added to the translation file. This must become a routine and regular process in order to continue to permit data to be easily and accurately integrated.

3.1.2 Structure

Partly because of the need to share data and information across different software applications and computer platforms, and partly because of the need to minimize the size of data files to facilitate their sharing, data are frequently exchanged and used in a text, or "flatfile", format. This format presents data as long strings of text, in which can be found coded information that can be used by any software application or operating system. In addition to an understanding of the codes used by the institution, a thorough knowledge of the data structure is essential to being able to use and integrate the data. Furthermore, in addition to using identification codes to identify specific schools and regions within a system, institutions use codes to indicate attributes of elements of the system. For instance, not only will a school have an identification code, it will also be coded as public or private, primary or secondary, urban or rural, etc. "Codebooks" – documentation from each institution that defines the codes used for each variable in the data record – are required to correctly interpret the information in each file. Like the codebook

documentation process, the data structure's documentation must be constantly maintained and updated as it evolves to make it continually usable.

3.1.3 Data context

Before this information can be used to its fullest capacity, documentation on what the data *means* must be provided. For example, examining achievement data may raise the following questions about its context:

- Does every student sit for this exam?
- Does every school participate in the examination system? Does the exam include private and public schools?
- How old should the student be in an ideal situation? What are the implications of a student who is 3 years older than the "target" age?
- What is the examination scoring method used?
- What are the implications of these test results on the student's future?

Knowing the context from which the data come enables the creation of meaningful indicators that will help guide education policy. In addition to the context of the data, it is essential that the hierarchy of the data and its relationship to other data hierarchy be clear. For instance, can records be grouped by school? District? Region? Are these levels of aggregation identical to the aggregation that is possible using other data sources? If not, is there any overlap? From a statistical analysis standpoint, it is advantageous to maintain data in as disaggregated a state as possible, while at the same time permitting aggregation when necessary. This permits analysis to be performed using the maximum number of data points, and, for example, treats each student as a separate record. Aggregating student-level data to school level presumes, during analysis, that every student at the school is identical and negates any variation within the school.

3.2 Data Integration Strategy - The Institutional

An institutional and organizational environment that supports data integration is essential for success in integration efforts.

3.2.1 Memoranda of Understanding

All too often, units gathering and managing education data are reluctant to share their information with other units. This can be attributed to one or more causes:

- The lack of value given to data integration, which is indicative of the lack of understanding and shared vision about information use in the education system.
- The perception that information is proprietary, and should not be seen or used by outsiders.
- The perception that information is a limited commodity, rather than a limitless resource, and should therefore not be shared. This point of view is particularly

true in situations where control of data and information equates to power and authority.

These issues must be met with continuous sensitization and reinforcement from education leaders of the value of data integration activities. To assist in this institutionalization, formalized agreements between education agencies and institutions, and between divisions within the same institution, must be drafted, adopted, and enforced to ensure timely, reliable exchange of data and information among education stakeholders. A Memorandum of Understanding should not only represent a commitment and a pledge to facilitate this flow of information, it should also be treated as a binding contract and as such should be enforced rigorously. A committed leader willing to oversee the implementation of and adherence to Memoranda of Understanding is necessary in order for them to have an impact. As time goes on, and as the data integration process becomes institutionalized, these Memoranda of Understanding will be relied on less and less, as the need for such mechanisms will diminish.

3.2.2 Data Integration as Part of the Data Production Cycle

Institutionalizing data integration is facilitated by including it as a regular and routine part of the data and information production cycle. Establishing timelines for all aspects of the data integration process, including exchange of data, updating of codes and codebooks, technical integration activities, use of integrated data in reporting, availability of integrated data, etc., will help to create accountability for the integration process.

3.2.3 Roles and Responsibilities

Further developing this sense of accountability is the designation of staff in each unit who should be responsible for data integration. This facilitates implementation of Memoranda of Understanding and clearly identifies staff throughout the system who serve as contact points for data integration issues.

3.2.4 Policy Documents

Units and institutions may consider their data as sensitive, and may be reluctant to share it due to issues of confidentiality. This is particularly true when dealing with data about individuals, e.g., teacher data, such as salary, age, qualifications, or ethnicity, and student data, such as achievement results, age, and ethnicity, among others. Creating policies that specify who has access to what pieces of information will help not only to protect individuals' privacy, but it also alleviates concern on the part of contributing units and helps to maintain the smooth flow of data and information.

