**Building Technical Capacity to Design Risk-Informed Public Infrastructure Investments at Scale**

**Technical Guidance for Terms of Reference**

Disclaimer: The following technical guidance for terms of references (ToR) have been shortened to reflect essential points (scope of work, deliverables, timeframe and qualification requirements) to be included in the terms of reference. In the technical guidance below the focus lays on two different countries (referred to as first and second country). However, this template can be adapted to include as many (or few) countries and regions as required. Every organization can then adapt the technical guidance to their standard ToR template.

# Objectives

The overall objective of this work is to provide technical support in the development of risk information and design of risk-reduction strategies for public facilities in [insert country and/or region]. Along with this objective, this work intends to strengthen the technical capacity of key stakeholders in the region on related technical aspects. The selected Consultant will cooperate with local institutions and consultants mobilized by the task team in the various activities proposed in these ToRs.

Specifically, this work aims to:

* Enhance the analytical baseline in the region to inform the design of risk-informed investments at scale in the public sector;
* Develop and deliver a learning by doing training program to strengthen the technical capacity of local stakeholders on seismic risk analysis and design of risk reduction strategies; and
* Provide on-demand technical support to the task team in country technical assistance projects worldwide.

# Scope OF WORK

The activities are organized in the following five components.

|  |  |
| --- | --- |
| Component | Aim |
| 1. Infrastructure baseline | Review and generate basic information about existing infrastructure. This information will serve as the baseline from which the seismic performance and the extent of risk can be determined, along with potential interventions to improve safety. |
| 2. Performance-based seismic assessment | Compute seismic performance of representative buildings (known as index buildings) and derive fragility and vulnerability curves for the selected index buildings. |
| 3. Risk reduction strategies | Conduct probabilistic risk assessment and define lines of intervention and corresponding value (benefit/cost) to inform risk reduction investment scenarios. |
| 4. Learning by doing capacity building | Strengthen the technical capacity of local stakeholders on seismic risk analysis and design of risk reduction strategies. |

## Component 1: Infrastructure baseline

* 1. Desktop study/literature review
* Review existing datasets and other information on physical characteristics of existing infrastructure;
* Review design documents and reports of existing infrastructure whenever available;
* Review local building codes and norms; and
* Others, as necessary to conduct the following activities.
  1. Public infrastructure baseline in the first selected country
* Develop inspection plan to collect information about typical building types of public facilities. Selected facilities to collect representative data about construction and structural characteristics of different building types. This activity includes the preparation of survey forms in line with Global Library of School Infrastructure (GLOSI) taxonomy, plan for compiling data, and coordination with data collection efforts conducted through local stakeholders in the country to ensure consistent data collection;
* Quality assurance and analysis of data compiled by the survey teams; and
* Organize a database with the data collected in the selected facilities. These data will be used in activities 2.1 and 3.1.
  1. School infrastructure baseline in the second selected country
* Identify statistically representative sample of public schools throughout the country for field inspection by local survey teams;
* Develop inspection plan for selected sample, including preparation of survey forms in line with GLOSI taxonomy, plan for compiling data, and coordination with data collection efforts conducted through local stakeholders in the country to ensure consistent data collection;
* Quality assurance and analysis of data compiled by the survey teams; and
* Based on existing data and results from the field inspection of the representative school sample, prepare a database with information about all public facilities in the country. These data will be used in activities 2.2 and 3.2.

## Component 2: Performance-based seismic assessment

* 1. Assessment of representative building types in the first country
* Create structural models of representative facilities of all building types identified to determine seismic performance;
* Perform a seismic assessment of the representative building types using the most suitable choice of software in relation to the building type and data available. This will take the form of performance points obtained by intersection of capacity curves and demand spectra in the Sd/Sa space;
* Verify whether representative building types comply with current local building codes and norms;
* Using standard approaches available in literature and the results of previous analysis to compute fragility functions for each representative building; and
* Use the fragility functions and an agreed expected event scenario to determine the vulnerability functions for each representative building type.
  1. Assessment of representative building types in the second country
* Determine the three most common building types of school infrastructure in the country based on existing work and results of field inspections. Exclude building types that have been analyzed in past projects. The GLOSI taxonomy and respective parameters must be used as reference in the structural classification and description of school infrastructure;
* Propose a set of consistent criteria to select and define up to ten index buildings;
* For each index building, create a quality range as proposed in existing guidelines[[1]](#footnote-1);
* Create structural models of each index building to determine seismic performance;
* Perform a seismic assessment of the index buildings using the most suitable choice of software in relation to the building type and data available. This will take the form of performance points obtained by intersection of capacity curves and demand spectra in the Sd/Sa space;
* Repeat analysis for different values of the parameters to reflect typical variability ranges, and quality of construction;
* Use standard approaches available in literature and the results of previous analysis to compute fragility functions for each index building. The GLOSI fragility and vulnerability approach must be used as reference in this activity;
* Use the fragility functions and an agreed expected event scenario to determine the vulnerability functions for each index building; and
  1. Organize a library of identified building types and index buildings to be integrated into the GLOSI.

