INCEPTION REPORT

URP/RAJUK/S-04

Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka

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Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka

(URP/RAJUK/S-04)

Final Inception Report

30 March 2018

Prepared by:

Prepared for:

Abdul Latif Helaly

Rajdhani Unnayan Kartripakkha

Contents

Document Version

Document	*Final Inception Report*
Ref	*Contract No. URP/RAJUK/S-04; Credit No.: 55990*
Date	*11 April 2019*
Prepared by	***NKY-PROTEK-SHELTECH JV***

Subject: **Submission of Inception Report for the "Contract No. URP/RAJUK/S-4; Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka".**

Revision History

Revision #	Revision Date	Details	Authorized Person
0	30 December 2018	1nd Draft Submission	NKY PROTEK SHELTECH JV
1	24 January 2019	2nd Submission inserting comments	NKY PROTEK SHELTECH JV
2	11 April 2019	Final submission Validated and Approved by PIU	NKY PROTEK SHELTECH JV

April 11, 2019

Abdul Latif Helaly
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Dear Mr. Abdul Latif Helaly:

Reference to signed contract between Project Director, Urban Resiliency Project, RAJUK and Joint Venture of NKY-PROTEK YAPI-SHELTECH herein we are submitting our Final Inception Report which is validated and approved by PIU and Stakeholders during the Inception Validation workshop in Dhaka on 27 February 2019. We have received your approval letter on 27th of March 2019 within which you had requested to incorporate comments and suggestions as required in the final version of the inception report and re-submit for your records. Kindly be informed that we have revised and incorporated the comments provided and enclosed the minutes of the meeting as an annex to this report for your reference. The inception report states the principles of the assignments to be carried out under the scope of the project along with the updated Work Plan and way forward activities.

We appreciate your acceptance of this report.

Very truly yours,
****
On Behalf of NKY-PROTEK-SHELTECH JV
Yilmaz YUVA,
Team Leader/S4
****

Executive Summary

Bangladesh is one of the world's most vulnerable countries to climate and earthquake hazards and faces significant risks of infrastructure failure. The Capital Development Authority (RAJUK), with the support of the World Bank, is responding to these pressures with several resilience initiatives, including the development of an Urban Resilience Unit (URU) to manage seismic preparedness and resilience for the Dhaka Metropolitan Area.

This inception report outlines the project structure and methodology of the World Bank financed "RAJUK/URP/S-04: "Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" project. As demonstrated by recent earthquakes and other disasters, the majority of the critical facilities in Bangladesh are inadequately prepared for diverse hazards. As one of its main priorities, multi-hazard performance evaluation and feasibility studies for selected critical facilities in Bangladesh to reach long-term investment plans for improving resilience of critical infrastructure.

Funded by the World Bank, the Project for Improving the resilience includes extensive surveys and analyses with due consideration for structural, non-structural, architectural, mechanical and electrical equipment. The project also includes several capacity development activities and consultations to elaborate diverse guidelines employing innovative methodologies and technologies. These will then serve as the basis for sustained investments in retrofitting and rehabilitation of essential assets, as well as institutional reforms to improve the resilience of health sector.

The proposed project will initiate a set of procedures that aims at transforming the vulnerable and prone to hazards Dhaka in the next 5 to 20 years into a resilient concept to major earthquakes and other natural disasters. The overall goal of the proposed project is take first step to save lives and reduce the social, economic and financial impacts in the event of future earthquakes. The specific objective of the project is to establish the foundations toward disaster preparedness and enhancement of response capacity, post-disaster recovery and disaster risk reduction associated with natural hazards in facilities.

The activities to be carried out will be based on the methodology provided herein with this inception report with due consideration for existing studies conducted at national and international level, as well as the modules and methodologies carried out for Hazards Vulnerability and Risk Assessment (HVRA) studies for critical structures under the scope of the Project. To achieve project expected achievements, the tasks, outputs and envisioned deliverables are broken into several stages outlined herein.

On WEDNESDAY, 27 FEBRUARY 2019, a validation meeting was held. The purpose of this meeting was to present inception report and methodologies for RVA and PEA to be endorsed by POC, PWG and related stakeholders. The workshop was successfully implemented with the participation of more than 60 participants from relevant directories and stakeholders. The outcome of the validation meeting is briefly as following:

1- The inception report has been approved with comments from PIU. These comments have been adopted in this version of the report

2- The Methodologies for RVA including checklist (see revised checklists based on the comments) and PEA has been approved based on the comments. The comments have been incorporated in this

report.

The inception report composes of 5 main chapters of which Chapter 1 refers to context, introduction, outline of the activities and project execution. In chapter 2 we have extensively discussed the project background, past studies and facts and figures related to Project. Chapter 3 refers to inception phase activities such as kick-off meetings, stakeholders' workshops, needs assessment, engagement activities, logistics and project development initiation studies including mobilization. In chapter 4 we will be discussing the technical approach & methodology while in the last chapter the amended work plan which can show more detail process during the project along with expectations from the Client such as the data required to be provided, financial issues etc.

CHAPTER 1

Context

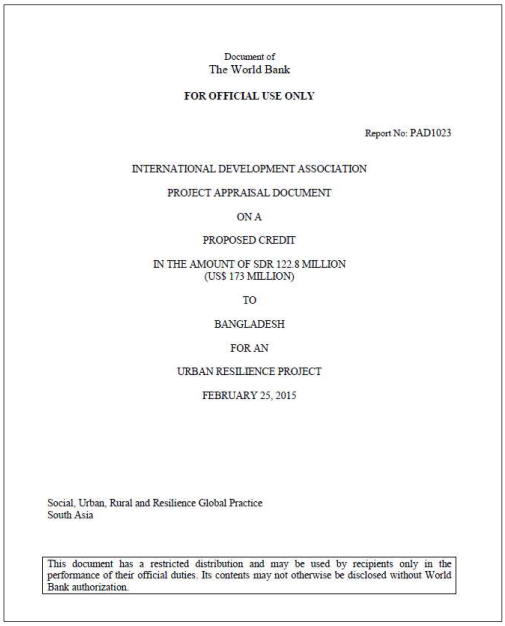
1.1 Introduction

Over the past decades, urbanization in Bangladesh has been rapidly taking place without proper guidance. As a result, many of the urban centers have developed haphazardly. These urban centers are fast growing and influence the economic developments of the country. It is therefore essential to have a realistic understanding on the nature, severity and consequences of likely damage/loss that a possible event of earthquake could cause. A strong earthquake affecting a major urban center like Dhaka, Chittagong, or Sylhet may result in damage and destructions of massive proportions and may have disastrous consequences for the entire nation.

A low to moderate level of earthquake may cause severe damages to the life and property that may go beyond the existing capacity of Dhaka City south and North Corporations. Considering likely earthquake threat in Bangladesh, the Comprehensive Disaster Management Programmer (CDMP) under the Ministry of Food and Disaster Management of the Government of Bangladesh (GOB), took initiative to develop likely scenarios of earthquake for Dhaka, Chittagong and Sylhet. This report presents the likely building collapse, debris generation, fire hazards and casualties during different level of earthquakes in these three cities and current preparations/ capacity of Dhaka City Corporation to cope with the situation.

1.1.1 Background and Objective

The Government of Bangladesh (GOB) requested a support program on earthquake risk mitigation. The Global Facility for Disaster Reduction and Recovery (GFDRR) of the World Bank has provided funds to undertake Technical Assistance projects entitled "Bangladesh Urban Earthquake Resilience Project (BUERP): Phase1(2012-2014) and Phase 2 (2014-2015)". BUERP Phase 1 has already accomplished its primary goals and objectives and its final deliverables are: a) Dhaka Profile and Earthquake Risk Atlas; b) Risk Sensitive Land-use Planning (RSLUP) Guidebook; c) Dhaka Earthquake Risk Guide Book; d) Legal and Institutional Arrangements (LIA) Framework Guide Book; e) Roadmap for Disaster Data Sharing Platform; f) Information, Education and Communication Action Plan; and g) Training and Capacity Building Action Plan.



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INTERNATIONAL DEVELOPMENT ASSOCIATION

PROJECT APPRAISAL DOCUMENT

ON A

PROPOSED CREDIT

IN THE AMOUNT OF SDR 122.8 MILLION
(US$ 173 MILLION)

TO

BANGLADESH

FOR AN

URBAN RESILIENCE PROJECT

FEBRUARY 25, 2015

Social, Urban, Rural and Resilience Global Practice
South Asia

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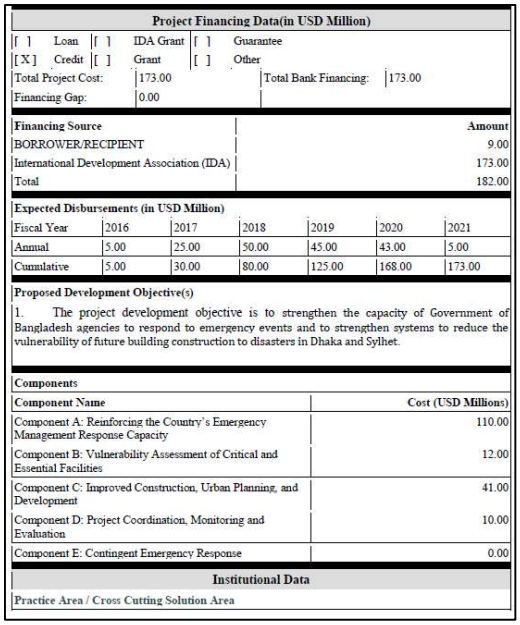


Project Financing Data(in USD Million)

[ ] Loan [ ] IDA Grant [ ] Guarantee
[X] Credit [ ] Grant [ ] Other
Total Project Cost: 173.00 Total Bank Financing: 173.00
Financing Gap: 0.00

Financing Source	Amount
BORROWER/RECIPIENT	9.00
International Development Association (IDA)	173.00
Total	182.00

Expected Disbursements (in USD Million)

Fiscal Year	2016	2017	2018	2019	2020	2021
Annual	5.00	25.00	50.00	45.00	43.00	5.00
Cumulative	5.00	30.00	80.00	125.00	168.00	173.00

Proposed Development Objective(s)

1. The project development objective is to strengthen the capacity of Government of Bangladesh agencies to respond to emergency events and to strengthen systems to reduce the vulnerability of future building construction to disasters in Dhaka and Sylhet.

Components

Component Name	Cost (USD Millions)
Component A: Reinforcing the Country's Emergency Management Response Capacity	110.00
Component B: Vulnerability Assessment of Critical and Essential Facilities	12.00
Component C: Improved Construction, Urban Planning, and Development	41.00
Component D: Project Coordination, Monitoring and Evaluation	10.00
Component E: Contingent Emergency Response	0.00

Institutional Data

Practice Area / Cross Cutting Solution Area

Figure :1-1

The People's Republic of Bangladesh has received a credit from the International Development Association (The World Bank) in the amount of US$173.00 million equivalent towards the cost of the Urban Resilience Project (URP) and it intends to apply part of the proceeds of this credit towards payment under the contracts of *Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for critical assets in Dhaka* that represents the second phase of a multi-phase national DRM program to build institutional capacity to mitigate the impact of earthquakes in the rapidly urbanizing cities of Bangladesh.

The Urban Resilience Project (URP) was approved by ECNEC on 25 June 2015 to strengthen the capacity of GoB agencies [Dhaka North City Corporation (DNCC), Dhaka South City Corporation (DSCC), Sylhet City Corporation (SCC), Department of Disaster Management (DDM), Rajdhani Unnayan Kartiphakka (RAJUK), Fire Service Civil Defense (FSCD) and Planning Commission (PCMU)] to respond to emergency events and to strengthen systems to reduce the vulnerability of future building construction to disasters in Dhaka and Sylhet city.

The project was designed to implement the following four main components (A to D) with number of sub-components under each main component. The 3 (three) Components (A, B & C) of the Project are being implemented by (3) three Implementing Agencies (IAs) namely DNCC (for DNCC itself, DSCC and SCC within MoLGRDC and FSCD within MoHA); RAJUK within MoHPW and DDM within MoDMR. Component D is being implemented by the Project Coordination and Monitoring Unit (PCMU) of the Programming Division of Planning Commission, Ministry of Planning. PCMU is mainly responsible for overall coordination, monitoring and evaluation of the project. This annex focuses on Components B and C of the project being implemented by RAJUK. The activities under the component B refers to:

Component B: Vulnerability Assessment of Critical and Essential Facilities

The objective of this component is to develop the consensus-driven analytical foundation required for longer-term investments to reduce risk in the built environment of Dhaka, Sylhet and other cities in Bangladesh. The component has 2 main activities:

- Component B1: Conduct a vulnerability assessment of critical and essential facilities and lifelines;
- Component B2: Support for development of a risk-sensitive land use planning practice in Dhaka;

In April 2017 the Joint Venture (JV) formed by NKY-PROTEK YAPI-SHELTECH was invited to submit a proposal for the Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka by the Project Implementation Unit (PIU) of Rajdhani Unnayan Kartripakkha (RAJUK) of Bangladesh. In October 2018 the JV was awarded with the contract for S4 Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka and signed the contract on 28th of October 2018.

1.1.2 Scope of Work and Inventory

The project has been designed to be carried out in 3 stages in duration of 36 months. The sequence of each activity has been well defined in ToR. The technical approach proposed by this consortium combines state-of-the-art methodologies with advanced tools and a strong participatory procedure, thus ensuring that all the objectives of the assignment are accomplished, while improving significantly the capacity of the experts and stakeholders in Dhaka to assess and mitigate their disaster risk. The activities envisioned within this project have been organized in three main stages, as recommended

by the terms of reference:

Stage 1 - Data Preparation and collection: The first stage of this project comprises the collection and evaluation of existing studies, datasets and models covering either Greater Dhaka, or regions with similar characteristics. This stage also covers the organization of relevant stakeholders to form the Project Working Group (PWG) and a Project Oversight Committee (POC), who will contribute and supervise the various activities within this project.

Stage 2 - Survey for vulnerability and risk assessment: This stage involves the development of a detailed methodology for the survey of critical public structures and a framework to prioritize retrofitting and rehabilitation investments. This methodology will be reviewed and validated by the PWG and POC. Feedback on the framework and methodology will also be solicited from subject matter experts and scientists through a series of workshops and consultation meetings. Following the review and validation, a group of assessors will be organized and trained in the methodology and techniques to conduct the surveys of the structures identified in Stage 1. Three levels of vulnerability assessment will be conducted in this stage, beginning with a rapid visual assessment of approximately 3,000 structures, followed by preliminary assessment using basic engineering analysis for around 600 structures, and a detailed vulnerability assessment for around 200 structures. This stage also involves a survey and vulnerability assessment for critical facilities including gas and water pipelines, road and railway networks, flyovers and bridges, and Dhaka International Airport; these results will be validated by the PWG and POC. A methodology recommending technical guidelines and evaluation criteria for conducting feasibility studies for the seismic retrofitting of vulnerable public assets will be developed in this stage, and will be validated by the PWG and POC. In addition, a geographical database and a catalogue of historical/ instrumental events will be created in Stage 2 of the project, which will be used to analyze the spatial characteristics of natural and social conditions of the Greater Dhaka area. The results from these analyses will be cross-checked for accuracy and convergence, and presented in the form of maps and other exhibits for communication of the risk to a general audience. The risk model and its outputs will be subjected to an internal peer review by a selected group of experts (from Applied Technology Council, EQE and Mott MacDonald London), and the results will also be validated with the PWG, POC and other stakeholders. The information collected in this stage will be used to update the GIS databases and the Dhaka City Risk Profile and Atlas.

Stage 3 - Design of long term vulnerability reduction investment for Dhaka: This stage involves the development of retrofit and rehabilitation methods that aim to a long-term urban resilience in Dhaka. The work in Stage 3 will start with the formation of a retrofit and vulnerability reduction prioritization list, according to the prioritization criteria set in Stage 2 with focus on a benefit-cost analysis. This will consider investment and direct budget allocation as well as social impact and disruption of people's everyday life. A risk reduction appetite will be proposed with consideration to resources, capabilities, databases, knowledge, experience, institutional availability and local experts. The team will also explore the possibilities of a conceptual upgrade of the existing risk maps and emergency preparedness plans. This will be followed by the development of a draft for the upgrade of the Dhaka Urban Resilience Strategy which will include a set of important initiatives tailored to Dhaka's characteristics. The implementation of the strategy will then be outlined with respect to technical guidelines and investment plans that will consider timelines, resources and budget allocation. Local urban characteristics, including administrative issues and regulatory mechanisms will be adequately taken into consideration. The team will propose the preparation of toolkits and materials for planned events and campaigns that will aim to the development of the public awareness. Throughout the work, all outcomes and reports will be consulted with RAJUK, PWG, POC, TITAS, OWASA and other relevant

agencies, stakeholders and local partners. All aspects and solutions will be explained and discussed for validation purposes. Technical presentations and joint workshops will be organized and conducted when needed.

The concept of our work will be that all our material, outcome, conclusions and recommendations should be easily communicated with multiple audiences that could be involved in the implementation of risk-reduction scenarios. The reports will include, but not limited to, approved and indicative lists of critical structures and/or facilities for retrofit and rehabilitation, a report on risk reduction and rehabilitation, contingency planning and long-term objectives, Dhaka Urban Resilience strategies with well-defined objectives and goals, reports for meetings/ discussions and others.

1.1.3 Project Execution

The main component of the project that is related to assessment and mitigation of the critical infrastructure in stage-II is regarded as a three-phased approach, consisting of:

Phase 1 – Initial investigation and screening,

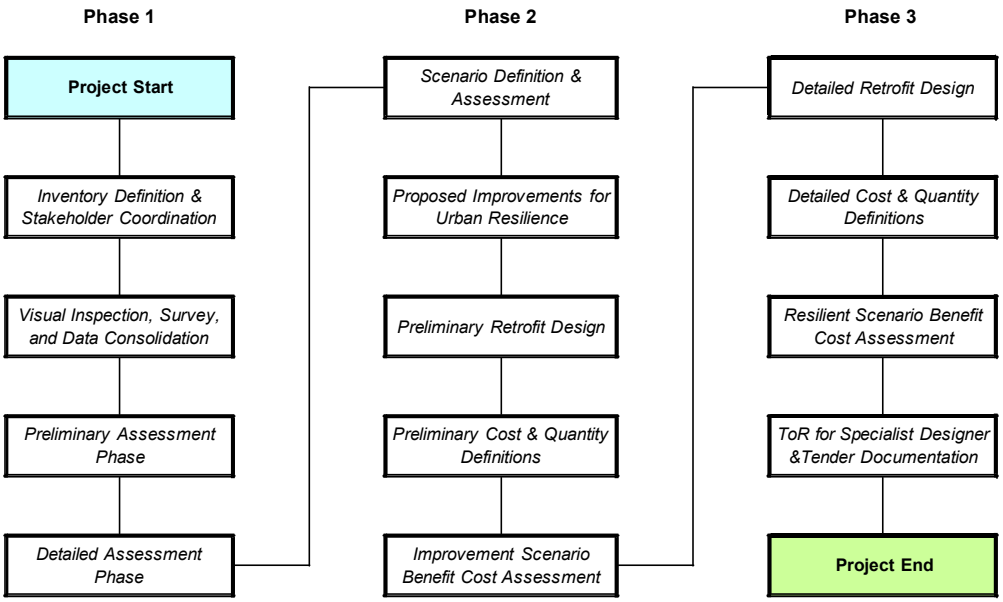
Phase 2 – Detailed investigation and conceptual retrofit design and costing of alternatives,

Phase 3 – Final design and production of design documents and a "bid package".

Although figures providing herein outlines a linearized process, the multi-hazard study on infrastructure, lifelines and buildings will have many parallel processes. Such processes will be required for 3-District Hazard assessment and/or large sub inventory groups like the Airport and/or distribution networks. A more detailed project program & flow will be prepared as the first priority after the establishment of a clear inventory list, access/permit conditions, and enabling efforts of involved stakeholders.

As described in the scope definition section the current project will involve several different scales of assessment, retrofit, costing, and recommendation for the infrastructure, lifelines and buildings;

- Building assessment and retrofit scope will be the most detailed per individual structure, where analyses, designs, costing and decisions will have to be made per structure/block.
    - Studies will be taken up to the level of detailed retrofit design if it can be shown feasible for a particular structure of the inventory. All associated cost of retrofit structural & non- structural construction and time will be reflected onto feasibility studies after the detailed assessment, and costed & updated at all phases with improving accuracy,
    - If a structure can be cleared as safe and conforming to the performance needs; non-structural improvements, maintenance and added benefits can be costed based on benchmark cost and time allocations derived from expert judgment and such structures can be kept in the inventory as they are.
    - If a structure can be shown extensively deficient not amenable to retrofit or any improvement for temporary use in the transition to resilience, such structures will be marked for demolition and/or replacement and included in the feasibility studies based on benchmark cost and time allocations derived from expert judgment.
- Infrastructure & Lifelines will be assessed through preliminary analyses and kept within feasibility context by expert opinion cost & time estimates. No detailed design or plans will be put forward for such systems. However, retrofit and improvement proposals will be made based on judgement and past local/global data derived from similar systems and equipment.



1.2 Situation Analysis and Outline State

1.2.1 Nature of Threats

Geographically Bangladesh is located close to the boundary of two active plates: The Indian plate in the west and the Eurasian plate in the east and north. In the past there where several earthquakes that caused severe damages to life and properties. Some of the major earthquakes around the region includes the 1548 earthquake, the 1664 earthquake, the 1762 earthquake, the 1869 Cachen earthquake (Ms 7.5), the 1885 Bengal earthquake (Ms 7.0), the 1897 Great Assam earthquake (Ms 8.1), and the 1918 Srimangal earthquake (Ms 7.6) (Earthquake in website “Banglapedia”; Oldham, 1883; Ambraseys, 2004; Bilham and Hough, 2006 etc). However, recently Bangladesh did not experience with any large earthquake since 20th century for about 100 years. The 1918 earthquake is thought not to be a characteristic one, since the magnitude is small for the plate boundary fault. This may mean that Bangladesh has a high risk of large earthquake occurrence in near future. Several major active faults, e.g. the plate boundary fault (the northern extension of subduction fault) and the Dauki Fault, are inferred in Bangladesh. These faults must generate large earthquakes over M 8. However, the nature, detailed location, and the faulting history on these faults are not well known yet (Morino, 2009).

- Potential Damage in different Scenarios of Earthquake
    - Three different scenarios have been developed to identify the possible damage to infrastructures, buildings, transportation and number of casualties. The scenarios are least, moderate and worst case as assumed based on different magnitude of earthquake. Following are the scenarios of elements at risk in Dhaka city.

- Buildings Damage

During an earthquake at 7.5 Mw originated from Madhupur fault, about 166,570 buildings will be moderately damaged. This is about 51.00 % of the total number of buildings in the city. It is estimated that about 75,218 buildings that will be damaged beyond repair. If the magnitude of the earthquake is 8.0 Mw, about 93,605 buildings will be at least moderately damaged which is about 29.00 % of the total number of buildings. During an earthquake originated from under the city at 6.0 Mw will moderately damage about 136,434 buildings and about 53,989 buildings will be damaged beyond repair.

- Collateral Hazards

There might be several hazards due to earthquake which may affect structures as well as may cause damage to human life and increase economic losses. These collateral hazards include fire, debris generations etc. Following are the possible fire hazards and debris generation that may appear due to earthquake in Dhaka.

- Fire Following Earthquake

Fires often occur after an earthquake. Because of the number of fires and the lack of water to fight the fires, they can often burn out of control. For this scenario development, possible estimation has been made using Monte Carlo simulation model to get the number of ignitions and the amount of burnt area. During an earthquake of 7.5 Mw originated from Madhupur Fault, there will be 920 ignitions that will burn about 4.12 sq. mi 9.04 % of the city area. It is estimated that the fires will displace about 701,134 people and burn about 1,577 (millions of dollars) of building value. Similarly, an earthquake originated from Plate boundary fault-2 will be responsible for 918 ignitions that will burn about 4.08 sq. mi 8.95 % of the city area. It is also estimated that the fires will displace about 726,606 people and burn about 1,665 millions of dollars) of building value. The earthquake if originated from under the city of Mw will be responsible for 920 ignitions that will burn about 4.22 sq. mi 9.26 % of the city and the fires will displace about 730,857 people and burn about 1,563 (millions of dollars) of building value.

- Debris Generation

Estimated the amounts of debris that will be generated by the earthquake are categorized into two general categories:

  - Brick/Wood
  - Reinforced Concrete/Steel.

This distinction is made because of the different types of material handling equipment required to handle the debris. During an earthquake of 7.5 Mw originated from Madhpur Fault a total of 30,599.00 million tons of debris will be generated. Out of this, Brick/Wood comprises 22.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 1,223,960,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake. Similarly, an earthquake originated from Plate boundary fault-2 will generate a total of 19,147.00 million tons of debris of which Brick/Wood comprises 19.00% of the total, with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 765,880,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake. The earthquake if originated from under the city of 6.0 Mw, will be responsible for generation of a total of 21,059.00 million tons. Out of this, Brick/Wood comprises 23.00% of the total,

with the remainder being Reinforced Concrete/Steel. If the debris tonnage is converted to an estimated number of truckloads, it will require 842,360,000 truckloads (@25 tons/truck) to remove the debris generated by the earthquake.

Bangladesh lies on the seismically active Indian plate. Studies by the Geological Survey of Bangladesh divide the country into three seismic zones, which show that earthquake risk increases towards the north and east of the country, but now that area is immune from the threat. The capital city Dhaka lies within the second seismic zone. Although there is some uncertainty, research suggests that an earthquake of up to magnitude 7.5 is possible. The nearest fault line runs just 60 km from the city Earthquakes and tremors happen regularly.