Furthermore, creating policy governing access to integrated data eliminates any bottlenecks in the flow of information *out* of the integrated system, enabling information users to easily gain access to required information without having to deal with "information brokers" – those who seek to control information.

3.3 Summary

To sum up, the data integration component of EMIS requires:

- A strategy for dealing with differing codes from the various data sources – either adoption of standard codes or the creation of a code translation file.
- Codebook details from each institution, along with an understanding of the file structure, to correctly interpret the information contained in the data records.
- An understanding of the context of the data, to create informative and relevant indicators that will shed light on policy questions and initiatives.
- Technical skills to integrate data files and a conceptual grounding in education indicator development and information management.
- Creation of a conducive environment that supports data integration by addressing issues such as the supply of data, timing and staffing of data integration activities, and access to integrated data and information.

4. Use of EMIS Data: Systems of Policy Planning and Evaluation

Management functions in the Ministry of Education can be categorized into two related sectors: policy planning and policy evaluation. Policy planning includes work of educational projection, budgeting, organizing resources, and other pre-policy analysis and assessment. Policy evaluation consists of monitoring and evaluation (M&E), policy research, and other post-policy analysis. These management functions at the central system level depend heavily on EMIS data and information. In this article, we mainly focus on the component of policy evaluation and its relationship with EMIS functions.

4.1 Monitoring and Evaluation Systems

Systems of Monitoring and Evaluation (M&E) exist to assess what works and what does not work, and to what extent it works or not. Monitoring and evaluation activities at Ministries of Education usually consist of a good set of well-developed indicators routinely produced by a small group of well-trained educational analysts. The function should be to assist policy makers in adjusting or re-adjusting the course of educational development and reform. The results of any valuation projects must help make decisions on the basis of available strategic options associated with uncertainties, imperfect information, and predicted values of consequences. It is essential that evaluation provide informative results that make the uncertainties more certain, the imperfect information more perfect, and the predicted values more accurate. An evaluation project that fails to design for such an objective or is unable to deliver the requisite information would be regarded as a project in vain.

The concept of evaluation belongs to the theory of organizational learning and systems thinking which "is based on a growing body of theory about the behavior of feedback and complexity – the innate tendencies of a system that lead to growth or stability over time." (Peter Senge 2000). The process of the evaluation is part of the process of systems

thinking that reflects the organizational culture of seeking, analyzing, and sharing information for decision making.

The value of the evaluation lies in the actual use of the provided information through evaluation work for making or changing strategic decision(s) that result in added benefits and values for systems, institutions, and individuals who are in them. Such value of the evaluation cannot be materialized if any of the following three are present:

1) Decision-makers and evaluators who do not share the objectives of the evaluation.
2) Evaluators who fail to deliver the "promise" of the evaluation project.
3) Decision-makers who irresponsibly ignore the results and "depreciate the value" of evaluation.

To conduct a system evaluation, we depend on data. In an education system, a routine system evaluation must be put in place, requiring routine data collection and analysis. System evaluators must design sufficient indicators that can be collected, monitored, and evaluated and they must do the job of converting the field data on individuals or schools to the aggregated and relevant system indicators. For this reason, EMIS is a prerequisite for monitoring and evaluating activities.

Many evaluations are carried out in various scales at many systemic or institutional levels. Large investments and sometimes strong commitments from decision-makers and evaluators have been made in such an important and valuable work. But the "investment returns" are often not materialized or even recognized in the end due to the reasons mentioned above. As John Willinsky[ii] (2003) recently pointed out, too much of what policy analysts or researchers have produced goes unheard, unseen, or unused by policy-makers who are actually in a position to do something with it, as well as by those who suffer the consequences of this inaction or ignorance. Therefore, it is an institutional development challenge that we not only produce data and information product, but also ensure that it gets heard, seen, and used.

