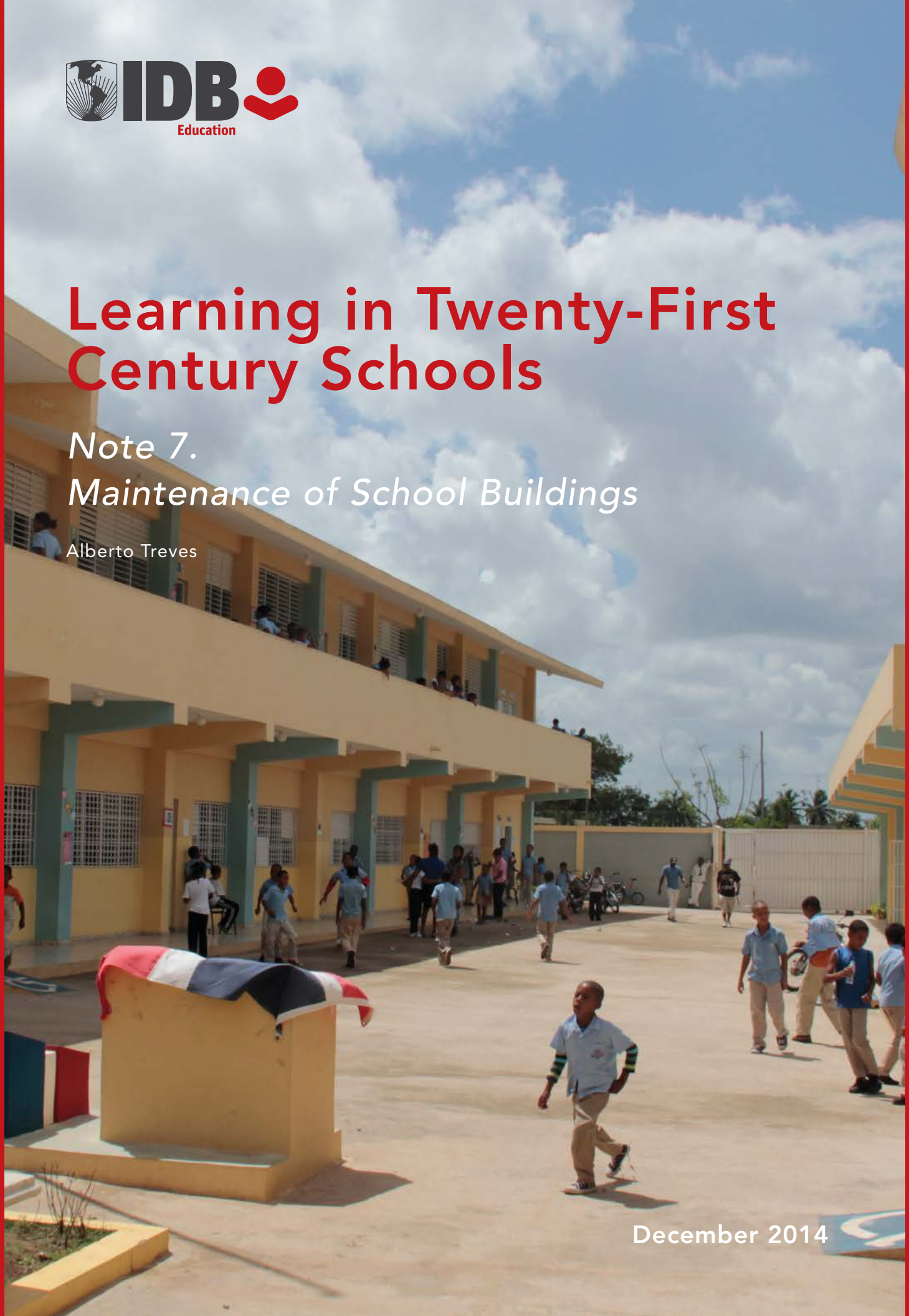
IDB Education

Learning in Twenty-First Century Schools

Note 7. Maintenance of School Buildings

Alberto Treves



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Maintenance of School Buildings

Introduction

This chapter contains information, criteria, and ideas compiled during direct interactions with public officials working in the fields of education and school building in Argentina, Barbados, the City of Bogotá, Colombia, the Dominican Republic, Guatemala, Honduras, Jamaica, and the Province of Buenos Aires. It also includes the results of the author's own observations made during visits to a large number of educational institutions in those countries and from reading official technical and strategic documents available on the subject.

In general terms, the conditions under which school buildings are maintained, used, and sustained in the Latin American and Caribbean (LAC) countries analyzed here are alarming and necessitate immediate, large-scale action. Many of the problems identified have their origins in the stages before the school buildings become operational, and the most troublesome of them are caused by damage to the facilities, improper use of physical resources, and carelessness in preserving them.

The scarcity of financial resources is frequently cited as the primary factor leading to the inadequate maintenance of school buildings. While this is certainly an important factor, there are many others that are also detrimental to school buildings, such as a lack of awareness of the conditions required to preserve the infrastructure of facilities in a particular district, the nonexistence or limited capacities of technical teams, dispersed forces, and insufficient legal instruments for regulating the activity.

To a greater or lesser extent, LAC countries are still dealing with issues that regularly arise in the form of overcrowding and lack of attention given to school-age segments of the population. This is due to both population growth and demographic change, including the closure of some educational institutions reaching or exceeding the end of their useful life. However, the attention due to be given to this shortage should not outweigh concerns for the appropriate use and maintenance of school buildings but rather act as a balanced complement to it.

Aside from technical, economic, and administrative issues, the attitudes of users, public officials, and society in general toward community assets (in this case, schools) are closely tied to each country's culture and history. To those with a short-term vision, maintenance is an expense that can be postponed compared, for example, to the creation of new educational infrastructure, for which there are insufficient resources for their maintenance. To others, with no forward-looking capacity, damaging a public asset is a legitimate expression of rebellion stemming from a perception of the government's ineffectiveness or inability to provide educational services.

Both preventive and corrective maintenance—each in its own way—are part of a complex, multifaceted system that administers resources for education and that, in the case of school buildings, ranges from the initial identification of the need for an educational service to the time when the building ceases to provide that service by way of the facilities' design, construction, use, conservation, maintenance, and finally, closure.

The studies conducted as part of this project and the discussions with representatives from the countries visited yielded three major themes of equal importance:

- Accelerated loss in the value of school buildings in use due to belated, insufficient, or even nonexistent maintenance;
- The buildings' inadequacy in terms of twenty-first-century learning requirements; and
- The nonexistence of appropriate strategies for dealing with and resolving the problem in a conclusive and permanent manner.

Generally speaking, building a school is an important expenditure for a country, engendering high expectations in the community where it is built. The non-fulfillment of those expectations, whether due to allowing its accelerated physical deterioration or a design with no vision for the future, creates a feeling of discontentment and frustration that spreads negativity throughout society but primarily in the community it was supposed to support.

The decisions needed to address these problems will in the short term entail the allocation of significant human and material resources as well as adjustments to certain administrative and budgetary structures responsible for continuity in employment. Teaching communities, which are made up of parents and teachers, have the potential for and an interest in contributing in various ways to the maintenance of schools. All that is needed is a number of technical tools, increased administrative flexibility, and a clear sense of value, purpose, and belonging.

The time for maintenance is now. First of all, a major effort is needed to restore the value and functionality for which all school buildings were originally designed. Leaky ceilings, windows that do not close properly, restrooms that are sources of infection, hazardous electrical systems, and structural systems that will clearly not survive the next earthquake are all unacceptable situations in a context of safeguarding and caring for students as well as a dire business proposition from the point of view of real estate and property management.

