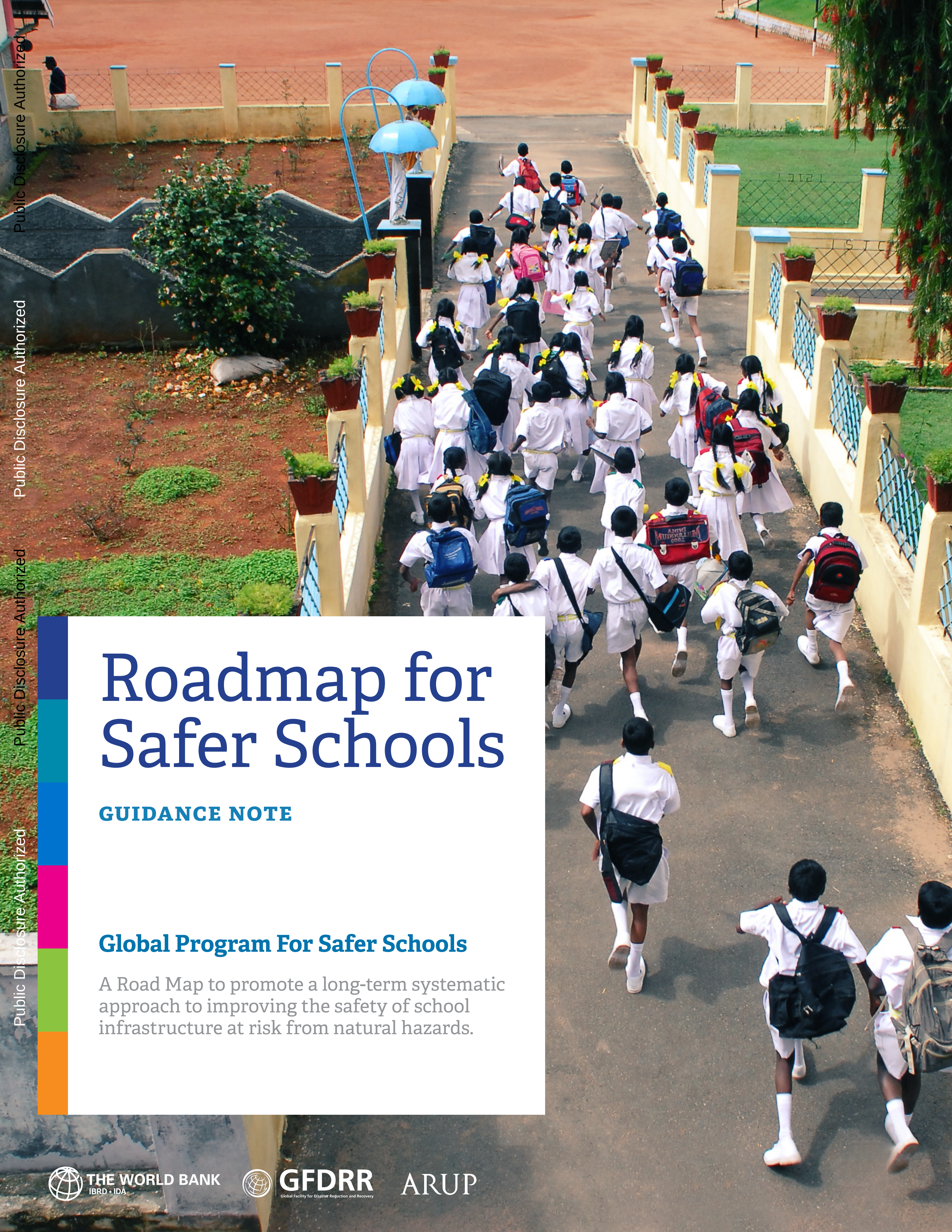


Roadmap for Safer Schools

GUIDANCE NOTE

Global Program For Safer Schools

A Road Map to promote a long-term systematic approach to improving the safety of school infrastructure at risk from natural hazards.

THE WORLD BANK
IBRD • IDA
GFDRR
Global Facility for Disaster Reduction and Recovery
ARUP

Acknowledgments

The preparation of this "Roadmap for Safer Schools" was led by **Fernando Ramirez Cortes** under the Global Program for Safe Schools of the Global Facility for Disaster Reduction and Recovery (GFDRR). The team consisted of **Niels B. Holm-Nielsen, Vica Rosario Bogaerts, Oscar Anil Ishizawa, Carina Fonseca Ferreira, Juan Carlos Atoche, Jesus Gomez Sanchez, and Laisa Daza Obando**. The document was developed by **Arup International Development, Hayley Gryc,** and **Joseph Stables** in collaboration with the Global Program for Safer Schools team.

Our particular thanks go to everyone who contributed to the development and review of the Roadmap, especially **Alanna Simpson** (Senior Disaster Risk Management Specialist, GFDRR-World Bank), **Artessa Saldivar-Sali** (Municipal Engineer, World Bank), **David Mason** (Urban Specialist Consultant, World Bank), Elif Ayhan (Senior Disaster Risk Management Specialist, World Bank), **Ko Takeuchi** (Disaster Risk Management Specialist, World Bank), **Marc Forni** (Senior Disaster Risk Management Specialist, World Bank), **Zaruhi Tokhmakhyan** (Senior Infrastructure Specialist, World Bank,), **Jo da Silva** (Director, Arup International Development), **Matthew Free** (Director, Natural Hazards and Risk, Arup), **Damian Grant** (Associate, Seismology and Risk, Arup), **Tigran Shmis** (Senior Education Specialist, World Bank) and **Ines Kudo** (Senior Education Specialist, World Bank).

Contents

Contents

Introduction

In 2014, the Global Facility for Disaster Reduction and Recovery (GFDRR) launched the Global Program for Safer Schools (GPSS). Through the GPSS, GFDRR support programs designed to establish safer school facilities in countries where the government has firmly committed to a reform or investment program in the education sector. GFDRR provides technical assistance to ensure that such education sector programs finance safer school facilities.

The aim of the GPSS is to make school facilities, and the communities they serve, more resilient to natural hazards. The program's objective is therefore to save lives, reduce the physical impact of natural disasters on school infrastructure, and minimize the negative educational outcomes resulting from natural disasters. Activities supported by the program focus on supporting Ministries of Education to avoid the creation of new risks and reduce existing risks through risk-informed construction and retrofitting of school infrastructure.

As part of a partnership with GFDRR, Arup International Development is providing technical support to GPSS. This includes the development of this guidance note for the preparation of safer school projects and programs.

Background

Each year countries suffer great tragedy when natural disasters destroy schools and disrupt children's education. In addition to causing immediate harm to children, there is mounting evidence that the direct impact of natural disasters can translate into a series of indirect long-term effects. For some time, multilateral and bilateral development finance institutions, United Nations (UN) agencies, and nongovernmental organizations (NGOs) have been engaged in efforts to make schools resilient to natural hazards. Despite these efforts, however, the safety of school facilities in many disaster-prone countries is unknown, and governments and donors continue to finance new school construction without taking sufficient account of safety.

Comprehensive School Safety Framework

The Comprehensive School Safety (CSS) Framework is a global framework in support of two initiatives: the Worldwide Initiative for Safe Schools and the Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector[1]. It was developed in preparation for the third UN World Conference on Disaster Risk Reduction in 2015. The CSS Framework rests on three pillars (*figure 1*):

- Safe learning facilities (school infrastructure)
- School disaster management
- Risk reduction and resilience education

1 For the framework, see UNISDR and Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector, "Comprehensive School Safety," **http://gadrrres.net/uploads/files/resources/Comprehensive-School-Safety-Framework-Dec-2014.pdf.**

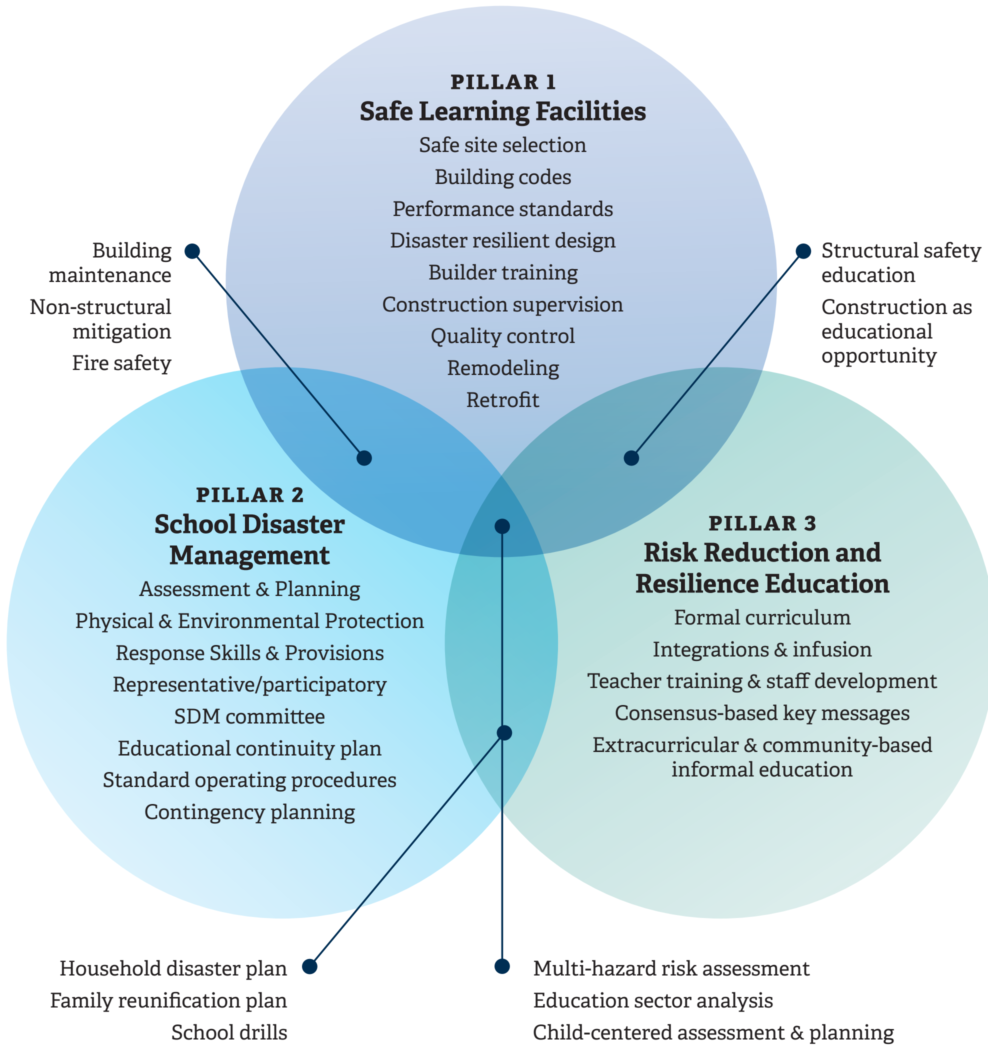


FIGURE 1

CSS Framework

Source: UNISDR and Global Alliance for Disaster Risk Reduction and Resilience in the Education Sector, "Comprehensive School Safety," **http://gadrrres.net/uploads/files/resources/Comprehensive-School-Safety-Framework-Dec-2014.pdf**.

This Roadmap directly relates to Pillar 1 of the CSS Framework, safe learning facilities. To integrate safety into school infrastructure, there needs to be an understanding of disaster risk as well as the school infrastructure project cycle, which includes planning, design, construction, operation, and maintenance.

This Roadmap is focused specifically on school infrastructure (which includes the school site and buildings). For investment opportunities to be effective and to have maximum impact at community and national scales, it is important that this support is coordinated with investments in school disaster management, risk reduction and resilience in education, and disaster preparedness in other sectors.

These other investments may seek to

- **Mobilize political commitment for school safety.**
  A commitment to act and provide resources should be sought from key political influencers and decision makers.
- **Build social demand for school safety.**
  Communities need to be aware of the importance of safe schools in order to create a community-driven desire for safe school infrastructure. Using crowdsourcing apps (such as "How safe is your school?"[2]) is a powerful way to raise awareness as well as to capture baseline data for measuring the effectiveness of interventions in the future.
- **Offer training and development.**
  There is an opportunity to use safe school construction programs as education tools by providing associated training programs for both practical skills and awareness.

2 The app is available at **https://itunes.apple.com/us/app/unisdr-school-safety-assessment/id786074863?mt=8**

Understanding Safer Schools

Defining a “Safe” School

School safety can mean different things to different people depending on their perception of risk. Typically, it is assumed that a safe school is able to withstand extreme events without collapsing and that the risk of loss of life is low: while the building may sustain extensive damage, occupants are able to exit safely and/or failure of the building is localized. In many instances, however, it is also desirable to minimize damage, since school buildings play an important role in creating resilient communities. Continuity of schooling is critical to rapid recovery, and the schools themselves may serve as a community refuge, distribution center, or resource center in the immediate aftermath of a disaster. Consequently, focusing on “safe and resilient” schools (rather than on “safe” schools) is more appropriate and better reflects a desire to minimize disruption as well as prevent loss of life or assets.