4.2 Policy Analysis

Applications of computer and information technology are increasingly prevalent, new analytical tools are becoming easier to use, and information and knowledge-sharing is an integral component in the new management culture across all systems. In this new age, a much stronger demand for system-level policy research and analysis to determine quality and support policy-making is emerging. As the primary catalyst for human resource development and knowledge production, education systems must lead all public sectors in building an internal capacity of conducting system-level policy research and analysis in which analytical inquiries, use of information, and management of knowledge form the basis for policy decision-making. In education systems, only strong institutional demand for, and capacity of, policy research and analysis can bring about the effective functions of educational monitoring and evaluation and management information systems, and only when these management capacities are well established can the quality of education in a large system be improved.

The objective of policy research and analysis is to assist educational policy-makers and policy analysts in developing critical perspectives on policy formulation and options through analytical processes. These analytical processes involve the development of policy-related inquiries, construction of measurements, collection of data, analysis of data, and policy relevant information and interpretation. In all, policy research and analysis serve to "mine data" effectively for policy-making. Reliable data, used in conjunction with appropriate analytical techniques, generate credible evidence or information for policy-makers and analysts to use in establishing a strong knowledge base and facilitating smarter decision-making. This requires examining applied techniques in educational policy research and analysis, and attempting to understand various complex models that are in place to capture the inner dynamics of the educational system, including the hierarchy of relationships between, and the information flow among, its components. One rational premise that we must always keep in mind is that research and analysis significantly contribute to the quality of information produced. Better information leads to better decisions. Therefore, it is critically important to realize and establish an institutional culture that uses data and information to improve the pace and quality of educational decisions, and to accumulate institutional knowledge, skills, and capacity to better use educational resources, creatively develop curricula, and effectively maximize learning.

The essence of educational policy research and analysis is to use and analyze routine and ad hoc system-generated indicators to answer system-level policy inquiries. This applies to both pre- and post-policy research and analysis. Because the education system is dynamic, the indicators that measure various aspects of the system must vary over time. The infrastructure of the education management information system and its timely and reliable production of system indicators is, therefore, the prerequisite for the policy research and analysis.

Longstanding challenges in education policy continue today: What and how should students learn and what and how should teachers teach in today's context and for tomorrow's world? What factors in education contribute effectively to learning or teaching? And what resources can we efficiently use or organize to ensure that learning happens with promising effect? These questions are easy to identify but not as easy to answer. Policy analysts must conduct relevant systems analysis in order to begin to answer these questions. Skills and knowledge that students have learned from schools must be proven relevant and useful outside the education system. For a long time, educators have been trying, unsuccessfully, to figure out what should be "taught" in the long education cycle to address the most current social and economic needs of societies and what should be the "right coefficients" for allocating limited resources (or investments) to the learning and teaching environment. Policy makers must be confident in making decisions concerning which elements in our education system and system inputs should be invested in this year and which next year or in the future.

Some people are satisfied with what they see in education because they do not have a benchmark against which they can compare. Others advocate constant reforms but fail to

spell out specific alternatives because these alternatives have not been tested to assess their effectiveness. Still others remain engaged in a classical debate about whether there should be an advocacy for the standardization of education production or the art of customization in teaching and learning practices. Although education is one of the foundations of human society, many of the same questions are continuously raised by new generations of educators and educational managers. If teachers can only teach what they learned from schools, then the knowledge and skills transferred in classrooms are already "obsolete." If students learn obsolete knowledge and skills, how can they become effective and productive in the social and economic environment that is becoming more global and dynamic? If learning achievement can be standardized and measured reliably, what are the educational policy-maneuverable factors that could positively impact achievement? How should educators manage the dynamic education system in which more questions than answers are constantly generated? These are the kinds of inquiries that the Policy Research & Analysis unit should be able to address and answer in quest of policy options and solutions.

4.3 Design in Policy Research

The most important element of research is design. The most important segment of the design is constructing research questions. It is the research question(s) that determines the type of research method to be used and the amount of resources to be required for the research. "Our theories determine what we measure." (Peter Senge 1990) In the field of education, there is no lack of researchable inquiries, ranging from asking questions about educational system efficiency and effectiveness to pondering the best teaching and learning practices. However, to translate the researchable inquiries into specific research questions requires a comprehensive understanding of the research process and skills. As Light, Singer and Willett put it "you can't fix by analysis what bungled by design." **(By Design, 1990)** This also suggests that no one should design research without knowing the appropriate analysis tools and techniques.