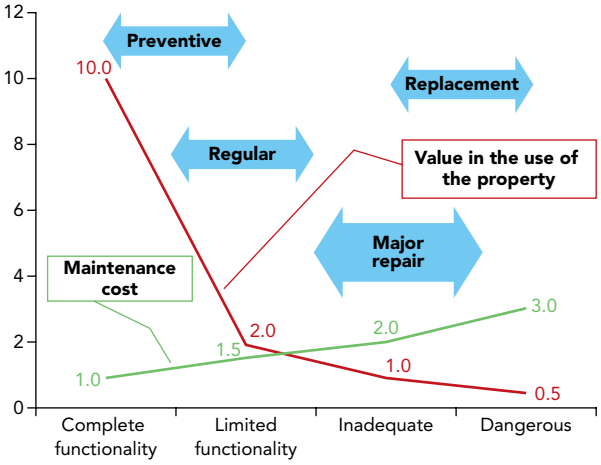
This chapter was conceived as the start of a renewed awareness of the urgent need to care for and protect school facilities and boost their contributions to growth strategies in LAC countries. The first step is always the acceptance of responsibility accompanied by a serious commitment to improving building conditions so that our schools can dispense education worthy of the twenty-first century.

Maintenance systems, analysis, and assessment

In general, little is known in Latin America and the Caribbean about how school buildings are operated and maintained. Although even in remote areas, educational institutions receive some form of academic and administrative supervision, there is no close follow-up on how spaces are managed, what services are provided by each component, or whether a bathroom has become clogged or a ceiling has collapsed.

In spite of the widespread view that safe, functionally appropriate, and comfortable school buildings are more attractive and stimulating for the learning process, in the majority of cases, neglect, negligence, and misuse are observed. This severe and unresolved contradiction, which results in mismanagement and potentially higher expenditure, makes it increasingly difficult to maintain the quality of education as well as the physical building itself. Rather than maintenance systems themselves, partial and ineffective processes for responding to extreme situations are observed in the region's countries.

FIGURE 1.
Loss of functionality and cost increases resulting from inadequate maintenance



The delayed execution of maintenance tasks generates a significant loss of value for school buildings, which can be seen in the red line in Figure 1, which moves from complete functionality when the building is new and well maintained to limited functionality when, for example, a window is broken or a restroom breaks down and the normal course of the classes is disrupted. If problems are not dealt with in a timely fashion, school buildings can gradually become inadequate or even dangerous, especially if climatic conditions intervene or there is a risk of contact between electricity and water or bathrooms become sources of infection.

If adequate maintenance actions are not performed, the cost of maintenance, represented by the green line, increases as the value in use and the property value of the school building decline.

Maintenance in context

The use and maintenance of a school building is the last link in a chain that includes, in order: proper planning, solid design, and flawless construction of the educational infrastructure. When managed correctly, each step in the process helps minimize maintenance needs, as described below.

Planning

Aspects with an impact on the building's use, preservation, and maintenance are as follows:

- **Choice of location.** Like other socially-oriented services, school buildings should be located at the epicenter of the demand for which they are built. Due to faulty planning and a lack of coordination with other responsible bodies, there are many cases of school buildings located on peripheral land with high levels of pollution and difficult or hazardous access roads. Additionally, the land should meet specific requirements as to its size, proportions, planimetrics, and access roads, which if not fulfilled can lead to unnecessarily costly or loss-making designs. Although in general, current regulations require appropriate land to be used for schools, in many cases, both urban and rural, school architecture firms accept land that does not meet those standards, the consequences of which are felt throughout the useful life of the building.

  One typical example of poor choice of land is shown in the photo on the next page, namely a school on the outskirts of the Tegucigalpa (Honduras), where a number of buildings are located on a plot of land on a pronounced slope with insufficient drainage. As a result, maintenance costs are higher due to the need to prevent moisture from entering the classrooms.

- **Architectural programming.** This consists of the definition of the required type and size of school being planned as well as its links to other institutions in the school system. Buildings that are over- or undersized are particularly costly to maintain as the facilities are either over-used or neglected, with a consequent deterioration of portions of the structure. Situations in which libraries or labs are adapted to function as standard classrooms (or vice versa) or gardens are converted into playgrounds may lead to their improper use, with negative repercussions for their durability. A typical example of flawed architectural programming can be seen in the photo on page 5, where a relatively

Example of poor site selection

new school in the city of Berazategui (Argentina) does not have enough classrooms, and many classes have to be held in inappropriate locations designed for other purposes, with excessive artificial lighting and air conditioning.

Design

This is the central component of the entire process, covering all of the precautions that need to be taken to ensure a long and efficient useful life for every school building. Some of the most noteworthy aspects of ensuring a long life and easy maintenance include:

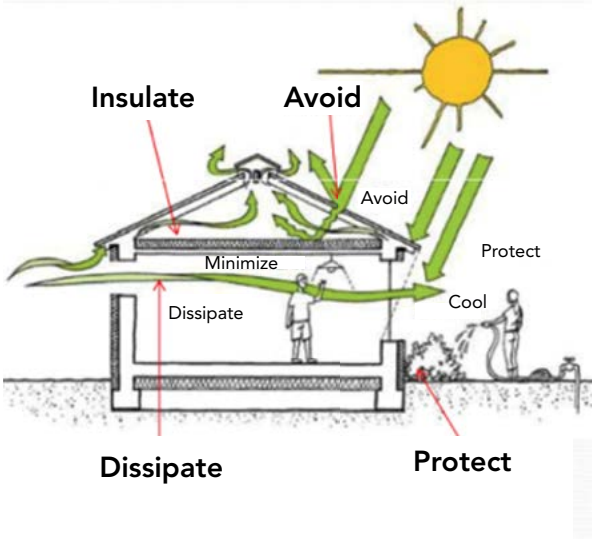
- **Structural systems and materials.** Among other aspects, the choice of bathroom fittings and electrical equipment and materials should be based on their uses and functions in the interest of lasting durability, resilience in frequent use, and low-level maintenance requirements. For this purpose, a life cycle analysis is conducted, consisting of a comparative review of the materials and systems covering their features, original cost, and the necessary expenses required for them to continue performing adequately the function for which they are needed. The cost-effectiveness analysis requires detailed knowledge of the variables available in the market as well as a dialogue with the supplying industry in the pursuit of economical solutions.
- **Environmental adaptability.** This is especially important in countries with extensive geographical diversity and encompasses the need to consider hot and cold temperature conditions, precipitation levels, ambient humidity, or conditions specific to coastal zones. Extensive studies have been conducted on these topics in the region, and many national standards define temperature and ambient humidity levels, maximum CO_2 levels in teaching spaces, and so on.
- **Architectural interest.** As important as the other factors, this dimension helps create an attitude of appreciation and respect for the public asset that can be achieved, for example, through the creative use of materials, shapes, and colors appropriate to the surrounding cultural environment. The use of

Example of deficiencies in architectural programming

art in school settings, spatial diversity, and appropriate scales for individual and group needs are all factors that further contribute to a building's visual value. A typical example of the importance of the architectural dimension can be seen in the schools recently built in Abu Dhabi, where it was necessary to create an indoor atmosphere with climate control and where there were also strong connections to external visuals.

- **Flexibility and adaptability.** These qualities are of the utmost importance given changing school system requirements. Load-bearing walls should be avoided, and bathrooms, labs, and other spaces requiring water or drainage should be clustered and arranged vertically. Electrical facilities should have the capacity to handle a 30% surge, and Internet connections should be provided via Wi-Fi so that the entire school is provided with online connectivity. If enrollment is expected to rise, the possibility of adding extensions (both horizontal and vertical) to the building should be provided for, beginning with the initial design.
- **Aesthetic and architectural quality.** Even though the concept of a beautiful school can be considered subjective, the reality is that when the aesthetic and architectural properties of the physical building manage to thrill the senses, the structure provides motivation and stimulation to supply a better quality of care and preservation, increasing the sense of belonging. Conversely, when those qualities are lacking, the result is the neglect or misuse of the facilities, including vandalism, which, in turn, substantially aggravates their deterioration.
- **Construction documentation.** Whether standardized or fully original plans are used, the documentation prepared for the bidding process, construction, and subsequent stages must be comprehensive down to the last detail. All blueprints, specifications, and calculations involving materials

FIGURE 2.
Design solutions to improve ambient indoor conditions in hot climates



must be consistent with one another, leaving no uncertainties or any other type of ambiguity to be resolved while the work is being carried out.