Understanding Risk

The extent to which a school is safe will depend on its location, construction, and operation. Four factors contribute to reducing (or increasing) risk: hazards, site location, physical planning, and quality of buildings. These are shown in figure 3 and discussed in more detail below.

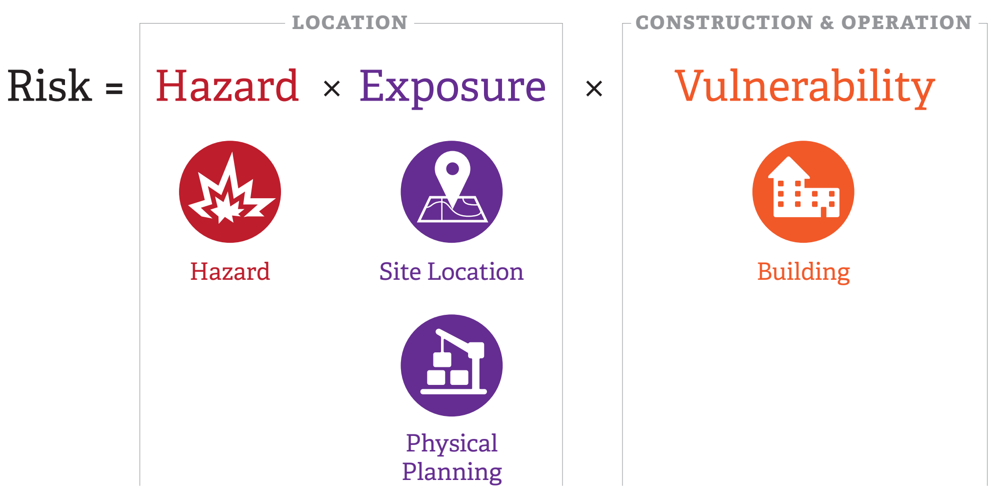


FIGURE 3

Factors contributing to safe schools mapped against the definition of risk.

Hazard

The risk posed by natural hazards is determined in the first instance by the likelihood of a particular type and magnitude of event occurring. The risk of a major earthquake with the potential to devastate a community might be comparable to that of annual hurricanes, which cause relatively minor damage more frequently. The assessment of all relevant hazards is a prerequisite for achieving safe schools.

Site Location

How hazards are experienced at the local level relates to exposure, which depends on the site location and physical characteristics, including soil conditions, topography, vegetation, and proximity to water bodies or fault lines. For instance, areas characterized by sandy soils and a high water table may be prone to liquefaction following an earthquake, while proximity to water bodies or deforested slopes may increase flood risk following periods of heavy rainfall.

Physical Planning

Exposure can be mitigated (or compounded) by the physical planning of the site. For instance, wind loads on buildings can be significantly reduced by the correct orientation, and civil engineering works, such as retaining walls, slope stabilization, and drainage, can substantially mitigate exposure to landslides and flooding.

Building Quality

The vulnerability of a school is influenced by the quality of buildings, including both structural and non-structural elements as well as building services. Inappropriate design and poor-quality materials or workmanship—the result of limited resources, corruption, or a move away from vernacular construction methodologies—have all contributed to high levels of vulnerability and the resulting collapse of numerous schools in recent years.

Some structural typologies are more suitable than others to withstand particular hazards; for instance, a lightweight timber frame is well-suited to areas subject to earthquakes but not high winds. The configuration of the building, the size and manner of connecting structural elements, and the quality of materials and workmanship will all affect the structural capacity, which determines the building's ability to withstand extreme loads.

Significant modifications, including extensions, large openings, and additional stories, may compromise the original design and also increase vulnerability; the same is true if there is deterioration in the building's condition, for instance due to corrosion, settlement, or cracking.

Additional vulnerability results from non-structural elements. Furniture, signage, pipes and ducts, and rooftop water tanks can contribute to increased vulnerability if they are inadequately fixed to the structure. Inadequately protected hazardous materials and combustible materials can also make buildings more vulnerable.

The construction methodology affects how a building is maintained and repaired; if the methodology leads to deterioration, there is an impact on safety.

Damage that may be costly or time-consuming to repair is unacceptable in a safe and resilient school. To promote safety, greater emphasis should be placed not only on the quality of design and construction, but on the ability to maintain, repair, and adapt facilities without compromising their structural integrity. Inadequate maintenance budgets, uncertainty over who is responsible for maintenance, and imported construction technologies may make schools less safe over time. Maintaining access and continuity of basic services after a disaster, particularly water and power, is also important and may be achieved through protective measures or standby (or backup) systems.

Characteristics of a Safe School

Ten characteristics of a safe school have been developed based on a review of best-practice literature and good engineering practices for designing, delivering, and evaluating schools. These are summarized in table 1.

Characteristic 1 relates to the measurements needed in order to establish the design criteria; Characteristics 2 and 3 relate to the site location; and Characteristics 4 to 10 apply to the building itself (including building services and non-structural elements).

In countries where there is a mature regulatory framework that is enforced, these characteristics will already be incorporated in building codes and practices, so that compliance becomes the predominant issue in achieving safe schools. Elsewhere, the characteristics provide a basis for developing assessment methods that identify the action needed at the various stages of the project delivery cycle or to support different methods of implementation.

TABLE 1

Characteristics of a Safe School

FOCUS	CHARACTERISTIC
Assessment	1. A hazard assessment has been undertaken to identify the types of hazard that the school may experience (e.g., tsunamis, volcanoes, earthquakes).
Site Location	2. A site assessment has been undertaken to identify key features that may impact exposure to specific hazards, including topography, soil conditions, proximity to water bodies/fault lines, vegetation. 3. Appropriate mitigation measures have been taken in the physical planning of the site to adequately mitigate the risks identified as a result of the hazard and site assessments.
Building	4. The building makes use of an appropriate structural typology—one that takes account of the most prevalent hazards. 5. The building configuration is reasonably symmetric, allows safe egress, and avoids irregular features. 6. Significant building modifications (e.g., openings, canopies, additional stories) have not been constructed unless allowed for specifically in the building design. 7. The structural capacity of key elements of the building (e.g., foundations, beams, columns, walls, roof, connections) have been assessed for their ability to transfer vertical and lateral loads. 8. The selection of the building's non-structural elements (e.g., facades, internal walls, storage of hazardous materials, equipment, signage) has taken account of the prevalent hazards, and elements are adequately fixed to the main structure. 9. There are systems in place to assure the quality of materials and workmanship during construction, and there are no signs of structural deterioration (e.g., settlement, cracking, corrosion) in key elements of the building (e.g., foundations, beams, columns, walls, roof, connections) that might impair the structural performance. 10. There is adequate funding and local skill available to carry out regular maintenance and repair of the building and site infrastructure (e.g., drainage channels, access and evacuation routes).

Safe School Roadmap

Purpose and Objectives of the Roadmap

The purpose of this Roadmap is to enable World Bank task team leaders (TTLs) to engage with the ministries of education, finance, and public works within a country so as to promote informed investment in the safety of new or existing school infrastructure at risk from natural hazards.

The intention is to promote a long-term, systematic approach to improving the safety of school infrastructure globally that uses a quantitative risk assessment to define needs and priorities. The focus is primarily on public school infrastructure.

The specific objectives of the Roadmap are as follows:

- To help the World Bank TTL identify entry points for Bank support (financing, policy reform, advisory services) to the education sector that facilitate the design and implementation of safer schools programs
- To influence policy reforms and wider investments in risk reduction that create safer school environments
- To inform long- term national strategies that prioritize safety at scale and that relate to previous and ongoing activities in the education sector

Audience

The Safer Schools Roadmap is an operational tool that will guide the interactions of World Bank TTLs with relevant ministries on the topic of school infrastructure safety. It can be used by TTLs from a variety of different backgrounds, including education, disaster risk management/reduction, and engineering (construction). It is important that TTLs lacking background or experience in both disaster risk reduction and (school) construction seek help from others with the appropriate experience.

The Roadmap itself, however, uses concepts and language that are accessible for those without experience in disaster risk reduction and construction, and it provides guidance on the technical expertise that is required by the activities.

Structure of the Roadmap

The Roadmap consists of six steps that follow a logical sequence from diagnosis to analysis, opportunity, and investment (figure 4). This guidance note focuses on **Steps 1–5**; **Step 6** is the discussion with the government about Bank support.

Each step of the Roadmap corresponds to a section of the guidance note. The beginning of each section presents an overview of that step, which outlines the purpose, key objectives, and number of modules for that step along with related activities. Each step will result in a key deliverable or deliverables that will enable TTLs to build an evidence-based argument (figure 5).

FIGURE 4

Safer Schools Roadmap

FIGURE 5

Structure of Each Step

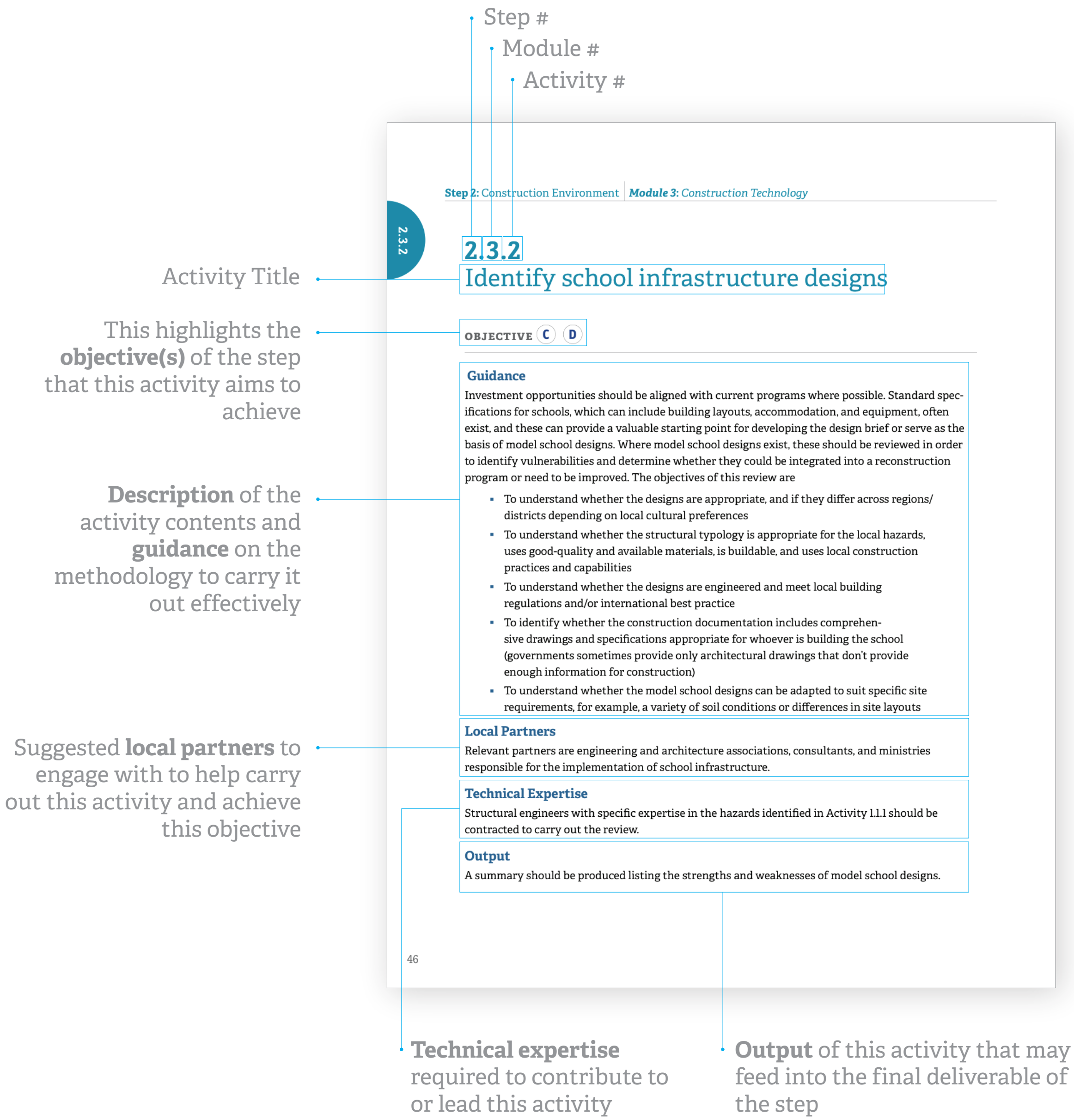


FIGURE 6

Activity Page

Step 1
School Infrastructure Baseline

Purpose
To establish a baseline of existing school infrastructure facilities and the demand for new school infrastructure.