When designing education policy research, a researcher must understand the policy context and articulate the fundamental problem(s). He or she must also be able to see the relevance of the research products to the problems. Only under this prerequisite can the researcher(s) start the design work. The tasks of the design work are 1) to compose relevant research questions, 2) to determine an appropriate method(s), 3) to develop a feasible data collection scheme, and 4) to plan analysis strategies.

System monitoring and evaluation is often yet to be institutionalized, and policy research and analysis is often yet to be established. Both are critical management functions for providing guidance for the policy makers in Ministries. Only by institutionalizing these functions can system-wide data integration, data sharing, and data production processes become valuable, and the culture of making decisions based on data and information be cultivated. A policy research and analytical capacity within ministries of education must be established and strengthened in order to use the existing data for production of various information products.

5. A Culture of Information Use

Volumes of educational data are collected annually. Sometimes, the collection process is quite sophisticated and the data content in the EMIS system alone is rich. Students' academic activity data, teacher qualification and salary information, and school general profile are all collected. Variables can be outputted and used for policy research and analysis. One question that remains is why Ministries do not see more data analysis reports, indicator reports, policy research reports, or system development briefs, given that fact data have been collected, stored, and organized in an even, timely, and reliable fashion?

"Structures of which we are unaware hold us prisoner." (Peter Senge 1990)[iii] All too often these structures within the education system, which may exist by design or by evolution, are invisible to Ministry staff, though they hinder the use of information and ultimately have a detrimental effect on education. Until they are identified and addressed, they continue to be white elephants that limit the effectiveness of EMIS.

Technical resources and abilities alone can guarantee neither data integration nor information use. Only after an organizational and institutional environment conducive to its development has been created, only after the structures which impede information use have been eliminated, can an integrated EMIS be expected to flourish.

5.1 Symptoms and Sources of a Lack of Culture of Information Use

A rational model informs us that the healthy development of an information-based decision-making culture can be nurtured by increasing the decision-makers' demand for data and information. This kind of demand can be demonstrated in the institutional capacity of the Planning and Budgeting Unit, the Monitoring and Evaluation Unit, and the Policy Research and Analysis Unit. However, these units are often weak or inefficient, demonstrating lack of information demand and lack of a value placed on information in the decision-making process.

More often than not, development of an institutional culture and capacity to use information requires a change in culture that is often met with resistance. Examples of this resistance include:

- A lack of faith in the merits of EMIS. "The system is unproven. We have not seen any improvement since we began to collect data."
- Appeals to tradition. "We've always done things our own way. The new way of using information to make decisions is not how things have been done in the past, and the old way was good enough."
- Finding continual flaw with data or information. "This information surely still has some errors in it. It must be 'preliminary' or unofficial."

Alleviating this limit to growth[iii] depends on a skilled leader's ability to identify and address the true source of resistance, rather than merely reiterating conceptual and

philosophical foundations, which are unlikely to be embraced so long as there is an obstacle in the way. Our experience shows us that common causes of this resistance include lack of a culture of communication and information exchange, lack of shared vision for EMIS, lack of organizational readiness, and a set of institutional issues common to most Ministries that impede the development of EMIS.

5.1.1 Importance of a culture of Communication and Information Exchange

Communication within Ministries of Education is often uncoordinated or nonexistent. Disjointed, semi-autonomous units operating independently of one another with no centralized management results in a lack of internal communication within the Ministry, and permits the individuals or units to control data and information. This influences the overall institutional culture of the Ministry and often results in poor external communication as well.

Part of the culture of information use is based on the notion of information sharing and communication. The absence of commitment to this idea hinders effective system management as well. In many places, data and information are viewed as a commodity. Should a data user need information on teacher salaries, for example, the person who is "in charge" of this data in the payroll department is in an advantageous position because he possesses something that is in demand. In his opinion, it is counterintuitive to freely share and disseminate this data and information because once he ceases to be the sole owner of the data, it stops having any value to him.