- **Sustainability.** This begins with the planning stage and continues throughout the school building's useful life. It is the process by which the negative environmental impacts of using certain construction materials are minimized and efforts are made to maximize the use of local materials, reduce the use of non-renewable energy sources, and protect the assets that make up the school's capital. By extension, this can be achieved through designs that have the ability to adapt over time to changing configurations based on new uses and needs. It also includes the need to maintain all of the school building's systems in proper working order in order to ensure their durability. During the design process, targets need to be set for energy savings and a reduction in water consumption, all of which are achievable through the incorporation of improved insulation, the use of sunshades, the collection and reuse of rainwater, and the use of low-flow devices. The savings this can generate in the medium and long term can be employed to capitalize on resources in the interest of the preventive maintenance of school structures. A typical example of a good sustainability practice is the Environmental Design Manual implemented in Honduras, an illustration from which is reproduced in Figure 2.

Construction

In general, this tends to be a weak link in the process as a result of the dispersion and size of buildings such that it is often somewhat impractical for the agencies in charge of the construction process to provide local supervision. This difficulty can sometimes be linked to the willful substitution of lesser-quality materials for better-quality ones, finishing work carried out with little care, or a lack of coordination between structural, mechanical, and electrical systems. All of these factors contribute to the accelerated deterioration of school buildings and to the need to perform preventable corrective maintenance actions very early on in the life of the building.

Each step in this process needs to be reviewed with an eye to possible savings that will not compromise the school building's value in use in the long run. Proper completion of each phase is particularly important in LAC countries since most of them take out international loans for their school construction programs, with cases having been observed in which poorly planned, poorly designed, and poorly constructed buildings stop supplying an efficient educational service long before the country is able to pay off the borrowed funds.

Definitions

Maintaining a school building is a relatively simple task that, when adequately conceived and scheduled, has the potential to support a school's functions while yielding substantial savings. Although the literature on the subject uses slightly different terminology, and different technical teams develop their own operating methods (often resulting from administrative and fund management systems), for the purpose of this report, a number of working definitions are provided

in order to foster a better understanding of the concepts expressed here.

There are essentially two types of actions, namely preventive maintenance and corrective maintenance, which can each be subdivided with regard to their scope and frequency, as follows:

- **Maintenance routines** (also known as recurring maintenance): These are typical preventive maintenance activities, for which within a previously established program, actions such as inspections, cleaning, lubrication, care taking, and others are defined with the purpose of keeping the school building appropriately operational. Its cost can be calculated in advance to a high degree of precision. The main components of this cost are the salaries of the buildings' janitorial personnel plus inexpensive consumables.
- **Minor repairs:** Preventive maintenance also includes actions that help preserve the property and its operations even if these cannot typically be programmed in advance. For example, these can involve changing light bulbs, replacing broken windows, or replacing or adjusting drainage valves. Their cost can be estimated based on the building's age and the average cost of minor repairs performed in previous years. In general, these can also be assigned to the school's janitorial personnel provided they were adequately trained.
- **Corrective maintenance and replacements:** So long as the school building has been well planned, designed, built, used, and maintained, the need for corrective maintenance or replacements should be minimal and sporadic and, generally speaking, programmable. Some common examples are the replacement of asphalt roofing, structural reinforcement as a result of changes in earthquake-resistant building codes, and the replacement of bathroom facilities due to obsolescence or breakage.
- **Partial and complete renovations:** These are generally performed when, after the building has been in use for a number of years, a need for functional changes is identified and that opportunity is then taken to renovate it to as-new status, with the additional benefit of reducing corrective maintenance requirements for many years to come.

All of these definitions should be used with a degree of flexibility given that a school building should be able to provide adequate service for at least 30 years, during which many new educational and administrative challenges may arise, entailing necessary adaptations to the physical space.

Conceptually speaking, the handling of emergency situations caused by natural disasters or accidents does not constitute a maintenance action; although, if not appropriately handled, there may be serious repercussions in terms of the preservation of the school structure. A typical case of this is flooding, which, once ended, requires an immediate assessment of possible damage to the building's structural systems and facilities. The necessary repairs must be carried out immediately at the risk of wide-ranging damage if not effected promptly.

The situation in Latin America and the Caribbean

The region remains saddled with unsatisfied demand, both quantitatively and qualitatively, in addition to the problem of buildings that are in poor condition. Today's school buildings pose more of a challenge than ever, due mainly to:

- The need to adapt to new municipal regulations that are more and more demanding with regard to alleviating the effects of natural disasters, zoning, and improving environmental conditions;
- Problems with securing adequate land for building schools, which must be located in central rather than marginal areas within an urban setting and meet safety and health conditions for educational and community purposes;
- Developing greater awareness of the effects of lead and organic elements in water and bacterial

spores and carbon dioxide in the air as well as of the need for proper lighting, acoustics, and temperature conditions;

- Demands for more sustainable architecture both in the choice of materials and technology in the construction of buildings and in their use and operation;
- The need to attend to disabled people, which can be summed up in the need for ramps and railings, doors meeting width regulations, and proper restroom facilities for such persons;
- The urgency of providing space to give students greater mobility, allowing them to work in large or small groups, on their own, or face-to-face with the teacher;
- The appeal of allowing a school to be used by the community during non-class hours for adult education and recreational, sporting, or cultural activities;
- The greater complexity of building designs, especially in urban areas, where construction must be undertaken between party walls and the safety of students must be considered carefully with regard to commuting to and from school;
- The desire to preserve buildings with historical and cultural heritage value through maintenance requirements that are not only functional but aesthetic in nature;
- More intensive use of educational technology, which is aimed at facilitating and enhancing the teaching and learning process and which carries with it certain requirements to take into account electrical wiring, data, wireless systems, furniture, and location within the building; and
- The rise in vandalism and delinquency, which forces the use of construction materials that are more durable and the holding of public awareness campaigns for school buildings to be better used and cared for.

To a large extent, these requirements are not new. Unfortunately they have not been properly taken into account in many of the construction programs in the region. The maintenance situation is regressive as regards the deteriorating conditions caused by the factors outlined above, to which should be added the passage of time and the application of bad practices that inevitably cause even faster deterioration.

Synthesis by country

Below is a brief description of school construction, focusing in particular on the issue of maintenance, in some of the countries of Latin America and the Caribbean.

Argentina

Since 1992, responsibility for school construction has been divided among 24 different jurisdictions, a Directorate of Infrastructure in the Ministry of Education, and Project Implementation Units in other ministries. Each of these 24 jurisdictions carries out maintenance activities through specialized bodies, often relying on municipalities and cooperative associations with disparate technical and administrative capabilities.

Most of the maintenance work is of a corrective nature, undertaken in response to damage or breakdowns reported by local or neighborhood authorities. In Buenos Aires Province, which is considered one of the wealthiest in the country, 40.7% of those polled in 2011 felt that schools are in bad or very bad condition. The results of the National Infrastructure Census, which began in 2009, have yet to be published.

Barbados

The agency responsible for the approximately 100 schools in Barbados is the Project Education Unit (PEU), which is part of the Ministry of Education. Funds routinely set aside for maintenance are limited, though there are occasionally additional funds, and the schools, which are generally of simple construction, are well maintained.

For Barbados, the biggest challenge is to improve design quality in order to address climate change on the island and the educational challenges of the twenty-first century. Furthermore, buildings will last longer if routines for their use and maintenance are improved.