Objectives
- **A** Identify the quantity and quality of existing school infrastructure
- **B** Determine the exposure of school infrastructure to natural hazards
- **C** Evaluate the potential shortfall of new school infrastructure
- **D** Estimate the scale of potential repair, retrofit, (re)construction, and relocation needs

MODULE	ACTIVITY	OBJECTIVE
1.1 Natural Hazards	**1.1.1** Identify the natural hazards that pose a risk to school infrastructure	B
1.2 Existing School Infrastructure	**1.2.1** Create an inventory of existing school infrastructure	A
	1.2.2 Examine the physical characteristics of existing school infrastructure	D A
	1.2.3 Identify existing interventions	A
	1.2.4 Identify the schools exposed to the natural hazards	B D
1.3 New School Infrastructure	**1.3.1** Identify the demand for new school infrastructure and estimate shortfall	C D
	1.3.2 Understand government's school infrastructure plans	C D

Deliverables
The key deliverables will be the following:

- GIS database that contains information gathered in the activities above, including locations of existing schools, available hazard data, and structural and non-structural characteristics of the existing schools. This database will be an important tool for monitoring and reporting on the progress of school infrastructure programs over time. It may be especially useful in securing additional funds and gaining political support. It will also be needed in further stages for the design, implementation, and monitoring of specific rehabilitation programs.
- Report summarizing the scale of potential school infrastructure construction needs.

1.1.1
Identify the natural hazards that pose a risk to school infrastructure

OBJECTIVE **B**

Guidance

As part of the initial diagnosis of school infrastructure, it is necessary to understand the range of hazards that may compromise the planning, design, construction, repair, retrofitting, and operation of school infrastructure projects. This activity is an initial screening of the exposure of school infrastructure to natural hazards; it aims to collect existing information about and knowledge of natural hazards that pose a risk to school infrastructure. At this stage no hazard or risk assessment is envisioned (this will be carried out in **Step 4**).

In many countries the risk to school infrastructure posed by natural hazards is not understood, or it has not been assessed in enough detail to inform the development of an investment plan for school infrastructure. However, countries (school communities, institutions, government) often have a basic knowledge of the natural hazards that affect school infrastructure based on previous events. There is more likely to be information on natural hazards that occur frequently, such as hurricanes or floods, and less likely to be information on infrequent hazards, such as earthquakes or tsunamis, especially if these hazards have not occurred in recent history.

Possible sources of information on hazards include existing hazard maps or historical event maps produced by relevant government departments (not necessarily the Ministry of Education [MoE]; historical damage assessments; existing hazard/risk studies and assessments conducted for the education sector; and data on disasters caused by natural hazards.

Existing information can be identified through a combination of stakeholder consultations (in both the education and disaster risk reduction sectors, and at both government and community levels) and desktop (multi)hazard studies, which review published research studies along with available hazard maps and publicly available data (e.g., SRTM topographic data available on the U.S. Geological Survey website). Where possible, evidence should be corroborated by more than one source; this corroboration may involve asking the same questions to different stakeholders and referencing the answers to existing sources of information. Data will need to be collated, reviewed, and commented on to identify the range, frequency, and intensity of the hazards that exist in the specified location.

Where hazard maps exist, they can be used to help establish a preliminary overview of the spatial exposure of school infrastructure by integrating them into the geographic information system (GIS) database to be developed as part of this step (under Activity **1.2.4**).

Local Partners

The MoE and its related departments need to be educated consumers of regional and local hazard information, and must be able to link this information specifically to school sites and facilities as well as the routes to access them.

Government departments—including the Ministry of Public Works (MoPW), National Disaster Management Agency, Ministry of the Interior, national and local fire departments, Planning Department, agriculture sector authorities, and health sector authorities—may have government records on natural hazards. Other key partners could include meteorological and geotechnical agencies, the construction industry (engineering firms), local universities, NGOs and international NGOs (INGOs), insurance companies, and consultancy firms.

The insurance industry typically has a comprehensive data set on natural hazards; and a number of initiatives, including the partnership of Risk Management Solutions (RMS) with the United Nations Office for Disaster Risk Reduction (UNISDR) and World Bank, have been developed to provide governments with open access to insurance companies' data and catastrophe models.

Technical Expertise

This activity should be carried out by technical consultants or academics with specific expertise in natural hazards.

Output

A technical note summarizing the natural hazards affecting the specified location should be developed; the note should also identify whether the information is up to date and where there are gaps. The note should indicate whether further, more detailed (multi)hazard assessments should be undertaken; these will inform Activity **4.1.1**.

1.2.1
Create an inventory of existing school infrastructure

OBJECTIVE A

Guidance

This activity generates the basic information needed to develop an inventory of existing school infrastructure; this inventory will serve as the baseline from which the extent of risk from natural hazards can be determined, along with potential opportunities for reducing these risks. The inventory should be developed as a geospatial database, such as a GIS, in order to facilitate data analysis and to enable overlaying school locations with hazards to determine exposure. Such a database also provides for comprehensive school mapping and is typically the most significant information required for assessing infrastructure improvements at scale.

The inventory database will become an important tool for reporting to government on the progress of school infrastructure programs (reconstruction or retrofitting), and it will be especially useful for raising additional funds and getting political support for future school infrastructure programs. It is therefore important that the database be formatted so it can be updated easily, and there should be clarity about who owns the database and will manage it going forward.

This collection of school-related data will also be very useful for all educational planning, as well planning for purposes of disaster risk reduction and emergency response. Without it, school authorities will not be able to process the data needed for rational planning, resource allocation, and monitoring of school infrastructure.

The school infrastructure's exposure to natural hazards and its vulnerabilities will be incorporated into the inventory during Activities **1.2.2** and **1.2.3**, although in practice these activities might be coordinated and carried out simultaneously. Developed nations with fully functioning Education Management Information Systems usually have this information in place. In other countries, the information may be fragmented, and it may be necessary to coordinate data from different ministries and government departments or agencies. Any existing inventory or database should be reviewed and used as a basis for this activity. The database should include enough information to clarify the problem but need not necessarily indicate how to prioritize an investment. Where information doesn't exist or there are gaps, the information should be gathered through a data collection method—e.g., rapid visual assessment (RVA), remote data collection methods, etc.)—that is tailored to the nature of the data, the purpose of the assessment, and the resources available.

Local Partners

Sectoral agencies typically have detailed information on their assets (e.g., location, age, and number of buildings). It will be important to identify which ministry/government department is responsible for school infrastructure, and it will be essential to involve the relevant government staff in this process to share ownership and responsibility. Information may need to be collected from different agencies.

If information on schools doesn't exist, a methodology for data collection will need to be developed. Data can also be obtained through INGOs, NGOs, and others implementing school infrastructure programs.

Technical Expertise

Technical consultants will need to design and set up the inventory database if one does not already exist. The Istanbul Seismic Risk Mitigation and Emergency Preparedness Project (ISMEP), for example, relied on technical assistance input from international experts. A project coordination committee was also established for ISMEP to coordinate and manage the different government agencies and flow of information. This approach helped build the capacity of the local government to manage the inventory. Local experts should if possible be engaged in this activity, since they typically have a good understanding of the characteristics and vulnerability of the local infrastructure.

Where further information needs to be developed, technical consultants should be hired to undertake the assessment and collect data on school infrastructure. A bottom-up approach to collecting nontechnical data is relatively inexpensive and can be done through crowdsourcing of information from school principals, teachers, parents, etc. Alternately, a simple approach can be developed that can be implemented on site by nontechnical staff, or with easy-to-find local technical support.

Output

The scope of the database (nature and detail of the data) should be tailored to its purpose and should be defined by technical consultants and the ministry/government department responsible for school infrastructure. A database of existing school infrastructure should include at least the following:

- Date of survey
- Number of school buildings and classrooms, including building/block reference identification
- Number of occupants (students, staff)
- Location (GPS coordinates) to enable GIS mapping and overlay with hazard maps (in Activity **1.2.4**), so that the extent of exposure can be identified
- Education service stream (primary, secondary, etc.)
- Urban/rural
- Public/private school (asset owner)
- Age of school buildings
- Photographic reference
- Number of stories
- Basic information about the type of structure of the school buildings (e.g., load-bearing masonry, reinforced concrete frame, steel frame, etc.)
- Basic information about the functional conditions of the school buildings (e.g., water and sanitation)

If one of the purposes of the inventory is to support the disaster risk analysis of **Step 4**, more information related to structural and non-structural characteristics and to the condition (level of deterioration) of the school buildings could be required, as explained in Activity **1.2.2**.

1.2.2
Examine the physical characteristics of existing school infrastructure

OBJECTIVE (A) (D)

Guidance

The physical characteristics of the school buildings influence their vulnerability.

The physical characteristics of school infrastructure may be classified as follows:

- Structural characteristics. In engineering terminology, these are the system of structural elements that provide building stability and resistance to external actions (e.g., earthquakes, wind, gravity) and that are often known as the structural typology. This classification needs to consider the building's condition, including historical or recent damage, since damage typically influences the response of the structural typology.
- Nonstructural characteristics. These are mostly related to the building envelope (if not part of the structural system) and include finishes such as windows, ceilings, and building equipment.

During this activity data should be collected, either through existing data sets or through primary sourcing, to build into the inventory of existing school infrastructure initiated in Activity **1.2.1**. The information gathered will be used to categorize school buildings by structural typology. It will also be used to get a high-level understanding of buildings' vulnerabilities and typical condition/historical damages for the risk assessment as part of **Step 4**; this assessment will inform the development of a prioritized investment plan in school infrastructure as part of **Step 5**. The data collection in this activity should be coordinated with activities in **Step 4** to ensure that the data's level of detail and format are appropriate for use in the risk assessment.

Preliminary categorization and vulnerability appraisal can be made by comparing how the physical characteristics collected above compare to appropriate hazard-resistant details—that is, whether the structural typology and building configuration are appropriate for the hazards present (reduced roof weight for seismic resistance, roof tie-down details for wind resistance, etc.).

Depending on the existing information available, it may be necessary to gather new information through a comprehensive field survey and to incorporate it into the assessment undertaken in Activity **1.2.1**. A methodology can be created to collect detailed structural data about each school building and to cover many (preferably all) schools by a high-level walk-through. The data should include both structural and non-structural elements that contribute to the building's performance during an event, as well as site conditions. If comprehensive field surveys of every school are not feasible because of limited resources, some strategy for prioritizing schools—for example, schools in the most exposed locations—should be developed; or only a sample of school buildings could be surveyed (using the stratified method of the Raosoft sample size calculator [**http://www.raosoft.com/samplesize.html**]). The sample of schools could be categorized into subgroup, such as structural typology (if known), type of school (public/private, etc.), school level (kindergarten/primary, secondary, university, etc.), number of students, and location (to ensure that a statistically representative sample of all schools is assessed).

Other sources of information to supplement primary survey data include; existing model school designs and existing damage assessments. Depending on the appropriateness of the existing information, it may be used directly or to prioritize existing schools for inspection.

Local Partners

Partners are the same as those described for Activity **1.2.1**.

Technical Expertise

Structural engineers, specifically those with expertise in the hazards identified in Activity **1.1.1**, should be contracted to design and develop the assessment methodology and provide training and guidance for those undertaking the surveys. See also the expertise described for Activity **1.2.1**.

To develop a robust and replicable process for the building assessment, there needs to be an understanding of who will be undertaking the assessment and establishing the tools for quality reporting and communication. A rigorous assessment process requires the following:

- **a.** Clarity about the purpose of the assessment and the action to be taken based on the outcome
- **b.** Competent assessors with appropriate training
- **c.** A robust and replicable assessment process
- **d.** A standard reporting format that records the basis of the assessment and the key findings
- **e.** An effective quality assurance procedure
- **f.** A database or platform that can readily collate and analyze assessments

Output

The following data should be input into the existing school infrastructure inventory database developed in Activity **1.2.1**:

- Structural typology
- Vulnerability factors, including
  - Building configuration (e.g., shape on plan, shape on elevation, configuration of openings, number of bays, roof shape)
  - Modifications
  - Existing interventions (repair, retrofit)
  - Dimensions of key building components, such as foundations, lateral and vertical load system, floors, roof
  - Non-structural elements
  - Physical condition (e.g., historical/recent damages, material deterioration, settlements)

1.2.3
Identify existing interventions

Objective A

Guidance

This activity identifies any repair or retrofitting programs that have been or are being implemented and identifies their impact, associated investments, and the specific intervention options (repair, retrofit).

In areas where a school structural safety program (repair, retrofit or reconstruction) is already under way, this activity provides critical information for determining where other safe school programs should be prioritized. It also helps in defining and selecting a repair/retrofit strategy (part of **Step 5**) that builds on existing capacities and lessons learned. Technical experts (engineers) should review all existing interventions to ensure that they are increasing the safety of school infrastructure. Information about existing interventions could be collated through the assessment conducted in Activity **1.2.2**.

As part of this activity, efforts should be made to understand the country's approach to improving school infrastructure safety: Is it nationally coordinated? Is it taking place at the district/local level (and not coordinated)? Or does it not exist at all?

Local Partners

The MoE and/or MoPW (the latter responsible for education facilities) should have an understanding of existing or historical repair or retrofitting programs. Depending on how established the regulatory framework is and whether it is enforced, any modifications to buildings should have been approved by the appropriate government department.

Other entities that may also have information on interventions include donors, INGOs, and NGOs implementing school infrastructure programs, as well as engineering and architectural associations or universities.

Technical Expertise

This activity requires technical experts in structural engineering, specifically those with expertise in the hazards identified in Activity **1.1.1** and in the retrofit and repair of existing buildings.