- Bangladesh is seismically active
- Dhaka is ranked among the 20 cities most vulnerable to earthquakes across the world
- No major earthquakes recently, but 3 events in the past year
- Major fault is less than 60 km from Dhaka

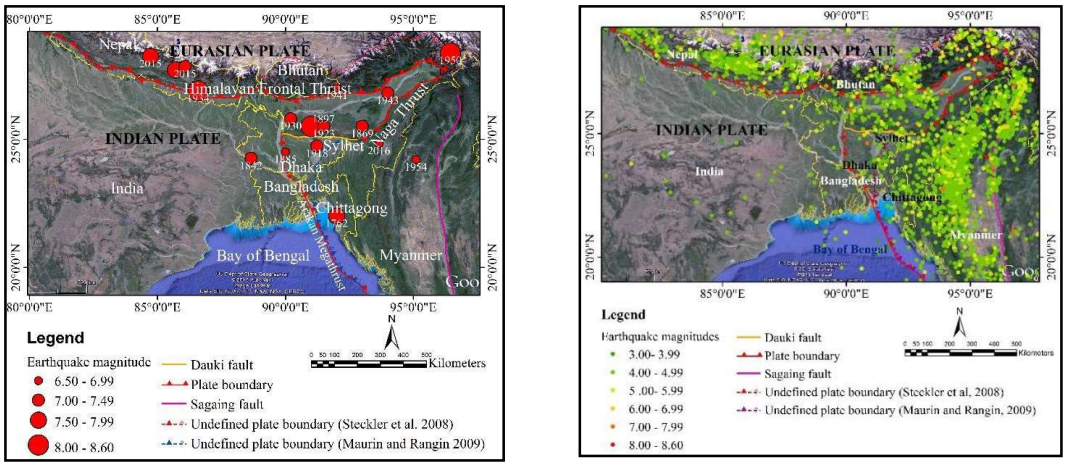


Figure :1-2

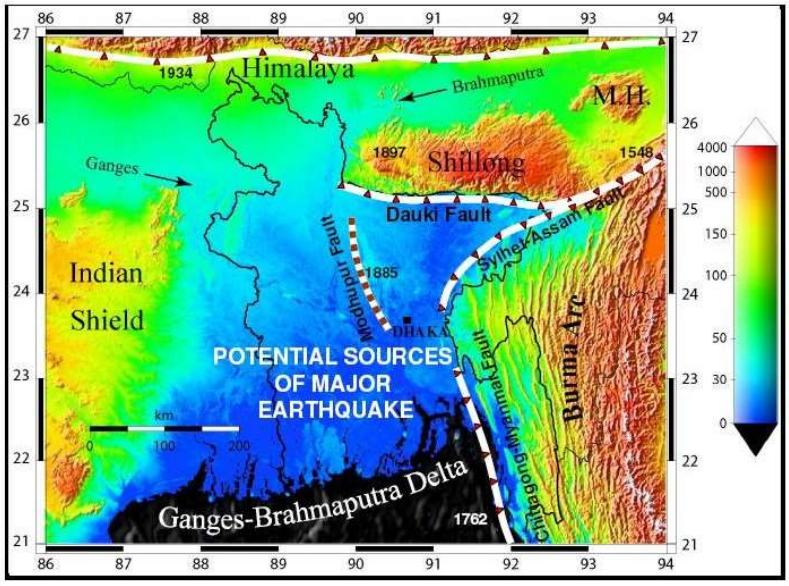


Figure :1-3

Historical records show that, during the last 150 years, Bangladesh and neighboring states in India have experienced seven major earthquakes of magnitude 7 and above on the Richter Scale. Any earthquakes of magnitude 7 and above would have a dramatic, devastating impact on the city. Moreover, the city and its inhabitants are poorly prepared to respond to a crisis of this scale within the metropolitan area. A joint research project conducted by the University of Kansas and Dhaka University found that 83 percent of Dhaka's residents do not consider themselves prepared for an earthquake.

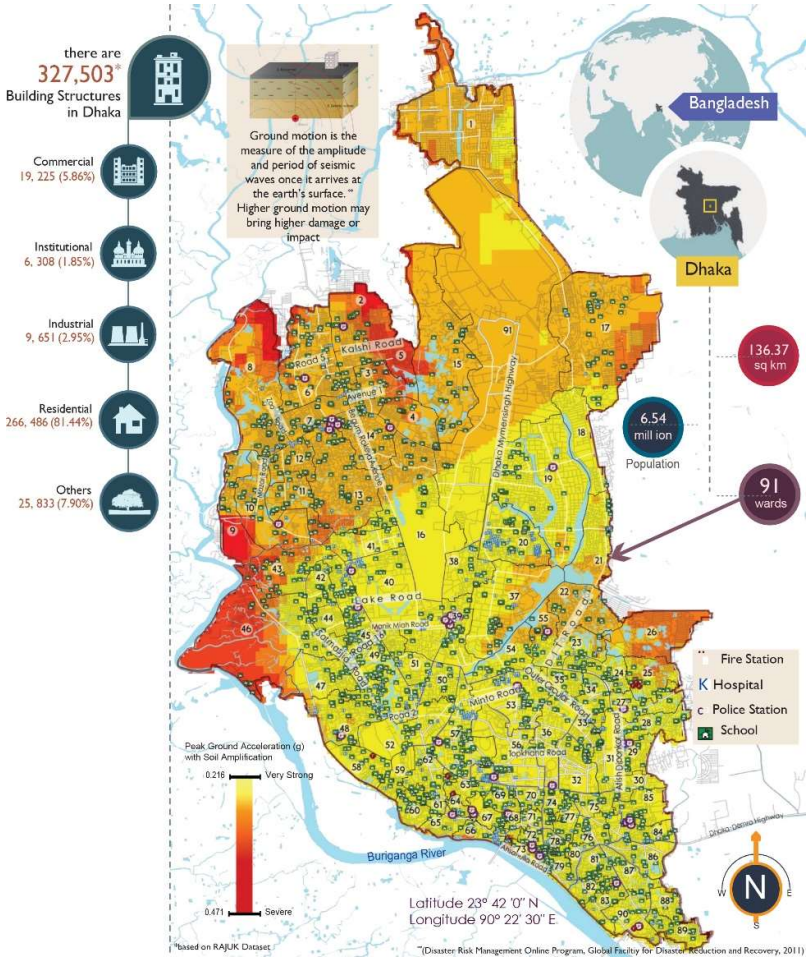


Figure :1-4

- Population of Dhaka: 15 million and one of the fastest growing cities in the world Widespread poverty 28% below the poverty line
- 3.4 million citizens live in slums
- 30% lack access to sanitation services
- Challenges of rapid urbanization
- Uncontrolled rural to urban migration
- Lack of land-use planning
- Dearth of government regulations and building standards
- Complex governance structures
- Overlapping authority in urban planning
- Political conflict leads to lack of decision-making

The Global Earthquake Disaster Risk Index has placed Dhaka among the 20 most vulnerable cities in the world. According to the Comprehensive Disaster Management Programmer's (CDMP) recent studies, Dhaka, Sylhet and Chittagong are the cities with the highest vulnerability to earthquake risk. Apart from earthquakes, incidences of urban disasters like the 2013 Rana Plaza collapse where 1,132 people were killed and the 2005 Spectrum Building collapse where 100 people died have raised alarming concerns about the lack of preparedness as well as capability of Bangladesh to handle urban disasters effectively. Dhaka, the capital and largest city in Bangladesh, is located at the bank of the Buriganga River in the central part of the country. The city is built partly on the elevated Pleistocene terrace (Madhupur terrace) and partly on the surrounding low-lying Holocene floodplains.
The surface geology of the city has been divided into six units:

1) Pleistocene terrace deposit
2) Holocene terrace deposit
3) Holocene alluvial valley fill deposit
4) Holocene alluvium
5) Holocene channel deposit
6) Artificial fill (Figure 1).

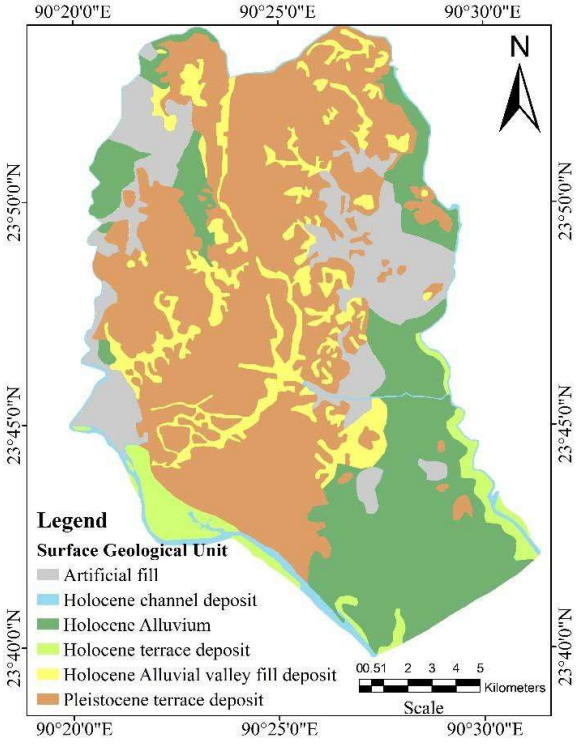


Figure :1-4

The subsurface geological materials of the Dhaka city are also divided into six lithological units. The units are:

1) Filling sand
2) Filling clay
3) Holocene sand
4) Holocene clay,
5) Plio-Pleistocene sand
6) Plio-Pleistocene clay.

The Pleistocene terrace consists of yellowish brown medium stiff to very stiff silty clay and medium dense to dense silty sand. The Pleistocene terrace sediments are the floodplain deposits of the earlier

Ganges-Brahmaputra river system. It occurs in an extensive area above the level of the Holocene floodplains, which indicates that there has been differential movement between the Pleistocene and Holocene time. The Holocene floodplain deposits of the Ganges and Brahmaputra rivers are composed of gray, very soft to medium stiff silty clay and very loose to medium dense sand, silty sand, and silt. Bangladesh is exposed to significant seismic risk due to its proximity to the seismically active tectonic plates. A Magnitude 7.5 event on the Madhupur fault and a Magnitude 8 event on the Plate Boundary 2 fault have the greatest impact on the city of Dhaka, Bangladesh's capital.
The Madhupur fault event is to the north of the city. Ground motions generally decrease from north to south and are amplified in areas of soft soil. The Plate Boundary 2 fault is to the east of the city and ground motions decrease going east to west. Earthquakes have impacted Dhaka are:

- Intensity VIII
  - Bengal Earthquake, 1885. Magnitude 7
  - Great Indian Earthquake, 1897. Magnitude 8.1
- Intensity VII
  - Srimangal Earthquake, 1918. Magnitude 7.6
- Intensity VI (intensity where structural damage begins to occur)
  - 1923, Magnitude 7.1
  - 1934, Magnitude 8.1
  - 1935, Magnitude 6.0
  - 1943, Magnitude 7.2
  - 2001, Magnitude 5.1

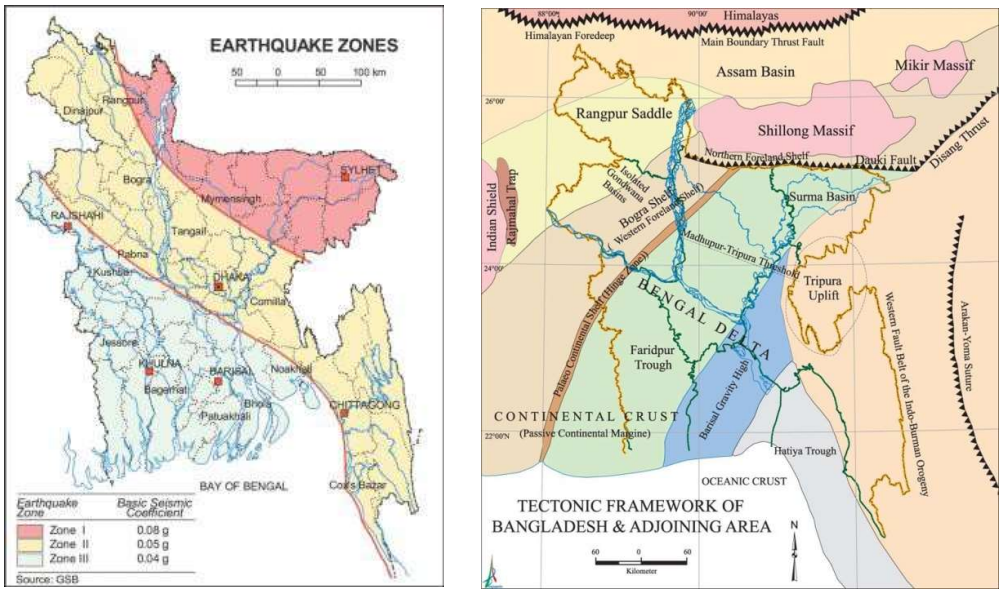


Figure :1-5

Furthermore, the building construction in Bangladesh is highly vulnerable because of rapid urbanization, lack of construction control and ethics. This is somewhat validated by more scientific risk studies, such as the micro-zonation study for Dhaka that was undertaken by CDMP2. This argument is strengthened by the rapid urbanization that the city is experiencing, which is quickly encroaching upon open space and increasing population density. Systems and processes for quality control of construction and adherence to building code provisions and other standards are believed to be insufficient. The rapid growth of Dhaka coupled with migration has increased its vulnerability to earthquakes and other hazards. The trend of increased vulnerability can be reserved into urban resilience and sustainability by

implementing risk-sensitive planning and sustainable development policies and strategies.

- Zone-1: Sylhet-Mymensingh is with the possible magnitude of 7 on Richter scale.
- Zone-2: Chittagong-Comilla-Dhaka and Tangail are with the possible magnitude of 6 on Richter scale.
- Zone-3: Rest of the country is with possible magnitude of 6 on Richter scale.

Chronology of important earthquakes placed in Bangladesh from 1548 to 2015	
1548	The first recorded earthquake in Sylhet and Chittagong were violently shaken, the earth opened in many places and threw up water and mud of a sulphurous smell.
1642	More severe damage occurred in Sylhet district. Buildings were cracked but there was no loss of life.
1663	Severe earthquake in Assam, which continued for half an hour and Sylhet district was not free from its shock.
1762	The great earthquake of April 2, which raised the coast of Foul island by 2.74m and the northwest coast of Chedua island by 6.71m above sea level and also caused a permanent submergence of 155.40 sq. km near Chittagong. The earthquake proved very violent in Dhaka and along the eastern bank of the Meghna as far as Chittagong. In Dhaka 500 persons lost their lives, the rivers and jheels were agitated and rose high above their usual levels and when they receded their banks were strewn with dead fish. A large river dried up, a tract of land sank and 200 people with all their cattle were lost.
1775	Severe earthquake in Dhaka around April 10, but no loss of life.
1812	Severe earthquake in many places of Bangladesh around May 11. The earthquake proved violent in Sylhet
1865	Terrible shock was felt, although no serious damages occurred.
1869	Known as Catcher Earthquake. Severely felt in Sylhet but no loss of life. The steeple of the church was shattered, the walls of the courthouse and the circuit bungalow cracked and in the eastern part of the district the banks of many rivers caved in.
1885	Known as the Bengal Earthquake. Occurred on 14 July with 7.0 magnitude and the epicenter was at Manikganj. This event was generally associated with the deep-seated Jamuna Fault.
1889	Occurred on 10 January with 7.5 magnitudes and the epicenter at Jaintia Hills. It affected Sylhet town and surrounding areas.

1897	Known as the Great India Earthquake with a magnitude of 8.7 and epicenter at Shillong Plateau. The great earthquake occurred on 12 June at 5.15 pm, caused serious damage to masonry buildings in Sylhet town where the death toll rose to 545. This was due to the collapse of the masonry buildings. The tremor was felt throughout Bengal, from the south Lushai Hills on the east to Shahbad on the west. In Mymensingh. Heavy damage was done to the bridges on the Dhaka-Mymensingh railway and traffic was suspended for about a fortnight. Loss of life was not great, but loss of property was estimated at five million Rupees.
1918	Known as the Srimangal Earthquake. Occurred on 18 July with a magnitude of 7.6 and epicenter at Srimangal, Maulvi Bazar. Intense damage occurred in Srimangal, but in Dhaka only minor effects
1930	Known as the Dhubri Earthquake. Occurred on 3 July with a magnitude of 7.1 and the epicenter at Dhubri, Assam. The earthquake caused major damage in the eastern parts of Rangpur district.
1934	Occurred on 3 July with a magnitude of 7.1 and the epicenter at Dhubri of Assam, India. The earthquake caused considerable damages in greater Rangpur district of Bangladesh.
1950	Known as the Assam Earthquake. Occurred on 15 August with a magnitude of 8.4 with the epicenter in Assam, India. The tremor was felt throughout Bangladesh but no damage was reported.
1997	Occurred on 22 November in Chittagong with a magnitude of 6.0. It caused minor damage around Chittagong town.
1999	Occurred on 22 July at Maheshkhali Island with the epicenter in the same place, a magnitude of 5.2. Severely felt around Maheshkhali island and the adjoining sea.
2003	Occurred on 27 July at Kolabunia union of Barkal upazila, Rangamati district with magnitude 5.1.
2006	Known as the Narail earthquake. This tremor occurred on 5 August. The earthquake had a magnitude estimated 4.2 on the Richter scale with epicenter located 110 km southwest of Dhaka near Narail. The tremor was widely felt in Dhaka as well as other places in the country.
2008	Known as the Manikganj earthquake. A minor earthquake jolted Dhaka and surroundings on the evening of 20 March 2008 and created considerable panic among the city dwellers.
2008	Known as Mymensingh earthquake, this temblor occurred in the middle of the night of 27 July 2008.The epicenter was located 12 km northeast of Mymensingh city and120 km north of Dhaka. It had a magnitude estimated 5.1 on the Richter scale. Apart from Mymensingh where the earthquake caused panic, tremors from this earthquake were felt in many parts of the Dhaka metropolitan area.

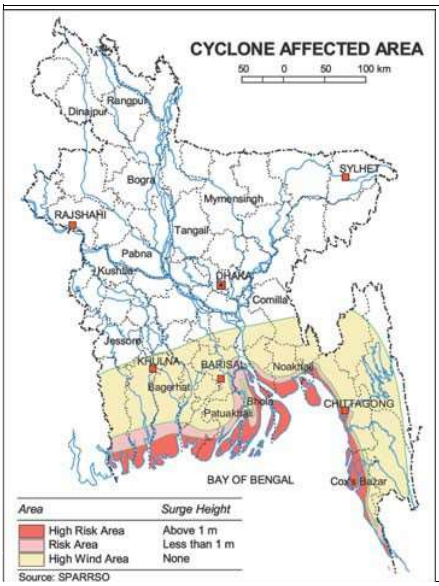
2008	Known as Chandpur Earthquake. An earthquake with couple of aftershocks jolted Dhaka on the evening of 20 September 2008. It caused tremendous panic among the city dwellers. The epicenter was 50 km southeast of Dhaka near Kachua of Chandpur. The magnitude was 4.5 on the Richter scale.
2009	Known as eastern Bhutan earthquake. A strong earthquake occurred on the day of Eid-ul-Fitr, 21 September 2009. The epicenter was situated in eastern Bhutan, 410 km north-northeast of Dhaka. This distant quake had a magnitude of 6.1, but shook most of Bangladesh including Dhaka.
2009	Known as Bay of Bengal Earthquake. Occurred on 11 August. The epicenter was located at the North Andaman Islands of the Bay of Bengal and seacoast of Myanmar. The magnitude recorded was 7.5. Though no significant damage was reported throughout Bangladesh the tremor was felt strongly in Dhaka.
2010	Occurred on 10 September night at 11:30 pm local time. The tremor was felt in Dhaka and its surrounding areas with magnitude 4.8. The epicenter was 45 km southwest from Dhaka.
2011	Occurred on 6:30 pm local time with magnitude 6.8. It lasted for 2 minutes. The tremor felt was strong enough in Capital city Dhaka and the districts of northern part of Bangladesh The epicentre was 500 north from Dhaka in Indian Sikkims's capital Gangtok.

1.2.2 Hazards Assessments

Cyclones and floods pose the greatest risk to Bangladesh on a national level. Sub nationally, the northern and eastern regions of the country are susceptible to earthquakes while the southeast is particularly vulnerable to cyclones, floods, droughts, and earthquake. Bangladesh is also vulnerable to other natural and man- made hazards, such as river bank erosion, tornadoes, tsunami, high arsenic contents in ground water, water logging, water and soil salinity, etc. Bangladesh is also at a great risk from global climate change impacts because of its low elevation and exposure to various climate related hazards. Although the magnitude of these changes may appear to be small, they could substantially increase the frequency and intensity of existing climatic events, such as floods, droughts, cyclones etc.

1.2.2.1 Cyclone and Storm Surge Hazard

The Bay of Bengal is the breeding ground for tropical cyclones and Bangladesh is the worst victim in terms of fatalities and economic losses incurred. The global distribution of cyclones shows that only 1% of all the cyclones that form every year strike Bangladesh, but, unfortunately, the fatalities they cause are 53% of the whole
world total.[4] The following table lists a few of the devastating cyclones that have affected Bangladesh.



Date of Occurrence	Nature of Phenomenon	Death toll
11.10.60	Severe Cyclonic Storm	3000
31.10.60	Severe Cyclonic Storm	5149
09.05.61	Severe Cyclonic Storm	11468
28.05.63	Severe Cyclonic Storm	11520
11.05.65	Severe Cyclonic Storm	17279
05.11.65	Severe Cyclonic Storm	873
01.11.66	Severe Cyclonic Storm	850
12.11.70	Severe Cyclonic Storm with a core of hurricane wind	200000
24.05.85	Severe Cyclonic Storm	4264
29.11.88	Severe Cyclonic Storm with a core of hurricane wind	6133
29.04.91	Severe Cyclonic Storm with a core of hurricane wind	138882
19.05.97	Severe Cyclonic Storm with a core of hurricane wind	155

Source: Bangladesh Meteorological Department (BMD)

Figure :1-6

1.2.2.2 Flood Hazard

Bangladesh is a low land country. Most of it is located within the flood plains of three great rivers, which is the Ganges, the Brahmaputra, and the Meghan, their tributaries, and distributaries. The river systems drain a total area of about 1.72 million square kilometers in India, China, Nepal, Bhutan, and Bangladesh. Only 8% of this area lies within Bangladesh. As a result, huge inflows of water, which Bangladesh has no control, enter the country. The lack of control is a critical problem because Bangladesh has an agrarian economy dependent on water. At different times and in an unpredictable manner it has too much or too little water. The intricate network of alluvial rivers carries a huge annual discharge and sediment load, causing channel shifting and bank erosion. Withdrawals in upstream areas seriously affect socioeconomic growth, the environment, and the ecology. The habitat of fish,

which is a major source of protein for the rural poor, is under threat from the increasing conversion of land to agricultural use. Inland navigation is hindered by blockages in the river delta. Meanwhile, the need for pure water is increasing along with the salinization of the coastal belt and the degradation of ecosystems. As an example of the above described situation, during the July 2004 event, the Megna River peaked, and Jamuna and Padma Rivers burst their banks. As a result, 36 million people, 25% of the total population, was affected, and 38% of the whole area of the country was flooded for nearly 55 days. To further complicate the scenario, in September of the same year, monsoon rains three times larger than normal flooded new areas.5

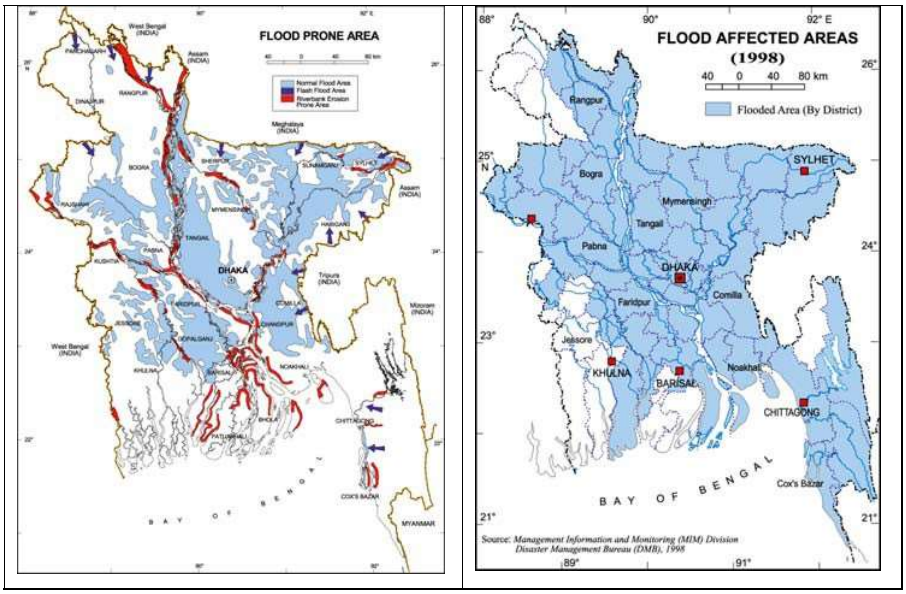


Figure :1-7

The flood of 1988 during August-September inundated an area of 89,000 sq. km of 52 districts of the country and caused a loss of 1,517 human lives. The 1998 flood in Bangladesh with an unprecedented duration of 65 days inundated 53 districts, covering about 100,000 sq. km, and took the lives of 918 people. Beside this, the severe floods of 1822, 1854, 1922, 1955, 1966, 1974, 1987, and 2002 are worth mentioning

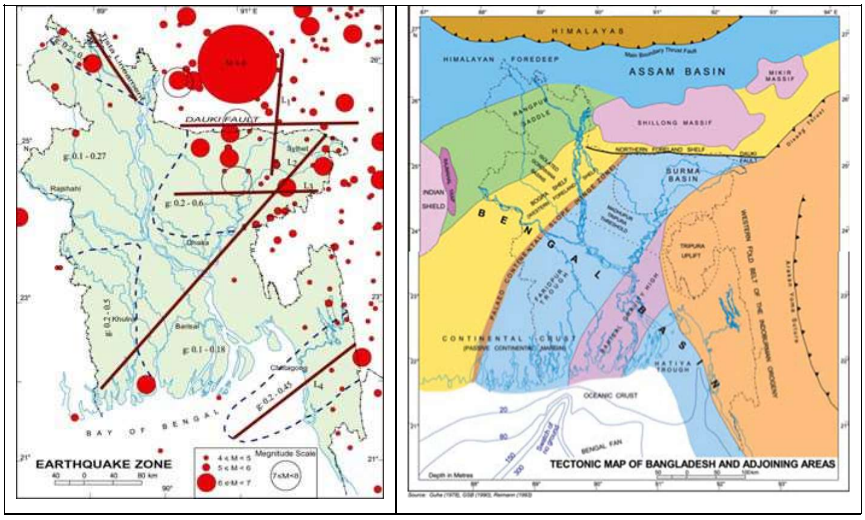


Figure :1-8

1.2.2.3 Earthquake Hazard

Bangladesh lies in the Burma basin, which was formed by the continent- continent collision of India to the north, and subduction of ocean crust beneath the Burma continental crust to the east. Bangladesh is surrounded by regions of high seismicity, which include the Himalayan Arc and Shillong Plateau in the north, the Burmese Arc, Arakan Yoma anticlinorium in the east, and complex Naga-Disang-Haflong thrust zone in the northeast.

The country has a long history of seismic activity related to its proximity to the Himalayas. Three great earthquakes of magnitudes exceeding 8 were felt in 1897, 1934, and 1950, and another four earthquakes exceeding magnitude 7 were felt between 1869 and 1950. Major seismic sources are the Meghalaya (8.0), Tripura (7.0), Sub-Dauki (7.3), and Bogra (7.0), all of them with associated earthquakes of expected magnitudes higher or equal to 7.0.