Colombia

Responsibility for school construction is divided among the country's 32 departments, the City of Bogotá, and a growing number of certified regional agencies that devise school infrastructure plans and finance work with funds from central or local government. In recent years, the highest priority has been to build new schools, and there is no formal, separate program that directly addresses the issue of school maintenance. The activity of agencies hired by the Education Ministry, such as FONADE, tends to be limited to making recommendations on the use and preservation of buildings.

In the federal district of Bogotá, resources (Education Funds) are earmarked for preventive maintenance, and they are managed directly by the schools. At the district level, a significant amount of resources is set aside for corrective maintenance and structural enhancement. These funds are administered by the Bogotá Secretariat of Education.

In many cases, school principals take responsibility for carrying out maintenance work, and the results vary widely. One factor of great concern is whether schools can withstand earthquakes, as it has been determined that many are highly vulnerable to such events.

Dominican Republic

Within the Ministry of Education, a General Directorate of School Infrastructure Maintenance works in coordination with regional supervisors and decentralized district boards. Necessary maintenance routines are clearly spelled out, and minor work is carried out efficiently by school staff with help from local communities. Major repairs and school expansion is carried out under the supervision of the centralized agency.

Although there has been some interest in closer dialogue between educators and architects, the designs employed and the construction materials used are not adequate to meet the challenges of learning in the twenty-first century. These designs must therefore be reviewed, a step that will probably lead to better use and maintenance of schools.

Guatemala

The Ministry of Education working through the Sub-Directorate of Educational Infrastructure has responsibility for regulating all aspects related to the design, construction, and maintenance of schools. It also provides funds to local educational councils and parents' associations, which administer repair and maintenance programs. However, the availability of funds is irregular, as are the processes of project planning and formulation. To a large extent, projects are handled with outside resources and technical organizations parallel to the ministry.

Several studies have been conducted with government participation on the issue of use and preservation of school buildings. Unfortunately, the studies have not been disseminated widely or followed up with rigor. Although there is a clear trend toward orienting the curriculum and teacher training toward the needs of twenty-first-century learning, this has not been accompanied by design solutions that would enable these goals to be reached.

Honduras

The Secretariat of Education, which answers to the Ministry of Education, is in charge of maintaining school buildings but at the present time has no budget with which to do so. What little maintenance activity that takes place is carried out by a variety of government and private institutions, with funding that is intermittent and unreliable. There is no efficient technical supervision or any formal registry of work done. Moreover, inventories from the country's approximately 16,000 school buildings have not yet been processed in their entirety.

The Honduran Social Investment Fund takes in much of the international aid sent to Honduras. It has built many schools with twenty-first-century designs and engages in maintenance work independently from the Ministry of Education.

Jamaica

The Education Ministry delegates responsibility for school construction and maintenance to a recently created organization called the National Education Trust (NET). It now has several new schools under construction. However, these were designed by private contractors without clear instructions as to rules or requirements. School principals acting on their own initiative sometimes earmark school administration funds for maintenance work. On occasion, they can rely on the specialized support of a NET architect or engineer headquartered in one of the 14 parishes that make up the country. Finally, availability of funds is unreliable, and the composition of technical teams often changes. In many cases, schools are maintained thanks to private and community contributions.

Challenges and possibilities

Pressure from growing demand, both qualitatively and quantitatively, remains a serious problem, even if it is less acute than in the past. There is a pronounced tendency to lengthen the school day, incipient attempts to increase the mobility of students within the school system, and the incorporation of new technologies. This leads inexorably to the need for more floor space and the optimization of existing infrastructure. The only way to address a neglected student body while improving school facilities is to strengthen planning systems, adapt designs to the demands of current teaching methods, improve construction oversight, and maintain schools adequately.

In Latin America and the Caribbean, educators, architects, and engineers for the most part still follow parallel paths and communicate little with each other. At the regional level, there is not yet a tendency to see school buildings as valuable tools in the learning and teaching process. School construction programs are essentially aimed at building as much floor space as possible, as quickly as possible, and at the lowest possible cost. Yet a dialogue between those who use schools and those who design them could reap major benefits for both and make for a better understanding of needs and expectations on both sides. More importantly, this exchange of ideas and feedback could generate a strongly positive sense of ownership of the results achieved. If building the school in a certain way meets everyone´s vision and everyone had the chance to contribute in their own small way, the building would be cared for and respected more efficiently.

Over the past 20 or 30 years, most countries in the region have redelegated many services that had been concentrated in the central government, seeking greater efficiency at the provincial or local level. In some cases, it worked, and in others, it did not, forcing central governments to fill the gaps. This process, which remains to be perfected over time, is marred by a serious problem that requires urgent attention, namely the lack of a single, nationwide vision of what is being sought for the building of schools and their role in the process of educating students.

In many cases the situation is complicated by the sporadic and unplanned appearance of international aid groups. For instance, they build schools without the knowledge of the Ministry of Education, use private property for public schools, or publish a maintenance manual that is not widely circulated and ends up filed in the school principal´s office and of use to no one.

Another problem has been the appearance and disappearance of Project Implementation Units, which administer school construction with outside financing. These units recruit highly paid professionals who generally work outside of normal government channels for project approval and follow-up. When a project is completed, the experience that has been accrued is rarely passed on to school construction agencies,

and the people trained and skilled in this area leave to work in the private sector in search of higher salaries.

Moreover, except in countries such as Barbados and Jamaica, there is great dispersion and disparity in the efforts made by different levels of government. Northern provinces may not know what is happening in the South, or the capital may lack sound information on what is happening in the rest of the country. Fortunately, twenty-first-century technology can help solve this problem. Managing projects in a collaborative way through websites involves simple, accessible technology that requires very little training.

At the regional level, the exchange of knowledge and experience is almost non-existent. In fact, countries could benefit from knowing more about what their neighbors are doing and achieving and the problems they have run into and are trying to resolve. This horizontal technical exchange at the regional level could also benefit the private sector, with the opening up of markets in which it could offer higher quality products at a lower price.

Solving educational infrastructure problems through new construction as well as maintenance and renovation requires a long-term vision that in many cases goes beyond the term of office of many of the officials charged with this responsibility. Frequent changes in government lead to a lack of consistency in what is done, failed initiatives, and therefore wasted funds. The only alternative to this situation is to encourage the professionalization of the civil service and to give job stability to the technical officials in charge of building schools. Moreover, it is important to back up and document all technical decisions through manuals and documents so that users can benefit from their predecessors' experiences rather than start from scratch every time a new government comes to power.

Several attempts have been made to properly record and process information regarding school buildings in the region through censuses and inventories. However, these failed for reasons ranging from the length of time needed to obtain the information, errors or inconsistencies in the filling out of forms, and difficulties in cross-checking information. Most worrisome of all is that in most cases, compiling an inventory of school buildings becomes a goal in itself without a clear and definitive link to a planning process that could be used to analyze strategies and make decisions on new construction, expansion, renovation, and maintenance.

The personal qualities of a school's principal have a major effect on how the building is looked after and maintained. Without training or experience in this area, with the same resources as other principals and relying only on the strength of their charisma, magnetism, and organizational skills, some principals often make very good use of the resources allotted to them, actively involving students, teachers, and members of the community.

It would be a good idea for each school, in line with its size, to be assigned a person with basic knowledge of maintenance (such as a building superintendent) to be responsible for detecting problems with the physical plant, preventing and repairing minor damage, and in general overseeing the care of the building and being a key source of technical support to the principal and the teachers.

Another problem seen in many countries of the region is that religious and non-governmental organizations are allowed to build, expand, or remodel schools without the participation of the competent authorities and often without their even knowing about it. Even though they mean well, these organizations often build public schools on land that does not belong to the government and ignore municipal ordinances and rules set by officials in charge of educational infrastructure.