Output

A summary report should be developed that identifies the existing intervention options for the common school infrastructure structural typologies identified in the previous activities. The report should review existing interventions for appropriateness, benefit in terms of structural safety, quality of implementation, and cost, and it should recommend potential intervention options to be included in a possible safe school program.

1.2.4
Identify the schools exposed to the natural hazards

OBJECTIVE B D

Guidance

Where hazard maps exist (see Activity **1.1.1**), they should be integrated into the inventory developed in Activities **1.2.1** and **1.2.2**. Doing so will enable the TTLs to map the school locations against the hazard zones to determine both the exposure of school infrastructure assets to natural hazards and the magnitude of the problem (number of schools/classrooms/occupants in hazard zones). This information could inform a preliminary estimation of the number of schools that might be relocated in case the level of risk is unacceptably high.

Information about schools' location will be most useful if it is in GIS format, which can be analyzed and updated effectively. The state of California provides a good case study of interoperable school location information displayed as a visible layer superimposed on the hazard maps.

Local Partners

Partners are the same as those described for Activity **1.1.1**.

Technical Expertise

The consultants contracted to develop the database should integrate the maps into the GIS database and analyze the data to identify those schools exposed to natural hazards.

Output

A map showing school locations against hazard zones should be produced.

1.3.1
Identify the demand for new school infrastructure

OBJECTIVE C D

Guidance

This activity involves understanding the demand for new school infrastructure in order to determine (1) if more schools are needed; and (2) if excessive stresses are being placed on existing school infrastructure. It should be noted that the demand for new school infrastructure is not always well defined by the MoE.

There are two key questions to address in this activity:

a. What are the drivers of demand? Answering this question involves identifying the factors that affect the demand for schools, such as the education policy (including compulsory education streams), population, and demographic trends.
b. What is the current demand for new schools? Answering this question involves assessing the demand in different locations; identifying any concentrations in urban or rural contexts; determining the different levels of demand in the different education service streams (kindergarten/primary /secondary); and quantifying the anticipated changes in demand over the short, medium, and long term.

This activity should seek to determine the current and future shortfall in schools; this information will help to inform the prioritization of investment in new or existing facilities.

Some existing data are likely to be available and may be supplemented through targeted stakeholder engagement, such as household surveys, focus group discussions, and meetings with government departments and administrators.

If data are difficult to obtain, demographic research (population, children in school) should be undertaken. A high-level assessment mapping of the school locations (see Activity **1.2.1**) relative to population concentrations is a good way of illustrating areas of potential demand.

Local Partners

Education specialists (World Bank TTLs) should be consulted in the first instance, along with the MoE. The MoE is likely to have specific information on capacity of schools and numbers of pupils in each school, including publications and documents relating to the demand for school infrastructure and to education policy.

Relevant demographic data, satellite imagery, and maps may be available from government departments responsible for master planning.

Technical Expertise

Education or school infrastructure specialists should be contracted to identify gaps in available information and undertake analysis to assess the demand for school infrastructure.

Output

Geospatial information should be collected that relates to demand for school infrastructure in the short, medium, and long term (such as school capacity, walking distance to nearest school, population density). Findings should be summarized in a report that includes an estimation of investment required for new school infrastructure.

1.3.2 Understand government's school infrastructure plans

OBJECTIVE C D

Guidance

This activity reviews and identifies the ongoing education policies that influence the development of the school infrastructure in the country. It is concerned with the following:

- National education policy and its long-term development strategy
- Integration of school infrastructure policy within national education policies
- Private education and contributions from nongovernmental organizations
- Role of religious organizations in school infrastructure policy
- Government's education coverage and quality indicators (education levels, rural versus urban)

Local Partners

Work should be coordinated with MoE and MoPW and with donors, NGOs, and INGOs supporting the government in implementing school infrastructure programs.

Technical Expertise

Education or school infrastructure specialists should be contracted to understand government's school infrastructure plans.

Output

A report should be produced summarizing current government's school infrastructure policies, plans, and/or programs.

Step 2
Construction Environment

Purpose

To gain an understanding of the institutional environment and regulatory framework within which school infrastructure is planned, designed, constructed, operated, maintained, repaired, and retrofitted in order to determine the factors placing school infrastructure at risk.

Objectives

- **A** Understand the strengths and weaknesses of the regulatory framework
- **B** Understand the strengths and weaknesses of the process for implementing school infrastructure
- **C** Identify vulnerabilities in the construction technology used for school infrastructure
- **D** Identify opportunities to improve the safety of school infrastructure

MODULE	ACTIVITY	OBJECTIVE
2.1 Regulatory Environment	2.1.1 Identify the planning regulation documents and understand what they cover and exclude	A D
	2.1.2 Identify the building regulation documents and understand what they cover and exclude	A D
	2.1.3 Map the history of the regulatory documents	A D
	2.1.4 Identify the regulatory process	A D
2.2 Implementation Process	2.2.1 Map key stakeholders	B D
	2.2.2 Identify capacity and capability of key stakeholders	B D
	2.2.3 Identify procurement and construction management processes	B D
2.3 Construction Technology	2.3.1 Identify typical construction materials	C D
	2.3.2 Identify school infrastructure designs	C D

Deliverables

The key deliverable will be a report that identifies the gaps and vulnerabilities affecting safe school construction/retrofitting and that recommends improvements to guide policy actions.

2.1.1
Identify the planning regulation documents and understand what they cover and exclude

OBJECTIVE (A) (D)

Guidance

Planning regulations provide guidance on where to locate buildings/infrastructure and on how to physically plan the site. Proper location and site planning can significantly reduce the exposure of schools to natural hazards (see box 1). Where they exist, planning regulations typically include planning guidelines, processes and requirements, and land use plans. This activity should identify what planning regulations exist and what they cover and exclude, along with any potential weaknesses and opportunities for improvement to reduce the exposure of school infrastructure.

The following should be considered:

- Is there a national development plan or policy, and do the planning regulations align with it?
- Do up-to-date land use plans exist?
- Do the planning regulations account for known hazards as identified in Activity **1.1.1**, in particular flooding, storm surge, and volcanoes?
- Do site selection guidelines exist for school infrastructure or other buildings?
- How old are the guidelines/regulations, and how often are they updated? Have they been updated since the last hazard event?
- Are regulatory documents consistent with each other?

BOX 1 : REGULATORY DOCUMENTS

Regulatory documents (such as building codes and land use plans) are important mechanisms for reducing disaster risk. However, they are effective only if they are up to date, incorporate current understanding and best practice, reflect local forms of construction and perceptions of risk, and are part of a wider culture of safety and environmental concern that includes education and training at all levels of society, as well as legislation and enforcement.

Local Partners

The relevant partners are MoE and MoPW; the Planning Department or department responsible for providing planning permission (if one exists); and engineering or architectural consultants/ universities/institutions/associations.

Technical Expertise

This activity requires construction professionals or academics in engineering or architecture who have a deep understanding of the regulatory environment.

Output

A report should be produced that summarizes the strengths and weaknesses in the regulatory framework and highlights opportunities for improvement (this output can be combined with that for Activity **2.1.2**).

2.1.2 Identify the building regulation documents and understand what they cover and exclude

OBJECTIVE A D

Guidance

Building regulations, including building codes and guidelines, provide guidance on how buildings/infrastructure should be designed and constructed. Proper design and construction can significantly reduce the vulnerability of schools to natural hazards. This activity should identify what building regulations exist as well as any gaps and potential opportunities for improvement.

The national building regulations should be identified and the codes and guidelines reviewed in order to understand what they cover in terms of hazards, materials and structural typology, building types (schools/educational facilities), new construction, and repair and retrofitting of existing buildings. This review should determine whether the regulations and codes are in line with existing schools and plans for school construction/repair/retrofit. The following questions should be considered:

- Are there building codes and guidelines for both new construction and repair/retrofit of existing buildings? Is there specific guidance for school infrastructure?
- Are building codes based on international codes and best-practice guidelines? If so, which ones? Have they been adapted to suit the local context (hazard, materials, technologies, communication), and is this adaptation appropriate for the local forms of construction? (See structural typologies identified in Step 1.)
- How old are codes and guidelines, and how often are they updated?
- Do the building guidelines complement the building codes, or were they developed to fill a gap in the building codes?
- Do they adequately cover the local hazards? Does the building code state that schools, usually defined as critical infrastructure, require a higher performance objective? (See box 2.)
- Are building regulation documents consistent with each other?

BOX 2 : PERFORMANCE OBJECTIVES

Performance objectives (POs) are used to define the maximum level of risk that can be tolerated in terms of damage and disruption. Table 2 identifies four levels of performance that reflect the extent to which a school is safe or safe and resilient based on the approach and terminology developed by the Federal Emergency Management Agency (FEMA).[1] International codes of practice (e.g., Eurocode 8, Part 1, BS EN 1998-1, and International Building Code: 2009) use importance factors that typically classify a school as critical infrastructure and imply a performance objective comparable to PO3. A school that meets PO2/PO1 designs will normally exceed building code requirements. Generally, building codes do not address the performance of non-structural elements, although their failure—notably the collapse of masonry partitions and facades, parapets, etc.—can also cause death, injury, and disruption.

1 FEMA, "Design Guide for Improving School Safety in Earthquakes, Floods and High Winds," Risk Management Series, FEMA P-424, December 2010.

PERFORMANCE OBJECTIVE	DESCRIPTION	LEVEL OF RESILIENCE	IMPACT ON SCHOOL
PO1 ***Continuous occupancy***	▪ No structural damage. The building is safe to be used during and after the natural disaster. ▪ Damage to contents is minimal and services will continue to function without alteration.	**High**	**Mild** Continuous education in the school or use as a community/ emergency shelter
PO2 ***Immediate occupancy/ operational continuity***	▪ Minor damage to structure that is repairable at a reasonable cost and in a reasonable amount of time. ▪ Specified assets are protected. ▪ Nonstructural components and systems needed for the building to operate are fully functional (with utilities possibly available from standby sources). Some cleanup and repair may be required.	**Moderate**	**Moderate** Delayed start to education in school while repairs are carried out
PO3 ***Life safety***	▪ Damage to both structural and nonstructural components, but risk of loss of life is low. ▪ Building systems and utilities are damaged and inoperable. ▪ Building may be beyond economic repair.	**Safe**	**High** Extensive delays or building to be demolished
PO4 ***Collapse prevention***	▪ Building is near collapse and significant hazard to life may exist. ▪ Building and emergency systems are extensively damaged and inoperable. ▪ Building beyond technical repair.	**Unsafe**	**Severe** No use; building to be demolished

Local Partners

Relevant partners are MoE and MoPW, the Building Control Department (or department responsible for certifying construction documents), and engineering or architectural consultants/universities/ institutions/ associations.

Technical Expertise

The same technical expertise is required as for Activity **2.1.1**.

Output

A report should be produced that summarizes the strengths and weaknesses of the regulatory framework and that highlights opportunities for improvements (this output can be combined with that for Activity **2.1.1**.

2.1.3
Map the history of the regulatory documents

OBJECTIVE A D

Guidance

Updated regulatory documents, along with enforcement mechanisms, are one of the main challenges in developing countries. Using the information on historical updates to the regulatory documents gathered during Activities **2.1.1** and **2.1.2**, this activity maps the updates on a timeline against information gathered during **Step 1** relating to hazard events, hazard studies, education policy, infrastructure programs, damage assessments, and other relevant events. This mapping should illustrate if the updates were responsive to historical hazard events, and if they resulted in a change in structural typology that in turn reduced school buildings' vulnerability.

Local Partners

Partners are the same as those described for Activities **2.1.1** and **2.1.2**.

Technical Expertise

The same technical expertise is required as for Activities **2.1.1** and **2.1.2**.

Output

A timeline should be produced, and information should be input into the summary of strengths and weaknesses in the regulatory framework.

2.1.4
Identify the regulatory process

OBJECTIVE A D

Guidance

Improving the regulatory framework for the implementation of school infrastructure can contribute to safer schools. This activity should identify the regulatory process and note any shortcomings or potential opportunities for improvement. Specifically, it should focus on the following:

- **Approval process.** This typically relates to the planning and final design stages to ensure buildings are designed in line with the regulatory documents. The approval stages and those responsible should be identified (see Activities **2.2.1** and **2.2.2**).
- **Certification.** This relates to the end of the construction stage, when occupancy certificates are typically awarded. The timing (at key construction stages) and nature of site inspections during construction should be identified, along with who is responsible for carrying them out (e.g., government, independent building inspectors, self-certification).
- **Regulatory documents.** The entities using the regulatory documents (in both the private and public sectors) should be identified.
- **Implementation process.** The key tasks at each stage of the school infrastructure implementation process should be outlined. Tasks include the following:
    - Planning (identifying the site, appraising the site, planning the site, obtaining planning permission)
    - Design (design of the school, communicating the design for construction, approvals)
    - Procurement
    - Construction (site supervision, quality assurance including quality of materials, certification, supply and quality of workmanship, procurement, approvals)
    - Operation and maintenance (ownership, assessment, works, protocols)
    - Repair and retrofitting
- **Enforcement.** This concerns the degree to which processes are followed and enforced as well as the challenges facing enforcement.