CHAPTER 2

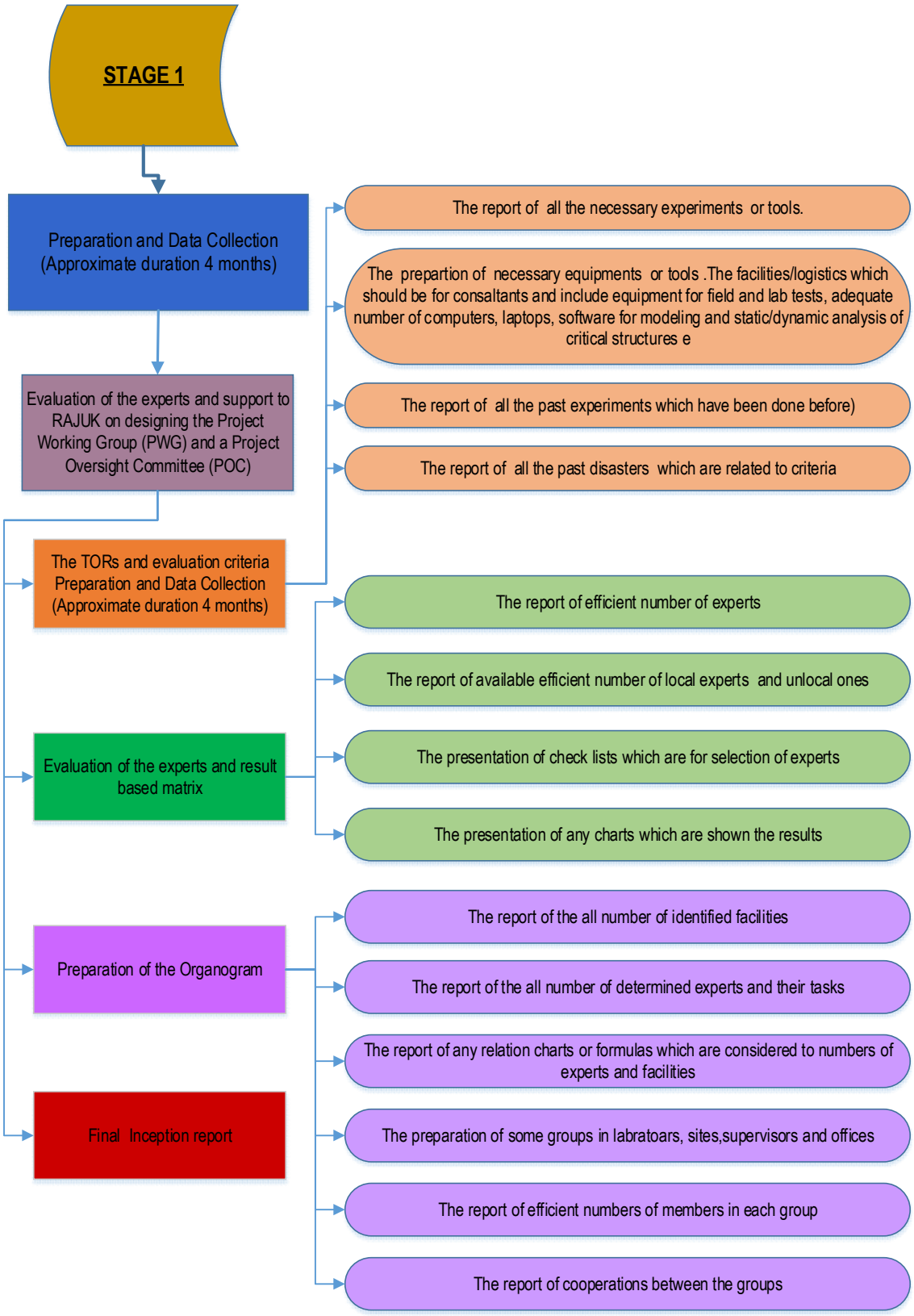
Project Implementation

2 Project Background, Deliverables, and Team Organization

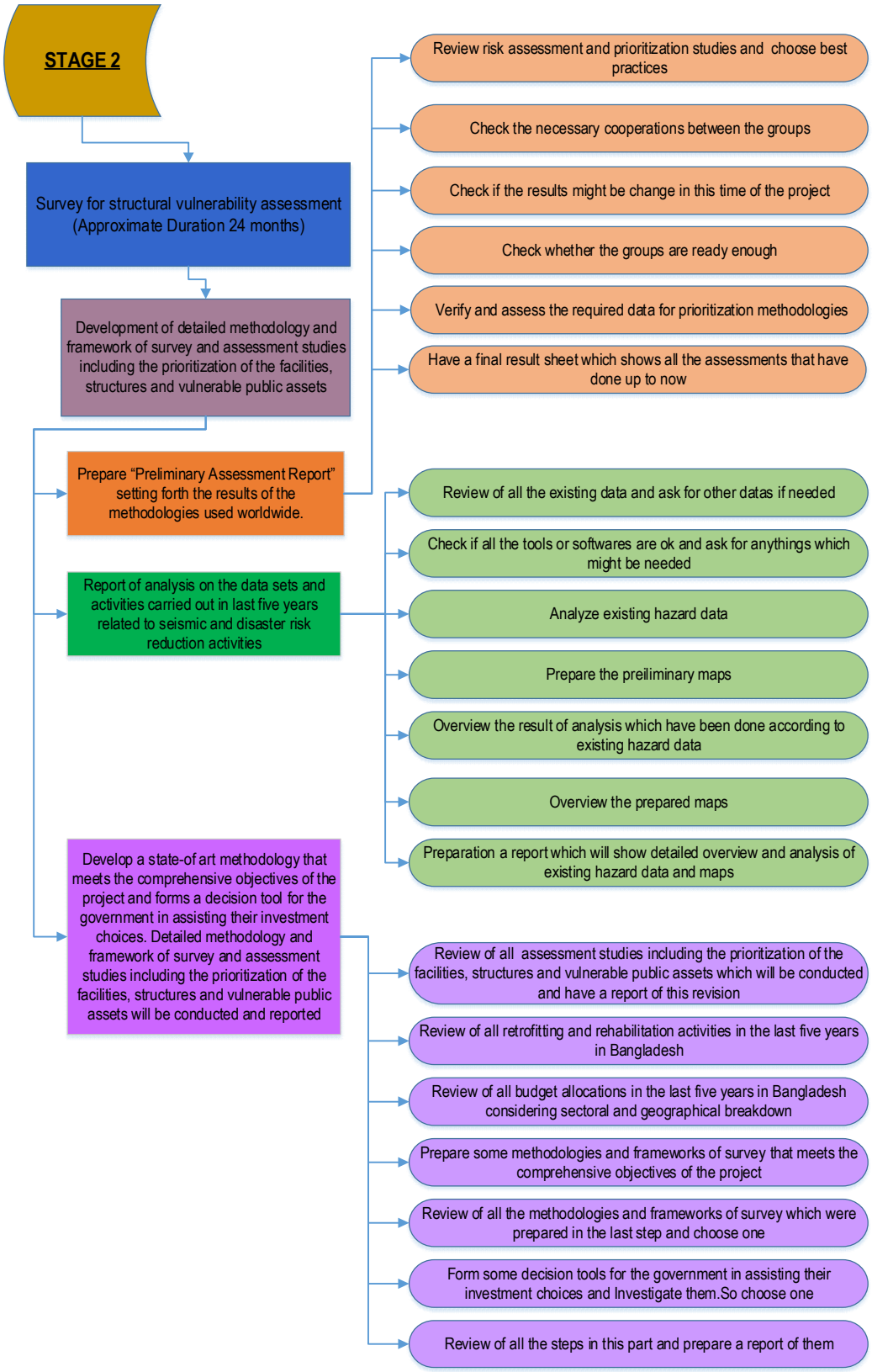
2.1 Project Objective, Goals, and Outputs

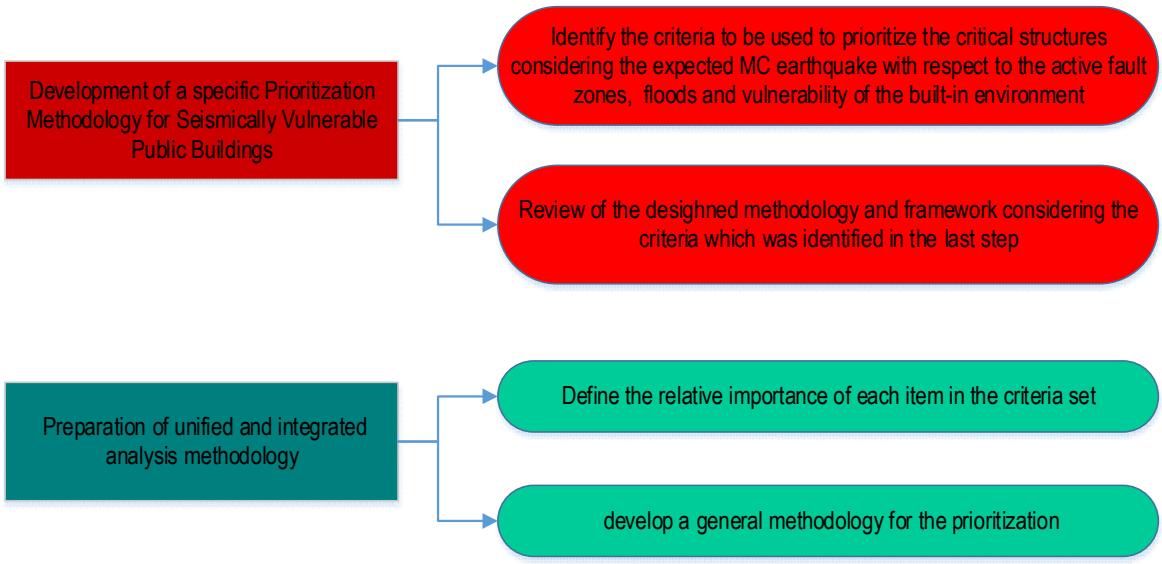
The making of the RAJUK's Urban Resilience Unit (URU) is an intense and convenient activity for Dhaka and the quickly growing urban focus of Dhaka. As late assessments1 have recognized, Dhaka is one of the 20 most seismically powerless urban areas on the planet. Seismic evaluation and flexibility must be consolidated into urban improvement, expert, and responsibility, and authority is expected to encourage private ventures and think about hazard and versatility inside advancement of the Dhaka Metropolitan Area.

The approach proposed by JV of NKY-PROTEK-SHELTECH combines state-of-the-art methodologies with advanced tools and a strong participatory procedure, thus ensuring that all the objectives of the assignment are accomplished, while improving significantly the capacity of the experts and stakeholders in Dhaka to assess and mitigate their disaster risk. Herein a brief introduction of the stages is provided in following Charts:

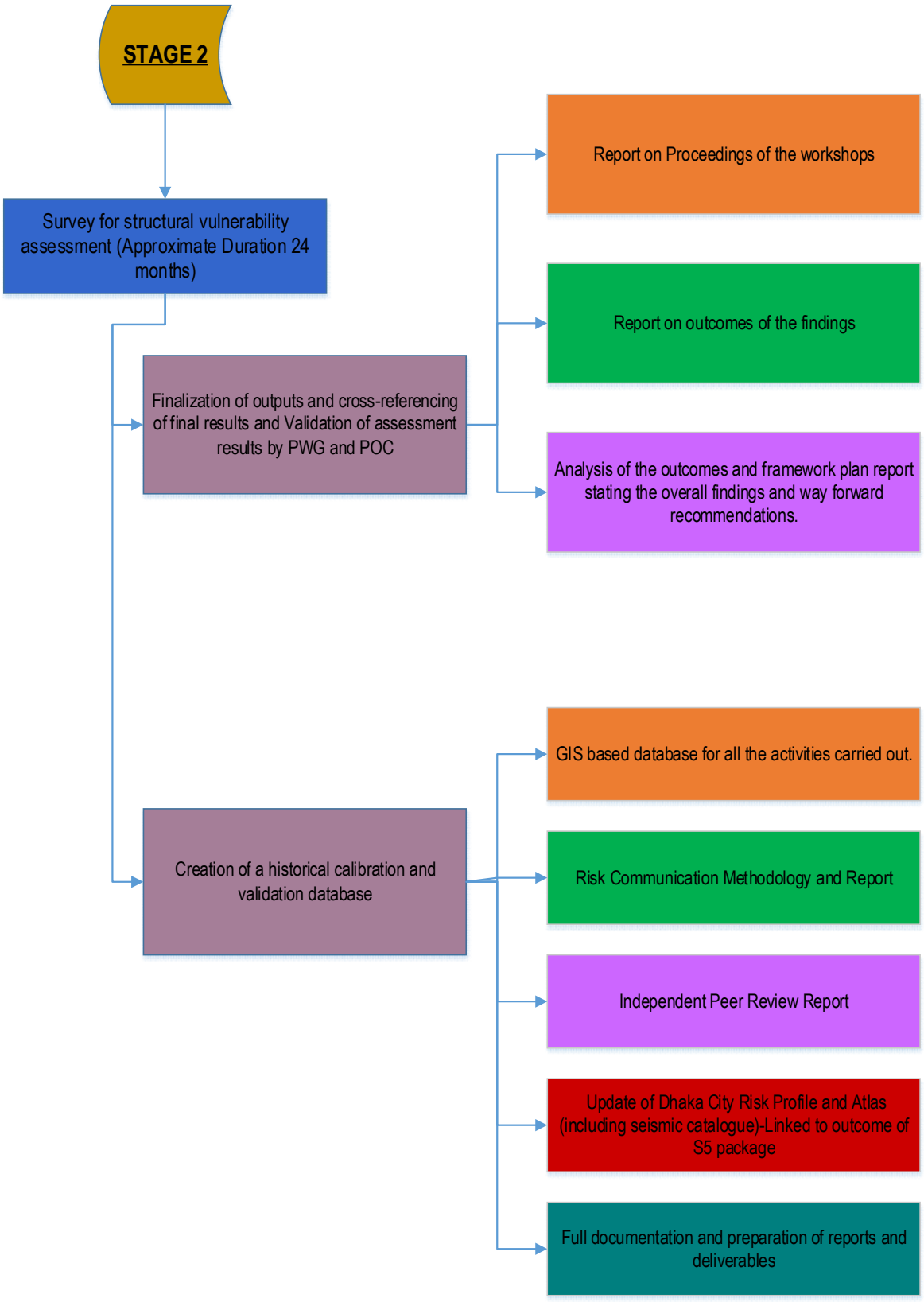

STAGE 1
Preparation and Data Collection (Approximate duration 4 months)
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)
The TORs and evaluation criteria Preparation and Data Collection (Approximate duration 4 months)
Evaluation of the experts and result based matrix
Preparation of the Organogram
Final Inception report
The report of all the necessary experiments or tools.
The prepartion of necessary equipments or tools .The facilities/logistics which should be for consaltants and include equipment for field and lab tests, adequate number of computers, laptops, software for modeling and static/dynamic analysis of critical structures e
The report of all the past experiments which have been done before)
The report of all the past disasters which are related to criteria
The report of efficient number of experts
The report of available efficient number of local experts and unlocal ones
The presentation of check lists which are for selection of experts
The presentation of any charts which are shown the results
The report of the all number of identified facilities
The report of the all number of determined experts and their tasks
The report of any relation charts or formulas which are considered to numbers of experts and facilities
The preparation of some groups in labratoars, sites,supervisors and offices
The report of efficient numbers of members in each group
The report of cooperations between the groups

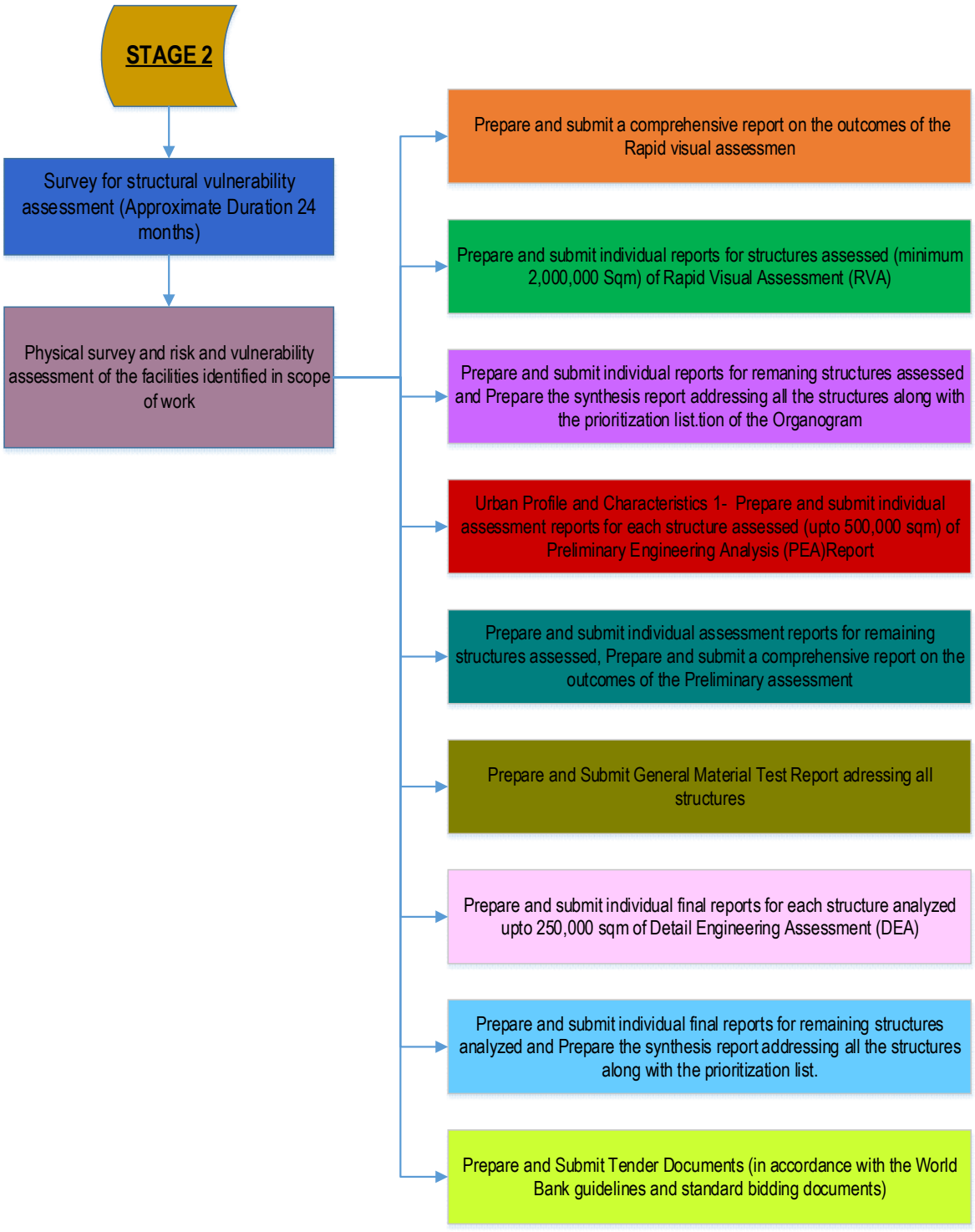

STAGE 1
Preparation and Data Collection (Approximate duration 4 months)
Data Collection and Documentation
Situation Analysis Interim Report
Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)
Provide up to date list of the all the critical infrastructure and facilities
Preparation a report of all buildings which are close to the one that we are considered even they are critical or notThe report of all the necessary experiments or tools.
Preparation a complete report about characteristic of the close critical buildings
The report of Preparation a report of the geotechnical characteristic of the groun all the past experiments which have been done before)
Preparation a report of any limitations which occurred by the location
The TORs and evaluation criteria Preparation and Data Collection Preparation a report which is about hazards data collection (flood and earthquake)(Approximate duration 4 months)
Preparation of the process in collecting of satellite imagery and development of urban characteristics patterns
Preparation of the process in collecting of microzonation studies
Preparation of the process in collecting of vulnerability assessment studies
Preparation of the process in development of proxies for missing data
Preparation of reports which are about remote sensing , GIS, vulnerability and seismic risk modelling tools;if they are available
Preparation of a group which should have revision reports of all the critical infrastructure and facilities.
Preparation a report which can show that to what extant each infrastructure and facilities are critical.
Prioritization of the critical infrastructure and facilities which we considered in the last row.
The report of cooperations bPresentation of any charts that would show the priority of the steps which should done after each other.etween the groups

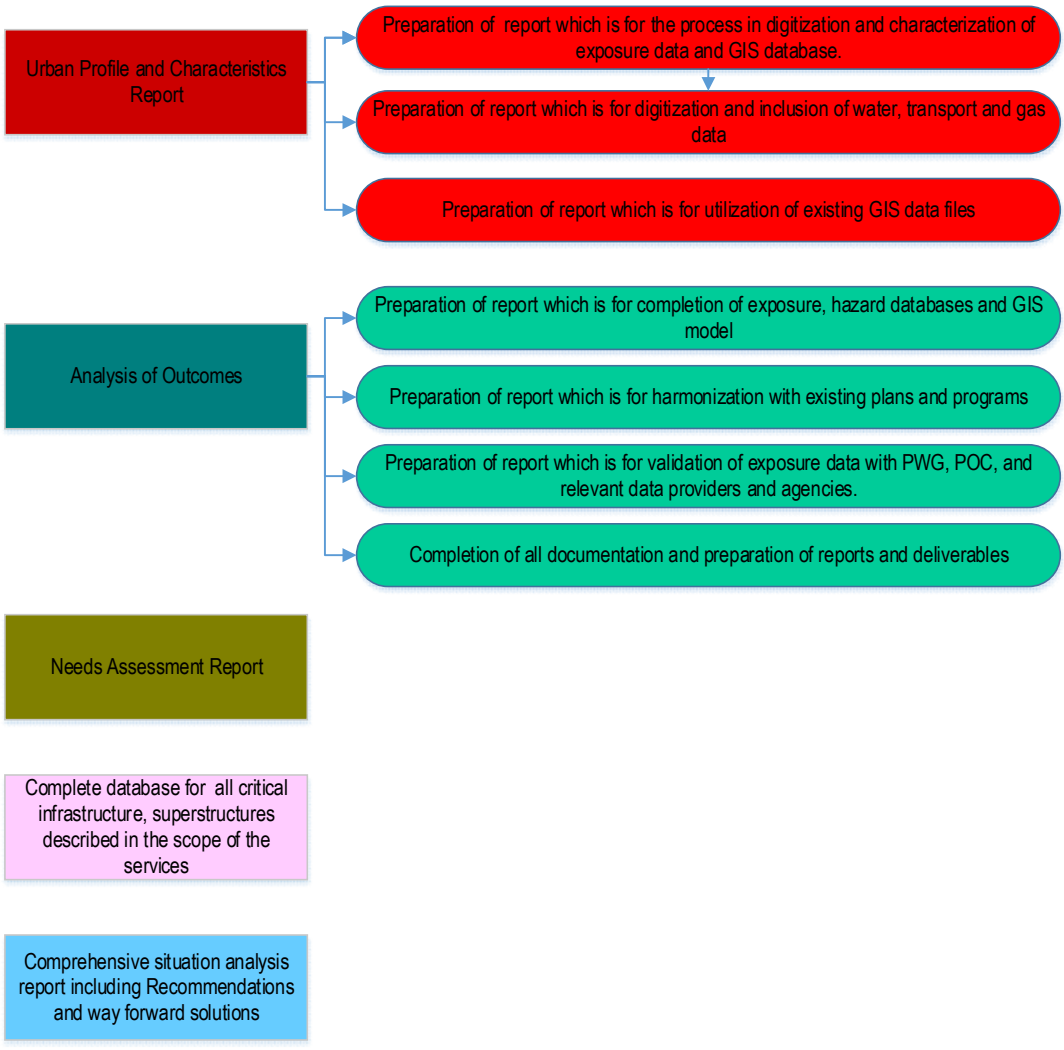

STAGE 2
Survey for structural vulnerability assessment (Approximate Duration 24 months)
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets
Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide.
Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities
Develop a state-of art methodology that meets the comprehensive objectives of the project and forms a decision tool for the government in assisting their investment choices. Detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets will be conducted and reported
Review risk assessment and prioritization studies and choose best practices
Check the necessary cooperations between the groups
Check if the results might be change in this time of the project
Check whether the groups are ready enough
Verify and assess the required data for prioritization methodologies
Have a final result sheet which shows all the assessments that have done up to now
Review of all the existing data and ask for other datas if needed
Check if all the tools or softwares are ok and ask for anythings which might be needed
Analyze existing hazard data
Prepare the preiliminary maps
Overview the result of analysis which have been done according to existing hazard data
Overview the prepared maps
Preparation a report which will show detailed overview and analysis of existing hazard data and maps
Review of all assessment studies including the prioritization of the facilities, structures and vulnerable public assets which will be conducted and have a report of this revision
Review of all retrofitting and rehabilitation activities in the last five years in Bangladesh
Review of all budget allocations in the last five years in Bangladesh considering sectoral and geographical breakdown
Prepare some methodologies and frameworks of survey that meets the comprehensive objectives of the project
Review of all the methodologies and frameworks of survey which were prepared in the last step and choose one
Form some decision tools for the government in assisting their investment choices and Investigate them.So choose one
Review of all the steps in this part and prepare a report of them

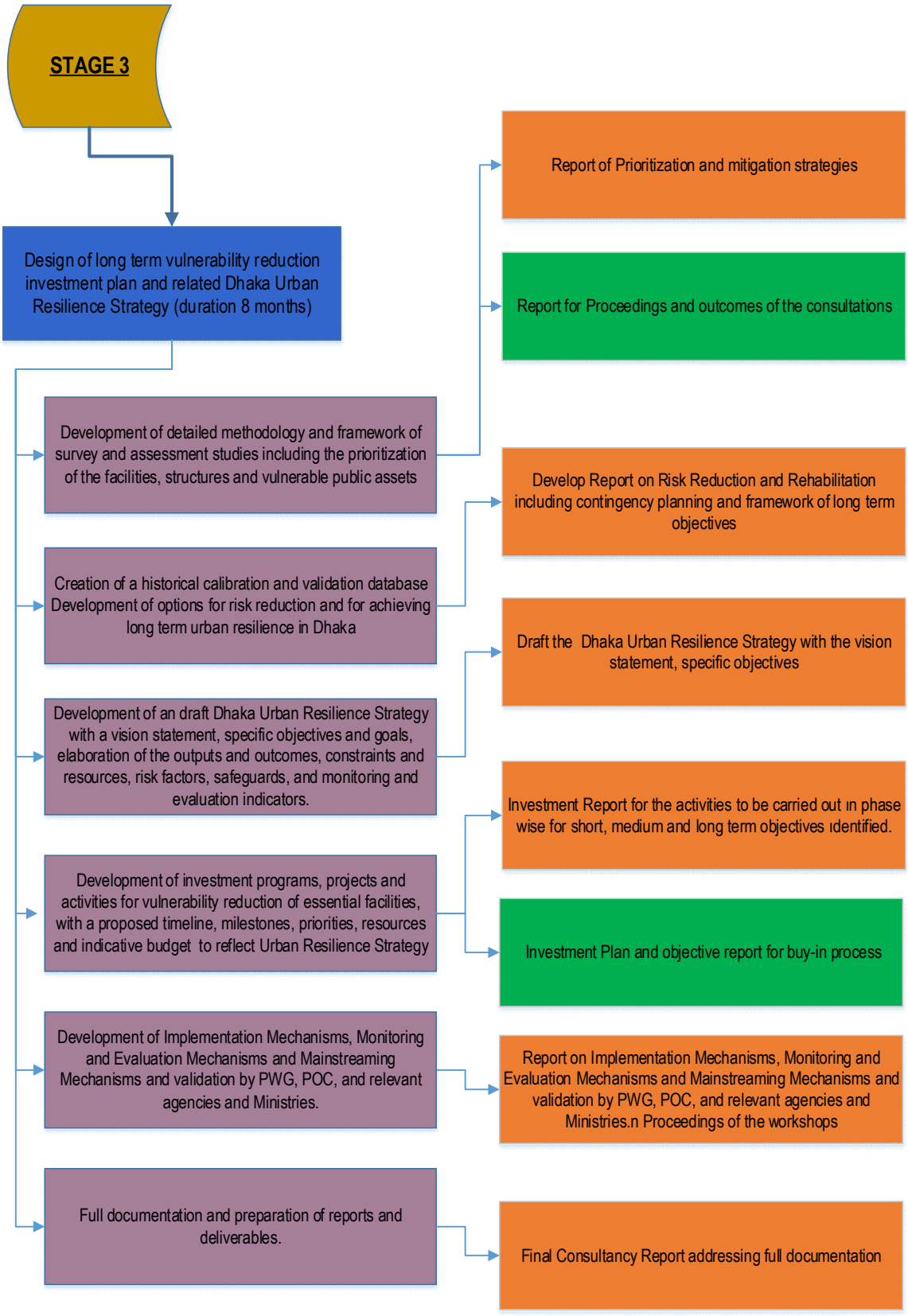

Development of a specific Prioritization Methodology for Seismically Vulnerable Public Buildings
Identify the criteria to be used to prioritize the critical structures considering the expected MC earthquake with respect to the active fault zones, floods and vulnerability of the built-in environment
Review of the designhned methodology and framework considering the criteria which was identified in the last step
Preparation of unified and integrated analysis methodology
Define the relative importance of each item in the criteria set
develop a general methodology for the prioritization