Although the task is immense and the challenges daunting, there are in LAC countries professional groups with great technical skills and solid ethics

that are working tirelessly in search of solutions and increased operational efficiency for the benefit of the education community and society in general.

Elements for an effective maintenance model

Although there is no ideal model for a maintenance system that worked well in one country and can guarantee similar results in all the rest, some ideas implemented in LAC and OECD countries can be useful as elements of an effective system, of which the most important components are:

Vision

Only by setting a clear goal can the steps needed to achieve it be laid out. Defining a vision for maintaining school buildings means recognizing the value and importance of school buildings as important tools for achieving teaching-related and community objectives. A school building that is safe, clean, efficient, pleasant, and well-ventilated and well-lit, where students can hear teachers without the teachers having to shout, where there is a place for every kind of activity as well as spaces for multiple and shifting purposes provides a setting that stimulates students' interest in learning and in personal and social achievement.

Information systems

These are essential for planning maintenance activities both in a given school and across a network of schools. Each time the construction of a school is completed, responsibility for the building shifts from the construction company to the education system. When the building is delivered, with it should come the final blueprints, technical studies, warranties for all of its systems, and a maintenance manual for the physical plant. This information, preferably in electronic form, should be stored in a place that is accessible within the school and from the hub of the education system. In a broad sense, the process of formulating an information system goes through the following stages:

- **Strategy.** Information systems for school building maintenance can be linked to censuses of physical infrastructure or handled independently. In general, exhaustive information gathering is not necessary, and the methodology to be adopted depends on the thoroughness of the information required. It is important to set clear points of reference so as to make an objective comparison between the status quo and whatever situation is considered ideal or desirable.
- **Data gathering.** All possible data on buildings and land should be gathered. In the case of newer schools, this information should be relatively easy to access. This work is done at the central level and does not require on-site verification. The age of buildings can be established in the same way. An evaluation with scores of Good, Average, and Bad can be obtained reliably from school principals. When cross-checked against data about the age of buildings, these scores can help set priorities. The most sensitive schools are those 10 to 20 years old, and in a context of scant resources, they are the ones that must be assessed first. Schools that are more than 20 years old may require corrective maintenance, replacement of some facilities, or total renovation, which must be assessed by specialized personnel. At the time of assessment, a draft of the work to be carried out should be drawn up, including sketches and a detailed description of the tasks planned, ranging from minor repairs to corrective maintenance and replacements or total renovation.
- **Processing.** It is a good idea for a central authority, be it provincial or national, to set evaluation criteria and processing strategies. When the valuations in the survey are well defined and the instructions sufficiently clear, the degree of reliability is sufficient for decisions to be made. From the information thus gathered from office studies and field work, action programs can be devised to address the problems that have been detected.

- **Updating.** As the various maintenance jobs are completed, they are logged and made accessible to all the interested parties so that information on the building is kept up to date continuously. The same information is necessary for existing buildings. If for some reason it is not available, it should be compiled in as much detail as possible.

Use of software

Several computer programs in English are used successfully to manage office buildings, commercial space of a particular degree of complexity, and networks of buildings such as university campuses. Programs designed specifically for school buildings are aimed mainly at addressing the needs of buildings of considerable size in medium to large school districts. The initial investment needed to have these programs up and running is relatively high, and a fee must be paid annually for the use of the software. For LAC countries, the best approach would be to design an *ad hoc* system that could operate at the national level in the various layers of jurisdiction and link infrastructure inventory data with maintenance data.

Building management systems (BMS) are mainly used to automate many of the mechanical and operational functions of a building, turning it into a "smart building," and to monitor electricity and water consumption, ambient temperature, and CO_2 content. While these systems are highly efficient for buildings with more than 10,000 square meters of floor space, they involve a costly initial outlay.

Technical administrative systems

As stated earlier, maintenance work ranges from the simplest and most routine tasks to others that probably require a greater degree of preparation and technical capability. An efficient way to go about this process is the following:

- **Routine maintenance and minor repairs.** This should be carried out under the administrative lead of the school principal according to a previously set schedule. It can be done by cleaning staff, either that of the school itself or brought in from outside, which must be qualified to carry out such tasks. Special attention should be paid to the terms of the contracts reached with such personnel to ensure that routine maintenance work is done effectively. Funding for this kind of activity must be separate from the school's regular operating budget. Besides paying those who do the maintenance work, these funds can be used to purchase cleaning and maintenance equipment and supplies such as filters and lubricants. Drawing on past experience, it is a good idea to stock up on what is most frequently needed for this kind of preventive maintenance and to store it in the school. The school community of teachers, parents, students, and alumni can make a valuable contribution to the administration, execution, and supervision of routine maintenance and minor repairs. In the unlikely event that a technical problem were to arise, district and regional officials should be available to resolve it even if their physical presence onsite is not necessary.

- **Corrective maintenance, replacement, and renovation.** Although it is both appropriate and necessary that the school principal and the community always be involved to some extent in such activities, more substantial tasks of corrective maintenance should be carried out with input from specialized technical staff and administered at the regional or central level. Many corrective maintenance tasks can be codified, with details and specifications specified in advance, thus facilitating the cost analysis and the assignment and oversight of work. This task is much easier if designs are also codified and maintenance information systems are kept up to date.

Centralized vs. decentralized systems

To be efficient in terms of quality and time, maintenance services should be decentralized to the extent allowed by the availability of resources. In other words, as the availability of resources must be on

par with needs, the administrative jurisdiction that provides such resources must have the required tax-collecting capabilities. Even though this has not been possible on a regular basis in the past, it is better for the responsibility for maintenance to be assigned to a jurisdiction that can pay for it. For instance, if a school district has its own resources and the financial capability to carry out routine maintenance and minor repairs, this work should be done at the school district level. If this is not possible, the responsibility should be assigned to the provincial, local, or central government. Regardless of the degree of decentralization involved in maintenance routines, all information generated at any level should be shared on a website so that all interested parties can have access to it.

Community participation

To various extents, community engagement in school-related issues is fundamental to the success of school management. This participation can take various forms that are not mutually exclusive, such as collaborating in carrying out periodic inspections, administering maintenance resources, and carrying out or supervising work for which community members are qualified. This participation brings with it several benefits, including encouraging a sense of ownership, which triggers feelings of appreciation and respect not just for the school building but also for the work of education in general and for the economic improvement of the community. Although in most cases communities contribute voluntarily, it should not be assumed that they are obliged to provide cheap or free labor to satisfy maintenance needs. It is also important to offer training programs to ensure that the work done by community members is of an acceptable level of quality and is done safely.

Manuals and preservation

Besides specific maintenance routines that are necessary to keep a building in use for as long as possible, appropriate use is an important factor when it comes to preserving the building. As teaching and administrative staff are not necessarily trained in the handling of the building's infrastructure, they should be provided with technical support through the use of instruction, maintenance manuals, and training courses. Although routine use and maintenance activities tend to be very simple, they are essential and include, for example, attending to doors and windows with an eye on personal safety and building protection purposes, electricity and water conservation measures, and the immediate reporting of breakages or damage. A simple Internet search can turn up dozens of examples of instruction manuals on the use and maintenance of school buildings. Although most of them are technically quite good, there is no evidence that any of the countries analyzed here use such manuals at this time.

Public-private partnerships (PPPs)

Under this type of financing, which is used mainly for new schools, certain responsibilities are taken on by the private sector, which is compensated by the government through a payment plan. The responsibilities assumed by the private sector can range from the joint development of a plot of land, the construction of a building at zero cost to the government, and costs that are shared or financed over the long term, to assuming full responsibility for the construction, operation, and maintenance of a school for a period of 20 to 30 years. Private partners minimize their risk by charging premiums that in general exceed the value of the service they provide, and the benefit for the government is that it acquires a building that otherwise would not have been built.