## Component 3: Risk reduction strategies

* 1. Risk reduction strategies for representative building types in the first country
* Develop conceptual retrofits and corresponding cost estimates for each representative building type. Rank incremental improvements based on value (improved capacity/cost);
* Assess the change in performance (enhanced safety) with incremental improvements and express as change in fragility;
* Derive fragility and vulnerability functions for the representative building types with retrofits. The GLOSI fragility and vulnerability approach must be used as reference in this activity; and
* Develop preliminary recommendations on intervention options to improve safety and quality of the representative building types and estimate costs.
  1. Risk reduction strategies for representative building types in the second country
* Develop conceptual retrofits and corresponding cost estimates for each selected index building. Rank incremental improvements based on value (improved capacity/cost);
* Assess the change in performance (enhanced safety) with incremental improvements and express as change in fragility;
* Derive fragility and vulnerability functions for the selected index buildings with retrofits. The GLOSI fragility and vulnerability approach must be used as reference in this activity;
* Conduct an education-sector specific national probabilistic seismic risk assessment:
  + - Review existing seismic hazard probabilistic models;
    - Adjust hazard models if necessary and generate information in adequate format for the risk assessment;
    - Process database generated in activity 1.3 to generate the exposure model for the risk assessment;
    - Estimate replacement and repair costs and time for the different building types;
    - Conduct probabilistic risk assessment using the hazard model, exposure model, and vulnerability functions derived in previous activities;
    - Compute annual average losses (AAL), expected maximum economic losses (PML) for selected earthquake scenarios, expected fatalities and downtime. Display results aggregated per school facility, building type, oblast/city and rayon.
* Calculate the indexes listed below for each and all schools in the country to establish a ranking of schools which will inform the prioritization of risk reduction interventions (existing analytical framework establish in past project in the second country must be used as a reference):
  + - Safety benefits index: this index evaluates the benefits of the interventions in terms of improvement on seismic performance. The aim of this index is to target schools with all or most school buildings having high vulnerability, which may collapse or sustain severe damage when subjected to an earthquake.
    - Cost/efficiency index: this index evaluates the efficiency of the investment by quantifying the number of students that benefit from the interventions as compared to the total investment needs in the school facility. The aim of this index is to target schools with the largest number of students benefitted per unit of investment.
    - Social equity index: this index evaluates poverty levels in the country. The aim of this indicator is to target schools serving the underprivileged.
* Develop recommendations on intervention strategy to improve safety of school infrastructure countrywide based on results of previous activities; and
* Estimate cost of recommended intervention options.

## Component 4: Learning by doing capacity building

This training program is expected to be designed following the principles of “learning by doing” which is also called “experiential learning”. It should be delivered in a studio-like creative workshop with hands-on sessions. The target audience of this program are local stakeholders in Central Asia. The training program is expected to be designed and delivered by modules over the course of this consultancy. Training materials are expected to be informed by available literature and the results of previous activities. After each training module is delivered in a specific country, the task team will mobilize local stakeholders to execute tasks in cooperation with the Consultant which will contribute to current task team engagements in the selected region.