STAGE 2
Survey for structural vulnerability assessment (Approximate Duration 24 months)
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies
Report on Proceedings of the workshops
Conduct capacity development workshop (2 workshop each 3 days) for scientists for briefing and introducing the methodology proposed
Prepare a plan which covers the abjectives of the workshops
Choose or train someones to be the supervisiors during the workshops
Prepare a report of how the workshops were held
Report on outcomes of the findings
Review of all the findings during the workshops and check if they can be merged to each other
prepare a report which shows what would be the outcomes of the findings
Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.
Determination of hazard levels for deterministic and probabilistic analyses
Analysis of ground conditions and seismicity
Seismic damage analysis and compilation of seismic microzoning maps
Overall evaluation and preparation of recommendations
Resource mobilization with manpower and equipment, including training of assessors


STAGE 2
Survey for structural vulnerability assessment (Approximate Duration 24 months)
Finalization of outputs and cross-referencing of final results and Validation of assessment results by PWG and POC
Report on Proceedings of the workshops
Report on outcomes of the findings
Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.
Creation of a historical calibration and validation database
GIS based database for all the activities carried out.
Risk Communication Methodology and Report
Independent Peer Review Report
Update of Dhaka City Risk Profile and Atlas (including seismic catalogue)-Linked to outcome of S5 package
Full documentation and preparation of reports and deliverables


STAGE 2
Survey for structural vulnerability assessment (Approximate Duration 24 months)
Physical survey and risk and vulnerability assessment of the facilities identified in scope of work
Prepare and submit a comprehensive report on the outcomes of the Rapid visual assessmen
Prepare and submit individual reports for structures assessed (minimum 2,000,000 Sqm) of Rapid Visual Assessment (RVA)
Prepare and submit individual reports for remaning structures assessed and Prepare the synthesis report addressing all the structures along with the prioritization list.tion of the Organogram
Urban Profile and Characteristics 1- Prepare and submit individual assessment reports for each structure assessed (upto 500,000 sqm) of Preliminary Engineering Analysis (PEA)Report
Prepare and submit individual assessment reports for remaining structures assessed, Prepare and submit a comprehensive report on the outcomes of the Preliminary assessment
Prepare and Submit General Material Test Report adressing all structures
Prepare and submit individual final reports for each structure analyzed upto 250,000 sqm of Detail Engineering Assessment (DEA)
Prepare and submit individual final reports for remaining structures analyzed and Prepare the synthesis report addressing all the structures along with the prioritization list.
Prepare and Submit Tender Documents (in accordance with the World Bank guidelines and standard bidding documents)


Urban Profile and Characteristics Report
Preparation of report which is for the process in digitization and characterization of exposure data and GIS database.
Preparation of report which is for digitization and inclusion of water, transport and gas data
Preparation of report which is for utilization of existing GIS data files
Analysis of Outcomes
Preparation of report which is for completion of exposure, hazard databases and GIS model
Preparation of report which is for harmonization with existing plans and programs
Preparation of report which is for validation of exposure data with PWG, POC, and relevant data providers and agencies.
Completion of all documentation and preparation of reports and deliverables
Needs Assessment Report
Complete database for all critical infrastructure, superstructures described in the scope of the services
Comprehensive situation analysis report including Recommendations and way forward solutions


STAGE 3
Design of long term vulnerability reduction investment plan and related Dhaka Urban Resilience Strategy (duration 8 months)
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets
Creation of a historical calibration and validation database Development of options for risk reduction and for achieving long term urban resilience in Dhaka
Development of an draft Dhaka Urban Resilience Strategy with a vision statement, specific objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators.
Development of investment programs, projects and activities for vulnerability reduction of essential facilities, with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy
Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.
Full documentation and preparation of reports and deliverables.
Report of Prioritization and mitigation strategies
Report for Proceedings and outcomes of the consultations
Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives
Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives
Investment Report for the activities to be carried out in phase wise for short, medium and long term objectives identified.
Investment Plan and objective report for buy-in process
Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.n Proceedings of the workshops
Final Consultancy Report addressing full documentation

To comprehensively address urban resilience in Dhaka, a long term three phased investment program is proposed, incorporating each core pillar in each subsequent investment. The proposed "Urban Resilience Project (URP)" would serve as the first of these suggested investments and will focus on improving the critical capacity and infrastructure for emergency planning and response. The proposed project will also lay the foundations for subsequent investment projects by identifying and addressing existing risks in the built environment, and fostering a culture of risk-sensitive urban development.

2.2 Team Organization and Key Professionals

The joined further consultants are a world-renowned research institution that has more than 60 years of experience in turning knowledge into practice. We have more than 15 years of experience operating in Bangladesh. Our project team includes organizations and individuals with local knowledge and outstanding performance record with previous urban resilience projects.

The joined further consultants include a core team as well as both national and international support staff. The team has been assembled to include advisory, technical, and engagement experts to ensure that URU design, outreach and development is carried out in an inclusive, participatory and efficient manner. Key team members and informants are listed in the following table:

KEY EXPERTS

No	Name	Position (Key-Experts)	Location	(%)
K-1	YILMAZ YUVA	Team Leader (International)	Home	15.00%
			Field	85.00%
K-2	DR. MD. MONJUR HOSSAIN	Project Manager (National)	Home	
			Field	100.00%

K-3	PETER I. YANEV	Practice Leader: Vulnerability and Risk Assessment Experts (International)	Home	25.00%
			Field	75.00%
K-4	TAHMEED MALIK AL-HUSSAINI	Practice Leader: Vulnerability and Risk Assessment Experts (National)	Home	
			Field	100.00%
K-5	AHMET YAKUT	Practice Leader: Seismic Hazard Experts (National/International)	Home	
			Field	100.00%
K-6	MD ABDUR RASHID	Practice Leader: Principal Structural Expert (National)	Home	
			Field	100.00%
Subtotal				

NON-KEY EXPERTS

No	**Name**	**Position (Non-Key Experts)**	**Location**	**(%)**
N-1	MOHAMMED AL AMIN	GIS expert (National)	Home	
			Field	100.00%
N-2	NURUNNAHAR MILI	Architect (National)	Home	
			Field	100.00%
N-3	TEKIN EKMEN	Senior Structural Design Engineer (Civil)(National/International)	Home	
			Field	100.00%
N-4	BURCAY YILMAZ	Foundation/Geotechnical Engineer(National/International)	Home	
			Field	100.00%
N-5	MD. ALI NUR RAHMAN	Electro/Mechanical Engineer (National)	Home	
			Field	100.00%

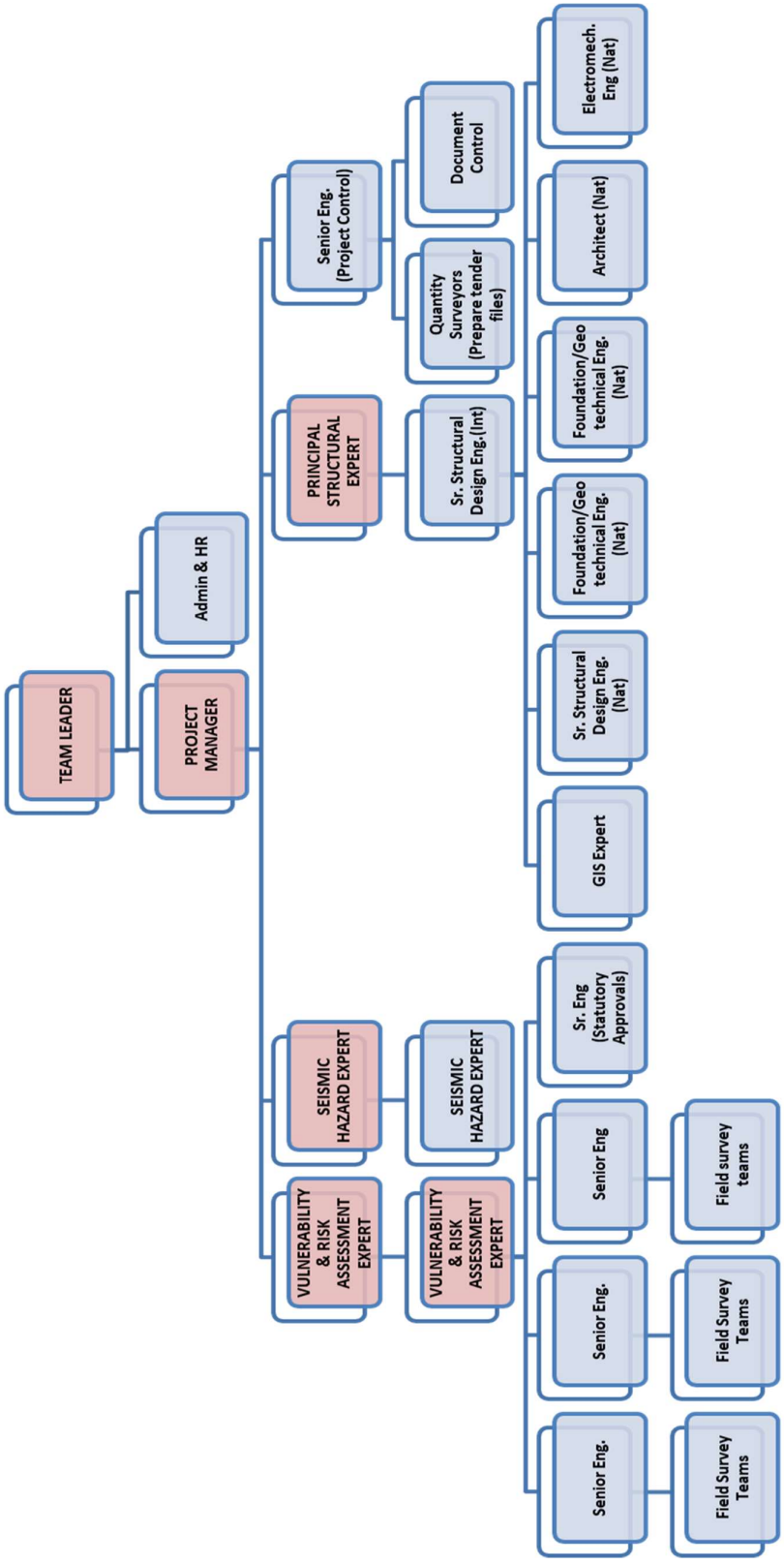

TEAM LEADER
PROJECT MANAGER
Admin & HR
PRINCIPAL STRUCTURAL EXPERT
Senior Eng. (Project Control)
Sr. Structural Design Eng.(Int)
Document Control
Quantity Surveyors (Prepare tender files)
Electromech. Eng (Nat)
Architect (Nat)
Foundation/Geo technical Eng. (Nat)
Foundation/Geo technical Eng. (Nat)
Sr. Structural Design Eng. (Nat)
GIS Expert
SEISMIC HAZARD EXPERT
SEISMIC HAZARD EXPERT
Sr. Eng (Statutory Approvals)
VULNERABILITY & RISK ASSESSMENT EXPERT
VULNERABILITY & RISK ASSESSMENT EXPERT
Senior Eng
Field survey teams
Senior Eng.
Field Survey Teams
Senior Eng.
Field Survey Teams

Figure :2-1

2.3 Project Organizational Chart

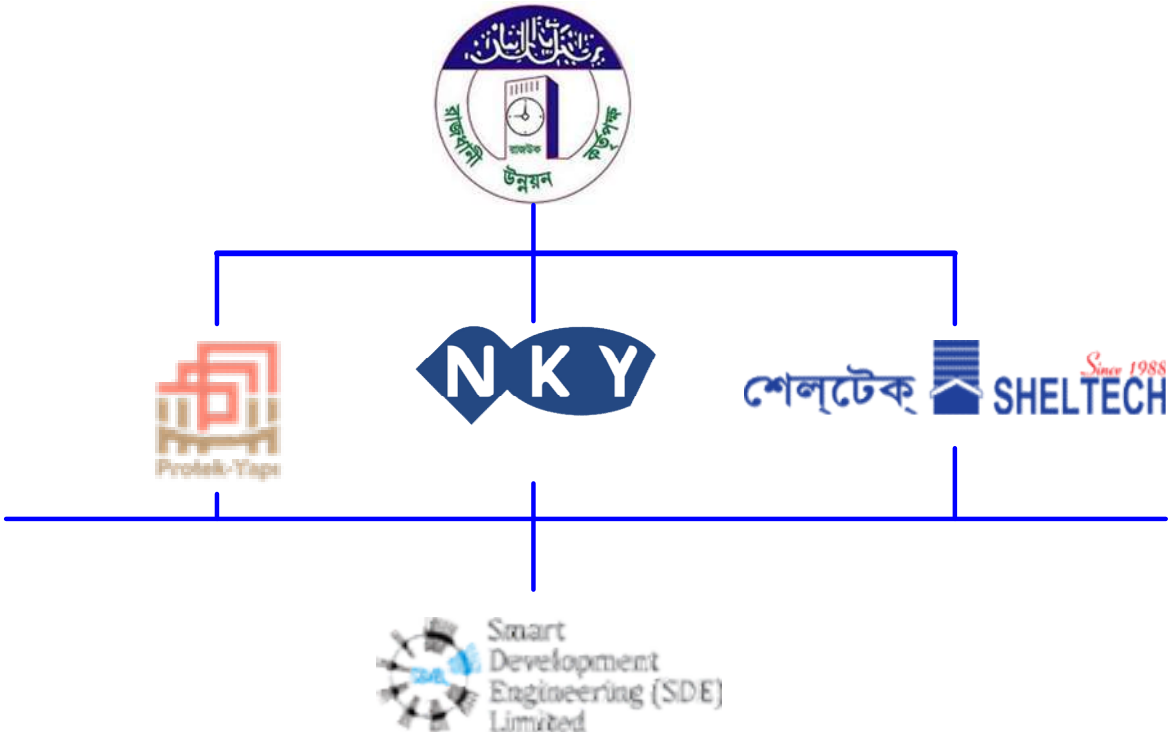


Figure :2-2

2.4 Project Execution, Oversight & Dissemination

The JV has been actively working on the ground since very beginning of the December 2018 despite the fact the contract has not been officially commenced due to the fact that the advance payment still has not been received which is required for official commencement of the works. The JV has rented an office and is ready to mobilize the experts which has been aimed to be officially start on 1st week of January 2019. The overall interaction with the stakeholders has been given in Figures below; details of which are noted below.

2.4.1 Project Working Group

Project Working Group (PWG) will be formed by technical & project management staff of Project Implementation Unit (PIU) and other stakeholder organizations to reflect the past experience from earlier projects and updates on developments from user perspective. We believe that the PWG will play a critical role on dissemination of data and developments across past & current projects, and project technical leadership & stakeholder organizations. Quarterly meeting will be held with PWG in the form of Workshops & SeminarsPWG will be formed byPIU and they will be the technical staffs of PIU.

Regarding PWG, main functions would be the guidance of the consultant in light with contract in order to allow rapid acceptance of the tasks and deliverables, enable smooth coordination of sites, properly inspection and testing. The input of PWG in the project will be substantive & meaningful. PWG will be as a mechanism for sharing knowledge, building capacity and developing sustainability.

2.4.2 Project Oversight Committee

Project Oversight Committee (POC) will be formed from systems managers and decision makers of the stakeholder groups as well as governmental organization representatives of ministry scale. POC's influence within public services organization matrix and leverage on public bodies, will allow rapid acceptance of the project and enable smooth coordination of site contacts, inspections and testing. Quarterly meetings will be held with POC in the form of Seminars & Conferences. These will serve as forums for dissemination of previously completed & approved phases of the projects. Formation of POC would be from PIU, other related stakeholders and experts from academia nominated by the Project Director. Review and Approval Cycle for the JV-PWG-POC Interaction will be as following:

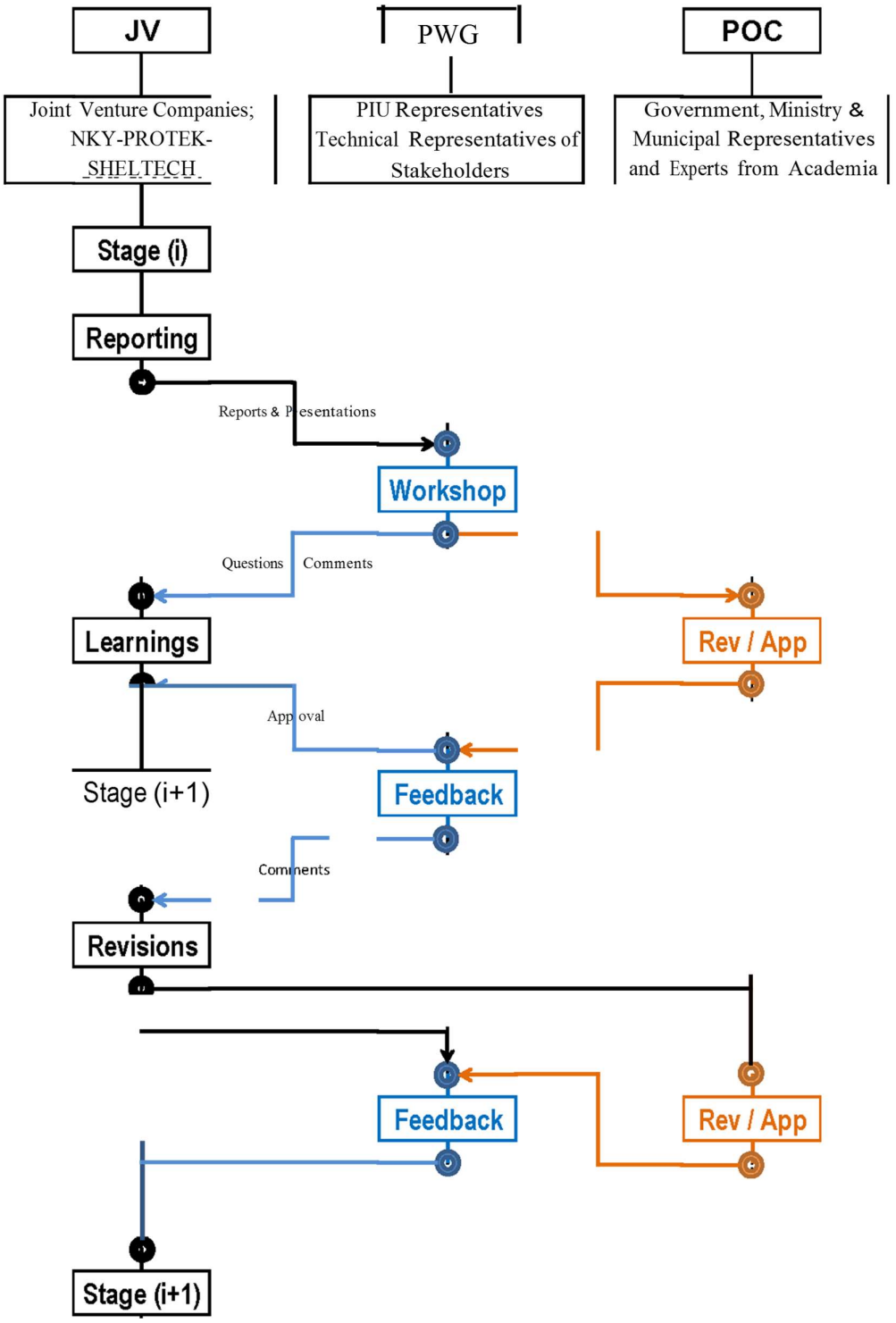


Figure :2-3

Joint Venture Internal Review and QA/QC Coordination will be as following:

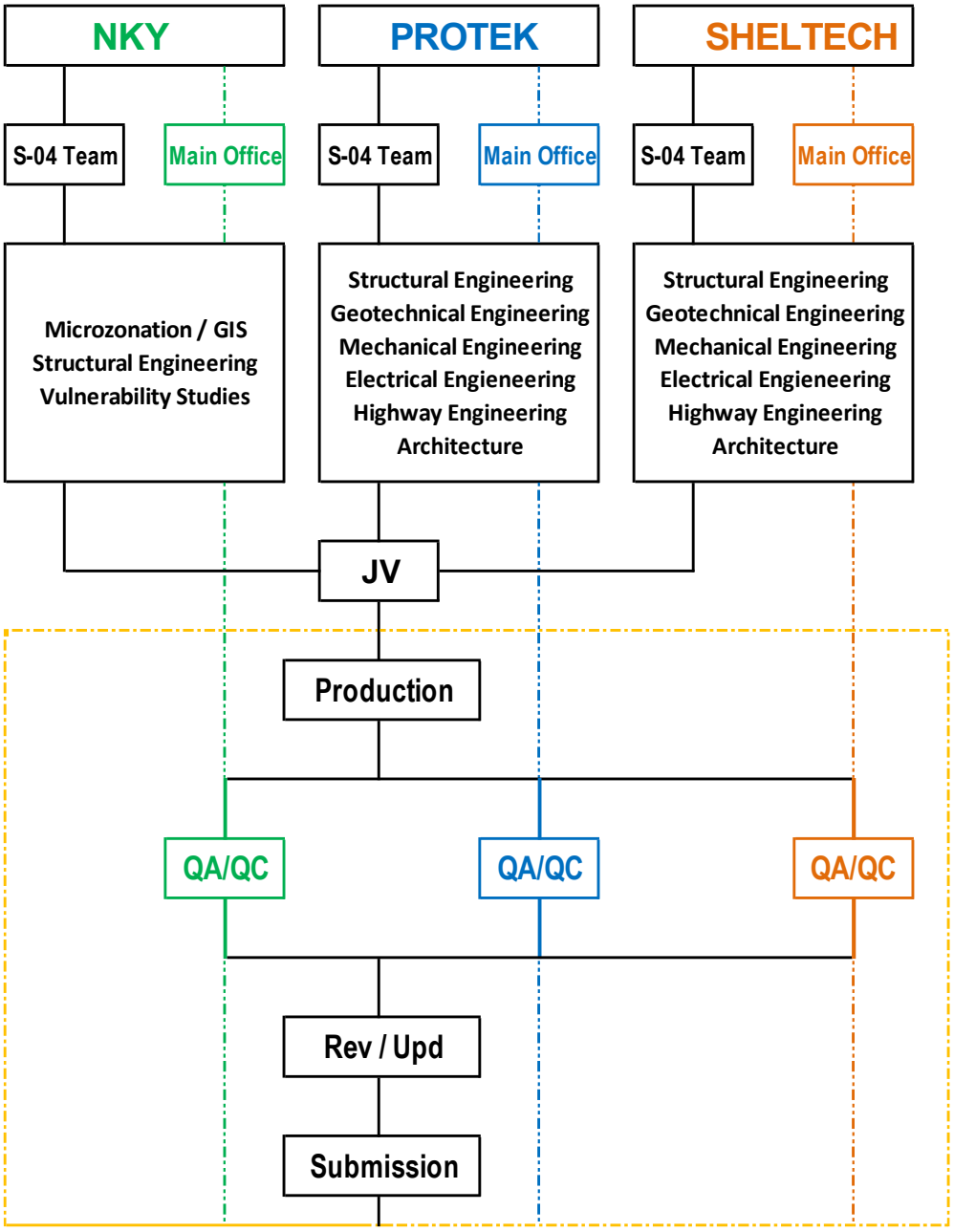


Figure :2-4

2.4.3 Stakeholder Conferences

PWG & POC Meetings will be used as forums of dissemination and following forms of communication employed;

- Workshop: for hands-on discussion of a few topics with PWG and invited experts,
- Seminar: for sharing a development on a particular narrow range of topics and broader discussion with stakeholder groups and/or engineering community.
- Conference: dissemination of field specific knowledge, recent developments, and collecting technical and non-technical attendee opinion.

It is expected that there will be one of such gatherings on an average interval of 3 months. All these meetings can be complemented with closed sessions for detailed discussions on immediate and detailed issues not developed for standard presentations.

2.4.4 Training & Workshops

There will be standard trainings and refreshers for the JV staff to coordinate the uniform execution of the planned tasks. There will also be dissemination workshops upon close of important project milestones to improve the national technical capability.

Workshops
Traning Kits
E-Learnings
Virtual workshops

These training and works shops are considering are discuss in chapter 4 in section 4.8.4.

2.4.5 Reporting & Publicizing

Reports will be prepared in a unified and structured format which is tailor made for the project by the JV. JV will run its internal quality assurance system to enable high quality of information production. Main offices of JV partners will have the control and maintain the oversight, Figure above. This will off load the site staff from revision works and will provide independent second checking opportunity. Upon internal agreement the data, report and presentations will be issued with the authorized signature of the JV- Leader.

As already outlined in Figure above the report and approval process will involve PWG and POC contributions. Public announcement will be undertaken by PWG upon approval of POC, JV will contribute to the process in sharing data, report and presentation material developed for and during the Stakeholder Conferences.

2.5 Project Deliverables

2.5.1 MD - Main Deliverables

Our deliverables have been categorized in 3 main categories. The first category refers to interim deliverables (ID) which are developed for the purpose of internal usage and database development. These interim reports will be part of the Deliverables (D) as Annex and submitted to PIU for their feedback which is the second category. The third category of the reporting refers to Main Deliverable (MD) that is linked to Payments. In following tables each category is separately provided. Complete Deliverables and their linkages can be seen in Work Plan.

Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka

Package No.: URP/RAJUK/S-04, IDA Credit: 55990

Correlation between Staff and Deliverable

Tasks and Accomplishments	Deliverable	List of Reports/ Documents to be submitted or approved	Duration
	MD-1	1-submission of the comprehensive situation analysis report defined in item # in FIN-5	01-Nov-18 to 28-Feb-19
	MD-2	2- submission of 1st level (RVA) vulnerability reports with ranking of all the buildings totaling a floor area of 2,000,000 sqm.	01-Apr-19 to 31-Jul-19
	MD-3	3- submission of 1st level (RVA) vulnerability reports with ranking of all the remaining buildings	01-Jun-19 to 31-Oct-19
	MD-4	4- submission of 2nd level (Preliminary Assessment) of vulnerability assessment reports with ranking of all the buildings totaling a floor area of 500,000 sqm.	01-Nov-19 to 30-Jan-20

	MD-5	5- submission of 2nd level (Preliminary Assessment) of vulnerability assessment reports with ranking of all the remaining buildings.	01-Sep-19 to 30-Jun-20
	MD-6	6- submission of feasibility report following DEA for all the buildings with floor area totaling 250,000 sqm including retrofitting design and cost estimates for buildings eligible for retrofitting works.	01-Jul-20 to 30-Nov-20
	MD-7	7- submission of feasibility report following DEA for all the remaining building at the 3rd level including retrofitting design and cost estimates for buildings eligible for retrofitting works.	01-Oct-20 to 31-Mar-21
Full documentation and preparation of reports and deliverables.	MD-8	1. submission of the Long Term Investment and Strategy Guideline as per activities defined in item # c in FIN-5	01-Oct-21 to 31-Oct-21

Note:

MD - Main Deliverable- Will be submitted to PIU for Approval and Payment

2.5.2 D - Deliverables

Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka			
Package No.: URP/RAJUK/S-04, IDA Credit: 55990			
Correlation between Staff and Deliverable			
Tasks and Accomplishments	**Deliverable**	**List of Reports/ Documents to be submitted or approved**	**Duration**
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)	D-1	Final report of the evaluation	01-Nov-18 to 30-Nov-18
Data Collection and Documentation	D-2	Needs Assessment Report	01-Dec-18 to 28-Feb-19
	D-3	Complete database for all critical infrastructure, superstructures described in the scope of the services	01-Dec-18 to 28-Feb-19
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	D-4	3. Develop a state-of art methodology that meets the comprehensive objectives of the project and forms a decision tool for the government in assisting their investment choices. Detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets will be conducted and reported	01-Mar-19 to 31-Mar-19
	D-5	4. Development of a specific Prioritization Methodology for Seismically Vulnerable Public Buildings	01-Mar-19 to 31-Mar-19
	D-6		

		5. Preparation of unified and integrated analysis methodology	01-Mar-19 to 31-Mar-19
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies	**D-7**	3. Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.	01-Mar-19 to 31-Mar-19
Physical survey and risk and vulnerability assessment of the facilities identified in scope of work	**D-8**	1- Prepare and submit a comprehensive report on the outcomes of the Rapid visual assessment	01-Apr-19 to 30-Apr-19
	D-9	1. Prepare and Submit General Material Test Report addressing all structures	01-Jul-20 to 28-Feb-21
	D-10	3. Prepare and Submit Tender Documents (in accordance with the World Bank guidelines and standard	01-Oct-20 to 31-Mar-21
Finalization of outputs and cross-referencing of final results and Validation of assessment results by PWG and POC	**D-11**	3. Analysis of the outcomes and framework plan report stating the overall findings and way forward	01-Jan-21 to 31-Jan-21
Creation of a historical calibration and validation database	**D-12**	5-Full documentation and preparation of reports and deliverables	01-Feb-21 to 28-Feb-21
Development of an draft Dhaka Urban Resilience Strategy with a vision statement, specific	**D-13**	1. Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives	01-May-21 to 31-May-21

objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators.			
Development of investment programs, projects and activities for vulnerability reduction of essential facilities, with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy	**D-14**	1. Investment Report for the activities to be carried out ın phase wise for short, medium and long term objectives ıdentified.	01-Jun-21 to 30-Jun-21
	D-15	2. Investment Plan and objective report for buy-in process	01-Jul-21 to 31-Jul-21
Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	**D-16**	1. Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	01-Aug-21 to 30-Sep-21
D - Deliverable- Will be submitted to PIU for verification and information purposes			

2.5.3 ID - Interim Deliverable

Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka			
Package No.: URP/RAJUK/S-04, IDA Credit: 55990			
Correlation between Staff and Deliverable			
Tasks and Accomplishments	**Deliverable**	**List of Reports/ Documents to be submitted or approved**	**Duration**
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)	**ID-1**	The ToRs and evaluation criteria	01-Nov-18 to 30-Nov-18
	ID-2	Evaluation of the experts and result based matrix	01-Nov-18 to 30-Nov-18
	ID-3	Preparation of the Organogram	01-Nov-18 to 30-Nov-18

Data Collection and Documentation	**ID-4**	Situation Analysis Report	01-Dec-18 to 28-Feb-19
	ID-5	Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)	01-Dec-18 to 28-Feb-19
	ID-6	Provide up to date list of the all the critical infrastructure and facilities.	01-Dec-18 to 28-Feb-19
	ID-7	Urban Profile and Characteristics Report	01-Dec-18 to 28-Feb-19
	ID-8	Analysis of Outcomes	01-Dec-18 to 28-Feb-19
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	**ID-9**	1. Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide.	01-Mar-19 to 31-Mar-19
	ID-10	2. Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities	01-Mar-19 to 31-Mar-19
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies	**ID-11**	1. Report on Proceedings of the workshops	01-Mar-19 to 31-Mar-19
	ID-12	2. Report on outcomes of the findings	01-Mar-19 to 31-Mar-19
Finalization of outputs and cross-referencing of final results and	**ID-13**	1. Report on Proceedings of the workshops	

Validation of assessment results by PWG and POC			01-Jan-21 to 31-Jan-21
	ID-14	2. Report on outcomes of the findings	01-Jan-21 to 31-Jan-21
Creation of a historical calibration and validation database	**ID-15**	1. GIS based database for all the activities carried out.	01-Feb-21 to 28-Feb-21
	ID-16	2- Risk Communication Methodology and Report	01-Feb-21 to 28-Feb-21
	ID-17	3-Independent Peer Review Report	01-Feb-21 to 28-Feb-21
	ID-18	4- Update of Dhaka City Risk Profile and Atlas (including seismic catalogue)	01-Feb-21 to 28-Feb-21
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	**ID-19**	1. Report of Prioritization and mitigation strategies	01-Mar-21 to 31-Mar-21
	ID-20	2. Report for Proceedings and outcomes of the consultations	01-Mar-21 to 31-Mar-21
	ID-21	1. Develop Report on Risk Reduction and Rehabilitation	

Development of options for risk reduction and for achieving long term urban resilience in Dhaka		including contingency planning and framework of long term objectives	01-Apr-21 to 30-Apr-21

Note:
ID - Interim Reports/Deliverable
D - Deliverable- Will be submitted to PIU for verification and information purposes
MD - Main Deliverable- Will be submitted to PIU for Approval and Payment

Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka			
Package No.: URP/RAJUK/S-04, IDA Credit: 55990			
Correlation between Staff and Deliverable			
Tasks and Accomplishments	**Deliverable**	**List of Reports/ Documents to be submitted or approved**	**Duration**
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)	**ID-1**	The ToRs and evaluation criteria	01-Nov-18 to 30-Nov-18
	ID-2	Evaluation of the experts and result based matrix	01-Nov-18 to 30-Nov-18
	ID-3	Preparation of the Organogram	01-Nov-18 to 30-Nov-18
Data Collection and Documentation	**ID-4**	Situation Analysis Report	01-Dec-18 to 28-Feb-19
	ID-5	Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)	01-Dec-18 to 28-Feb-19
	ID-6	Provide up to date list of the all the critical infrastructure and facilities.	01-Dec-18 to 28-Feb-19
	ID-7	Urban Profile and Characteristics Report	01-Dec-18 to 28-Feb-19
	ID-8	Analysis of Outcomes	01-Dec-18 to 28-Feb-19

Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	**ID-9**	1. Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide.	01-Mar-19 to 31-Mar-19
	ID-10	2. Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities	01-Mar-19 to 31-Mar-19
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies	**ID-11**	1. Report on Proceedings of the workshops	01-Mar-19 to 31-Mar-19
	ID-12	2. Report on outcomes of the findings	01-Mar-19 to 31-Mar-19
Finalization of outputs and cross-referencing of final results and Validation of assessment results by PWG and POC	**ID-13**	1. Report on Proceedings of the workshops	01-Jan-21 to 31-Jan-21
	ID-14	2. Report on outcomes of the findings	01-Jan-21 to 31-Jan-21
Creation of a historical calibration and validation database	**ID-15**	1. GIS based database for all the activities carried out.	01-Feb-21 to 28-Feb-21
	ID-16	2- Risk Communication Methodology and Report	01-Feb-21 to 28-Feb-21

	ID-17	3-Independent Peer Review Report	01-Feb-21 to 28-Feb-21
	ID-18	4- Update of Dhaka City Risk Profile and Atlas (including seismic catalogue)	01-Feb-21 to 28-Feb-21
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	**ID-19**	1. Report of Prioritization and mitigation strategies	01-Mar-21 to 31-Mar-21
	ID-20	2. Report for Proceedings and outcomes of the consultations	01-Mar-21 to 31-Mar-21
Development of options for risk reduction and for achieving long term urban resilience in Dhaka	**ID-21**	1. Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives	01-Apr-21 to 30-Apr-21

Note:

ID - Interim Reports/Deliverables

D - Deliverable- Will be submitted to PIU for verification and information purposes

MD - Main Deliverable- Will be submitted to PIU for Approval and Payment

CHAPTER 3

Inception Phase Activities

3 Inception Phase Activities

3.1 Inception Phase Steps

The objective of this section is to provide a summary of feedback and inputs from the inception phase activities and events.

3.2 Inception Activities

Following activities has been conducted during the inception report period

3.2.1 Stakeholders Identification

The list of the stakeholders has been identified after carefully review of all the possible stakeholders in Dhaka in close collaboration with PIU director Mr. Helaly. An invitation letter has been extended to all the stakeholders for participation to the Meeting that was arranged for 10th of December 2018. The complete list of the stakeholders is as following;

Serial	Organization
1.	Rajdhani Unnayan Kartripakkha (RAJUK)
2.	Detailed Area Plan Project (2016-2035), RAJUK
3.	Department of Civil Engineering, BUET
4.	Department of Urban and Regional Planning, BUET
5.	BUET-Japan Institute of Disaster Prevention and Urban Safety (JIDPUS)
6.	Department of Geology, University of Dhaka
7.	Department of Disaster Science and Management, University of Dhaka
8.	Ministry of Disaster Management and Relief
9.	Department of Disaster Management
10.	Local Government Engineering Department (LGED)
11.	Education Engineering Department (EED), Ministry of Education
12.	Urban Development Directory (UDD)
13.	Bangladesh Fire Service and Civil Defense
14.	Public Works Department
15.	Infrastructure Division, Ministry of Planning
16.	Dhaka South City Corporation
17.	Dhaka North City Corporation
18.	Narayanganj City Corporation
19.	Gazipur City Corporation
20.	Housing and Building Research Institute (HBRI)
21.	Dhaka Transport Coordination Authority (DTCA)
22.	Department of Environment (DoE)
23.	Geological Survey of Bangladesh (GSB)
24.	Dhaka Water Supply and Sewerage Authority (DWASA)
25.	Civil Aviation Authority of Bangladesh (CAAB)
26.	Dhaka Electric Supply Company Limited (DESCO)
27.	Dhaka Power Distribution Company Limited (DPDC)
28.	Titas Gas Transmission and Distribution Company Limited
29.	Urban Building Safety Project, Public Works Department
30.	Bangladesh Institute of Planners (BIP)
31.	Institute of Engineers Bangladesh (IEB)
32.	Institute of Water Modeling

Serial	Organization
33.	Center for Environmental and Geographic Information Services (CEGIS)

Following list are the main stakeholders has been identified to take part in POC and PWG

- Ministry of Disaster Management & Relief
- Infrastructure Division, Planning Commission
- Rajdhani Unnayan Kartripakkha (RAJUK)
- Public Works Department (PWD)
- Local Government Engineering Department(LGED)
- Department Of Disaster Management(DDM)
- Bangladesh Meteorological Department(BMD
- Education Engineering Department
- Fire Services and Civil Defense(FSCD)
- House Building and Research Institute(HBRI)
- BUET Department Of Urban and Regional Planning (DWASA)

3.2.2 Needs Assessment and Data Required

List of the Critical Facilities to be assessed under the scope

1. **Adequate number of the structures composed of Hospitals, School Buildings, Fire Stations, DRM and DDM buildings, Critical Facilities with a total area of 5 million sqm**

PWG and POC

1. Nominates for Project Oversight Committee and for Project Working Group

Digitization and characterization of exposure data and Preparation of GIS database

Studies have been conducted by national and international stakeholders with regarding to vulnerability and risk of the lifelines in Dhaka City including Water, transport, lifelines and gas line, pipeline, electricity line, etc for whole Dhaka City including city extension

1. Hazards data collection (flood and earthquake)
2. Complete list and database of the all critical infrastructure, superstructures and lifelines described in the scope of the services
3. Collection of satellite imagery and development of urban characteristics patterns
4. Development of proxies for missing data
5. Past studies conducted with regard to assessment of Critical Infrastructure
6. Existing GIS data files in raw format;
7. Exposure, hazard databases and GIS models available
8. Maps:
    - Topographic map
    - Census zone boundary map
    - District and sub-district boundary map
    - Traffic zone map
    - Geological map
    - Groundwater level
    - Detailed Area Plans
    - Master Plans including Revisions

Existing Building Vulnerability Assessment & Geotechnical Reports conducted for Dhaka

1. CDMP Project (Department of Disaster Management, Ministry of Disaster Management & Relief)- detailed assessment of critical structures and Geophysical Analysis. These were more than 400.000 structures. The data including final reports is required for Database purposes.
    - ADPC- consultant to CDMP
    - NSET-Nepal- sub consultant to ADPC
    - OYO Int. Jp – sub consultant to ADPC (Geophysical)
    - AIT- Thailand- sub consultant to ADPC
    - Dhaka University – Geology Department
    - Geological Survey of Bangladesh (GSB)
    - Atlas:
2. CDMP II: Detailed Data regarding following project. The data shall cover all raw data and Maps related to Seismic Risk Assessment
    - http://www.bd.undp.org/content/dam/bangladesh/docs/Publications/Pub2016/Seismic%20Risk%20Assessment%20in%20Bangladesh.pdf
    - http://emi-megacities.org/wp-content/uploads/2015/01/EQRiskAtlasBrochure.pdf
    - https://www.geonode-gfdrrlab.org/documents/421/download
    - UNDP Dhaka can be contacted for the data: http://www.bd.undp.org/content/bangladesh/en/home/operations/projects/All_Closed_Projects/Closed_Projects_Crisis_Prevention_and_Recovery/comprehensive-disaster-management-programme/publications.html
3. JICA & Public Works Department – Detailed Assessment for Emergency Structures
4. Accord, Alliance, ILO and BUET for detailed assessment of the Garments buildings,
5. EMI-Megacities –ATLAS based on CDMP I: http://emi-megacities.org/wp-content/uploads/2015/01/Dhaka-City-EQ-Risk_ProfileandAtlas_FINAL.pdf

The data should come through the proper channel, verified and official.

3.2.3 Kick off meeting

Kick-off: The kick-off meeting with URP team members was held in the URP Project Director's office on 30 October 2018.

Project Name	Vulnerability Assessment and Prioritized Investment Plan for critical Assests in Dhaka for URU – S-04				
Related Department	RAJUK				
Meeting Subject &Number	Kick Off Meeting				
Location	RAJUK PIU Head Office	Date	10.12.2018	Time	17:45 – 19:30
Chairperson / Moderator	Mr. Abdul Latif Helaly				

AGENDA:			
	Subjects	Presenter	Duration (mins)
1	Introduction of the Joint Venture and Experts	Omer Unlu	10
2	Briefing the attendance about the Stakeholder Workshop	Ahmed Yakut	20
3	Subjects related with starting works		60

No.	Discussion
1	PIU Director requested the JV to submit Inception Reports on 20 December 2018. It will be submitted to the World bank.
2	PIU Director said the test results of the SPT and CPT tests done previously should not be used. Only the reports of the new tests should be used.
3	PIU Director said there is no truck mounted CPT equipment available in Bangladesh. He further advised that a truck mounted CPT equipment should be provided. NKY General Coordinator said that, the JV is looking for a locally available CPT equipment.
4	PIU Director advised that the offices of S-04 and S-05 should be different. The staff should not use the same office.
5	PIU Director criticized the NKY General Coordinator that presentations of S-04 and S-05 projects should be done separately on 10 December 2018.
6	PIU Director said that Sheltech has the Revised Detailed Area Plan (Revised DAP) and the JV can use it.
7	PIU Director instructed the JV to submit the CVs of the key experts.
8	The status of the already submitted Advance Payment Bond discussed.




ATTENDEES			
Sr.	Name	Organization	Role / Affiliation
	Abdul Latif Helaly	**RAJUK – Project Implementation Unit (PIU)**	Project Director
	Md. Aminur Rahman (Sumon)	**RAJUK – Project Implementation Unit (PIU)**	Deputy Project Director
	Md. Taimur Tanvir	**RAJUK – Project Implementation Unit (PIU)**	Asst. Engineer (Geotechnical)
	BM Nurul Absar	**RAJUK – Project Implementation Unit (PIU)**	Asst. Engineer (Geotechnical) Focal Point S-05
	Saleh Ahmed Helaly	**RAJUK – Project Implementation Unit (PIU)**	Technical Officer, S-04
	Omer Unlu	NKY	General Coordinator
	Tolga Sahin	NKY	Overseas Director

	Ahmadul Hasan	SDE	Executive Director
	Ugurhan Akyuz	NKY-PROTEK-SHELTECH-SDE	Team Leader S-05
	Ahmet Yakut	NKY-PROTEK-SHELTECH-SDE	Practice Leader S-04
	Sadettin Sezer	NKY-PROTEK-SHELTECH-SDE	Coordinator S-05
	Sara Khoshnevis	PROTEK	CEO
	Abu Saleh Md. Shahidullah	NKY-PROTEK-SHELTECH-SDE	Urban Planner, S5
	Mehmet Yildiz	NKY-PROTEK-SHELTECH-SDE	Logistics & Admin
	Rafael Alaluf	NKY-PROTEK-SHELTECH-SDE	Practice Leader –Urban Hazard Vulnerability and Risk Assessment Expert-S5(International)
	Syed Ahsanul Haq	NKY-PROTEK-SHELTECH-SDE	S-4, Civil Engineer
	Md. Anisur Rahman	Sheltech	Deputy General Manager

3.2.4 Stakeholders Meetings

Main Objective: To assess the vulnerability & risk of Dhaka's critical facilities and develop a prioritized investment plan through an analytical approach

Major Outputs: Long-Term Vulnerability Reduction Investment Plan, Dhaka Urban Resilience Strategy.

Project Name	**Vulnerability Assessment and Prioritized Investment Plan for Critical Assests in Dhaka for Urban Resilience Unit – S-04 - DHAKA**				
Related Department	**RAJUK**				
Meeting Subject &Number	**Inception Workshop**				
Location	**Multi-purpose Hall JIDPUS-BUET, Dhaka**	**Date**	10.12.2018	**Time**	11:30 – 14:45
Chairperson / Moderator	Mr. Omer Unlu				

ATTENDANCES

Sr.	Name	Organization	Role / Affiliation
1.	Engr. Md. Kamruzzaman Khan	Titash Gas T&D Company Ltd.	Director (Operation)

2.	Sadettin Sezer	NKY	Coordinator S-05
3.	Saiful Alam	IWM	Sr. WRP
4.	Dr. Ahmadul Hasan	SDE	
5.	Tolga Sahin	NKY	Overseas Director
6.	Ugurhan Akyuz	NKY	Team Leader S-05
7.	Syed Ahsanul Haque	SDE	Coordinator
8.	Fathiya Zaman	SDE	
9.	Mehmet Yildiz	NKY	Logistics & Admin
10.	Sarwar Jahan	SDE	Project Manager
11.	Shaheen Ahmed	Urban Development Directorate	Senior Planner
12.	Ahmet Yakut	NKY	Practice Leader S-04
13.	Md. Nuruddin Sarker	GSB (Geological Survey of Bangladesh)	Director
14.	Engr. Shahnamul Quader	EED	XEN (Design)
15.	Md. Atikur Rahman	Sheltech	Junior Urban Planner
16.	Zinan A. Urmi	SDE	Geotechnical Engineer
17.	Raquib Ahsan	BUET JIDPUS	Director
18.	Dr. M Hossain	SDE	P. Manager
19.	Rafael Alaluf	EQRM/Protek	Practice Leader S05
20.	Md. Shajal Khan	SDE	Civil Engineer
21.	Iffat Haque	SDE	Consultant
22.	Prof. Dr. M. Qumrul Hassan	Geology, DU	Professor
23.	Md. Samsur Rahman	BUET JIDPUS	Admin
24.	MusferaJahan	Sheltech	Urban Planner
25.	Abu Musa Md Abdullah	Detailed Area Plan (2016-2035)	Urban Planner
26.	Uttama Barua	Dept. of URP, BUET	Lecturer
27.	Helaluddin Haque	DTCA	APSL
28.	Prof. AbulKalam	BIP	Professor
29.	Md. Nazrul- Islam	DSCC	City Planner
30.	Tanjiba Rahman	SDE	Urban Planner
31.	K. Habibur Rahman	SDE	Admin
32.	Ishrat Islam	Dept. of URP	Professor
33.	Ugurhan Akyuz	NKY	Team leader S-05
34.	Towhidul Islam	Sheltech	Urban Planner

35.	Abu Saleh Md. Shahidullah	Sheltech	Urban Planner

ATTACHED DOCUMENTS:		
1	Agenda	
2	List of Data required	
3	List of Stakeholders	
4	Questionnaire for Implementation	
5	Presentation slides	

AGENDA AND OUTCOME OF THE STAKEHOLDERS MEETING

Sr.	Subjects	Presenter	Duration (mins)
1	Welcome speech and Project overview	Arch. Omer Unlu	15
2	Introduction of Consultants, Team Composition, Overall Objectives, Methodology and Work Plan	Prof. Uğurhan Akyuz	25
3	Questions and answers from the participants		90
4	Group Panel Discussion		
5	Concluding Remarks	Arch. Omer Unlu	10

Sr.	Discussion
1	Presentation for S-05 project done.
2	**Shaheen Ahmed,** Senior Planner, Urban Development Directorate (UDD) asked about techniques or criteria for RVA.  **Ahmet Yakut** replied, • RVA is dependent on effects of any earthquake hazards on buildings which vary place to place with topography, active faults, building category etc. • The output for RVA should be suitable for Bangladesh. • The technique for assessment is similar to FEMA 154 but not exactly the same as FEMA has been prepared considering the buildings of USA. • Turkey has its own strategy for RVA. Data of earthquake hazard for Bangladesh is required to develop a unique strategy for Bangladesh. **Comment from Dr. Rquib:** There is no available data for EQ damage for Bangladeshi buildings as no major

	earthquake had any severe damage on the structures in the last decade. Besides available data from earthquake in India or Nepal may be used for the determination of earthquake intensity but not for vulnerability analysis. FEMA only covers lateral loading but for Bangladesh vertical loading capacity should also be assessed.
3	**Sayed Ashraf, CMS, Department of Disaster Management** said, WHO have some specific guideline for assessment for hospital building for visual inspection and it's not just a structure it has some service delivery area. So, its need to enter their operation theater also? **Mr. Dr. Ahmadul Hasan** replied In this project we are not going into hospital only, there have school, police station and public structure. This is the framework planning for government structure strengthening and this is the sample so that they can estimate what they will have to do and what will be the cost, resources and time needed.  **Comment from Dr. Hasan:** There are some guidelines for RVA provided by Accord and Alliance for Bangladesh. Also the output of hazard assessment will be an input for vulnerability assessment. **Comment from Mr. Ashraf (DDM):** WHO guidelines for hospital buildings can be considered too for RVA for hospital buildings. There should be two other inclusion of stake holders. ✓ Medical Department ✓ Airport Authority
4	**Mr. Dr. Sarwar Jahan** said, Many of the structure in the city vulnerable in fact fire brigade structure so every ward should have Emergency Operation Center (EOC). 

	 **Mr. Dr. Ahmadul Hasan** replied to **Mr. Sarwar** this is the World Bank RAJUK component, there are disaster management component under the World Bank, also fire service and planning commission doing the different component. Finally it will be integrated. The thing EOC should be added one of them component.
5	**Sayed Ashraf, CMS, Department of Disaster Management** said, • Medical facility department should be a stakeholder. • Airport authority is absolutely a different authority so it should be added. Specifically Sahajalal International Airport Authority. • In main streaming part it should be going in stage three main streaming, monitoring can make it overlap 2-2-3. • CDMP data is also basis on earthquake as well as urban flooding. If all the data especially geo-technical data (it is specially based on Dhaka city earthquake) is collected then it will be helpful. • Urban flood hazard data collection is one thing and impact assessment regarding flood is a different issue. That should be considered.
6	**Mr. Dr. Sarwar Jahan** said, important thing about the health facilities after the earthquake there are more than 100 hospital and clinic all over the city. There are few of them are public most of them private. Majority of them converted to residential use to hospital so they did not follow any criteria for hospital building. **Mr. Ahmedul Hasan** replied to Mr. Sarwar, in this component only public critical structure considered but not private ones. In this component public hospital consider not private clinic it should be other component.
7	**Shaheen Ahmed, Senior Planner, Urban Development Directorate (UDD)** said, • When disaster happened ministry of home affairs comes first to rescue so it should be added as a stakeholder. • Military also help to rescue people so Bangladesh Army should be added. • During the visual inspection it should be periodic maintenance. If it is not maintained properly than it will give different result. It could be considered. **Comment from representative of Education Ministry:** • No building prototype, each building type vary according to available land • All buildings have design life more than 100 years • 7 types of category for vulnerability analysis • Design records are available and can be provided •

8	**Mr. Dr. Raquib Ahsan** said, • We have lot of damage data but unfortunately we don't have any data in recent past because we did not have any significant damage in near past. • Historically Great Indian earthquake 1897 there are some survey done by British Geological Society and they have some publication.  • Their damage data would not be relevant to the structure assessment purpose it relevant to understanding of density of earthquake. Their structure type, damage type are not relevant in terms of materials and strength of material. • In terms of damage data we do not have any damage data. • Regional damage data may be used in some extend in Guzrat, Vupal. That could be used in some types of structure but it does not cover all category.
9	**Prof. Dr. Muhammad Qumrul Hassan** said, • We have epicenter in and around Bangladesh. • In Colombia University website there have jointly collaborate project of Dhaka University and Colombia University. • In Potsdam University, Germany website they have in and around maximum website. Where you can collect 200 hundred year data. 
10	**Prof. Dr. Abul Kalam Azad** said, In the master plan that is done by the RAJUK that could be important sources of the data. 
11	**Mr. Tolga Sahin** asked Mr. Quader, what about education engineering department?