The issue that is at hand here is one of lack of commitment to the notions of data integration and data use. Data must be shared before it can be integrated to create meaningful policy indicators. And only then can it be used to make better decisions. The more information is shared and used, the more valuable it becomes *perhaps not personally, but systemically and communally.* Data managers and data users often fail to see the overall benefit to the system because they are too concerned with personal benefits. This short-sightedness must be overcome by creating an institutional vision for EMIS on the basis of the personal visions of EMIS staff, as well as through training and awareness campaigns accompanied by policies and protocols that guarantee that data and information will be shared.

5.1.2 Lack of shared vision for EMIS

Resistance to adopting a culture of information use can often be attributed to lack of a shared vision for EMIS development. A shared vision is one that is developed from individuals' visions for EMIS – what it should be, how it should function, what goals it seeks, how it should be able to improve the education system for the common good. Without a shared vision, units and individuals within the Ministry are less likely to feel ownership of EMIS, are less likely to be proactive in the advancement of EMIS, and are more likely to contribute less-than-best levels of effort and intention.[iv]

5.1.3 Lack of organizational readiness

Organizational structures influence the environment in which EMIS develops. Organizations with unclear lines of accountability, with redundant or nonexistent responsibility assignments, and with poor coordination and leadership hinder EMIS development.

Failing to establish an organization that holds staff accountable may result in an inefficient structure composed of loosely-affiliated units with different goals and missions, poor or no collaboration or communication, and general inefficiency and ineffectiveness. Without accountability, demand for information can not possibly be created because those who would be responsible for producing information have no management or supervision.

Furthermore, lack of clearly defined responsibilities for staff may result in certain functions being overlooked or neglected, while at the same time other functions are performed by multiple individuals or units. Functions for which no one is responsible are unlikely to be performed, to the detriment not only to EMIS development but also to its ability to operate. Redundancy in responsibility, either de facto or by design, results not only in inefficiency, but also in the lack of legitimacy, as no single office is viewed as the authority. This may result in conflicting data and information being used, which jeopardizes the legitimacy of EMIS as a whole, and may decrease demand for information.

One function that often goes overlooked when examining organizational structure for EMIS development is marketing and promoting of EMIS. This is a critical aspect of creating demand for information use, as well as for decentralization and democratization in education management. Promoting data and information entails both internal and external marketing campaigns to raise awareness of the existence of information products, in the hopes of increasing their use at all levels of the system. Failing to successfully market information may result in valuable, useful information products collecting dust on shelves not because of a lack of desire to use them, but rather because of a lack of awareness of their existence.

Assigning responsibility for promoting and marketing information also establishes one unit as the authority for fielding and fulfilling information requests, which helps to alleviate any confusion or obstacles to free-flowing information.

5.1.4 Common institutional issues

There seem to be some institutional "headaches" that are quite prevalent in the Ministries of Education. Although many require changes in social and economic conditions, government structural reforms and social attitudes, some remain as challenges for the top management of the Ministry. These headaches include:

- Low salary (lower than other social sector profession)
- High turn-over rate (higher than other sectors' average)

- Low motivation in education sector
- "Brain-drain" within the Ministry and the country (well trained staff leave)
- Lack of data integration and quantitative analysis skills
- Lack of data and information sharing
- Lack of system and program monitoring and evaluation
- Lack of policy research and analysis
- Lack of optimal ways to manage resource allocation
- Too many uncertainties (lack of visions, goals, targets, ways of achieving them)
- Major decisions are made but staff cannot explain why they are made
- Lack of guidance for dealing with educational dilemmas such as "fees or free", "private or public", "standardization or customization", "skill or knowledge teaching"

Although institutional problems appear to be many and known to all, a systemic analysis of these problems and an institutional capability of identifying strategies for resolving these problems remain inadequate. System monitoring and evaluation is yet to be institutionalized, and policy research and analysis is yet to be established. Both are critical management functions for providing guidance for the policy makers in these ministries. Only by institutionalizing these functions can system data integration, data sharing, and data production processes become valuable and the culture of making decisions based on data and information be cultivated. We must establish and strengthen a policy research and analytical capacity within Ministries of Education using the existing data for production of various information products.

5.2 Building an Environment that Nurtures a Culture of Information Use

Some Ministries have a tremendous potential for enabling a new management environment where educational policies are made on the basis of timely and reliable data and information. With computer technology and office network connectivity available in most offices, and electronic data rich in content, these Ministries are ready for the establishment of the institutional capacity of using data and information for policy decisions.