Local Partners & Technical Expertise

Partners and technical expertise are the same as those described for Activities **2.1.1** and **2.1.2**.

Output

A report should be produced that summarizes the strengths and weaknesses of the regulatory process.

2.2.1
Map key stakeholders

OBJECTIVE B D

Guidance

This activity involves identifying and mapping the stakeholders (public and private and end users/school communities) against the tasks outlined at each stage of the implementation process (as identified in Activity **2.1.4**). A stakeholder analysis should be undertaken to identify stakeholders' roles and responsibilities, including any overlap, gaps, or possibility for corruption or inefficiencies, and to understand stakeholders' relationship to one another, including how effectively they communicate and share information.

This activity should be related specifically to the education sector and may include a review of education policies.

Local Partners

Partners are the same as those described for Activities **2.1.1** and **2.1.2**, and also include donors/INGOs/NGOs and the public and private sector.

Technical Expertise

The same technical expertise is required as for Activities **2.1.1** and **2.1.2**.

Output

A map should be produced that shows the stakeholders involved in the implementation of school infrastructure projects and that identifies their roles and responsibilities.

2.2.2
Identify capacity and capability of key stakeholders

OBJECTIVE B D

Guidance

With all the relevant stakeholders having been identified in Activity **2.2.1**, this activity aims to establish their skills, expertise, and capacity. The goal is to determine any gaps or weaknesses in the school infrastructure implementation process and to target potential investment opportunities for physical interventions (such as retrofitting/reconstruction) and for technical assistance to improve the regulatory framework. For example, retrofitting and reconstruction options should duly consider the skills and capacity of the contractors implementing the construction.

This activity should consider the following:

- Educational and professional environment
- Construction capacity of contractors/ local labor
- Capability and capacity of government agencies/approval bodies to enforce regulations

Local Partners

Partners are the same as those described for Activities **2.1.1** and **2.1.2**, and also include donors/ INGOs/ NGOs and the public and private sector.

Technical Expertise

The same technical expertise is required as for Activities **2.1.1** and **2.1.2**.

Output

Summary notes should be produced that describe the capacity and capability of key stakeholders (those involved in all stages of the implementation process), specifically their strengths and weaknesses. The notes should also make recommendations about how resources can be strengthened.

2.2.3
Identify procurement and construction management processes

OBJECTIVE B D

Guidance

Procurement and construction management processes relate specifically to the approaches adopted to secure construction services. To understand how the construction environment functions, it is important to identify the typical methods of construction (contractor build or community build; see boxes 3 and 4) for school infrastructure, as well as the mechanisms for procurement and construction management, both of which have an impact on the implementation of safer school infrastructure.

How the building is procured—i.e., who is responsible for the design and construction of the school—will depend on the maturity of the construction industry, the available skills and capacity, and the complexity of the school design. For public buildings like schools, governments often have defined procurement procedures and standard tender processes that should be followed. However, these procedures may involve the risk of corruption, which will need to be investigated.

Effective construction management is critical to the delivery of buildings, and an understanding of construction management practices will make it easier to devise reconstruction, retrofitting, and repair strategies. Construction management requires skill in managing finances, programs, personnel, and supply chains, along with a sound understanding of quality and risk. When construction involves a combination of centralized and decentralized approaches, construction management can become complex. It will be important to identify whether schools are planned and implemented centrally or locally, and whether the approach has changed over time. It will also be important to explore the participation of both public and private sector agencies and organizations, and specifically to determine whether public-private partnerships have been established. These partnerships can be an effective way to finance new schools (as addressed in **Step 3**).

BOX 3 : CONTRACTOR BUILD

A contractor-build process places the responsibility for the quality of construction (and sometimes the design) with the contractor.

The safety of the school will depend on the design being undertaken by competent technical experts and verified—either in accordance with international or local building codes, or through an alternative method (e.g., prototypes, testing). Good-quality design documentation that clearly communicates what needs to be built will facilitate construction. Such documentation requires engineering plans, sections (1:20), construction details, and connection details (1:10 or 1:5), as well as clear specifications.

Provided the contractor is competent, employs suitably skilled subcontractors, site staff, and laborers, and exercises appropriate site management and supervision, the construction will most likely comply with the design intent. Competent contractors are expected to have suitable quality assurance procedures in place, such as material verification certificates and site supervision by a technical expert to monitor quality of materials and workmanship.

The disadvantage of the contractor-build method is that in some countries there is a risk of corruption, especially in public procurement, and there may be no functional control mechanisms in ministries or other levels of the government. Another disadvantage is that the community can feel excluded from the building process, particularly if the designs, labor, and materials are imported,[a] which in turn can influence how the community and other end users maintain the building or carry out repairs if damage occurs. For this reason it is desirable to involve communities in the early planning and construction stages.

a. Jo da Silva, "Lessons from Aceh: Key Considerations in Post-Disaster Reconstruction," Practical Action Publishing, 2010.

BOX 4 :COMMUNITY BUILD

Community build, or "self-build," uses community labor in construction projects. The advantage of community build is that it allows people to develop the construction skills that provide livelihood opportunities. It is also an effective way to generate ownership of the building within a community, which encourages maintenance.[a]

Communities typically have a good local knowledge of the hazards that affect them, and this can be enhanced by public databases and hazard maps. They also have a good local understanding of risk and so can easily define the performance requirements of the school and choose suitable sites. Moreover, they have a vested interest in ensuring that the level of risk is acceptable.

Site selection guidelines and site assessment tools can help facilitate the early decisions regarding location and physical planning of the school. Locally, craftsmen may be highly skilled in specific building practices. However, it is unlikely that the skills exist within a community to verify the designs of a safe school. For vernacular methodologies, it is unlikely that guidelines or codes exist. Thus if the intention is to use community labor to build schools, it is essential that appropriate measures are taken to ensure that the design of the school is sound. For example, communities could use model school designs that are appropriate for the hazards identified in the geographical areas they are building in.

Ensuring that construction information is conveyed clearly is key. Information could be conveyed in the form of a construction manual illustrated with 3-D imagery and pictures. Drawings and models will need to be read and understood by a non-technical, often unskilled, and possibly illiterate workforce. In addition to step-by-step guidance on how to build safe schools, detailed information on material quantities and quality should be given, such as concrete mix ratios, the risks associated with using sea sand in concrete, and methods for mixing concrete, making soil blocks, and undertaking simple verification tests (such as slump tests for concrete). Quality of construction and materials on self-build sites can be verified only if there is site supervision.

a. Michal Lyons, Theo Schilderman, and Camillo Boano, eds., "Building Back Better: Delivering People-Centred Housing Reconstruction at Scale," Practical Action Publishing, 2010.

Local Partners

Relevant partners are engineering and architecture associations, consultants, and ministries responsible for the implementation of school infrastructure.

Technical Expertise

The activity requires engineering expertise along with knowledge of procurement and contract management.

Output

A summary of construction capacity, gaps, and procurement issues should be produced.

2.3.1
Identify typical construction materials

OBJECTIVE C D

Guidance

The choice of construction materials can have a significant impact on the safety of school infrastructure. Local and cultural building practices and capacities, as well as and local markets, can support the construction and maintenance of safe school infrastructure. This activity focuses on understanding the availability and quality of the typical materials currently used in the construction of schools and more generally; the goal is to identify potential vulnerabilities in existing school infrastructure as well as appropriate construction materials to be used in a repair, retrofitting, and reconstruction program. The activity requires the following:

- The identification of materials available locally. Materials may vary between regions, districts, or islands, and should include traditional materials as well as modern materials.
- The identification of materials specifically used in school construction.
- An assessment of the quality of materials. This may include raw materials such as sand, water, and cement; site-mixed materials such as concrete; and prefabricated materials such as steel beams or trusses and precast concrete. The assessment should consider materials' resistance to degradation from wood-boring insects or climatic conditions. Construction materials should be consistent with the design specification and will require verification on delivery, appropriate storage, and testing.
- Material certification. It is necessary to understand whether construction materials (such as timber, concrete, and steel) require certificates for material quality or sustainability.
- Material codes of practice. It is necessary to understand whether the building code includes specifications for materials, and if so whether it deals with traditional materials such as earth blocks or bamboo.

When planning a retrofitting/reconstruction program, there may be an opportunity to invest in improved construction practices, new materials, or new technologies. However, these need to be balanced against cultural acceptability and—to ensure good-quality construction and the ability to repair and undertake future modifications—the requirement of skilled labor.

Local Partners

Relevant partners are engineering and architecture associations, consultants, and ministries responsible for the implementation of school infrastructure, as well as contractors, fabrication specialists, and manufacturing and material suppliers.

Technical Expertise

This activity requires the expertise of engineers with experience in construction and knowledge of construction materials.

Output

A summary should be produced that lists local/cultural construction practices and technology as well as innovation opportunities.

2.3.2
Identify school infrastructure designs

OBJECTIVE C D

Guidance

Investment opportunities should be aligned with current programs where possible. Standard specifications for schools, which can include building layouts, accommodation, and equipment, often exist, and these can provide a valuable starting point for developing the design brief or serve as the basis of model school designs. Where model school designs exist, these should be reviewed in order to identify vulnerabilities and determine whether they could be integrated into a reconstruction program or need to be improved. The objectives of this review are

- To understand whether the designs are appropriate, and if they differ across regions/districts depending on local cultural preferences
- To understand whether the structural typology is appropriate for the local hazards, uses good-quality and available materials, is buildable, and uses local construction practices and capabilities
- To understand whether the designs are engineered and meet local building regulations and/or international best practice
- To identify whether the construction documentation includes comprehensive drawings and specifications appropriate for whoever is building the school (governments sometimes provide only architectural drawings that don't provide enough information for construction)
- To understand whether the model school designs can be adapted to suit specific site requirements, for example, a variety of soil conditions or differences in site layouts

Local Partners

Relevant partners are engineering and architecture associations, consultants, and ministries responsible for the implementation of school infrastructure.

Technical Expertise

Structural engineers with specific expertise in the hazards identified in Activity 1.1.1 should be contracted to carry out the review.

Output

A summary should be produced listing the strengths and weaknesses of model school designs.

Step 3
Financial Environment

3

Purpose

To gain an understanding of the financial environment within which school infrastructure is planned, designed, constructed, operated, maintained, repaired, and retrofitted in order to determine the factors placing school infrastructure at risk.

Objectives

- **A** Identify historical and planned investment programs
- **B** Understand the financing framework for school infrastructure
- **C** Navigate the investment system and mechanisms related to school infrastructure investment programs

MODULE	ACTIVITY	OBJECTIVE
3.1 Historical Investment	**3.1.1** Identify previous investment programs in construction of new school infrastructure	A B
	3.1.2 Identify previous investment programs for existing school infrastructure, including those for repair/retrofitting and maintenance.	A B
3.2 Current and Planned Investment	**3.2.1** Identify current and future investment programs for new school infrastructure	A B
	3.2.2 Identify current and future investment programs (repair/retrofitting) for existing school infrastructure	A B
3.3 Financing Investment System	**3.3.1** Identify the funding mechanisms, investment requirements, and key decision makers	B C

Deliverables

The key deliverable will be a financial summary report that includes quantitative data on investment allocation.

3.1.1 Identify previous investment programs in construction of new school infrastructure

OBJECTIVE A B

Guidance

The historical financial framework for new school infrastructure should be understood in order to align potential investment opportunities and be aware previous financial constraints. This activity explores the historical sources of funding and budgets for school infrastructure construction programs. The following avenues of funding should be considered:

- Government. Identify any previous national building programs and determine if funding of new schools has been based on a national, regional, or even single-location approach.
- NGOs, INGOs, international donors. Identify who has been active in funding of new schools in the past, how big the programs were, and whether they were undertaken in collaboration with government (public) or private schools.
- Private sector or public-private partnerships. Many developing countries have seen a recent rise in private schooling due to the poor education provided in public schools. Where there is a strong private school presence, investigate how private schools have been funded. In addition, determine whether private funding has been used to deliver government (public) schools, and if so, how this was done.

It is important to clarify if third-party funding has historically made up a significant proportion of funding for school construction programs, since such funding can suggest the extent of government resources allocated to building of schools.

Local Partners

The government departments of education and finance at national and district levels should be consulted as key stakeholders. Any NGOs/INGOs and other international donors that have historically been involved in funding/implementing school infrastructure should also be consulted. Private donors and businesses involved in new school construction should be identified and consulted as well.

Technical Expertise

This activity should be carried out by persons with expertise in finance and specific experience and knowledge of the history of the construction industry in the country under consideration.

Output

A financial summary should be produced listing historical investments and funding mechanisms and including any factors that have influenced the characteristics and quality of school infrastructure.

3.1.2
Identify previous investment programs for existing school infrastructure, including those for repair/retrofitting and maintenance

OBJECTIVE A B

Guidance

The historical financial framework for existing school infrastructure should be understood in order to align potential investment opportunities and be aware of previous financial constraints. This activity explores the budgets and sources of funding for repair/retrofitting and maintenance of existing school infrastructure.