	Engr. Shah Naimul Quader replied,  • Education Engineering Department constructs high schools and they follow all the guideline of BNBC. • Recently they constructed school building, college building and some new university like Barisal University, Rangpur University. • Some of these building are typical. • There use different layout and plan for educational structure. • There always follow the latest instruction of the BNBC. • Buildings are constructed by engineering department as per design and if they are properly maintained than it will sustain lifetime which is 99 years.
12	**Prof. Dr. Muhammad Qumrul Hassan** asked Mr. Quader, how foundations were and about the site selection because most of the education building site in our country selected by the politician. **Engr. Shah Naimul Quader** replaied, in building construction all time the soil conditions should be followed and there are different types of classification like costal area, flood affected area and urban area. There have 7 types of category of building in under Engineering Department.
13	**Mr. Sayed Ashraf** added, from the Prime Minister of Bangladesh provide the instruction to Educational Engineering Department in 1999 that all the educational buildings should be constructed according to the upper limit of flood level in 1999. But still some new university constructed below the flood level 1999.
14	**Mr. Dr. Raquib Ahsan** asked Mr. Quader, do you preserve your design drawing in your previous building? If NKY asked design and drawing for their vulnerability assessment could they provide? **Engr. Shah Naimul Quader** replayed, they preserve all the design, drawing and document and they can provide to NKY for vulnerability assessment.
15	**Mr. Tolga** asked Mr. Rakib, people talked about FEMA, so in our project can we use FEMA or other international regulation? **Mr. Dr. Raquib Ahsan** replied, • In FEMA there are correlations with like building height, modified pre-code and post-benchmark so here it cannot be followed. If it is to be used it needs to be modified. • Another thing is assessment of condition in many cases corrosion is big problem for the building if it is not properly maintained. If those building will be assessed as per the provision of FEMA it won't work. So assessment of condition is very important. • In FEMA it does not have any provision of gravity loads. They consider only lateral load and earthquake load and if the building are not design even

	properly to the gravity load even we just check the column capacity it don't pass. So it is needed to assess the condition, assess the capacity of vertical load bearing system than. **Mr. Ahsan** added There are some guidelines for RVA provided by Accord and Alliance for Bangladesh. Also the output of hazard assessment will be an input for vulnerability assessment.
16	**Mr. Tolga Sahin** replied to the Mr. Hasan question, in this project hospitals, fire stations, police stations, airport and school buildings will be assessed. All of them should be assessed as per all the circumstances. That does not mean high priority to the hospital and low priority to the school. It will be checked as per uses, capacity.
17	**Shaheen Ahmed, Senior Planner, Urban Development Directorate (UDD)** said, KPI (Key Performance Infrastructures) should be considered like electric power station. Utility lines and electric lines are also should be considered. **Mr. Tolga** replied Mr. Ahmed, it should be another project. In this project only public critical assets will be considered.
18	Conclude the meeting of S-4 Decisions: ➢ Two more stake holders should be included o Medical department o Airport authority ➢ Available data from CDMP, ECRRP and Education Ministry should be collected

3.2.5 Participants Lists

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Urban Resilience Project: RAJUK Part
RAJUK Commercial Complex Cum Car Parking Building (8th & 9th Floor),
Gulshan,- 1, Dhaka-1212

Rajdhani Unnayan Kartripakkha (RAJUK)

Meeting with Consultants

Package No. : URP/RAJUK/ S-445

Date: 10-12-2018

Time: 5:45 pm

Venue: Office of the Project Implementation Unit at 9th Floor of RAJUK Commercial Complex cum Car Parking Building, Gulshan-1, Dhaka-1212

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Rajdhani Unnayan Kartripakkha (RAJUK)

Meeting with Consultants

Package No. : URP/RAJUK/ S-4&5

Date: 10-12-2018

Time: 5:45 pm

Venue: Office of the Project Implementation Unit at 9th Floor of RAJUK Commercial Complex cum Car Parking Building, Gulshan-1, Dhaka-1212

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16			
17			
18			
19			

3.2.6 Project Implementation Concept Workshop

3.2.6.1 WORKSHOP OUTLINE

Considering the complexity of the components and interrelationship and interdependency of the sub-components the coordination among the agencies and stakeholders has a crucial importance. For establishment of effective implementation mechanisms and coordination, the stakeholders needed to be aware of overall progress and implementation frameworks which have been aimed to be provided through serials of trainings throughout the project development.

Furthermore, it was important to identify the actual needs and come up with a sustainable long term capacity development programmer for the senior management/staff of the project partners and stakeholders. For that reason, the first serial of these trainings with above objective coupled with basic understanding of the coordination and implementation mechanisms was held and facilitated by PIU between December 8th to December 10th, 2018.

The workshop had aimed to provide an understanding of overall concept of the URP project that will be analyzed in detail and a common ground for effective implementation strategy is expected to be formed. The stakeholders were given a detail understanding of the common inter-relationships among the components and possible coordination mechanisms will be set by providing logical and applicable methods by providing presentations for S4 package.

Furthermore, the weaknesses and strengths were being identified and the shortcomings leading to unexpected delays in delivering the project components will be discussed and necessary tools to overcome those weaknesses will be elaborated.

The three days stakeholders' workshop was conducted in form of short presentations delivered by facilitators and elaboration will be through open discussions in general. The discussion on roadmap framework, expectations and challenges are going to be through the panel discussions.

We provide a brief on the project overall aims and objectives, the implementation framework of the activities, M&E process, outputs and expected achievements along with the up-to date progress on the activities provided. In particular we addressed following issues.

- Challenges breaking the effective coordination among the stakeholder
- The Risk component and risk management
- Are the end-users defined appropriately
- Are the activities being carried out are duplicated? How to integrate similar projects and get benefit from the outputs
- How to make the implementation effectively and how to sustain the long term implementation objectives
- Is Community engagement any of interest

Workshop was successfully implemented and many bilateral discussions with the Stakeholders, PIU and other authorities were convened. NKY-PROTEK-SHELTECH JV participated to the Workshop with full capacity including Team Leaders and National/International Experts.

PROJECT IMPLEMENTATION CONCEPT WORKSHOP

FOR

CONSULTANCY SERVICES FOR VULNERABILITY ASSESSMENT AND PRIORITIZED INVESTMENT PLAN FOR CRITICAL ASSETS IN DHAKA (S-4)

DHAKA, 9 DECEMBER 2018
BY
NKY – PROTEK YAPI – SHELTECH JOINT VENTURE + SDE LIMITED

3.2.7 JV internal Workshops

Several internal JV workshops have been conducted during since contract signature as well as after the initiation of the project. Among them a Workshop in Ankara/Turkey with the presence of all JV members was convened to identify way forward including arrangement of management and implementation plan. Furthermore 2 technical workshops among JV members were convened to technically discuss the final methodologies to be implemented as well as the proper implementations of the field and desk works.

3.2.8 Site visits

The consultants' teams in order to identify the major problems associated with the Critical infrastructures as well as buildings and in order to identify the capacity of the national stakeholders convened site visits in Dhaka.

Buildings

Some of the buildings visited are as following:

- Azampur Govt. Primary School 11Dec18
- Fire Service HQ Visit 10Dec18
- Hospital Visit_10Dec18
- Dhaka Medical Visit 10Dec18

Laboratories

Some of the laboratories visited are as following:

- BUET CE and JIDPUS Lab Visit 11Dec18
- Military Institute Lab Visit 11 Dec 18

3.3 Challenges and Important Outcomes of the Meetings

Following Key challenges has been identified as critical and have crucial importance for successful implementation of the project.

Duration

The duration of 36 months is sufficient enough to carry out all the activities within the responsibility of our JV in accordance with ToR requirements and our methodologies. However, during the kick off meetings and bilateral meetings with PIU a specific request was made if a fast track of the activities would be possible. Our teams have extensively studied the workplan and deliverables and have reached to following conclusion:

1- The duration of the 36 months can be reduced to 30 months- the quality of the outputs and achievements will remain the same- with the understanding and acceptance of following terms:

   a. The data required which has been stated in Chapter 3 of this report including the list of the buildings shall be immediately provided.
   b. The duration for the approval of the reports from the PIU/WB shall be limited to 10days.
   c. The additional staff/individual consultants/sub-contractors may require and the consultant will provide as required. No extra charge for these consultants will be requested however the expectation from PIU is to facilitate their utmost assistance to timely provide the payments in accordance with the revised workplan of Deliverables provided in Chapter 5.
   d. Facilitation from PIU for getting necessary approval from the relevant building authorities to be able to conduct RVA/PEA/DEA studies. Especially providing necessary permissions have crucial importance.
   e. With the workplan provided we have aimed to have a deliverable/financial progress of at least 40% by July 2019 and 75% by July 2020 while we have aimed to complete project by June 2021.

Data Validation and Security

Data Validation is important part of the project success and PIU is expected to assist our JV for establishment of the Project Working Group and Project Oversight Committee. The responsibilities of PWG along with the core team of JC in Dhaka will be validation of these data.

Lack of Technical Capacity

One of the aims of the project outcomes is capacity building and training of the national staff on the outcomes of the project. In that sense we have come to understanding that this is a big challenge that we need to overcome. A successful project should have sustainability and resiliency so that we expect the technical teams of PIU and relevant stakeholder be part of the project and have close cooperation with our experts in the ground. We do as well believe that international workshops to see best practices has crucial importance so that we hereby state our readiness to provide a workshop in Turkey for Bangladesh stakeholders and PIU to show best practices especially ISMEP Project.

CHAPTER 4

Technical Approach & Methodology

4. Methodology for Technical Activities

4.1 General

The risk assessment process is one of the initial steps for developing cost effective mitigation strategies to achieve URP's overall goal. The critical facilities within the concept of the consultancy that are expected to be more than 2000 facilities and infrastructure in Dhaka region. The facilities include schools, hospitals, health centers, warehouse, residential units etc., and this infrastructure is located in highly seismic areas. Thus there is an urgent need to assess the structural and nonstructural components of these facilities and ensure the long term sustainability of future development.

Earthquake risk assessment and safety planning usually recommends a two pronged approach. First, assess the existing facilities and strengthen them as needed. Second, introduce seismic consciousness among the organizations to mainstream earthquake safety in their respective development planning.

Also, this is very important to mentioned that it's the responsibility of PIU to provide the list and type of the facilities however JV consultant will support PIU in selection to make sure they resemble all the types for long term investment plan purposes.

4.1.1 Project Scope and Inventory

Within the context of Urban Resilience Project: RAJUK Part and under a loan from IBRD Loans and IDA Credits & Grants by World Bank, a number of public service buildings; water, gas, electricity & transmission systems; essential infrastructure components & complexes will be selected to be assessed for possible improvement, decommissioning, or retrofitting; which are required to provide support and shelter to disaster response and recovery operations.

The studies will aim to develop the following;

- Rapid Visual Screening of building & non-building structures and infrastructure systems,
- For building structures;
  - Preliminary and detailed assessment for structural systems,
  - Preliminary and detailed retrofit designs for structural systems,
  - Non-structural upgrade for the safety of the inhabitants,
  - Plans, section, & details drawings indicating and detailing the proposed measures,
  - Cost-estimates and bills of quantities,
  - Specifications to be followed,
  - Tender documents,
- Recommended performance improvement strategies for non-building structures and infrastructure systems,
  - Preliminary assessment,
  - Expert opinion on improvement recommendations and cost-estimates,
  - Typical improvement sketches and details.
- Multi-hazard vulnerability rating of building & non-building structures and infrastructure systems,
- Maps, databases, and web repositories for the collected and processed data on GeoDASH,
- Synthesis report on feasibility of the project.

While undertaking the tasks above, a group of stakeholders formed by PIU and technical departments of relevant authorities are to be designated by the Joint Venture as the Project Working Group (PWG) and they will provide;

- Thorough review and comments on all output of JV,
- Provide additional input on local design practices, applied retrofit solutions, and their experience with public building retrofits.
- Provide specialists help on particular points not explicitly address by codes.

Another group of stakeholders from managerial positions of the relevant authorities are to be designated by the Joint Venture as the Project Oversight Committee (POC) and will provide;

- Integrated coordination of policy decisions and their dissemination,
- Enable widespread support to the JV operations within their organizations,
- Provide specialists help on particular points not explicitly address by legislations.

Concrete Moment Frames	
C1	These buildings consist of a frame assembly of cast-in-place concrete beams and columns. Floor and roof framing consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Seismic forces are resisted by concrete moment frames that develop their stiffness through monolithic beam–column connections. In older construction, or in levels of low seismicity, the moment frames may consist of the column strips of two-way flat slab systems. Modern frames in levels of high seismicity have joint reinforcing, closely spaced ties, and special detailing to provide ductile performance. This detailing is not present in older construction. The foundation system may consist of a variety of elements.
Concrete Shear Walls	
C2 (with Stiff Diaphragms)	These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Buildings may also have steel beams, columns, and concrete slabs for the gravity framing. Floors are supported on concrete columns or bearing walls. Seismic forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced but often extend throughout the building. In more recent construction, shear walls occur in isolated locations, are more heavily reinforced, and have concrete slabs that are stiff relative to the walls. The foundation system may consist of a variety of elements.
C2a (with Flexible Diaphragms)	These buildings are similar to C2 buildings, except that diaphragms consist of wood sheathing, or have large aspect ratios, and are flexible relative to the walls.
Concrete Frames with Infill Masonry Shear Walls	
C3 (with Stiff Diaphragms)	This is an older type of building construction that consists of a frame assembly of cast-in-place concrete beams and columns. The floor and roof diaphragms consist of cast-in-place concrete slabs and are stiff relative to the walls. Walls consist of infill panels constructed of solid clay brick, concrete block, or hollow clay tile masonry. The seismic performance of this type of construction depends on the interaction between the frame and the infill panels. The combined behavior is more like a shear wall structure than a frame structure. Solidly infilled masonry panels form diagonal compression struts between the intersections of the frame members. If the walls are offset from the frame and do not fully engage the frame members, the diagonal compression struts do not develop. The strength of the infill panel is limited by the shear capacity of the masonry bed joint or the compression capacity of the strut. The postcracking strength is determined by an analysis of a moment frame that is partially restrained by the cracked infill. The shear strength of the concrete columns, after racking of the infill, may limit the semiductile behavior of the system. The foundation system may consist of a variety of elements.
C3a (with Flexible Diaphragms)	These buildings are similar to C3 buildings, except that diaphragms consist of wood sheathing or untopped metal deck or have large aspect ratios and are flexible relative to the walls.

Expected Building Structural Types in the Inventory, ASCE 41-13.

4.1.2 Expected Project Inventory

Project Inventory is not defined explicitly; however, likely Inventory Components for the current study are;

- Essential and Client Specified Facilities,
- Transportation Lifelines System,
- Hazardous Materials Facilities,
- High Potential Loss Facilities,
- Utility Lifeline Systems.

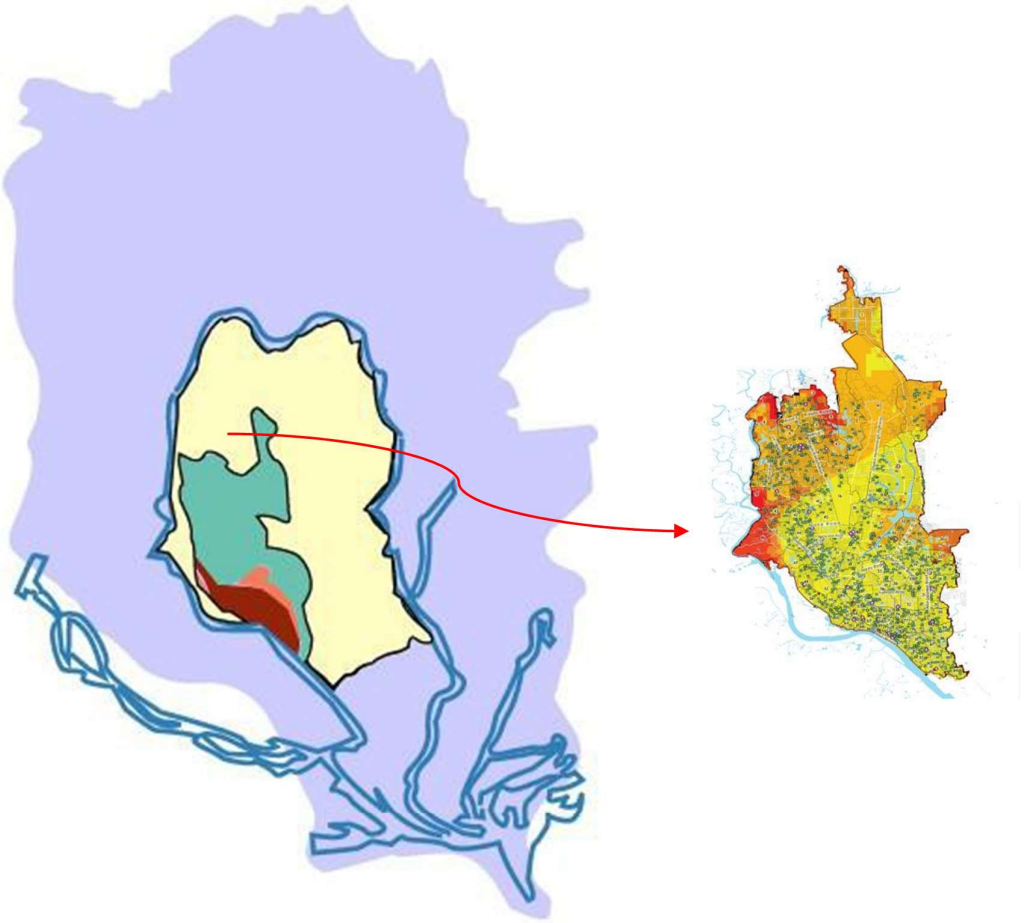


Figure 1.2 *– RAJUK Jurisdiction Area of 590 square miles versus North & South City Corporation Areas of 105 square miles with past assessment projects,*

Mughal 1640; British 1847; Pakistan 1951; Pakistan 1974; DMDP 2006

Adapted from the "RAJUK's planning and development activities and conservation measures for the lakes and success stories from Dhaka" presentation and the Earthquake Risk in Dhaka Poster of EMI.

Building structures in the inventory are expected to be comprised of reinforced concrete structures possibly with the following occupancy types, Figure 1.1;

- School Complexes – Classroom and Dormitory Buildings,
- Hospital Buildings – Inpatient Buildings, Operation Theatres, Laboratories, etc.,
- University Buildings – Lecture Rooms, Laboratories, Student Lodging Facilities, etc.,
- Municipal & Government Offices – Police Stations, Fire Stations etc.,
- Dhaka International Airport – Building and Non-Building Structures as much as cleared for access,

Infrastructure systems and components may include components from following and/or additional stakeholders;

- DPDC – power distribution system,
- DWSSA – drinking water transmission and distribution & sewerage collection systems,
- TITAS – gas transmission and distribution system,
- FSCD – fire and civil defense system,
- RHD – transportation and traffic system,

To assess the number, size, complexity, condition and accessibility of the above summarizes building groups a Rapid Visual Screening phase will be undertaken and the inventory consolidated through the discussions with the Client.

4.1.3 Previous Projects & Data Availability

It is expected that there will be a large document pool of original design data and previous study data & reports from earlier works run by DIT, RAJUK and PWD. Some of the projects could be traced from open sources and these suggest that following types of and other are undertaken and will be made available to JV;
Previous studies on Seismic Hazards with data, maps, drawings & reports,
Previous studies on Flood Hazards with data, maps, drawings & reports,
Statistics and distribution on urban and rural habitat, population, and environment,
Original building architectural, structural, mechanical, electrical design data,
Infrastructure maps, data and drawings,
Multi-Hazard studies of local and national scale with data and reports,
Hazard map, census, building structure, building function, and similar data on GeoDASH and other Repositories.

4.1.4 Parallel Projects & Data Availability

We are aware of a parallel project on “Consultancy Services for Development of Risk Sensitive Land Use Planning practice”. With this project running in parallel there could & should be a significant data flow for maintaining the relevance of both projects. Since the two projects can change one another’s underlying assumptions; interaction at the close of major milestones of each project would prevent the projects from getting “outdated” before their close. We propose a common data pool to be shared for both of the projects by RAJUK and the project outcomes shared and discussed at relevant intervals.

The vulnerability assessment process we would like to propose has five stages i.e., Level 0 (data collection stage), Level 1, Level 2, Level 3 and Level 4. The brief description of each of the levels of the vulnerability assessment is explained below.

Level 0 Survey (Preparation and Data Collection Stage)

In order to assess the seismic and non-seismic risk of facilities, the survey collects the location and other basic details about critical infrastructure in Dhaka. Any facility that is totally or partially (a) owned, (b) rented, or (c) operated by RAJUK or provided by the Gov. of Bangladesh will participate in the survey process. The survey parameters will include name of agency, location, latitude/longitude, primary purpose, facility manager details, number of structures within a facility, their age, average and maximum capacity, tenure, number of floors and general condition.

Level 1/2/3 Survey (Structural Vulnerability Assessment)

NKY+PROTEK+ SHELTECH JV have developed a detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets. This will include reviewing risk assessment and prioritization studies done by other countries or cities abroad which have similar earthquake risk, geographic or demographic conditions or any such countries or cities that might set an example for the purposes of this assignment.

The "Level 1 Rapid Survey", will employ a standard method for conducting low-cost, quick seismic vulnerability assessments. The Level 1 survey will help Project Implementation Unit (PIU) to identify those buildings in their property portfolio that may have inadequate seismic design and construction, location, and/or unsatisfactory seismic performance. Once completed, the Level 1 survey will enable PIU and RAJUK to determine if/how to conduct a more detailed vulnerability assessment, and to decide whether retrofitting, reconstruction or relocation of certain facilities is required. The objectives of the Level 1 survey are to:

- *validate the "Level 0 Pre-Survey" facility database;*
- *rapidly assess the structural and non-structural vulnerability critical infrastructure and facilities within the scope (up to 5000 structures);*
- *identify facilities that warrant optional "Level 2 Detailed Surveys" or "Level 3 Structural Audits";*
- *prioritize facilities that require relocation or reconstruction;*
- *improve the long-term disaster risk reduction activities across the Dhaka region.*

The Level 2 survey requires limited engineering analysis based on information from visual observations and structural drawings or on-site measurements. The survey process requires more time, technical inputs and resources. The survey collects structural and architectural drawings, characteristics of structural and non-structural components and building conditions which results in structural and non-structural retrofitting of simpler buildings.
The level 3 survey is case specific and will only be carried out for complex and large structures. The survey process comprises of building data collection, analytical and experimental. studies, non-destructive testing etc. The survey is recommended for all important and lifeline buildings.

LEVEL 4 Survey (Design of Long Term Vulnerability Reduction Investment Plan)

To complete the level 4 survey, the consultant shall carry out the following activities:

- development of a prioritized list of retrofitting and rehabilitation investments to strengthen critical facilities for the critical facilities lifelines and infrastructure in the transport, water and public building sectors
- Presentations and workshops with PWG, POC and other relevant stakeholders Consultations with various agencies and relevant stakeholders on interpretation of risk outputs and indicators on exposure to risk
- Development of options for risk reduction and for achieving long term urban resilience in Dhaka
- Integrating natural resources assessments under a decision-oriented framework,
- Exploring the possibilities for provision of concepts for development/upgrading of the risk maps and emergency preparedness plans
- Providing information on technical skills and institutional solutions specific to disaster situations.
- Define the impacts of disasters and climate change on natural resources, agriculture and food security
- Developing public awareness on development and rehabilitation of critical facilities, transportation and road, water and sanitation facilities/infrastructure and management Validation of options with PWG, POC and with relevant agencies (TITAS, DWASA, and others)
- Development of a draft Dhaka Urban Resilience Strategy with a vision statement, specific objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators. Consultations and workshops to validate proposed Strategy and to finalize. Development of investment programs, projects and activities for vulnerability reduction of critical and essential facilities, water systems, gas systems and the transport network with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy
- Extensive validation of investment program with PWG, POC, and relevant agencies and ministries
- Ensuring "buy-in" and from policy makers on the investment program, including PCMU and PIU.
- Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.
- Full documentation and preparation of reports and deliverables.

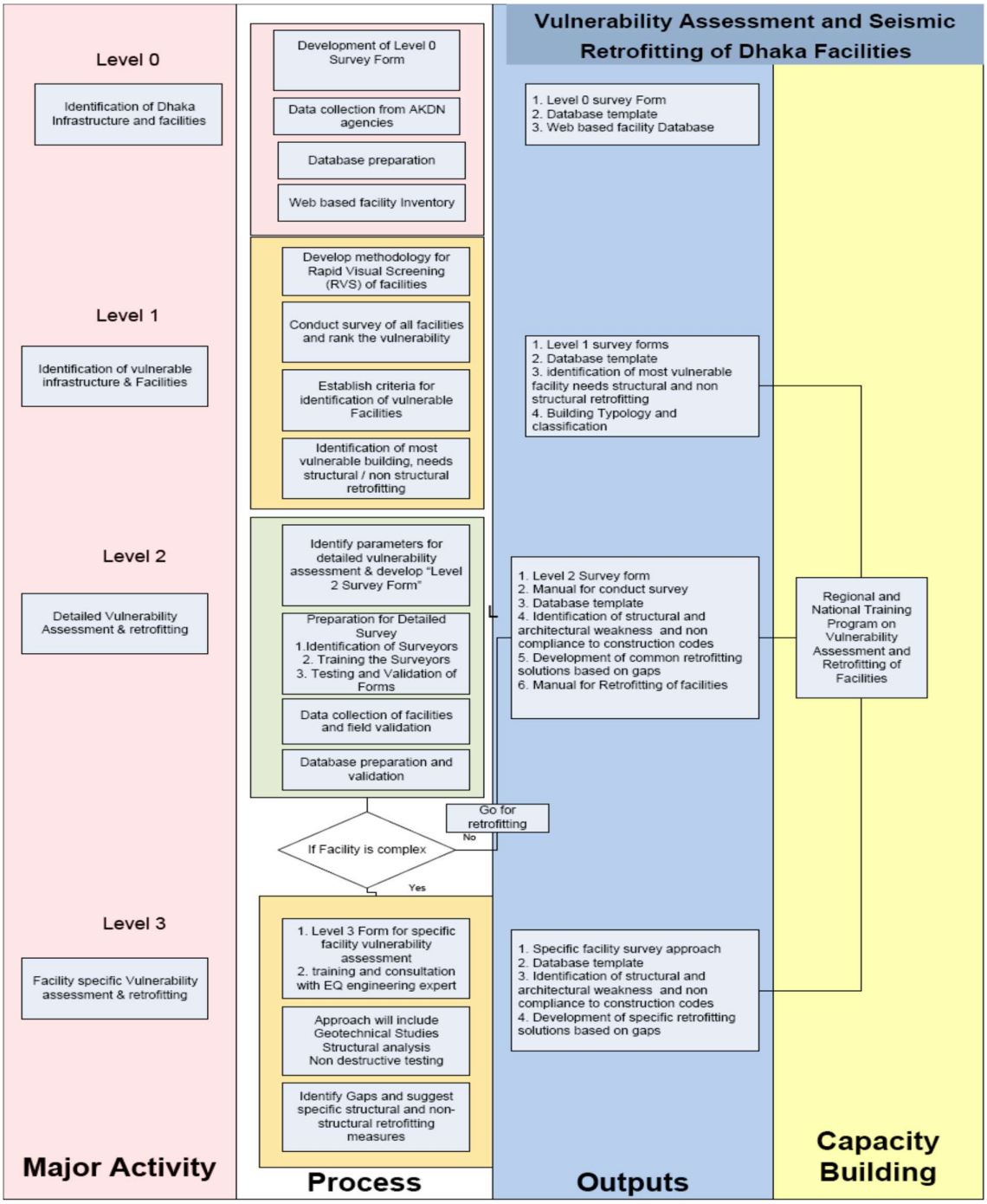

Vulnerability Assessment and Seismic Retrofitting of Dhaka Facilities
Level 0
Identification of Dhaka Infrastructure and facilities
Development of Level 0 Survey Form
Data collection from AKDN agencies
Database preparation
Web based facility Inventory
1. Level 0 survey Form
2. Database template
3. Web based facility Database
Level 1
Identification of vulnerable infrastructure & Facilities
Develop methodology for Rapid Visual Screening (RVS) of facilities
Conduct survey of all facilities and rank the vulnerability
Establish criteria for identification of vulnerable Facilities
Identification of most vulnerable building, needs structural / non structural retrofitting
1. Level 1 survey forms
2. Database template
3. identification of most vulnerable facility needs structural and non structural retrofitting
4. Building Typology and classification
Level 2
Detailed Vulnerability Assessment & retrofitting
Identify parameters for detailed vulnerability assessment & develop "Level 2 Survey Form"
Preparation for Detailed Survey
1.Identification of Surveyors
2. Training the Surveyors
3. Testing and Validation of Forms
Data collection of facilities and field validation
Database preparation and validation
1. Level 2 Survey form
2. Manual for conduct survey
3. Database template
4. Identification of structural and architectural weakness and non compliance to construction codes
5. Development of common retrofitting solutions based on gaps
6. Manual for Retrofitting of facilities
Regional and National Training Program on Vulnerability Assessment and Retrofitting of Facilities
Go for retrofitting
No
If Facility is complex
Yes
Level 3
Facility specific Vulnerability assessment & retrofitting
1. Level 3 Form for specific facility vulnerability assessment
2. training and consultation with EQ engineering expert
Approach will include
Geotechnical Studies
Structural analysis
Non destructive testing
Identify Gaps and suggest specific structural and non-structural retrofitting measures
1. Specific facility survey approach
2. Database template
3. Identification of structural and architectural weakness and non compliance to construction codes
4. Development of specific retrofitting solutions based on gaps
Major Activity
Process
Outputs
Capacity Building

Figure :4-1

4.2 Rapid Visual Assessment Methodology

The purpose of this short methodology is to introduce the concept of vulnerability assessment and explain the methodology used to conduct the level 1 survey. At later stage of RFP an instruction manual will be provided that defining a detailed understanding of structural and nonstructural survey parameters and processes to identify the parameters during the survey. The survey will be carried out using an Android/Apple based tablets, UVA technologies, digital documentation which will be synchronized with RAJUK Servers to securely manage the data. The outcome analysis of the collected survey data will be later developed and create a base for Level2/3 Survey.
It is paramount to understand the basics of earthquakes and the performance of structure during earthquake ground shaking before commencing the survey. It is recommended that the staff of RAJUK and so the surveyors be trained so that necessary capacity building is in place. The Level 1 survey training will also address the basics of earthquake engineering. National survey teams and the technical staff of the RAJUK and PIU Coordination Office will be contacted for technical consultation and further advice.