Assessing costs

Design, construction, and operational and maintenance costs are intimately linked and should be analyzed in terms of the key factor of time. As a starting premise, it can be stated that a responsible initial investment in terms of planning, design, and construction will more than pay for itself over the life of the school building.

Every year, a school building requires certain preventive and corrective maintenance routines whose cost is to a large extent predictable and can be controlled. If these measures are not carried out on a given date or within a reasonable period of time, a backlog of maintenance work develops, and the value of the building depreciates. Even if these tasks are carried out later and adequately, the backlog and loss of value are often impossible to overcome and generate accumulated deficits exponentially. Over the years, that deterioration and loss of value become irreversible at predictable and reasonable costs. It is at this point that buildings generally stop being looked after properly, which causes an acceleration in their drop in value and a rise in the cost of future maintenance. In other words, if maintenance is not carried out in a regular and timely manner, its cost will be much greater when it is carried out later.

For example, simple arithmetic shows that a building designed to last 30 years must be totally renovated or replaced four times over the course of 120 years. If it is designed to last 40 years, total renovation frequency drops to three times over the same period. However, in practice, buildings are used 10, 20, or more years beyond the period for which they were designed to last. This leads to the need for costly corrective maintenance measures.

Fixing problems with buildings is not intrinsically expensive if the work is done correctly and in a timely manner. Below, we outline some strategies that are necessary not only to keep costs under control but also to produce savings that lead to benefits for the entire system.

Strategies for maintenance at zero or low cost

Although it may seem obvious, the best alternative to measures that are expensive, disorganized, untimely, and inefficient is to adopt a maintenance program that is well planned and efficient, with adequate human resources and funds available when these are needed. It is never too late to change a way of going about things, however deeply rooted and established it may be, especially when the advantages offered by change are clear. Not all maintenance measures are costly and complex. Rather, it is much easier to take care of a building and maintain it in a timely manner than have to repair it once the damage is irreversible. Some of the zero- or low-cost measures that can be undertaken include the following:

Instruction manuals

Over the years, several maintenance manuals have been devised in LAC countries, describing how replacement tasks or minor repairs in schools should be done. These manuals should start off with a chapter on how to operate buildings in ways that allow them to last longer. Some measures that can help achieve this include the following:

- **Restricted access.** Do not allow animals such as dogs, cats, or chickens onto the school grounds. Be sure that when it is rainy and muddy, students and staff enter the school with clean shoes. Avoid conflicts with vehicular traffic, parking lots, and the movement of people.
- **Care of doors and windows.** Establish a routine for windows so that they are open when it is necessary for ventilation but shut when the school must be protected against rain or dust. Avoid the use of curtains as much as possible as they block out natural light and necessitate the use of artificial light. Make sure that doors are firmly hinged so that they do not rattle in gusts of wind. Take care with the use of keys and master keys to avoid having to replace locks.
- **Cleaning.** Define precisely the expectations and procedures to adopt for keeping the building clean. These should be communicated to the cleaning staff or the firm responsible for cleaning and used to verify and evaluate their work.

Don't waste water!

- **Lubrication.** Oil all moving parts as per the maintenance manual provided by suppliers of maintenance and other equipment.
- **Electricity consumption.** Keep lights, fans, and other equipment turned off when rooms are unoccupied. Turn computers off when not in use, both in the school and in administrative areas. Regulate the use of air conditioning by ensuring that moisture and mold do not accumulate when it is turned off. Make sure that doors and windows are firmly closed when the air conditioning is on.
- **Water consumption.** Avoid wasting water in sinks, toilets, and sprinkler systems by constantly monitoring the workings of the valves. Water consumption can be reduced by applying devices designed to cut water flow. Green areas should be watered in the evening, using a spray device if possible. Do not use water hoses as a substitute for brooms and brushes when cleaning.
- **Recycling.** Provide means of separating different components of garbage. If possible, use organic waste produced in the school to fertilize the school garden. Garbage should never be burned.

Self-evaluation

The instruction manual may contain a checklist of periodic maintenance routines. If in doubt, there should be a telephone number or messaging system via the Internet through which technical assistance can be provided from off-site. In this case, it is a good idea for the provider of that service to have on hand the technical documentation of the school incorporated into the network as well as ready answers to routine questions.

Leadership

When school principals take a leading role in the proper use and maintenance of a school building, the results are highly satisfactory. Principals must understand that they have been entrusted with an important public asset and a working tool that can make their mission as leaders much more successful. Committees comprising students, parents, and members of the community can take an active part in looking after the building and in detecting problems early. If it becomes necessary to undertake a specific procedure involving school district officials or higher authorities, principals must be prepared to make their case with the help of graphic and written documentation.

Written notices

Reminders of preventive measures and of how to use a building properly can be placed at strategic spots throughout the school. If possible, it will also be highly beneficial to evaluate and publish the results of campaigns to save water and energy. Moreover, the school community should be provided with a space on the school walls to express its views without causing damage through improper use of walls or windows.

Incentives

Holding contests related to the school's care and maintenance can encourage a sense of ownership and teamwork that leads to better preservation of the school infrastructure.

Storage Room

It is always a good idea to store an adequate number of replaceable items that might be required at any given moment to keep the school running, such as lamps and light bulbs, packaging for valves, and cleaning equipment.

The cost of these activities is generally covered by allocations schools receive for their regular operations. Thanks to their low cost, this financing can continue through the same established channels. Accountability does not require innovation and falls under the responsibility of the school principal. To increase the efficiency of the funds disbursed, the following measures should be introduced:

- Conduct a study via a sampling of the exact destination of the funds, and determine if it is necessary to increase them in any area. Funds may also need to be adjusted in relation to the age of the building, state of maintenance, and condition;
- Schedule awareness raising and motivational and training programs for members of the school community; and
- Prepare collateral material as backup for the training measures.

These measures should be taken in all schools. Over the medium term, significant savings in the running of the school will become apparent and more than offset the expenditure.

Maintenance strategies that are low-cost and save money

These are the first measures that should be considered when the idea for a school building is conceived and over the course of its years in use. Although they are very simple, they require a degree of study and planning. Responsibility should be shared among the design and maintenance teams and school principals. The most important responsibilities are the following:

- **Inspections and Cleaning.** Regardless of whether these are done by school staff or outside contractors, the scope of these tasks should be clearly defined and control mechanisms should be put in place to ensure the quality, timeliness, and efficiency of the work.
- **Meters.** All school facilities should be equipped with individual meters for electricity, water, and gas (if they receive this service) in places that are accessible to school staff so that information about consumption levels can be gathered periodically. This information should be analyzed and compared with previous periods with the twin goals of seeking savings and detecting energy or water leaks that require immediate attention.
- **Solar panels for heating water.** Unlike solar panels for generating electricity, solar heaters have come down to a reasonable price that makes them highly competitive compared to domestic heaters that use electricity or gas. Installing them in schools can serve as a learning tool and have symbolic value in the community, which will gradually see the benefits of using renewable energy sources in their own homes.
- **Low-consumption lighting.** In recent years, major progress has been made in this field. The most recent models of LED bulbs are much less expensive than they once were and longer-lasting than traditional incandescent lighting.
- **Awnings.** When it is impossible to block direct sunlight impacting windows, the best solution from a technical standpoint is to install awnings to create shade. Although this raises the total cost of the building somewhat, it reduces the need for curtains, which are only a temporary solution as they wear out easily. Furthermore, curtains tend to be kept shut during class hours, with the dual negative effect of blocking the view of the outdoors and the resulting

additional consumption of electricity as in many cases, lights must be left on during the day.