5.2.1 Culture of communication and information sharing

Creating a culture of communication and information sharing is no small task. This, too, may be met with resistance. Policies can be established, formalized, implemented, and enforced to promote internal and external communication and information sharing, but this does not create a culture.

Adopting a culture of communication and information sharing is a step toward system thinking. This shift requires "seeing interrelationships rather than linear cause and effect chains, and seeing processes of change rather than snapshots." (Senge 1990) It requires individual staff and units to understand the way in which their interaction with other in the Ministry affects overall education.

This shift in culture depends on understanding the value of communication and the free flow of information, creating opportunities that promote the culture, and changing organizational structure to eliminate the ability of units to exist in isolation.

5.2.2 Shared vision

Creation of a shared vision for EMIS leads to all stakeholders, from data entry staff to policy-makers, feeling a sense of ownership not just in EMIS but in its outcome as well. It empowers individuals and units to do more than merely comply with directives; they are willing to do whatever is in their power to guarantee the success of EMIS. In systems of semi-independent units with no recent history of collaboration, a shared vision is critical for enabling coordinated work designed to develop EMIS. "A shared vision is the first step in allowing people who mistrust each other to begin to work together." (Senge 1990)

Creation of a shared vision for EMIS requires a strong leader and manager who possesses a personal vision himself and who is able to identify the individual visions of his staff and incorporate them into a shared vision that all will embrace. Too often, the vision of the donor, the consultant, an individual, or a small group is enforced on others. This stifles effectiveness of EMIS and relegates it to the status of "project."

5.2.3 Institutional Home

To establish EMIS as a permanent and sustainable operational unit within a Ministry of Education, a clear "institutional home" needs to be put into a vision as well as a reality. Although the EMIS's position within the organization will vary depending on the pre-established structure of the Ministry, the pre-existing relationships between units or divisions, and the intended role EMIS is to play in the policy process, EMIS officer ranks, career professional development, personnel compensation packages, departmental service-orientation, permanent budget, etc. must be established and honored. The EMIS must be accountable to management functions such as educational planning, budgeting, and resource allocation, as well as decision-making functions such as monitoring, evaluation, and policy research and analysis. Satisfaction from these functional units within the organization is the ultimate criteria for measuring the EMIS achievement. Without an institutional home, an EMIS cannot easily operate or be held accountable. A failure in EMIS development often lies in a "project status" with temporary officers borrowed from other divisions under an ad hoc budget playing semi-independent role with no accountability for the domestic management functions except for the external project sponsor.

Furthermore, failure to establish EMIS' home within the Ministry may lead to:

- A divisional and management distrust that result in an inability to establish an authority as the official source of educational data and information which in turn leads to redundancy of efforts of data and information management by others.

- A failure to sustain a long-term collaboration among all EMIS relationships established under the EMIS project in data collection, data sharing, data integration and data dissemination.
- A likely disruption or total collapse due to personnel loss, budget cut, or technical misfortune (or technical transition).

5.2.4 Accountability

Accountability within the organization can be created by establishing an EMIS organizational structure with clearly defined responsibilities and policies to guide what data should be collected and what should be disseminated. EMIS alone can not and should not do the job. These require strong leadership from education policy makers who represent the demand for EMIS's products, which will compel EMIS to deliver. Ultimately, educational policy makers are the management to which the EMIS is accountable. Without the appropriate institutional structure and accompanying policies, an accountability system is nothing more than rhetoric.

Accountability for EMIS can be considered from two perspectives: internal accountability and external accountability. Internal accountability refers to the processes wholly within the auspices of EMIS' mandate and power. EMIS is internally accountable for activities such as technical data collection, data entry, data processing, producing data reports and meeting ad hoc report requests. External accountability refers to the actions that must be taken by other units on behalf of EMIS, such as budget support, policy research and analysis, and collaboration with other divisions and policy guidelines in data and information sharing:

Internal accountability is created by establishing work-related procedure policies, individual task descriptions, and responsibility charts, as well as other administrative guidance. External accountability is created through sensitisation and marketing of EMIS information and its role in the management of the education system, coupled with the constant reaffirmation of the value of information-based decision making. Accountability is pointless if there is no demand for the product. Whether or not the product is created becomes a moot point.