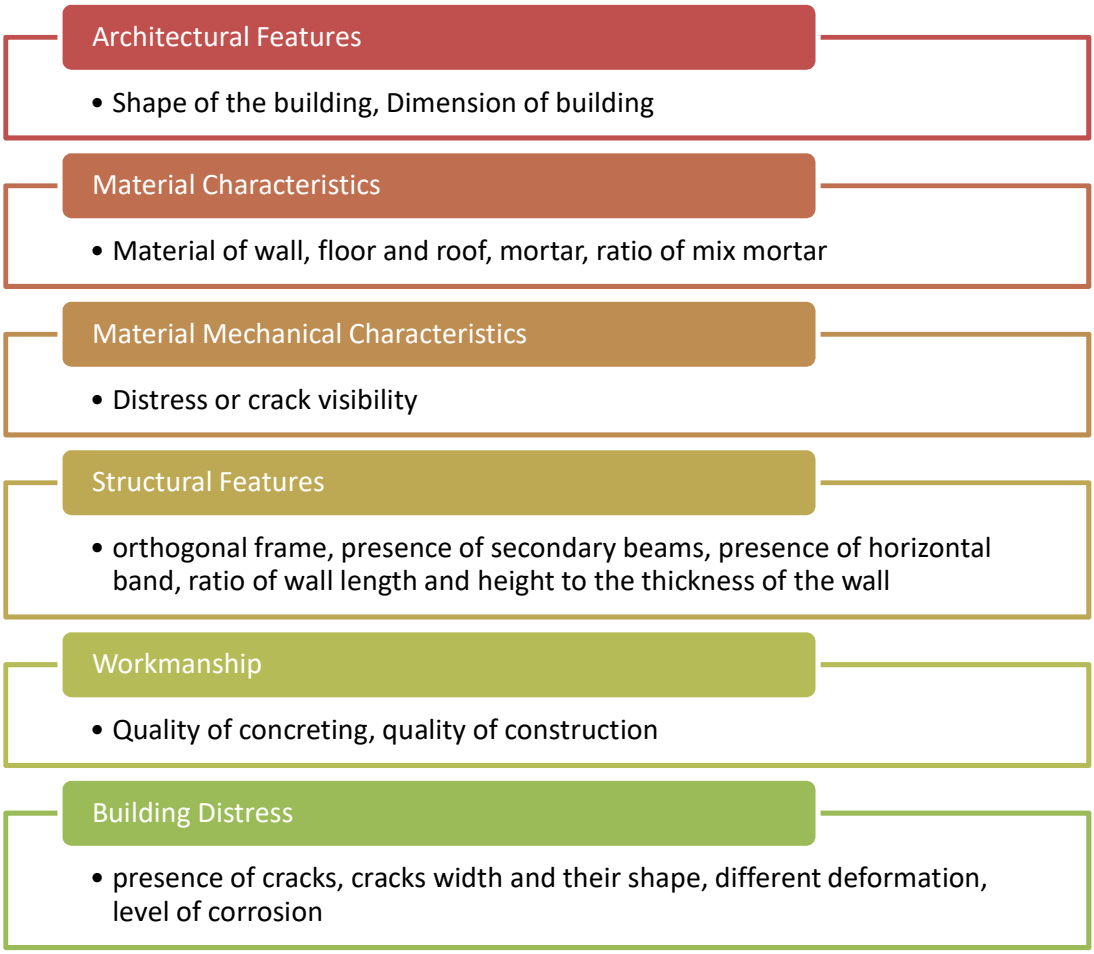
To assess the buildings of the surveyed area two methodologies were mainly used named R.V.S (Rapid Visual Screening) suggested by FEMA (Federal Emergency Management Agency) and Turkish Method. Rapid visual screening (RVS) of buildings for potential seismic hazards, originated in 1988 with the publication of the FEMA 154 Report, Rapid Visual Screening of Buildings for Potential Seismic Hazards a Handbook. RVS provides a procedure to identify record and rank buildings that are potentially seismically hazardous (FEMA 154, 2015). This screening methodology is encapsulated in a one-page form, which combines a description of a building, its layout and occupancy, and a rapid structural evaluation related to its seismic hazard.
Although RVS is applicable to tall buildings, its principal purpose is to identify (1) older buildings designed and constructed before the adoption of adequate seismic design and detailing requirements (2) buildings on soft or poor soils, or (3) buildings having performance characteristics that negatively influence their seismic response. Once identified as potentially hazardous, such buildings should be further evaluated by a design professional experienced in seismic design to determine if, in fact, they are seismically hazardous.
The rapid visual screening method is designed to be implemented without performing any structural calculations. The procedure utilizes a scoring system that requires the evaluator to (1) identify the primary structural lateral load-resisting system, and (2) identify building attributes that modify the seismic performance expected for this lateral load-resisting system. The inspection, data collection and decision-making process typically occurs at the building site, and is expected to take around 30 minutes for each building. The screening is based on numerical seismic hazard and vulnerability score. Basic Structural hazard scores for various building types are provided on the RVS form. The screener modifies the basic structural hazard score by identifying and circling score modifiers which are then added (or subtracted) to the basic structural hazard score to arrive at a final structural score, S. The basic structural hazard score, score modifiers, the final structural score S, all relate to the probability of building collapse. The result of the screening procedure is a final score that may range above 10 or below 0, with a high score indicating good expected seismic performance and a low score indicating a potentially hazardous structure. While the score is related to the estimated probability of major damage, it is not intended to be a final engineering judgment of the building, but merely to identify buildings that may be hazardous and require detailed seismic evaluation. If the score is 2 or less, a detailed evaluation is recommended. On the basis of detailed evaluation, engineering analysis and other detailed procedures, a final determination of seismic adequacy and need foe rehabilitations can be made. Figure 4-1 shows a sample R.V.S scoring form.

Rapid Visual Assessment (RVA) is also going to consider construction quality and any quick check for gravity load while assessing. Also, JV consultancy believe that considering the perspective of

Bangladesh, these are also governing criteria to consider along with seismic assessment and retrofitting options.
So RVA may include quick these items:

- Check material quality
- Check capacity against certain loads (e.g. gravity loads)

For instance, for quick check, a certain compressive strength of concrete could be used based on the design proposals and Bangladesh's practice and available literatures for check against gravity load. Another key issue would be assessment of substructures which is depend of soil, pile, foundations and etc. which is consider in RVA step of this project. Also, this is integrated RVS Process which is as below.



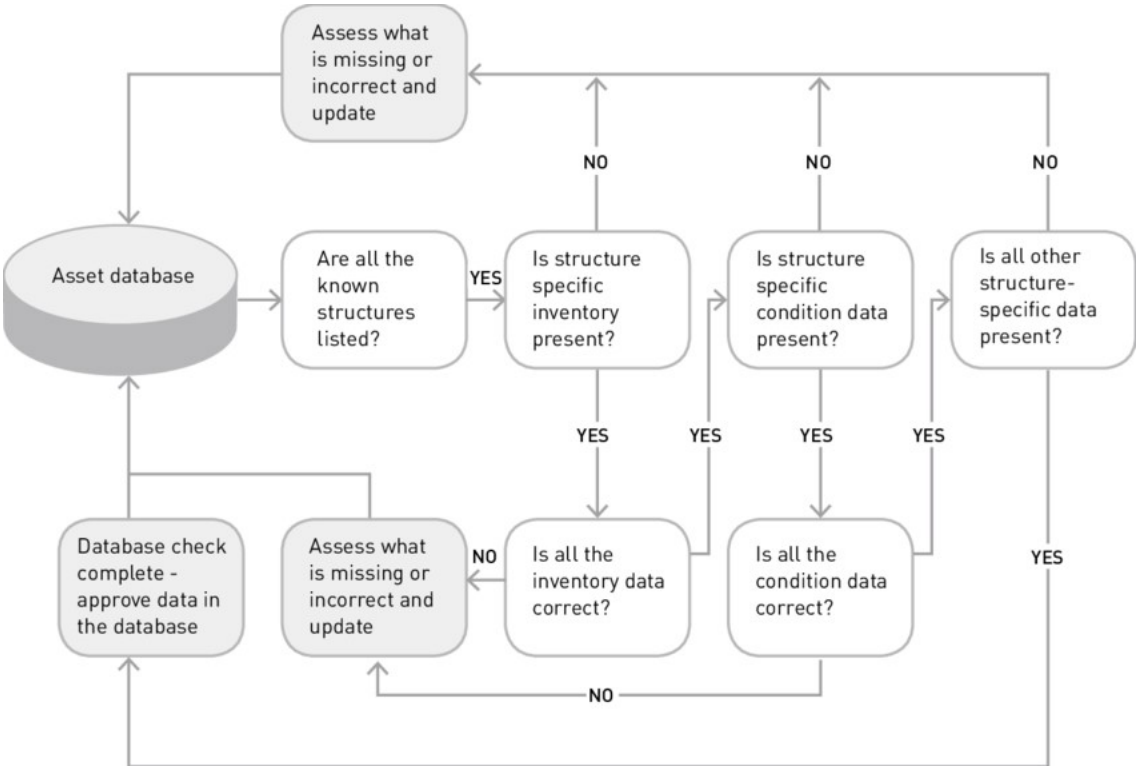
4.2.1 Data Validations

Data services is a complex and constantly changing field. Because of the constant change, data conversion firms and vendors are in high demand. As a RVA system, it is necessary to understand the data conversion process, define your data details and expectations and ask the right questions up front to ensure the highest degree of accuracy during your conversion. Internal validation methodology of available data which consider by JV is based on these topics:

- Source system loop back verification

- Ongoing source-to-source verification
- Data-Issue tracking
- Data certification
- Statistics collection
- Workflow management

There are many scenarios to valid data's but in in the worst case scenario, all required data may not be available at a time to initiate a particular work. So, the PIU should assess the severity of this and coordinate with the consultant about the work plan for optimized output. Also the JV should clarify on internal validation methodology of available data from other agencies, e.g. on a sample basis or frequency of verification. Below figure illustrate asset data's in data bases of RVA methodology.



4.3 Literature survey on rapid visual screening

An extensive literature review has been carried out to understand the current practices on rapid visual screening. Well established rapid visual screening processes proposed by FEMA, NORSAR and ASCE were reviewed in detail and informed the RVS process.

4.3.1 Objectives

The objectives of the Level 1 survey are to:

- *validate the "Level 0 Pre-Survey" facility database;*
- *rapidly assess the structural and non-structural vulnerability critical infrastructure and facilities within the scope (up to 5000 structures);*
- *identify facilities that warrant optional "Level 2 Detailed Surveys" or "Level 3 Structural Audits";*
- *prioritize facilities that require relocation or reconstruction;*
- *improve the long-term disaster risk reduction activities across the Dhaka region.*

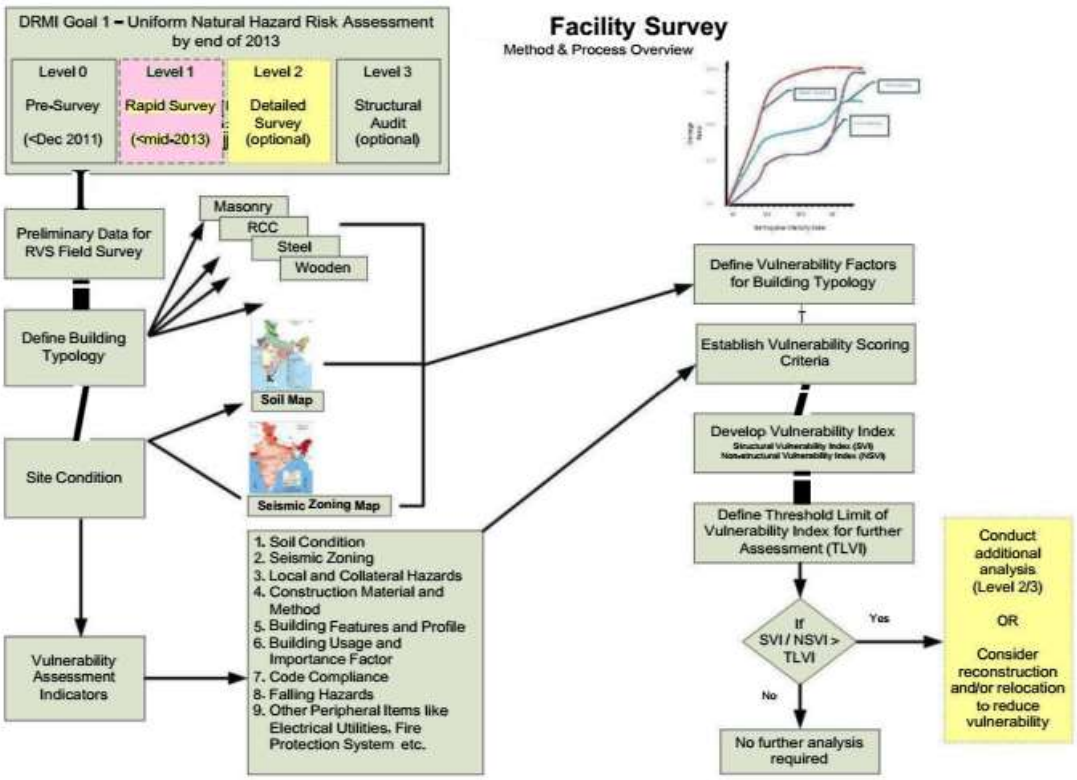


Figure :4-2

4.4 General Methodology

4.4.1 RVA Methodology

4.4.1.1 INTRODUCTION

4.4.1.1.1 Context

Bangladesh with a population more than 164 million is the eighth most populous and the most densely-populated country in the world. Natural calamities, such as floods, tropical cyclones, tornadoes, and tidal bores occur almost every year, combined with the effects of deforestation, soil degradation and erosion.

In September 1998, Bangladesh witnessed the most severe flooding in modern world history. As the Brahmaputra, the Ganges and Meghna spilt over and swallowed 300,000 houses, 9,700 km (6,000 mi) of road and 2,700 km (1,700 mi) of embankment, 1,000 people were killed and 30 million more were made homeless; 135,000 cattle were killed; 50 km2 (19 sq mi) of land were destroyed; and 11,000 km (6,800 mi) of roads were damaged or destroyed. Effectively, two-thirds of the country was underwater. Bangladesh is now widely recognized to be one of the most vulnerable countries to climate change. Natural hazards that come from increased rainfall, rising sea levels, and tropical cyclones are expected to increase as climate changes, each seriously affecting agriculture, water and food security, human health, and shelter. There is also evidence that earthquakes pose a threat to the country and that plate tectonics have caused rivers to shift course suddenly and dramatically which stands for existence of highly tectonic activities in the past. Such historical evidences pose a considerable seismic hazard to the Bangladesh cities.

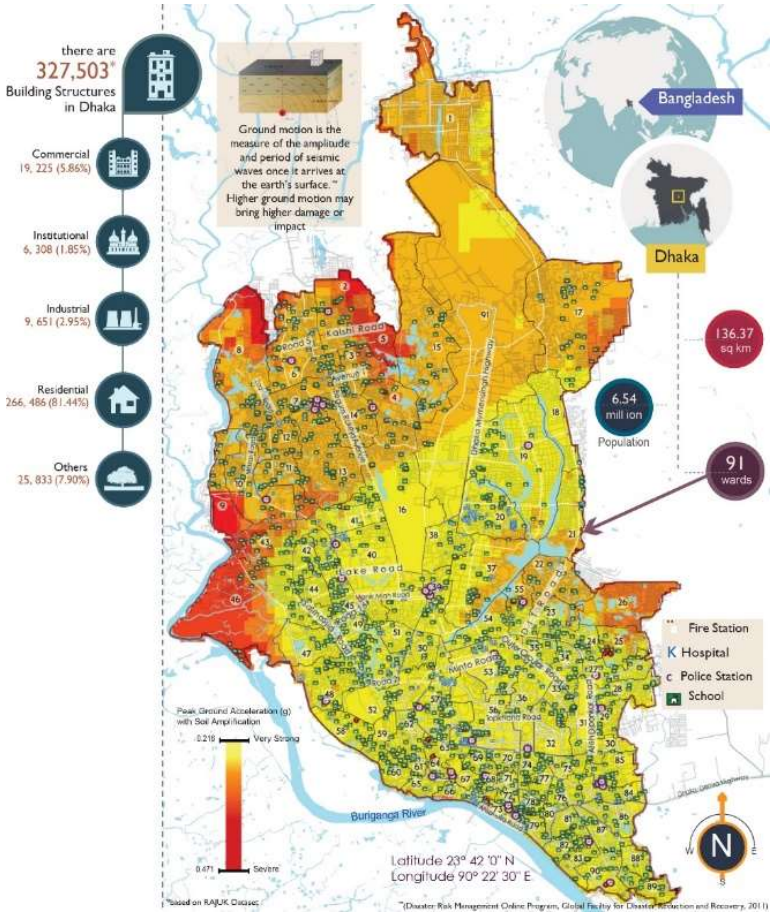


Figure1: Overview of Critical Structures in Dhaka

Within the context of Urban Resilience Project: RAJUK Part and under a loan from IBRD Loans and IDA Credits & Grants by World Bank, a number of public service buildings; water, gas, electricity & transmission systems; essential infrastructure components & complexes will be selected to be assessed for possible improvement, decommissioning, or retrofitting; which are required to provide support and shelter to disaster response and recovery operations.

Funded by the World Bank, the Project for Improving the resilience includes extensive surveys and analyses with due consideration for structural, non-structural, architectural, mechanical and electrical equipment. The project also includes several capacity development activities and consultations to elaborate diverse guidelines employing innovative methodologies and technologies. These will then serve as the basis for sustained investments in retrofitting and rehabilitation of essential assets, as well as institutional reforms to improve the resilience of health sector.

4.4.1.1.2 Scope of Work

The proposed project will initiate a set of procedures that aims at transforming the vulnerable and prone to hazards Dhaka in the next 5 to 20 years into a resilient concept to major earthquakes and other natural disasters. The overall goal of the proposed project is take first step to save lives and reduce the social, economic and financial impacts in the event of future earthquakes. The specific objective of the project is to establish the foundations toward disaster preparedness and enhancement of response capacity, post-disaster recovery and disaster risk reduction associated with natural hazards in facilities.

The risk assessment process is one of the initial steps for developing cost effective mitigation strategies to achieve URP's overall goal. The critical facilities within the concept of the consultancy

that are expected to be close to 4000 structures in Dhaka region[1]. The facilities include schools, hospitals, health centers, warehouse, residential units etc., and are located in moderate to high seismic areas. Thus, there is an urgent need to assess the structural and nonstructural components of these facilities and ensure the long-term sustainability of future development.

Building structures in the inventory are expected to be comprised of reinforced concrete structures possibly with the following occupancy types, Figure 1.1;

- School Complexes – Classroom and Dormitory Buildings,
- Hospital Buildings – Inpatient Buildings, Operation Theatres, Laboratories, etc.,
- University Buildings – Lecture Rooms, Laboratories, Student Lodging Facilities, etc.,
- Municipal & Government Offices – Police Stations, Fire Stations etc.,
- Dhaka International Airport – Building and Non-building Structures as much as cleared for access,

Infrastructure systems and components may include components from following and/or additional stakeholders;

- DPDC – power distribution system,
- DWSSA – drinking water transmission and distribution & sewerage collection systems,
- TITAS – gas transmission and distribution system,
- FSCD – fire and civil defense system,
- RHD – transportation and traffic system

4.4.1.1.3 General Approach for Multi-Hazard Safety of the critical facilities

Earthquake risk assessment and safety planning usually recommends a two-pronged approach. First, assess the existing facilities and strengthen them as needed. Second, introduce seismic consciousness among the organizations to mainstream earthquake safety in their respective development planning. The overall stages of the studies including Rapid Visual Assessment, Preliminary Engineering Analysis and Detailed Engineering analysis are outlined as following:

[1] Annex-1: Complete List of the facilities

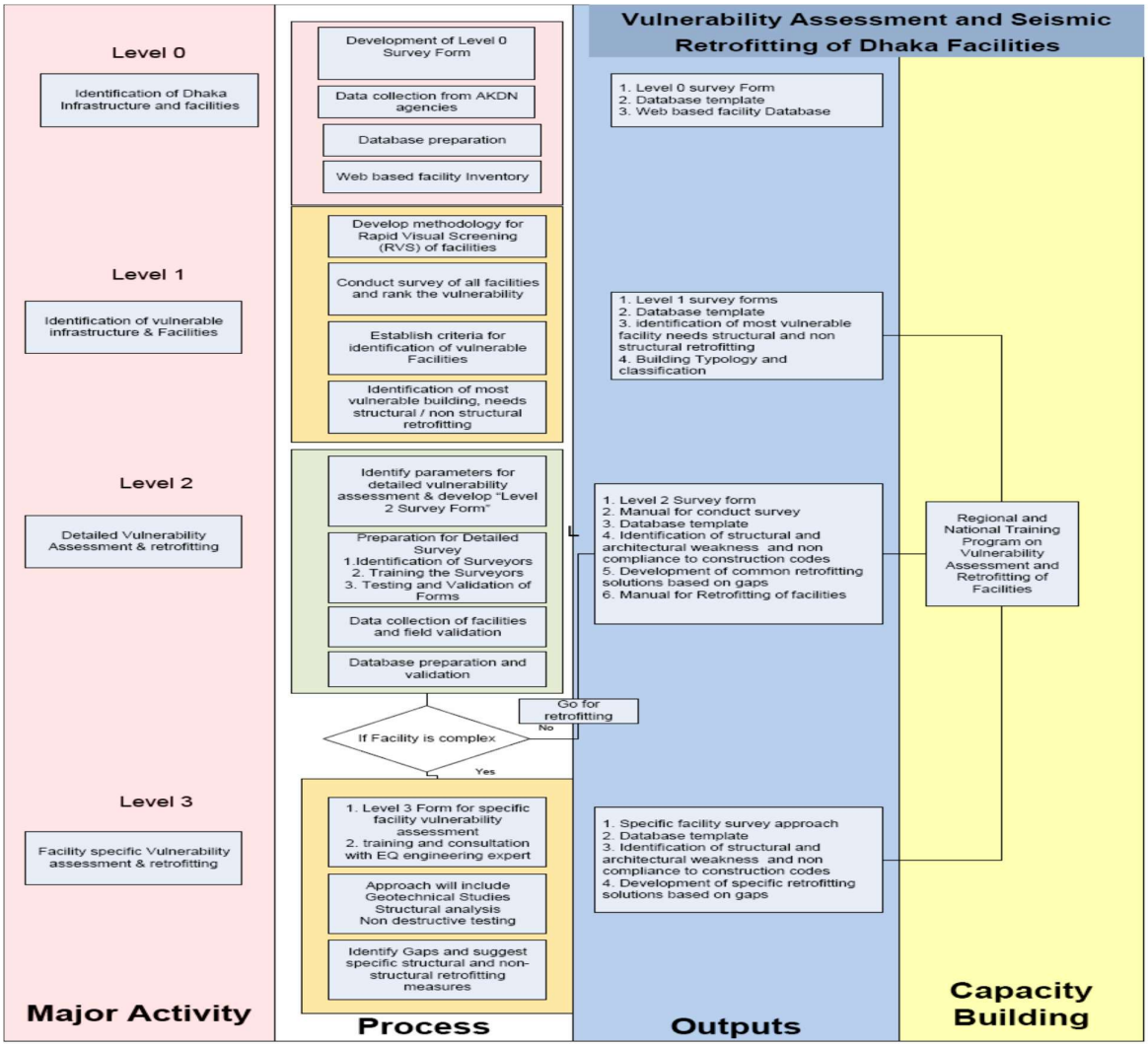


Figure2: Flow-Chart of the Assessment Studies

The activities to be carried out will be based on the methodology provided herein and the methodology has been derived with due consideration of existing studies conducted at national and international level, as well as the modules and methodologies carried out for Hazards Vulnerability and Risk Assessment (HVRA) studies for critical structures under the scope of the previously conducted Projects.

To assess the number, size, complexity, condition and accessibility of the above summarizes building groups a Rapid Visual Assessment phase will be undertaken, and the inventory consolidated through the discussions with the Client. Providing such an assessment will be a fundamental step towards risk reduction and disaster management strategies as well as a quantitative measure for decision makers for allocation of resources and urban development plans.

In this context, following methodology that is proposed by internationally recognized assessment codes, in order to provide an initial quantitative measure of the buildings risk against existing hazards and also in order to screen the buildings with respect to the failure risk for further more detailed investigations Rapid Visual Assessment (RVA) is going to be performed for the critical and essential facilities with approximately 5 million square meters of built-up area (approximately 4000 structures). This assessment requires data collection of the buildings and facilities from both structural and non-structural features as well as urban resiliency context. In this respect data collections must be performed for each building by trained experts and these data should be analyzed as a dataset to provide the risk index of each building.