* 1. Design training program with the following minimum content (includes training materials and training process):
* Module 1: Infrastructure baseline
  + - Survey forms
    - Survey process
    - Quality assurance
    - Creating an inventory of existing infrastructure
* Module 2: Performance-based seismic assessment
  + - Structural classification
    - Defining index buildings
    - Numerical modelling
    - Performance-based seismic assessment
    - Deriving fragility and vulnerability functions
* Module 3: Seismic retrofitting
  + - Seismic retrofitting solutions
    - Designing retrofitting solutions
    - Assessing the value of retrofitting (improved capacity/cost)
* Module 4: Design of risk reduction strategies to improve safety and quality of existing infrastructure at scale
  + - Use of probabilistic risk assessments to inform the design of risk reduction strategies at scale
    - Defining lines of intervention and prioritization criteria to implement risk reduction solutions at scale
    - Preparing intervention strategies and estimating costs
  1. Deliver training program (modules 1 to 4) in the first country
  2. Deliver training program (modules 1 to 4) in the second country

## Deliverables

Successful completion of this project includes the preparation and submission of the following deliverables:

* Component 1
  + - Inception report with detailed work plan
    - Inspection plan (Republic of First country, Second country)
    - Inspection report, including statistics derived from data compiled by local survey teams (Republic of First country, Second country)
    - Exposure databases (Republic of First country, Second country)
* Component 2
  + - Library of building types and index buildings in both countries
    - Reports with results of the performance-based assessment in both countries
    - Reports with results of the fragility/vulnerability assessment in both countries
    - Original files with analytical results of both countries (numerical models, calculation worksheets, among others)
* Component 3
  + - Reports with results of the fragility/vulnerability assessment of index buildings with retrofits of both countries
    - Report with summary of the probabilistic risk assessment (second country)
    - Reports with recommendations on intervention options and costs in both countries
* Component 4
  + - Training materials and program
    - In-country training sessions in both countries

# Timeframe

The task team will need the services of the Consultant within a period of 15 months (see Annex 1). The consultant to be contracted will provide their services in order to carry out the activities described under these Terms of Reference as required by the task team.

# Minimum qualifications

## General

The Firm should be able to demonstrate:

* At least 20 years of experience in civil/structural engineering;
* Demonstrated expertise on disaster risk management with emphasis on the education and health sectors;
* Demonstrated experience in designing and delivering training programs in seismic risk assessment, seismic retrofitting, and performance-based engineering; and
* Demonstrated experience in managing projects worldwide, including the region of the engagement.

## Specific qualifications

Team Leader

* Master’s and/or Doctorate degree in Civil/Structural Engineering from a leading international university;
* Minimum of 20 years of professional experience in engineering; and
* Experience with international organizations, governments, corporations, and academia

Project Manager

* Master’s degree in Civil Engineering and/or another relevant field;
* Minimum 10 years of experience in engineering, including international experience;
* Proven ability to work with international organizations, national governments, and NGOs; and
* Experience in managing construction projects in the education and health sectors.

**Annex 1**

**Timeline for delivery of activities**

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
|  | 2018 | | | 2019 | | | | | | | | | | | |
|  | Oct | Nov | Dec | Jan | Feb | Mar | Apr | May | Jun | July | Aug | Sep | Oct | Nov | Dec |
| Component 1-3 | Kick-off  1.1 Desktop study |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
|  | 1.2 Public infrastructure baseline in 1st country | | | | |  |  |  |  |  |  |  |  |  |
|  |  |  | 1.3 School infrastructure baseline in 2nd Country | | | |  |  |  |  |  |  |  |  |
|  |  |  |  |  |  | 2.1 Assessment of representative building types in 1st country | | | |  |  |  |  |  |
|  |  |  |  |  |  |  | 2.2 Assessment of representative building types in KR | | | |  |  |  |  |
|  |  |  |  |  |  |  |  |  | 3.1 Risk reduction strategies for representative building types in 1st country | | |  |  |  |
|  |  |  |  |  |  |  |  |  |  | 3.2 Risk reduction strategies for representative building types in KR | | | | |
|  | | | | | | | | | | | | | | | |
| Component 4  Learning by Doing |  |  |  |  | Module 1: 1st country |  |  |  | Module 2:  1st country |  |  | Module 3:  1st country |  |  | Module 3:  2nd Country |
|  |  |  |  | Module 1: 2nd Country |  |  |  | Module 2:  2nd Country |  |  | Module 4:  1st country |  |  | Module 4:  2nd Country |
|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |

1. https://www.globalquakemodel.org/single-post/2017/05/17/Guidelines-for-Analytical-Vulnerability-Assessment---LowMid-Rise [↑](#footnote-ref-1)