The following should be considered:

- Government. Identify any previous national repair/retrofitting programs and determine if they involved making schools safer or were undertaken just for maintenance. Understanding the government resource allocation for maintenance is critical, as maintenance will be required to ensure long-term durability of the existing school infrastructure.
- NGOs, INGOs, international donors. Identify who was active in the past in funding national or local repair/retrofitting programs for existing schools.
- Private sector or public private-partnerships. Determine whether other private funding contributed to school repairs and upgrades in the past.

It is important to clarify if third-party funding has assisted in maintenance of existing schools, since such funding can suggest the extent of government resources allocated to maintain schools.

The purpose of previous investment programs for existing school infrastructure should be clarified; possible purposes include retrofitting to reduce the vulnerability of school infrastructure as part of a disaster mitigation program, repair as part of a disaster response and recovery program, and repair for routine maintenance.

Local Partners

The government departments of education and finance at national and district levels should be consulted as key stakeholders. Any NGOs/INGOs and other international donors that have been involved in funding school repairs or retrofitting should also be consulted. Private donors and businesses involved in school repairs or retrofitting should be identified and consulted.

Technical Expertise

This activity should be carried out by persons with expertise in finance and specific experience and knowledge of the history of the school maintenance and upgrading strategies in the country under consideration.

Output

A summary should be produced of historical investments and funding mechanisms that contribute to maintaining or improving existing school infrastructure.

3.2.1
Identify current and future investment programs for new school infrastructure

OBJECTIVE (A) (B)

Guidance

The financial framework for new school infrastructure should be understood in order to align potential investment opportunities and recognize potential financial constraints. This activity explores the current and planned sources of funding for school infrastructure (re)construction programs. The following avenues of funding should be considered:

- Government. Identify current and planned national building programs, or regional/district or other government funding streams.
- NGOs, INGOs, international donors. Identify who is currently active in funding new schools, including the scale of the program and whether the program collaborates with government (public) or private schools.
- Private sector or public-private partnerships. Identify any planned private school funding programs and whether there are plans for collaborative private funding for government schools.

Local Partners

The government departments of education and finance at national and district levels should be consulted as key stakeholders. Any NGOs and other international donors that are now, or plan to be, involved in funding new school infrastructure should also be consulted. Private donors and businesses involved in new school construction should be identified and consulted as well.

Technical Expertise

This activity should be carried out by persons with expertise in finance and specific experience and knowledge of the construction industry in the country under consideration.

Output

A summary should be produced listing current and planned investments and funding mechanisms and including any factors that have influenced the characteristics and quality of school infrastructure.

3.2.2
Identify current and future investment programs (repair/retrofitting) for existing school infrastructure

OBJECTIVE (A) (B)

Guidance

The financial framework for existing school infrastructure should be understood in order to align potential investment opportunities and recognize potential financial constraints. This activity explores the current and planned sources of funding for repair and retrofitting of existing school infrastructure.

The following should be considered:

- Government. Identify any current or planned national repair/retrofitting programs and determine if they involved making schools safer or were undertaken just for maintenance. Understanding the government resource allocation for maintenance is critical, as maintenance will be required to ensure long-term durability of the existing and planned school infrastructure. The MoE's budget is usually among the largest public sector investments, and a significant part of that budget goes to investment in new infrastructure. For these reasons, the retrofitting, repair, and maintenance of school infrastructure usually face serious budgetary constraints.
- NGOs, INGOs, international donors. Identify who was active in the past in funding national or local repair/retrofitting programs for existing schools.
- Private sector or public-private partnerships. Determine whether other private funding contributed to school repairs and upgrades in the past.

It is important to clarify if third-party funding has assisted in maintenance of existing schools, since such funding can suggest the extent of government resources allocated to maintain schools.

The purpose of current or planned investment programs for existing school infrastructure should be clarified; possible purposes include retrofitting to reduce the vulnerability of school infrastructure as part of a disaster mitigation program, repair as part of a disaster response and recovery program, and repair for routine maintenance.

Local Partners

The government departments of education and finance at national and district levels should be consulted as key stakeholders. Any NGOs and other international donors who are involved in funding school repairs or retrofitting should also be consulted. Private donors and businesses involved in school repairs or retrofitting should be identified and consulted as well.

Technical Expertise

This activity should be carried out by persons with expertise in finance and specific experience and knowledge of school maintenance and upgrading strategies in the country under consideration.

Output

A summary should be produced listing current and planned investments and funding mechanisms that contribute toward maintaining or improving existing school infrastructure.

3.3.1 Identify the funding mechanisms, investment requirements, and key decision makers

OBJECTIVE B C

Guidance

The financing framework for school infrastructure largely determines what options are affordable under a safer school program. In order to access funding or meet approvals, any proposed investment opportunities should be aligned with existing funding mechanisms and specific requirements.

This activity identifies investment policies, funding schemes, and financing mechanisms as well as the requirements for mobilization for any proposed investments. It should also identify the key decision makers who facilitate the existing funding processes that enable school infrastructure implementation.

The analysis of the investment policies, funding schemes, and financing mechanisms should consider both the private and public sectors as well as donor funding, and it should also determine any differences between new construction (usually a significant part of the education budget) and repair and rehabilitation (often constrained). The size of budgets should be determined as well as how they are allocated and distributed (e.g., whether they depend on education service, region or district, urban or rural, etc.) Centrally funded infrastructure provides a single point of entry for potential investments to tap into, and may be more likely to influence change at national scale. Decentralized funding provides an opportunity to target high-risk areas and tailor investment opportunities for specific locations. It is useful to obtain disaggregated district-level expenditure data to provide a more detailed breakdown of the costs and budgetary distribution.

An understanding of the financial flows and key decision makers in the processes will help to define rehabilitation and replacement strategies more effectively.

Local Partners

This activity should start with discussions with government departments to identify the key decision makers and determine which department they reside in. This should also be corroborated through discussion with school management committees, INGOs, NGOs, and other private donors.

Technical Expertise

This activity should be carried out by persons with expertise in investment policy and finance mechanisms who have experience and knowledge of the finance system in the country under consideration.

Output

A summary report should be produced that outlines the investment policies, funding mechanisms, and requirements for school infrastructure implementation; lists key decision makers; and analyzes decision makers' strengths and weaknesses.

Step 4
Disaster Risk Analysis

4

Purpose

To provide TTLs with a step-by-step guide to quantifying the potential damage and losses to school infrastructure due to adverse natural events of various intensities and frequencies.

Objectives

- **A** Assess whether is it feasible to undertake the analysis with the available information and determine the approach to take
- **B** Build the components of a disaster risk assessment for school infrastructure
- **C** Quantify disaster risk of school infrastructure—from the spatial distribution of risk to risk metrics
- **D** Inform the prioritization of risk reduction intervention measures for school infrastructure

MODULE	ACTIVITY	OBJECTIVE
4.1 Risk Components Analysis	**4.1.1** Define risk assessment objective	A
	4.1.2 Undertake a hazard analysis	B
	4.1.3 Analyze the exposure of school infrastructure	B
	4.1.4 Analyze the vulnerability of school infrastructure	B
4.2 Risk Quantification	**4.2.1** Carry out disaster risk assessment for school infrastructure	C
4.3 Informing of Prioritization of Interventions	**4.3.1** Inform the prioritization processes for risk reduction in school infrastructure	D

A disaster risk assessment will allow the team to build a risk baseline, which will be used (1) to identify and prioritize investment needs to ensure school infrastructure safety, and (2) to monitor the progress of risk reduction programs. The disaster risk assessment methodology is outlined in Module **4.2**. This assessment could be based on a probabilistic approach for relevant hazards like earthquake and windstorm. For other hazards, the methodology should be based on the specific hazard conditions and the scope of the safe school project. The assessment will need to include an analysis of the hazards potentially affecting the region where the school is located (Activity **4.1.2**); an exposure model (Activity **4.1.3**); and an understanding of the school infrastructure's structural vulnerability to the identified hazards (Activity **4.1.4**). The output format from Module **4.1** should be aligned with the input required for the risk assessment methodology applied in Module **4.2**.

Deliverables

A report should be produced that summarizes the key results of the disaster risk assessment. In addition, a database should be created that includes relevant risk metrics in terms of potential losses for each school facility and a spatial analysis of the results. These products will include key elements to inform a proposal for prioritizing interventions.

4.1.1
Define risk assessment objective

OBJECTIVE (A)

Guidance

Under this activity the team should determine how the results of the risk assessment are expected to be used. This discussion should be based on the results of Activity **1.1.1**, the overview of the school infrastructure condition (**Step 1**), and the MoE's main objectives for rehabilitation and improvement of school infrastructure. This decision about how to use risk assessment results will have implications for the level of input detail (resolution), format, and quality of the relevant information. Data resolution, format, and quality should be determined prior to developing Activities **4.1.2**, **4.1.3**, and **4.1.4** to ensure consistency in the results (see figure 8). The assessment criteria should be agreed upon with the stakeholders and typically might include avoiding or reducing loss of life, reducing physical damages in the infrastructure, and reducing financial losses in the portfolio.

Output

A database should be created that includes information on existing hazards and school infrastructure exposure and vulnerability in the studied area. This database should be analyzed to assess the quality of the information included in it.

4.1.2
Undertake a hazard analysis

OBJECTIVE B

Guidance

This activity aims to quantify the intensity and probability of occurrence of selected hazards as an input for a disaster risk assessment (Module 4.2). Using the existing hazard information collected in Activity **1.1.1**, hazards should be qualitatively prioritized in order to determine which hazards are the most relevant in the selected area. A more detailed analysis could be then undertaken for the selected hazards as an input for the risk assessment. This analysis will include determining the intensity and frequency for each hazard that could potentially affect the school infrastructure. The spatial distribution of the intensity of each hazard for a given probability of occurrence (return period) could be used to inform new school infrastructure construction.

Hazard data sets and maps may already exist, in which case they should be assessed for quality and completeness. Any new information available should be assessed and integrated into the hazard analysis to improve the model. The following sources of information may be useful:

- Existing hazard event catalogues that include physical characteristics of the events, which could be used to define critical events for a scenario risk assessment
- Historical events intensity maps
- Hazard maps
- Soil and geological information; topographical and hydrological information at the local and regional levels
- Global hazard information

The metric used to represent the hazard intensity should be consistent with the approach used to define the vulnerability information, and the resolution should be consistent with the resolution of the exposure (see Activity **4.1.3**).

Local Partners

Relevant partners will have local knowledge and expertise in hazard assessment; they may be found in technical agencies in the country, specifically in seismic monitoring networks, geological surveys, and university engineering departments and research centers.

Technical Expertise

This activity should be carried out by highly skilled technical consultants with expertise in the analysis of the specific natural hazards being considered, with input from local technical agencies.

Output

The following should be produced under this activity:

a. A technical summary note of the existing hazard information, including the approaches or methodologies used to generate this information (including quality assurance and quality control procedures followed)

b. Probabilistic hazard information produced for the studied area

c. Hazard maps for given return periods

d. Historical scenarios for hazard events in the studied area

4.1.3
Analyze the exposure of school infrastructure

OBJECTIVE B

Guidance

This activity aims to build an exposure model for the school infrastructure based on the information collected in **Step 1**, including the location and key characteristics of the school infrastructure (e.g., construction material and year, replacement or construction value).

School buildings need to be categorized by structural typology based on the material of the construction. If the replacement value of the infrastructure is not known, each typology will need to be assigned a unit value of construction so that an estimated economical value of the infrastructure can be calculated.

An exposure data set will therefore be created, including an inventory of assets at risk, each one with an assigned replacement value. This information should be aligned with the hazard metrics (Activity **4.2.1**) and vulnerability metrics used throughout the risk assessment; please refer to Activity **4.2.2** for further explanation. A detailed cost analysis will be carried out for the actual retrofitting and reconstruction options, as further elaborated in Activity **5.1.2**.

Local Partners

MoEs and/or MoPWs may be able to determine structural typologies used for school infrastructure and associated construction costs.

Technical Expertise

Construction typologies should be defined by professionally qualified structural engineers with specialized knowledge of hazard-resistant construction. Construction costs should be ascertained in consultation with appropriate construction industry experts.

Output

The following should be produced:

- **a.** A database of the structural typologies identified, including their main characteristics
- **b.** An exposure model for school infrastructure that includes at a minimum the school ID, the facility's structural typology, the occupation, and the replacement value

4.1.4
Analyze the vulnerability of school infrastructure

OBJECTIVE B

Guidance

This activity aims to identify the susceptibility of school infrastructure to selected hazards, in order assign the vulnerability function[1] to each proposed structural typology. A vulnerability analysis helps to quantify the severity of the damage caused by a particular hazard to a given infrastructure. Vulnerability analysis takes into account building configuration—e.g., construction systems, building components, and building condition (including year of construction and level of maintenance).

The following factors may for example contribute to the seismic vulnerability of a specific typology: irregular building floors, irregularity in elevation, heavy roofs, large openings, soft or weak stories, short columns, large wall panels, and weak foundations. Vulnerability functions are derived from fragility functions, which are developed for the different structural typologies identified and agreed upon with local experts.