- **Efficient thermal insulation.** Although this may not be a strategy with a low initial cost, it provides many benefits over the course of the building's period of use. Improving thermal conditions inside the school makes occupants more comfortable and helps control operational costs in terms of energy, maintenance, and repairs.
- **Sorting and recycling solid waste.** The initial outlay for this operation is very low, and the benefits have high impact within the school grounds and are of great value to the community in general. In many cases, recycled organic material can be used to great benefit as fertilizer for school and community gardens. In this case, although there is no significant savings in operational spending, there is a major educational benefit.
- **Rooftop gardens.** This involves covering flat spaces on the roofs of school buildings with inert aggregates, fertile soil, and vegetation along with watering and drainage systems. Although the initial outlay can be relatively high compared to traditional asphalt surfaces, over the long term, such gardens have a major effect in terms of improving the thermal insulation of ceilings, making classrooms more comfortable, and cutting energy use for heating and air conditioning. Maintenance is relatively simple as it does not require more care than a regular roof-top terrace. Such roof-top gardens can also be used for educational and recreational purposes and to some extent help reduce the size of the land needed by the school as such land is expensive, especially in urban areas.

Minor repairs

The strategies to adopt to attend to minor repairs depend on the thoroughness of the information available on the condition of the building. The need for such repairs and the regularity with which they are carried out can be minimized through the proper use and care of the buildings.

If a detailed inventory of maintenance needs is available, costs can be calculated with a high degree of precision by seeking bids from various contractors. If minor repairs are needed in schools that are close to each other, more competitive prices can be obtained by seeking a package deal on the work that needs to be done.

When there is no detailed inventory, a reliable approximation can be obtained using a methodology consisting of the following steps:

1. Classifying the maintenance measures required in a school building, the most typical of which are:
   - Partial repair of roofs
   - Repair of ceilings
   - Repair or replacement of windows
   - Repair or replacement of restroom equipment
   - Repair or replacement of electrical equipment
   - Repair or replacement of heating or cooling equipment
   - Repair or replacement of coverings and floors
   - Painting touch-up jobs
   - Repair or replacement of furniture or equipment
   - Repair or replacement of grounds-keeping equipment
   - Replacement of outer fence;
2. Determination that one or more buildings can be considered average by estimating the mathematical average of the buildings in a given region, taking into consideration such variables as state of maintenance and age and use of the building;

3. Estimation of how often these maintenance measures are needed for the average building;

4. Once the buildings and the measures have been classified, it is possible to determine the annual cost of each of the actions to be undertaken. These are added up per building and multiplied by the number of buildings in the school district. This gives an approximation of the total cost of minor repairs.

After maintenance routines at zero or low cost, minor repairs are the second-most-important factor in making a building last longer. If these are not carried out correctly and in a timely manner, the state of the building can deteriorate quickly, making more complex procedures necessary. Examples include small leaks that are not taken care of in time, which soon become major leaks that affect ceilings, furniture, floors, and the entire operation of the school as well as the health of the students.

In general, minor repairs do not involve functional or systemic changes, and the original specifications of a building are maintained to the greatest extent possible. For this reason, it is important that when a building is designed, the specifications include the use of long-lasting materials that are also easy to find in local markets.

All maintenance and repair routines, no matter how small, must be logged and coordinated under the responsibility of the school principal. This applies to work done with school funds or donations from the education community. Under no circumstances should permission be given to members of the school community to do work on the school for which they were not properly trained or in which there could be danger to persons or property.

Assuming that school buildings are cared for following pre-established maintenance routines, the financing needs for minor repairs are predictable with a high degree of reliability as the amount to budget for each year can be determined by looking at what was spent the previous year, plus inflation. The amount should also be adjusted by taking into account new schools that may have joined the district or that were decommissioned as well as any corrective maintenance or renovation work that was carried out during the previous year. These maintenance allocations should not be linked to tax revenues or any other random factor that might leave schools without the resources they need.

Corrective maintenance, replacement, renovation

If through carelessness, negligence, or intentional destruction of school property the deterioration goes beyond what can be addressed with minor repairs, the next step is to undertake corrective maintenance. In this case the evaluation of the needs and the specification of what work should be carried out requires bids from specialized staff. As in the previous cases, the school principal must report the problem to the Maintenance Office, which will schedule the work to be done in each school in line with the needs of all the schools in the district. Many of these corrective maintenance routines must be carried out when school is out or by closing off part of the school, for which a contingency plan must be devised, depending on what impact the work will have.

Examples of corrective maintenance tasks include:

- Complete replacement of ceilings, double ceilings, coverings, and floors;
- Structural reinforcement;
- Window replacement;
- Septic tank replacement;
- Construction of tanks for collecting rain water;
- Enlargement or renovation of restrooms; and
- Wall repairs and overall painting.

When major renovations are undertaken even in part of the school only, the entire building should be examined to see if its functional requirements have changed or whether structural enhancements or expansions of facilities are needed. Demographic

and attendance studies should also be conducted in order to see what kind of enrollment the school will have over the next five years at least. If it is necessary to expand the educational, administrative, or service areas, this opportunity should be used to carry out a full renovation of the building.

Maintenance Offices may have a record of contractors that can be used in each area and may keep their qualifications and fees up to date. The administration and financing of corrective maintenance, replacements, and renovations should be compatible with funds earmarked for new construction and should take priority. Every year, once total funding available is known, a list of jobs to be done should be compiled, starting with corrective maintenance, replacements, and renovations that cannot be delayed until the following year. It is a good management policy to ensure the continued supply of services in existing schools before diverting funds for building new schools. Unsatisfied demand for new schools can always be eased by adding new shifts in existing schools, adding more students to classes, or using school rooms for new purposes.

Accounting methodology

Total maintenance needs consist of the sum of individual maintenance needs over the course of an administrative period, which is generally a year. The underlying premise is that every building in the school district needs some kind of preventive or corrective maintenance.

The starting point is to know the condition of school buildings at the time at which the assessment is to be conducted. In general, infrastructure inventories are done over the course of a given period of time, and the information gathered at the outset of the process should be updated when the assessing of the total is completed.

Buildings that require corrective maintenance, replacements, or renovations should be budgeteddifferently, depending on:

- The area to be treated, generally in terms of square meters or units of equipment needed;
- The kind of work to be done, i.e., replacement, demolition, or construction;
- Unit costs of work expressed in $/m^2$ or unit; and
- Special features of the project, whether in an urban or rural areaor on land located on an incline.

Buildings that require maintenance routines or minor repairs should be assigned budgets in line with the average needs of the previous five years in which the buildings received appropriate maintenance. If this information is not available, the estimate can be based on what is recommended in the instruction manual submitted upon completion of the building or in consultation with the team that designed the building.

In general, costs break down into the following categories:

- Materials
- Labor
- Supervision
- Project administration

The way in which contracting for jobs is handled has a significant impact on their cost. For example, buying cleaning materials in bulk and distributing these among schools is a cheaper alternative to buying individually in local stores. A similar criterion applies to procedures that are done repeatedly in schools, such as hiring a company to waterproof surfaces. A company could thus be hired on the basis of a pre-established unit price that could be adjusted depending on the area to be treated.

With regard to strategies that save money or are low-cost, in general, their cost does not exceed 2% of the initial construction cost or the additional 2% of operating expenses. The savings that can be made are

at least 5%, and can reach 30% or more of the operating expenses because to a large extent they obviate the need for expensive corrective measures. A detailed calculation should be done during the design phase in line with an estimate of the life cycle of each component of the system. For existing buildings, the estimate of costs should be calculated taking into account the variable of the time span in which the work is to be carried out. For example, when in approximately two years, the time comes to replace low-quality, high consumption electric bulbs, these can be replaced with high-quality, low-consumption ones.