5.2.5 Budget

EMIS activities are frequently funded initially by donor organizations. This initial investment of capital and capacity building must be met with sustained levels of input. This implies continued training and development of staff, as well as the inclusion of EMIS activities in a Ministry's annual activity cycle. As such, funding must be secured as with any other activity, and EMIS initiatives must be explicitly cited in Ministry budget proposals.

The continuation of EMIS funded by donors or one-off disbursements does a disservice to sustainability of information management and perpetuates the notion that EMIS is both temporary and exogenous. The full potential of EMIS can only be realized when

ownership by local staff is created, and this can only come about when a budget is secured.

5.2.6 Staffing

For EMIS to be successful, it needs an able and willing staff. Technical and conceptual skills can be transferred and capacity can be built. However, there will always be challenges in the area of staffing.

- EMIS is frequently a "new" undertaking, and as such its staff is often cobbled together from existing personnel. These staff members may have additional responsibilities unrelated EMIS, which they may view as their "official" jobs. In environments of limited resources where staff are stretched thin, "extra" responsibilities such as EMIS may suffer.

- Civil service staff may be more likely to leave the public sector after acquiring additional training, especially in the area of IT, as it may enable them to earn a higher salary elsewhere. This may increase staff turnover, which is already quite high.

- Many EMIS positions are "cutting-edge", in the sense that their roles and responsibilities are unique and on the forefront of education development. As such, it is conceivable that there is no existing career path for EMIS staff. While this may not seem an immediate concern, it is important when considering the long-term organizational needs of EMIS.

Under most contexts, staff motivation is the key to the sustainability. Ministries of Education must be more creative in supporting their staff's level of confidence and motivation. It is commendable if management can create incentive programs for overtime work, contractual terms for professional training and study tours, etc.

5.2.7 Coordinating Body

An effective EMIS requires the collaboration of many individuals and units. A coordinating body, made up of representatives from as many stakeholder groups as possible, is needed to provide EMIS policy guidance and maximize its impact on the education system. Such an oversight committee should be made up of data providers, data users, information managers, researchers and policy makers. This group must meet on a monthly basis to:

- Identify data and information needs. This includes input from policy-makers, researchers, donor partners, NGOs, government agencies, etc.
- Monitor the progress of data and information and address impediments to its free flow both into the EMIS and out of the EMIS.
- Ensure that data is integrated successfully.
- Promote and market data for use in the policy process.

- Disseminate relevant information.
- Monitor progress toward EMIS' goals.
- Determine areas for future EMIS development and future courses of action.

6. Conclusion

The development of an Education Management Information System (EMIS) is essential in the modern management of education systems. It is designed to support information-based decision-making processes. Computer technology, database tools, and technical skills provide necessary assistance in the data and information production capacity for the education system. However, an EMIS unit needs a clear vision to see and know what to produce, who the product is designed to support, and which departments and units to include. The development of EMIS involves nurturing a new management culture more than establishing a data and information system. The process of data collection, integration, analysis, and dissemination is important, but even more critically, it is the culture of data sharing, information use, and organizational management that leads to the effectiveness of the EMIS development. It is important to remember that EMIS development is not IT development.

No one wants just "policy talk." Policy must be supported by evidence or analysis of the evidence. EMIS is developed to provide that evidence. EMIS and other management functions such as monitoring and evaluation, policy research and analysis, and budgeting and planning together should provide the results of the analyses of that evidence. This is the support that Ministries of Education need and policy makers in the Ministries of Education deserve.

Endnotes

[i] Peter Senge is a senior lecturer at MIT, and the bestselling author of "The Fifth Discipline". His book "Schools that Learn" is an important resource for all educators and policy makers in all cultures.

[ii] John Willinsky is a Professor of Literacy and Technology at the University British Columbia, Canada. His paper "Policymakers' Online Use of Academic Research" is published in Education Policy Analysis Archives, Volume 11, Number 2. January 2003

[iii] "Limits to growth" is one of the system archetypes developed by Peter Senge in his book "The Fifth Discipline."

[iv] Senge describes in detail a range of participation in vision-less organizations, ranging from apathy to commitment.