There are two main approaches to developing vulnerability functions:

a. Empirical. Where sufficient loss or damage data exist, empirical vulnerability functions can be developed on the basis of past observations of loss or damage due to a particular hazard experienced by buildings of a particular typology. Conversely, if there are very limited building loss or damage data from previous hazards in the selected area, expert knowledge of overseas damage data can be used to adjust existing global fragility functions to local conditions.

b. Analytical. Analytical vulnerability functions may be calculated using structural engineering technical analysis, which stems from industry standard capacity curves and subsequent fragility functions produced for assessed infrastructure.

1 Vulnerability functions provide a direct assessment of the different levels of damage to the infrastructure associated with different hazards and hazard intensities, namely the damage ratio.

Local Partners

Local architects, civil engineering professional bodies, or local civil engineering consultants should undertake vulnerability assessments and categorization of school buildings.

Collaboration with local, regional, and international research institutions may also provide access to the latest available information, or provide an opportunity to work together to develop vulnerability functions and adapt them to the local context.

Technical Expertise

This activity should be carried out by a professionally experienced structural engineering team or individual with specific expertise in structural analysis and knowledge of local construction building codes and methods.

Output

Vulnerability functions should be generated for each structural typology defined. Vulnerability functions proposed should be consistent with other components of the disaster risk assessment.

4.2.1
Carry out disaster risk assessment for school infrastructure

OBJECTIVE C

Guidance

The purpose of a disaster risk assessment is to quantify the potential damages and losses of school infrastructure (physical/structural risk). The output from the assessment can inform investment prioritization and options for risk reduction.

The basic steps involved in the risk assessment process are as follows:

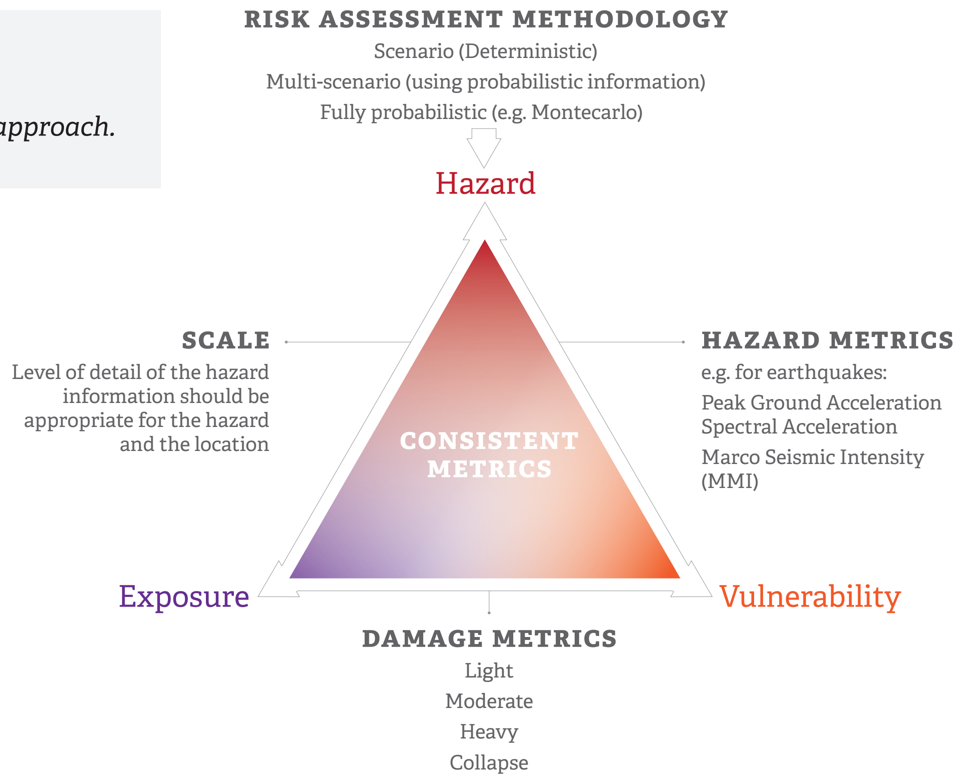
a. Hazard analysis (see Activity **4.1.2**)
b. Exposure model (see Activity **4.1.3**)
c. Definition of structural vulnerability per typology (see Activity **4.1.4**)
d. Risk quantification

The following risk assessment methodologies or approaches are recommended among others:

- **Probabilistic risk assessment.** Using the input data of the hazard analysis, this analysis is based on all possible hazard scenarios that the infrastructure being evaluated could face. It can provide a particularly useful detailed assessment for earthquake and windstorm risk. With this approach it is possible to estimate the expected cost in terms of different metrics attached to the occurrence of hazard events. Probabilistic risk assessments have results in terms of annual average losses (AALs), probable maximum losses (PMLs), and other financial metrics. These assessments are based on probabilistic hazard information, available exposure information, and probabilistic vulnerability functions.
- **Deterministic (scenario) assessment.** In certain cases, it could be useful to employ a simplified methodology using a single hazard scenario to determine the potential losses that could result from a particular hazard. Scenario-based risk assessment results make it possible to offer stakeholders comparisons to historical events. Single scenario assessments should be based on given hazard scenario information, available exposure information, and vulnerability information (that could be probabilistic to facilitate a range for the results).

FIGURE 8

Disaster risk assessment approach.



Local Partners

The MoE is the key stakeholder and should agree to the assessment criteria and objectives.

Technical Expertise

This activity should be carried out by hazard risk modeling specialists.

Output

Depending on the risk assessment methodology, the expected output will vary. Loss exceedance curves[2], PML[3] curves, and AAL[4] curves should be produced as part of a probabilistic assessment. Other outputs may include

- Potential structural damage or casualties
- GIS-compatible spatial data sets comprising hazard maps and different loss metrics

A summary report should be prepared containing the results and findings of the risk assessment and including the outputs above as appropriate.

---

2 A loss exceedance curve shows the annual frequency of exceedance for a determined value of losses.

3 PML (probable maximum loss) is the maximum loss amount for a given return period for a given hazard.

4 AAL (average annual loss) is the sum for all scenarios of the product of the expected loss and the annual frequency of occurrence of every scenario.

4.3.1
Inform the prioritization processes for risk reduction in school infrastructure

OBJECTIVE D

Guidance

The results of the risk assessment provide a quantitative estimation of risk for the entire portfolio, as well as by structural typology and spatial distribution. Risk assessment reveals the main vulnerability or hazard factors. Based on this understanding, the following steps could be taken:

- Rank the physical risk for the school facilities in order to identify those at highest risk, and calculate distribution of risk across the portfolio
- Disaggregate the portfolio by subgroups of school facilities that share similar risk conditions and characteristics
- Disaggregate the portfolio by structural typology
- Disaggregate the portfolio by spatial criteria (urban, rural) and risk condition
- Define potential risk reduction alternatives to maximize life safety, potential damage reduction, and post-disaster operational continuity

The design of a risk reduction strategy is based on the information generated from these steps. At this point the team may seek to consult with the MoE in order to discuss the results and begin identifying potential intervention alternatives in keeping with the political, financial, technical, and cultural context of the country (this is the objective of **Step 5**).

It is important to note that further analysis (e.g., cost-benefit analysis) might be required of the risk assessment results in order to design the risk reduction strategy. Thus new variables (e.g., financial) are introduced into the decision making process through complementary analytic work.

Local Partners

The prioritization criteria should be agreed upon with stakeholders such as the MoE, MoPW, and department of disaster management.

Technical Expertise

This activity requires a consultant with expertise in risk assessment and structural engineering (with appropriate knowledge of the relevant hazard).

Output

A summary of the prioritization criteria should be produced, along with comparison tables of critical scenarios for the intervention options (such as reconstruction, retrofitting, and repair).

Step 5
Safer School Investment Opportunities

5

Purpose

To recommend investment scenarios to the MoE that integrate safety into both existing and new school infrastructure.

Objectives

- **A** Identify, define, and prioritize lines of intervention to increase the safety of existing school infrastructure and improve the planning and building regulatory framework
- **B** Identify, define, and prioritize opportunities for investment in integrating safety in school infrastructure
- **C** Approach government on investment opportunities

MODULE	ACTIVITY	OBJECTIVE
5.1 **Existing School Infrastructure**	5.1.1 Enable structural rehabilitation/retrofitting	A B C
	5.1.2 Enable functional rehabilitation	A B C
	5.1.3 Design intervention strategy and investment scenarios	A B C
	5.1.4 Undertake cost-benefit analysis	A B C
5.2 **Implementation Process**	5.2.1 Consider planning and design gaps and opportunities	A B C
	5.2.2 Consider regulatory framework improvements	A B C
	5.2.3 Consider implementation process adjustments	A B C

Deliverables

A proposal for an intervention plan should be produced that includes a roadmap prioritizing possible investment scenarios. These will form the foundation for the government's specific action plan and its efforts to seek technical and financial support from international banks, donors, NGOs, and the private sector.

5.1.1 Enable structural rehabilitation/retrofitting

OBJECTIVES A B C

Guidance

This activity aims to consolidate the requirements and alternatives for the structural rehabilitation/retrofitting of the school infrastructure portfolio based on the results of the risk assessment, in particular Activity **4.3.1**. It involves the following:

- Defining the need for, and priorities of, a field campaign to undertake detailed structural inspections, by different structural typologies
- Defining the need for complementary analytic work (e.g., structural engineering analysis) to inform the intervention plan
- Reviewing previous experience in the country on school retrofitting
- Proposing criteria for the selection of retrofitting versus replacement
- Quantifying and recommending retrofitting alternatives for different structural typologies
- Estimating a preliminary investment plan for structural rehabilitation

Retrofitting is an expensive and disruptive measure whose feasibility should be carefully evaluated. Toward this end, different building performance levels can be defined and graduate accordingly the retrofitting strategy. The concept of setting performance objectives for school infrastructure is referred to in various guidance materials; see also Activity **2.1.2**. The highest standard, “continuous occupancy,” is expensive to achieve and is usually reserved for hospitals, emergency service centers, and similar critical infrastructure. It may be appropriate for schools where they are expected to function as postdisaster shelters or for continuous education. The more typical performance objective level for new schools is “immediate occupancy,” which considers some damage acceptable, as long as the infrastructure investment is largely protected. For a low-cost minimum retrofit, “life safety” is often considered to be the acceptable performance standard and can often achieve code compliance.

The difficult economic decision lies in setting acceptable cost criteria to decide whether to replace unsafe schools with new schools, or to minimally retrofit them. When undertaking the cost comparison of these options, it is important to note that the level of damage (and therefore the residual cost) of repairing or replacing new or retrofitted investments varies based in part on the performance criteria.

Local Partners

The performance criteria should be agreed upon with the government, as it will form the basis of the retrofitting and redesign options prioritized under the cost-benefit analysis.

The identification and analysis of retrofitting solutions should be made with the participation of local senior structural engineers to ensure the solutions are appropriate, viable, and cost-effective. Local academic institutions may also have relevant expertise.

The performance criteria and retrofitting options should be coordinated with the MoE, MoPW, and Ministry of Finance.

Technical Expertise

The retrofitting options should be developed by an engineering consultant with expertise in structural engineering and specific experience in the hazards that pose a significant risk to school infrastructure (as identified in Activity **4.1.1**).

Output

A report should be produced to serve as the basis for a school retrofitting program.

5.1.2
Enable functional rehabilitation

OBJECTIVES A B C

Guidance

This activity aims to identify the needs for improving the architectural, service, and environmental conditions of the existing school infrastructure. There are two main reasons to integrate this dimension into the Safe School program: first, safety is only one of a number of attributes that school infrastructure should possess, and second, public investment projects usually integrate both structural and functional rehabilitation works.

Functional characteristics are related to campus layout, buildings' architectural characteristics, accessibility, energy supply, communication connection, and water and sanitation. The following steps may be followed to define the functional rehabilitation needs for a specific portfolio:

- Define functional indicators to establish the current condition of existing infrastructure (based on results of Module 1.2)
- Establish the gap in functional rehabilitation by analyzing the current condition of existing school infrastructure and the planning and building regulation (Activities **2.1.1** and **2.1.2**)
- Discuss and define priorities with the infrastructure office regarding functional needs to be covered in the short, medium, and long term
- Identify potential intervention alternatives for urban and rural areas and define criteria to integrate structural and functional rehabilitation or replacement of buildings
- Estimate a preliminary investment plan

Local Partners

The functional indicators should be identified, reviewed, and agreed upon with the Ministry of Education, in particular those within the MoE working on functional aspects of infrastructure.

The gap in the functional rehabilitation should be analyzed by a multisectoral team. Local consultants and firms with expertise can contribute to the analysis to ensure it is appropriate, viable, and cost-effective.

Technical Expertise

The activity should be carried out by a multidisciplinary team with expertise in areas such as engineering, architecture, water and sanitation, education, and data analysis.

Output

A report should be produced to serve as the basis for a school functional rehabilitation program.