Formula for calculating costs

As maintenance offices accrue and document their experience, it is possible to use methods that are quite accurate (though laborious) to make decisions. For instance, below is a formula commonly used to calculate the life cycle of construction materials or components:

$$\text{Life cycle cost} = \frac{\text{Initial} + \text{Operating} + \text{Replacements} + \text{Maintenance}}{\text{Years of use}}$$

Factors in the formula:

- **Operating** costs refer to the consumption necessary for the proper functioning of the school building. For example, although low-consumption electric bulbs have a higher initial cost, the (operating) cost of the electricity over the years is much lower, and such lights also last longer;
- By **replacement** cost, we mean the cost of replacing totally or partially a given construction material or component. For instance, if low-impact glass is used for an exterior window, experience suggests that such windows will have to be replaced several times over the course of the building's life cycle, raising the total cost of that cycle;
- **Maintenance** costs refer to the sum of the preventive and corrective measures needed to ensure the correct functioning of a given component or material. For example, in the case of restroom equipment, preventive measures consist of periodic inspections and cleaning, while corrective measures consist of occasional repairs and replacement in case of more serious damage.

In general the idea is to use construction materials and components with a life cycle that is within a range that can be controlled accompanied by timely and appropriate maintenance measures. In the study of new design models, calculating the life cycle is particularly important because it makes it possible to properly estimate the capital goods necessary as well as the recurring costs and to plan maintenance measures in line with this.

Allocation of maintenance funds

School buildings that are poorly maintained cause two kinds of problems, which are linked to each other: health and safety, and problems with using the building. To a large extent, when the former are resolved, the latter find acceptable alternative solutions. Top priority should therefore be given to solving problems that might jeopardize the physical integrity of the building as well as the health of the students and other users of the building regardless of its geographic location or their educational level, age, or any other factors.

Priorities

Setting priorities to be given attention has a technical component but also a strategic component that in many cases goes beyond the priorities of the school building itself and has to do with regional or sectorial development strategies. In this case, the authorities might decide to give top priority to, for example, urban areas with high social mobility. Besides supporting the educational process, this will benefit the consolidation and stability of communities as well as improve their social and economic conditions.

From a strictly technical standpoint, a model for establishing priorities might follow the following sequence:

1. Measures that save money and are low-cost;
2. Measures that are zero- or low-cost
3. Measures that ensure the safety of occupants without protecting them from natural disasters;
4. Measures that ensure the health of occupants without protecting them from natural disasters, including the functioning of electrical and sanitary facilities;
5. Measures that make the outer surface of the building waterproof;
6. Measures that ensure the proper thermal insulation of the building;
7. Measures that provide the necessary space for twenty-first-century learning; and
8. Measures that ensure the safety and health of occupants while also protecting them from natural disasters.

In situations in which two school buildings require the same remedial measures but there is only enough money for one of them, the higher priority should be assigned to the school with higher enrollment or of more recent construction.

Once the individual cost of each of these measures is calculated, it is possible to decide whether it is necessary or a good idea to reorganize or juxtapose some of these so as to achieve greater administrative efficiency, simplification in the handling of funds, and better results.

As for a working strategy, priorities can also be in line with the degree of community participation and its capacity for generating resources locally. Another way to set priorities is to take into account the economic and operational benefit of sets of measures that cover a large number of schools rather than individual measures, going from building to building.

In some cases, higher priority should be given to maintenance measures that favor the largest number of students, for which a coverage index can be devised using the following formula:

$$\frac{\text{Coverage index} = \text{Enrollment} / \text{Capacity}}{\text{Repair cost}}$$

By dividing enrollment by capacity, this formula also allows for assigning the highest priority to schools whose space is being used better or where there is classroom overcrowding.

One of the most difficult decisions faced by maintenance offices is determining the point at which it no longer makes economic sense to keep spending money for the upkeep of a building that has reached the end of its life cycle. To facilitate this decision-making process, indices can be calculated using the following formula:

$$\text{Replacement index} = \frac{\text{Cost of correcting problems}}{\text{Replacement cost}}$$

In general, when the replacement index exceeds 50%, it is thought that the building should be included in the replacement program and withdrawn from the maintenance program so long as the conditions for a healthy and safe operation are met. This formula is particularly useful when the goal is to assign replacement priorities to a group of schools in similar states of decay.

Alternative model

If countries wish to have educational facilities on par with the needs of twenty-first-century learning, we will be offered an unprecedented opportunity in the region of raising educational infrastructure to a level at which it can efficiently provide the services required of it in a way that is economical and sustainable. A new policy could then be defined that stresses long-term investments in education and therefore in schools' physical plants.

As a result of this new policy, three highly coordinated work programs could arise as necessary to

address the challenge of education-related construction. They are the following:

A program to improve technical-administrative systems to tackle the problem of maintenance. This task, in which national governments must take the lead, includes the entire range of levels of jurisdiction that have (or may have) a role not just in maintenance but also in planning, designing, and building schools;

- A program to restore the value of all school buildings not scheduled to be replaced. This is a major task and must be scheduled over time but with a timetable that does not exceed five years; and
- A program to replace school buildings that have reached the end of their life cycle and must be replaced so that they meet all the requirements of twenty-first-century learning.

Building maintenance carries with it requirements that should not be put off in case more severe problems arise. Every year, maintenance spending levels must be matched to what is required. It is not possible to favor schools at one educational level to the detriment of another, or rural schools as opposed to urban ones, or vice versa. Old or dilapidated schools need attention just as much as recently built ones. Large schools need as much care as small ones. It is therefore highly risky and undesirable to establish attention priorities using these parameters.

Distribution by type of maintenance measure

The degree of complexity of maintenance measures dictates which jurisdictions should take responsibility for their planning, execution, and financing. In brief and in line with what was stated above, the following are the variables to be taken into consideration:

- **Maintenance routines and minor repairs.** These fall under the full responsibility of each school and are done under the supervision of the principal in line with a pre-established schedule using the same funds used to run the school. The results of inspections and maintenance work should be reported via the Internet to the Central Maintenance Office. Technical questions can be raised on occasion by that office. The same routines should be followed and reports filed when cleaning, maintenance, and minor repairs are handled by an outside contractor.
- **Corrective maintenance, replacement, and renovation.** These tasks require a competitive bidding process for the projects to be assigned and qualified technical oversight that should be centralized at the level where the database of physical infrastructure and allocation of resources is centralized.

Regardless of the jurisdiction that carries them out, tasks—both large and small—should be conceived and carried out under the same technical rules governing quality and closely coordinated with the strategy adopted for the design of the school buildings.

Sources of financing

To be sustainable, the maintenance of school buildings must always be done with funding from the country itself, whether it comes from the central, provincial, or municipal government or other sources. However, there is now a great opportunity for lenders and international donors to collaborate in the upgrading of existing buildings, an essential condition if maintenance measures are to be minimized and be carried out more effectively.

If the sources of external funding or donors are interested in addressing part of the problem, the work must be well coordinated at the central level, using the same technical procedures. Once the upgrading work on the building is completed, all of the documentation should be transferred to the jurisdiction that will take charge of maintenance measures.

If it is decided to purchase furniture or equipment with external financing, the supplier should have a long-standing representative in the country so as to provide follow-up service for whatever items are bought.

Conclusion

The proper use, preservation, and maintenance of school buildings is the next major challenge in the countries of Latin America and the Caribbean, even though the idea has not yet been fully embraced. The situation is serious, and signs point to it getting worse if a solid commitment is not made to protect and improve what countries already have and have worked so hard to build. Maintenance problems stem from poor planning, poor design, and substandard construction of school buildings. They worsen with indifference, negligence, and even malice among some users who do not realize that a school building that is safe, comfortable, and adequate for learning can yield great benefits for students, teachers, and the community at large.

The culture of preventive maintenance should be encouraged. This will generate savings on corrective measures that require considerable resources and have a greater impact on the school.

Solutions are simple from a technical standpoint and relatively low-cost. Yet a major effort that is well-coordinated and effective will need to be made soon, not just to correct the status quo but also to reach a point at which maintenance becomes a simple routine and school buildings can provide an effective service as a fundamental pillar of education.

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