5.1.3
Design intervention strategy and investment scenarios

OBJECTIVES (A) (B) (C)

Guidance

Whether both the structural and functional rehabilitation needs (Activities **5.1.1** and **5.1.2**, respectively) have been identified or only the former, the next step is to define a prioritized and affordable intervention strategy in keeping with the construction and financial environment (**Steps 2** and **3**), government priorities (**Step 1**), and local territorial characteristics (urban or rural). The design of an intervention strategy might follow these steps:

- Define the scope of the intervention strategy in terms of levels of government (national or subnational), geographic interest, and time line.
- Discuss the objectives and prioritization criteria that will drive the design of the strategy. These should come from the prior activities.
- Define the budgeting approach by reviewing previous interventions (if available) and local condition of the targeted area.
- Define the approach for comparing the retrofitting and reconstruction options, such as cost-benefit analysis (CBA), cost-effective analysis, and multi-criteria analysis.
- Define a set of intervention scenarios by combining options of retrofitting, reconstruction, and functional rehabilitation to achieve the proposed objectives in the short, medium, and long term.
- Conduct comparative analysis for intervention scenarios and consolidate a proposal for the intervention strategy
- Discuss the proposed strategy with the government. This step envisions a back-and-forth process with the MoE to look at preliminary results, adjust the scenarios, and gradually devise a strategy aligned with government's perspective.
- Consolidate the proposed intervention strategy in a formal document to be presented to and discussed with other stakeholders.

Local Partners

The scope of the intervention strategies should be defined, discussed, and agreed upon with the MoE. Government agencies and local universities and consultants may also be able to provide information on past retrofitting, reconstruction, and functional rehabilitation programs and costs.

Technical Expertise

This activity should be carried out by a team with expertise in engineering, economics, and data analysis.

Output

A report should be produced outlining a risk reduction and rehabilitation strategy for a targeted school infrastructure stock.

5.1.4
Undertake cost-benefit analysis

OBJECTIVES A B C

Guidance

The retrofitting and reconstruction options identified in Activity **5.1.3** can be compared through a cost-benefit analysis; this approach makes it possible determine which investment opportunities will offer the maximum benefit and to prioritize them accordingly.

CBAs have two primary purposes: to make a compelling argument for investment in the strategic replacement of school infrastructure, and to facilitate decision making about how to differentiate between retrofitting and replacing school facilities.

Comparing the costs and benefits of hard solutions (such as retrofitting or new build) is more straightforward than evaluating costs and benefits of soft solution investments (such as changing the regulatory framework). Therefore this CBA activity is focused on the hard solutions, with the soft solutions considered separately in Activities **5.2.2** and **5.2.3**.

Cost-benefit analysis can be approached as follows:

a. **Scope and context.** Set out the objectives and qualitative criteria; define the parameters, including the key indicators; and set a discount rate (particularly for long-term benefits).
b. **Feasibility and option analysis.** Screen the options identified in Activity **5.1.3** against the qualitative criteria to establish a short list of ranked suitable alternatives and select preferred options based on their net present values in financial and economic terms. Using the revised vulnerability curves, the risk analysis can be repeated to measure the potential benefit of introducing the risk reduction measures.
c. **Financial analysis.** Assess the costs of the physical intervention with the direct benefits such as the saving from avoided or reduced damages. In addition to comparing the investment options with one another, the analysis may also compare them with a "do nothing" baseline scenario.
d. **Sensitivity analysis.** Identify the most critical variables, and highlight the uncertainties and assumptions that should be communicated to the key decision makers.
e. **Conclusion.** Determine how many building typologies or locations to strengthen or rebuild.

Alternative approaches may be taken, such as the following:

- Cost-effective analysis. This type of analysis is useful where costs are easy to predict and benefits are difficult to evaluate. It involves a comparison of alternative options; for a given output level, it seeks the minimum net present value of costs, and for a given cost, it seeks the maximum output level.
- Multicriteria analysis. This type of analysis balances the needs of multiple stakeholders to consider the costs and benefits that do not ordinarily have an economic value, such as biodiversity, well-being, or community spirit.

Local Partners

The cost of the retrofitting/rebuilding options should be estimated based on advice from local surveyors and available local and international data on market costs. Government agencies and local consultants may also be able to provide information from current building/retrofitting programs.

Technical Expertise

This activity should be carried out by a team with expertise in finance, economics, quantity surveying, and disaster risk reduction.

Output

A technical report should be produced that documents the sample retrofits developed, the analytical models used to define upgraded vulnerability curves, and the results of the CBAs. In addition, a summary should be produced that includes recommendations for and prioritization of retrofitting options.

5.2.1 Consider planning and design gaps and opportunities

OBJECTIVES A B C

Guidance

Using the information and analysis in **Steps 1**, **2,** and **3**, it is possible to look for opportunities to improve the planning and design of school infrastructure in order to promote safer schools.

The following should be evaluated for identifying opportunities:

- **Model school designs.** If these exist already, they should be reviewed to determine how they could be improved to better resist the identified hazards. Previous case studies have shown that typical upgrades made to achieve a life-safety performance level for earthquakes involve less than a 10 percent increase in the cost of construction.
- **Value engineering.** Existing designs should be assessed to see if they can be value engineered to be more cost effective. This step will help to increase the impact of a capped investment.
- **Communication.** Improvements should be made in the way design information is communicated to local builders; specifically, more engaging and understandable drawings and specifications should be used.
- **Technical guidelines.** Guidelines for building (including extension and modification), retrofitting, and site selection and planning typically seek to ensure that safe building practices are incorporated into non-engineered buildings. There is an opportunity to develop (or update existing) guidance documents to illustrate how to apply the requirements of the code to small (community-built) schools. Schools in the examples must be typical of the local context in terms of structural typology and hazards.

Local Partners

The model school designs and value-engineering solutions should be discussed with the MoE. Local design consultants and construction contractors can help to ensure that designs are appropriate, viable, and cost-effective. Local academic institutions may also have relevant expertise here and in the assessment of demographic information to identify spatial investment priorities.

The performance criteria and design options should be coordinated with the MoE and MoPW. The spatial planning should be coordinated with the government department responsible for geohazard information.

Technical Expertise

The model designs, value-engineering solutions, and technical guidelines should be developed by a design consultant with expertise in structural engineering and site planning and with specific experience in the hazards that pose a significant risk to school infrastructure (as identified in Activity **4.1.1**).

The spatial analysis should be conducted by a planning specialist.

Output

A summary should be produced listing recommendations, options, and priorities for a government action plan. It should include updating of model school designs and of technical guidelines.

5.2.2
Consider regulatory framework improvements

OBJECTIVES A B C

Guidance

Using the information and analysis in **Steps 1**, **2**, and **3**, it is possible to look for opportunities to improve the regulatory framework of school infrastructure in order to promote safer schools.

The following provide potential lines of action:

- **Updates to regulatory documents**, such as
  - Hazard and risk maps (with the resolution required by education infrastructure). Updates would ensure that maps include appropriate hazards at a useful level of detail to inform land use plans, site selection, and site planning.
  - Land use plans. Updates would ensure that plans consider known hazards and appropriate distribution of schools to suit the spatial population/demographic.
  - Planning guidelines. Updates would ensure that guidelines are consistent with other regulatory documents, are current (so that schools are appropriately situated and planned), and provide guidance on appropriate mitigation measures to reduce the exposure of schools.
  - Building codes. Updates would ensure that codes are consistent with other regulatory documents and include current understanding and best practice, appropriate structural typologies, and hazards that affect school infrastructure. Stricter structural design requirements constitute a relatively small portion of the overall construction cost of new buildings and are a cost-effective investment against future hazards. Building codes should also include guidance for retrofitting and repair of existing buildings.
- **Institutional adjustments**, such as
  - Design checking and approval process. Adjustments would ensure that there is a standard, streamlined design process with checking and approval stages throughout the design phase (prior to construction).
  - Enforcement of regulatory documents. An effective enforcement system could be established by training and licensing professional engineers to act as reviewers and undertake site inspections, exert tighter control over engineering and construction quality, and define consequences for noncompliance.

Consideration should be given to whether private schools are subject to the same regulatory processes. How private schools are regulated may have a significant impact on the nation's school safety, particularly if private schools constitute a substantial portion of the nation's schools.

Local Partners

Proposed adjustments to the regulatory documents and process, including design checking and approval procedures, should be made in collaboration with the appropriate regulatory body and the MoPW. Institutional adjustment recommendations should be informed by relevant stakeholder consultation.

Technical Expertise

Structural engineers, planners, and hazard specialists should review existing regulatory documents and identify opportunities for improvement. Institutional adjustments should be proposed by persons with specific expertise in the construction regulatory and institutional environment.

Output

A summary should be produced listing recommendations and prioritizations for adjustments and improvements to the regulatory and institutional processes.

5.2.3 Consider implementation process adjustments

OBJECTIVES A B C

Guidance

Using the information and analysis in **Steps 1**, **2**, and **3**, it is possible to look for opportunities to improve the implementation of school infrastructure in order to promote safer schools.

The following provide potential investment opportunities:

- **Build capacity of the construction industry.**
  - Provide training and/or improve education (or training for trainers) on safe school construction to develop and strengthen the competencies of the construction industry.
  - Incorporate education on known hazards into university education.
  - Introduce requirements for professional qualifications for engineers and architects designing, reviewing, and checking school infrastructure.
  - Introduce certification schemes to confirm skills and experience of contractors.
- **Improve quality assurance.**
  - Propose continuous on-site inspections by an independent third party rather than periodic inspections to maintain a consistent quality performance level.
  - Introduce quality assurance methodology and tools in the delivery of school infrastructure to clarify roles and responsibilities, and introduce checklists and audits for checking and certifying the quality of materials and workmanship on site and in the supply chain.
- **Seek clarity, accountability, and clear lines of communication in school implementation processes.**
  - Define roles and responsibilities for national and local government and other institutional stakeholders.
- **Improve construction management practices.**
  - Streamline procurement and management processes.
  - Define roles and responsibilities, and clearly delineate responsibility at each step of the process.

Local Partners

Proposed adjustments to the financial implementation process should be made in collaboration with the MoE, MoPW, and Ministry of Finance.

Recommendations for improvements to the physical implementation processes (such as construction management and quality assurance) should be made in collaboration with local contractors, suppliers, and the MoPW.

Technical Expertise

Financial implementation adjustments should be recommended by consultants with expertise in economics, finance, and the construction industry. Infrastructure implementation adjustments should be made by consultants with expertise in the construction industry, contracting, quantity surveying, and supply chains.

Output

A summary should be produced listing recommendations and prioritizations for adjustments and improvements to the financial and infrastructure implementation processes.

Glossary

building regulation
Local and national legislation related to the design of the school infrastructure (e.g., structural design of buildings).

deterministic analysis
Approach to assessing risk that considers an individual event with a certain probability of occurrence.

earthquake resistant
Quality of structures designed and built in accordance with seismic codes and guidance at a minimum.

mitigation
The action of reducing the risk.

nonstructural elements
Elements that do not contribute to the stability of the building, such as finishes, windows, ceilings, and building equipment.

performance objective
Used to define the maximum risk level that can be tolerated in terms of damage and disruption. The performance objective for a hospital or school may be higher than for individual houses.

planning regulation
Local and national legislation related to the physical planning of school infrastructure (e.g., site selection, arrangement of buildings on the site, interfaces with services, size and layout of buildings)

probabilistic analysis
Approach to assessing risk that considers all possible and relevant events.

reconstruction
The action or process of rebuilding a building or part of a building that has been damaged or destroyed.

rehabilitation
The action or process of returning a building to its former condition.

relocation
The action or process of rebuilding a building in a different location after it was damaged or destroyed, or because a high level of risk exists in the original location.

repair
The action or process of restoring a damaged building to a good condition.

risk
The combination of the probability of an event and its negative consequences.

risk analysis
The process that seeks to comprehend the nature of risk and to determine the extent of risk.

risk assessment
A methodology to determine the nature and extent of risk by analyzing potential hazards and evaluating existing conditions of vulnerability that together could potentially harm exposed people, property, services, livelihoods, and the environment on which they depend.

RVA (rapid visual assessment)
A methodology to quickly inspect and evaluate buildings. It can be used in postdisaster contexts in damaged areas with minimum manpower to judge whether a building can be reoccupied.

school campus or facility
The site of the school where all school buildings are located. Typical characteristics of the campus to be evaluated are the location, number of buildings, and building layouts.

seismic retrofit
The addition of new technology or features to an existing building aimed at improving its earthquake resistance. This approach may fall short of code standards in order to allow pragmatic incremental enhancement.

structural system
Set of building elements that contribute to both the vertical and horizontal stability of the building.

structural typology
Engineering categorization of a building based on the principal vertical and lateral stability system from which it has been built. The structural systems of a building are those that resist gravity, earthquake, wind, and other types of loads. These are called structural components and include columns (posts, pillars); beams (girders, joists); floor or roof sheathing, slabs; load-bearing walls (i.e., walls designed to support the building weight and/or provide lateral resistance); and foundations (mat, spread footings, piles).

About GFDRR:

The Global Facility for Disaster Reduction and Recovery (GFDRR) is a global partnership that helps developing countries better understand and reduce their vulnerabilities to natural hazards and adapt to climate change. Working with over 400 local, national, regional, and international partners, GFDRR provides grant financing, technical assistance, training and knowledge sharing activities to mainstream disaster and climate risk management in policies and strategies. Managed by the World Bank, GFDRR is supported by 34 countries and 9 international organizations

THE WORLD BANK IBRD • IDA
GFDRR Global Facility for Disaster Reduction and Recovery
ARUP