Since there are facilities such as hospitals, fire stations and schools which may be used after disasters and their functionality after disaster is of importance, risk indices will include both structural and non-structural aspects of these facilities and specific indices will be assigned for different aspects of the building. The overall risk index of each facility will be calculated considering both structural and non-structural indices. The methodology for calculating the risk index of the buildings has been covered in this methodology however may require refinement after initial data is collected. These indices will then be compared for prioritization of the buildings with respect to their existing condition risk index and achieving the most vulnerable facilities. The aim is to reach the most representable studies that will create basis for long term investment plan.
In the next section steps that are taken for selection of the best fitting RVA methodology among various international codes is explained.

4.4.1.2 RAPID VISUAL ASSESSMENT (RVA)

4.4.1.2.1 Critical review of existing methods

Many RVS/RVA methods have been developed worldwide. According to the difference in building codes and construction practices, the scoring system and parameters that are taken for assessing the vulnerability of buildings also differs among these methods. As a basic step to find and develop the best scoring methodology, the most common RVA methods has been critically reviewed. Next sections present summary of the well-known and acceptable RVA frameworks.

4.4.1.2.1.1 U.S. A method

FEMA 154 procedure for RVS was first proposed in the U.S.A in the year 1988. However, the procedure was further modified by incorporating latest technological advancements and lessons from earthquake disasters and published as FEMA 178, FEMA 310 and FEMA 154. FEMA 154 method assigns a basic structural score based on seismic hazard intensity of the region, building type and lateral load resisting system of the building. Performance modifiers are specified to take into account the effect of number of stories, plan and vertical irregularities, pre-code or post-benchmark code detailing, poor condition of the building and type of soil. A score of 2 is suggested as a cut-off and score less than 2 require detailed analysis.

4.4.1.2.1.2 RVS method for India

The procedure for RVS used in India utilises a damageability grading system based on the primary structural lateral load-resisting system and building attributes that modify the seismic performance expected for this lateral load-resisting system along with non-structural components. The screening is based on code-based seismic intensity scale, building type and damageability grade as observed in past earthquake and covered in Medvedev Sponheuer Karnik (MSK) and European macro-intensity scale.

4.4.1.2.1.3 New Zealand method

The RVS method by the New Zealand Society for Earthquake Engineering (NZSEE) proposed in 1996 largely follows the process presented in FEMA 154. The document places much greater emphasis on the presence of structural irregularities such as torsion and weak storey. A structural score is given based on structural irregularities which are then combined with the building area to decide whether a detailed assessment is required. The building area parameter reflects the occupant population and potential causalities. In this procedure, the conclusion for a more detailed evaluation of the building comes from a graph, which is a function of the building gross area and the final structural score.

4.4.1.2.1.4 European method

This process consists of the verification of the seismic resistance of an existing damaged or undamaged building by taking into account seismic and non- seismic actions for the period of its intended lifetime. In order to calculate the design action-effect under the actual condition of the structure, the standard method or the time-domain dynamic non-linear analysis is carried out. A model uncertainty factor covering the additional uncertainties related to the analysis of the pertinent structure is also incorporated. At the end, it gives a procedure for repair or strengthening of buildings.

4.4.1.2.1.5 Greek method

The Greek method developed RVS procedure in 2000 which needs to identify both the primary structural lateral load resisting system and structural materials of the building. By this identification, the building is classified as one of 18 structural types and it is assigned an initial structural hazard score. This score will then be modified to get the basic structural hazard score by identifying both the seismic zone and three significant structure characteristics (weak story, short columns and regular arrangement of the masonry). Finally, this score will be modified by identifying modifiers related to the observed performance attributes to arrive at the final score. Buildings having a final score of 2 or less should be investigated in more detail.

4.4.1.2.1.6 Italian method

Vulnerability assessment methodology developed in Italy is based on eleven building parameters. The eleven parameters are resisting system type and organization, resisting system quality, conventional resistance, location and soil condition, diaphragms, plan configuration, vertical configuration, connectivity between elements, low ductility structural members, non-structural elements and preservation state.

4.4.1.2.1.7 RVS modified for Indian condition

Jain et al. developed RVS procedure based on a database of damaged buildings during Bhuj earthquake of January 26, 2001. The parameters considered in this procedure are building typology based on occupancy type (residential or non-residential building), presence of basement, number of storeys, maintenance condition of building, asymmetric location of staircase with respect to plan, presence of re-entrant corners, presence of open storey, presence of stub column, presence of substantial overhang and presence of short column. Based on the type of seismic zone and type of soil, basic score is assigned to the buildings and later on modified based on the parameters mentioned above.

4.4.1.2.1.8 Turkey method

In RVS procedure in Turkey, a basic capacity index is computed considering the assessed orientation, size and material properties of the component comprising the lateral load resisting structural system. This index is then modified by several coefficients that reflect the quality of workmanship, detailing and architectural factors. The procedure has been developed based on the data compiled from damage surveys conducted after the earthquakes that occurred within the last decade in Turkey.

4.4.1.2.1.9 Japan method

The Japanese procedure is based on the seismic index for total earthquake resisting capacity of a storey which is estimated as the product of a basic seismic index based on strength and ductility index, an irregularity index, and a time index.

4.4.1.2.1.10 Canada method

The RVS method developed by National Research Council, Canada is based on a seismic priority index which accounts for structural as well as non-structural factors including soil condition, building occupancy, building importance and falling hazard to life safety and a factor based on occupied density and the duration of occupancy. As the data are obtained from site survey, it is entered on the screening form given by NRCC, often by simply circling appropriate descriptors listed on the form for each of the factors, and appropriate numerical values for each major factor on the form. The numerical values are then multiplied to determine the scores, both for structural and non-structural hazards, which are then combined to determine a final score for the building as a whole.

4.4.1.2.1.11 RVSP method

This method is a modification of FEMA 154. The final score is calculated by using the vulnerability score sheet as per FEMA 154 while the interpretation of vulnerability grade for the vulnerability score depends on 5 damage grade systems. If the Score lies between 2.0 and 2.5, it gives the probability of grade 1 and grade 2 damage which is moderate damage. For these two damage grades, detail evaluation is not necessary, only minor repairing is required. If the score is less than 2, it gives heavy structural damage. Generally, the score S less 0.7 indicates high vulnerability requiring detail evaluation and retro fitting of the building.

4.4.1.2.1.12 Other modified versions of RVS

Wallace and Miller followed the RVS methodology proposed in FEMA 154 to identify potential seismic hazards for Oregon's public facilities, including schools, hospitals, fire stations, and emergency response centres. Sucuoglu et al. proposed a simple screening procedure for three- to six-story substandard concrete buildings in Turkey; the procedure is calibrated with field data compiled after the 1999 Duzce Earthquake. The method assigns a basic Score to different RC-frame buildings depending on the number of stories and the seismic zone. Vulnerability coefficients consider the presence of soft stories, apparent quality, and heavy overhangs. Perrone et al. proposed a RVS method for the evaluation of a Safety Index for hospital buildings. The methodology is based on the Hospital Safety Index initially proposed by the Pan American Health Organization which is modified to suit the peculiarities of the Italian context. The assessment of the vulnerability of structural elements, non-structural elements and plants as well as organizational aspects is considered in this method.

4.4.1.2.2 Gap analysis of existing methods

From the above study, it is clearly shown that the different RVS procedures use different vulnerability parameters based on their available building stocks, building typology and geological conditions of the area. They follow different scoring system to identify the vulnerability level of the existing buildings. In most of the available RVS procedures, the vulnerability function of a certain building type depends much on the vertical and plan irregularity, the soil condition and the seismic zone of the area. From the above review of the available RVS procedure, it was found that, FEMA 154 , Greek , New Zealand, Wallace and Miller and RVSP procedure provide a more generalized approach to rapid screening procedure, but they require a higher degree of understanding. While, Japanese procedure and Italy procedure are based on very few parameters and lack clarity regarding the ranking of buildings based on a scoring system. European method requires a higher degree of understanding as it requires detail structural analysis of the buildings and is a time taking procedure. Canada rapid screening procedure can be used for ranking the building in an inventory, which follows National Building Code of Canada and is not suitable to apply in other countries. The Indian procedure by Arya is very similar to FEMA code. RVS procedure by PAHO/WHO and D. Perrone et al. are specifically for

hospital buildings. Indian procedure by Jain et al. RVS procedure and turkey procedure of RVS are case specific based upon regional building construction system and available vulnerability parameters. According to the aforementioned critical review, amongst the various methodologies proposed by institutes, the methodology that is proposed by FEMA code is the most convenient one and is utilized as the basis for development of methodology by many other codes. However, this code mainly considers the structural aspects of a building and consideration of the non-structural aspects are for providing the life safety. Since there are facilities such as hospitals and fire-stations which their functionality after the earthquake is important, in this study some additional assessments of the non-structural components, masonry buildings in particular, resiliency of the structures and contextual information are added for such buildings.

Selection of the FEMA's RVA methodology is also consistent with the Bangladesh's national building code (BNBC). As the review of methodology used for design of buildings with BNBC (Vol2. Part 6) reveals that it is in very good consistency with the method used in FEMA356 for assessment of the buildings and building design codes of the United States such as AISC-LRFD2005 and ACI318-05. Considering that the screening methodology used in FEMA 310 is based on the RVA method which was primarily introduced in FEMA 365 for individual buildings, consistency of the method used by FEMA 310 methodology and BNBC codes may be guaranteed to high extends. Also, our research among various codes for rapid visual assessment revealed that due to the high dependency of the flood exposure risk of the buildings to the surrounding area of the buildings therefore assessment of buildings for flood risk is mainly controlled by the building's environment instead of the building itself. As a consequence, codes do not consider flood risk assessment for buildings as the methodology that is used for seismic hazards which is mainly dependent on the structural and non-structural elements of the target building, instead flood risk for buildings is assessed for each region by providing flood velocity and flood depth maps, that are proposed due to hydrological and hydraulic analyses by governments and municipalities.

4.4.1.3 RVA DATA COLLECTION

4.4.1.3.1 Pre-Screening Activities

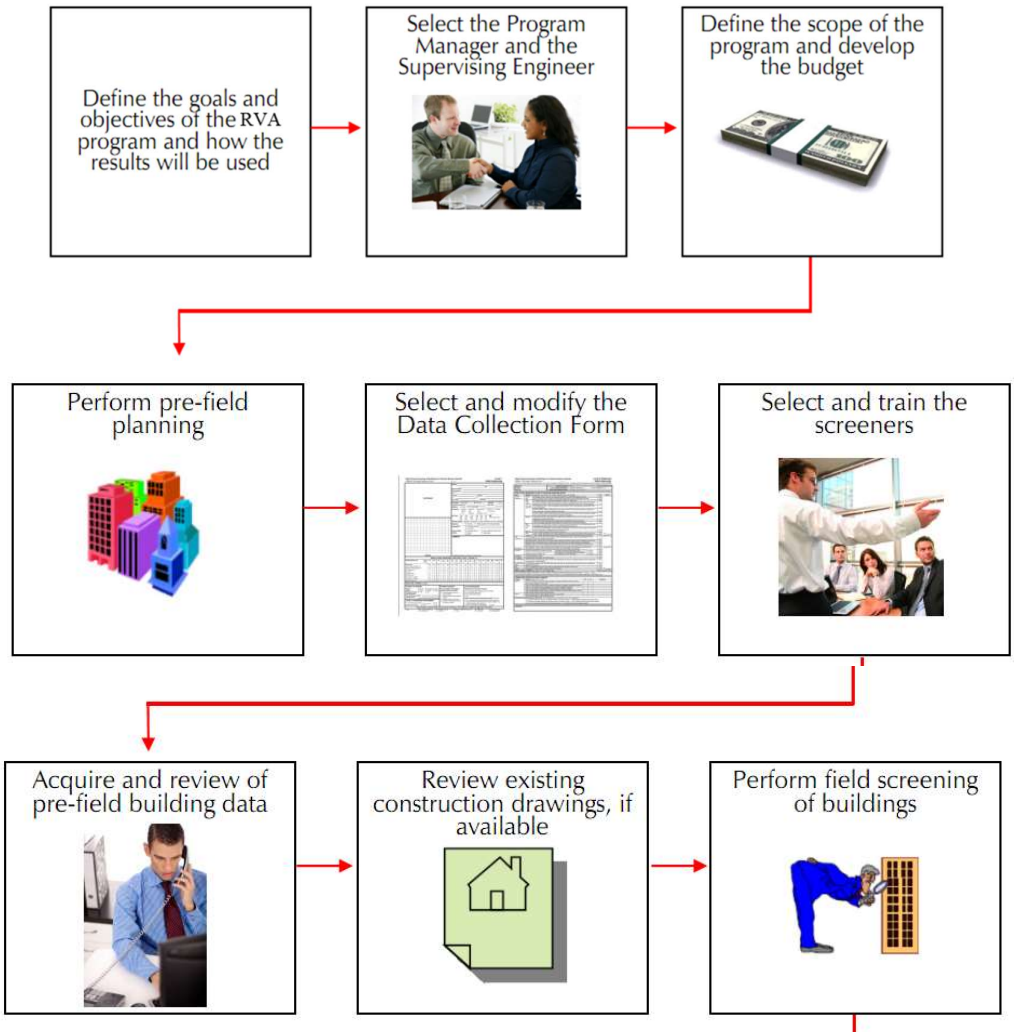
An inventory of the components should be obtained before field visits. If some components or buildings subdivisions are going to be removed soon, it may be appropriate to omit them from the screening. Available "as-constructed" design documents should also be obtained to be compared with "as-is" situation. Safety equipment and HSE briefing, as well as security arrangements (special clothing or masks) needed for different divisions of sites should also be procured.

4.4.1.3.2 General process

Seismic vulnerability assessment should be implemented through several steps. Available design documents will be reviewed to determine general features and design criteria. When feasible, components should be visually observed to verify they were constructed in accordance with the design documents, to identify features and characteristics not shown on the design documents, and to assess the as-is condition. Engineering judgment can often be used to assess seismic vulnerability, however there are detailed descriptions helping evaluator to decide about the level of risk associated with each item.

During the assessment, questions may arise which require further design document review and/or additional site visits to view the components. These types of observations must be clearly explained in the comment section of any item. All observations made during the RVA process should be

recorded. Standard documentation can include filling out the checklists and photographing and/or recording field observations. Those components that cannot be observed due to system operation constraints (for example, in-service surgery rooms) should be noted. A summary report of the design documents reviewed should be prepared. Assumptions, calculations and engineering judgment used to assess the seismic vulnerability should be documented when the evaluator cannot decide about the level of risk corresponding to one item easily. Deterioration may increase the seismic vulnerability. Documentation of deterioration at different times may also be used to estimate the rate of deterioration (history of maintenance should be checked for equipment). The RVA process is complete when all of the checklist items have been reviewed and risk factors have been identified.



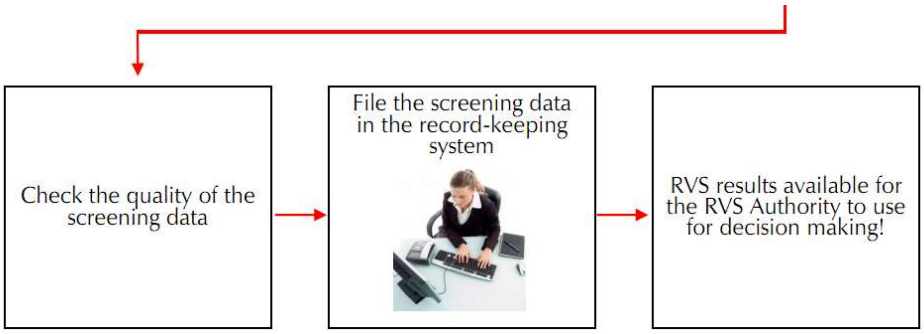


Figure 1 General steps of RVA

4.4.1.3.3 Checklists

The RVS checklist is consisted of main parts and information which are noted here:

1) Geological information of the building region: this part is designed to assess the primitive seismic hazard that can threaten the building. It also includes secondary hazards due to an earthquake such as potential of liquefaction, landslides and surface faulting.

2) Other hazards: this information includes considering possibility of other hazards on the building such as flood, hurricanes, etc. which will be considered as information layers in the processing stage.

3) Building general characteristics: these characteristics are the ones that effect on the overall behaviour of the building and its classification in FEMA such as No. of stories, year of built, code used for design, floor area and existence of additional parts or alternations.

4) The occupancy of the building: As the population and the duration of service as well as type of service of a facility is of importance in the risk that collapse of a building will impose to the society, the occupancy of buildings should be investigated such as commercial, emergency, educational uses.

5) Urban resiliency: factors such as compliance with the land use plans, existence of environmental problems of the building and adjacencies, etc. that will be used for flood hazards.

6) Structural details: details that will influence on the overall behavior of buildings such as existence of irregularities in plan or elevation is the point that will be assessed in this part. Most important irregularities in the elevation are existence of weak or soft stories, setbacks, short columns and etc. most important plan irregularities can be named as non-parallel lateral force resisting systems, torsion of the building, large openings and etc.

7) Type of Gravity and lateral force resisting systems: in order to provide a safe load path in the structure type of the load resisting systems are of great importance and as various systems exist and each has its own sufficiency and deficiency, therefore achieving information about the type of the system and the code that the system is designed with are important. If any version of the building code that is used for design of the structure is also important as the building codes have developed during the years.

8) Quality of the material: specifically, for the masonry and concrete buildings which are built by in-site materials the quality of material such as strength of the mortar and bricks, deterioration of material and etc. should be investigated.

9) Non-structural hazards: As the failure of Non-structural elements such as collapse of infill walls, falling of the ceiling covers, etc. may cause damages to the passengers or make the facility out of service (e.g. failure of mechanical or electrical systems in hospitals) investigation of these elements are also considered. The overall features that are inspected are as follows:

   - Existence of life safety systems such as fire suppression piping, emergency power, etc.
   - Hazardous materials
   - Infill and partitions
   - Ceilings
   - piping's, mechanical and electrical equipment
   - Elevators and ducts and etc.

A complete list of the Questions can be referred in Annex2.[2]

4.4.1.3.4 Mobile survey device and Application

Survey teams will utilize a handheld computing device (i.e. a tablet) to validate the information collected during the Level 0 survey and to collect the data for the Level 1 survey. All information collected in the field will be synchronized with the central database server in Turkey. The mobile device will have the relevant base maps for navigation/orientation, a GPS receiver, an integrated camera, and the survey application software. The devices will be durable and adaptable and will also be useful for other types of field surveys such as the Detailed Surveys, and post-earthquake damage assessment surveys.

The JV Coordination Office has developed a custom survey application software to run on any Android-based mobile device (such as the Asus Eee Pad Transformer or Panasonic Tough Pad). The survey application will be accessible through a web browser with WiFi connectivity, where coverage is available. It will automate the process of collecting GPS locations, structure photographs, building floor plans and facility mapping while in an offline mode. Along with the Application, a user manual (RVA instruction manual) for the usage of RAJUK engineers a help-guide will be provided.

4.4.1.3.5 Data Governance

All aspects of the RVA method are protected by the JV Data Governance Strategy as Licensed data. That Strategy commits to rigorous principles of (1) Data Minimization, (2) Least Privilege, (3) Security, (4) Integrity, and (5) Identity, and has been vetted by relevant authorities.

4.4.1.3.6 Survey kits

The survey team will carry essential equipment, which will include:

- Android based Tablet for data collection (inclusive of camera and GPS)
- A sufficient number of blank questionnaire forms in paper format
- In case tablets are not available, then pre-populated forms
- A copy of the survey instruction manual
- Community awareness kits (posters, guidelines and awareness material)

[2] Annex2: Checklists

- Personal and official identification, i.e. professional business cards, official invitation letter
- Notebook for collection of additional information
- Tape measure (30 feet) and/or foot rule (ruler)
- Flashlight and extra batteries
- Handheld GPS in order to document the building's geographical position
- Work gloves and/or rubber gloves (especially important in health facilities)
- Disinfectant hand lotion (especially important in health facilities)
- Boots/sturdy shoes
- Hard hat and dust mask
- Adequate personal clothing

4.4.1.4 DATA ANALYSIS AND RISK SCORING

4.4.1.4.1 Basic Calculations

At the first stage of the screening and assessment of buildings, a preliminary assessment of the some of the important structures (Hospitals and Fire Stations) in response to the gravity loads is considered. This assessment can evaluate if the existing buildings have acceptable safety margin for bearing the solely gravity loads and if further evaluation of these buildings for natural hazards should be considered or not. In this regard, structural members with approximately the most vulnerable conditions against the gravity loads are analysed with simple approximate methods and their demand to capacities are evaluated against the gravity loads. In this context the columns and walls capacities are to be estimated considering the pure axial actions due to the gravity loads, which can be simply calculated with respect to the known building codes such as BNBC, AISC or ACI. Axial load demand on the vertical elements can be calculated considering the effective load areas of multiple stories on the columns and typical loads of the stories. The Capacity of Horizontal elements can be estimated using simplified equations of the building codes and their demand action (moment) due to the gravity loads can be estimated considering both-end fixed or free restrains.

In this regard some primitive information is required for gravity assessment calculations including typical bay lengths of the structure, number of stories and usage of the building for demand calculations as well as section types, section areas and material strength for calculation of the member capacities. All this information required has been embedded in the checklists.

As the required geometrical information are gathered in the RVA stage of the assessments, evaluation of the material strength is required through performing some Non-invasive procedures especially for the target structures. Therefore, information about the material strength should be gathered if any documents from tests during constructions or previous studies on the Bangladesh buildings exists for the target buildings. If such information does not exist then some Non-invasive tests such as Schmidt's hammer test, nail tests will be required. This test can estimate the concrete compressional strength with minor disturbance of the architectural coatings and no damage to the structural elements.

4.4.1.4.2 Risk Scoring and prioritization

In this work, an RVA method is proposed which is mainly based on the FEMA310 methodology for the evaluation of a Risk Index for all type of structures especially hospitals, fire-stations and other emergency facilities being the most complex however modifications have been conducted tailored to the Project of S4- Vulnerability and risk assessment of Critical Facilities in Dhaka. The objective of the RVA method is not to substitute the more advanced analysis but only to identify the buildings with the highest risk against natural hazards and that require urgent and adequate assessment. The following aspects involved in the definition of seismic risk are considered: vulnerability, exposure, and hazard. For assessment of the vulnerability, the structural elements and non-structural elements are considered by the FEMA methodology.

The RVA method is designed to be implemented without performing any detailed structural

calculations from seismic point of view however carries simple calculations for gravity load checks. The procedure utilises a damage grading system that requires the evaluator to (a) identify primary structural lateral load-resisting system, and (b) identify building attributes that modify the seismic performance expected for this lateral load-resisting system along with non-structural components.

The inspection and data collection typically occur at the building site and is expected to take couple of hours for a building, depending on its size. The screening is based on Code based Seismic Intensity, Building Type and Damage Grade as observed in past earthquakes. Once the data gathered, the data will go through a detailed review by expert engineers for decision-making process, risk scoring and prioritization. The main uses of this procedure in relation to seismic upgrading of existing buildings are:

- To identify if a particular building requires further evaluation for assessment of its seismic vulnerability.
- To assess the seismic potential damage (structural vulnerability) of the building and seismic rehabilitation needs.
- To create a basis for selection of the most vulnerable structures to be taken for further analysis
- To create a cadre of reliable results and assumptions for development of long-term investment plan for Greater Dhaka Metropolitan.

As FEMA is primarily a screening tool (i.e., it separates buildings into two bins: those that require additional detailed evaluation and those that do not), and has a system that provides each building with a numerical score that increases its usefulness as a prioritization tool. The definition of the scores is basically as S = –log10(Probability of Collapse). FEMA considers that the demand is based on the full value of MCER (Risk targeted Maximum Considerable Earthquakes). This methodology also considers the seismicity parameter of any region in development of the scores by categorizing the seismicity levels to five steps for each region. Also the soil conditions are implemented into scorings in this methodology by considering scoring modifiers for each type of soil classifications with respect to the shear wave velocity in the soil layers. FEMA methodology uses the procedure proposed by the California Office of Statewide Health Planning and Development (OSHPD) that can be used to calculate the collapse probability of buildings considering specific types of plan and vertical irregularities. Considering mentioned above and other aspects for each building the scoring of the buildings is such that the combination of basic scores and scoring modifiers predict the probability of collapse. Basic Scores and Score Modifiers are calculated by determining the probability of collapse, and then converting this to a score, S:

$S = -\log_{10}(P[Collapse \mid MCE_R\ ground\ motions])$

For each Building Type in each seismicity region, the probability of collapse considering the worst-case combination of deficiencies is calculated. This probability of collapse is then converted to a Minimum Score.

To understand the meaning of FEMA P-154 scores, it is first necessary to understand how FEMA P-154 defines collapse probability. FEMA provides a general definition of collapse where, in a portion of the building or in the entire building, the gravity load-carrying system (its beams, columns, floors, shear walls) loses the ability to carry its own weight and the weight of whatever else it supports. That failure leads to severe structural deformation of a potentially life-threatening nature, especially falling of all or portions of a structure. The word collapse, however, has no formal uniform definition in the relevant literature. From an analytical perspective, structural engineers sometimes treat large displacements or substantial reduction in tangent stiffness estimated during structural analysis to indicate that dynamic instability would occur in the real structural system, but collapse is the instability itself, not the proxy that engineering practitioners and researchers use to estimate it.

FEMA P-154 develops a methodology in order to correlate the probability of collapse of a building to

the damage that can be predicted by the HAZUS methodology. To calculate the scores, collapse probability is defined as the probability that a building will be in the HAZUS Complete structural damage state when subjected to MCER shaking, times the collapse factor. The FEMA P-154 collapse probability also equals the probability of at least partial building collapse given that the building is subjected to MCER shaking, reduced by expected value of the collapsed portion. The process for calculating probability of collapse by the HAZUS methodology includes three distinct parts: (1) calculation of peak response (i.e., peak displacement for evaluation of damage to the structure) of the building for a given set of ground motions (e.g., MCER response spectral accelerations); (2) calculation of the probability of complete damage given the peak response; and (3) calculation of probability of collapse given the probability of complete damage.

HAZUS methods are used to calculate the peak response of the building by finding the intersection of the building capacity curve (a plot of a building's lateral load resistance as a function of a characteristic lateral displacement) and the demand spectrum of earthquake ground motions as in figure below:

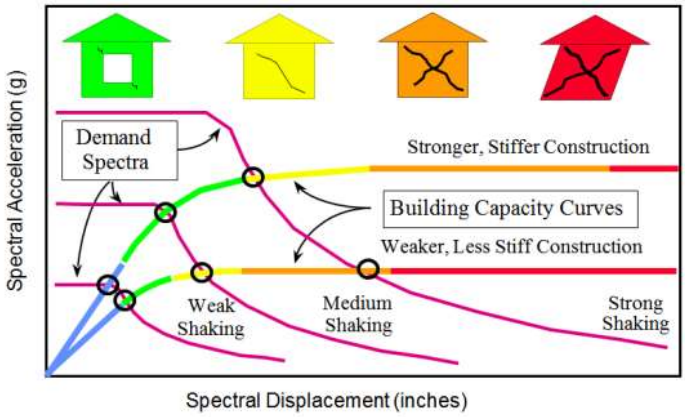


Figure- intersection of the capacity and demand curves

HAZUS building fragility curves are lognormal probability functions that describe the likelihood of reaching, or exceeding, discrete states of structural and nonstructural damage, given an estimate of peak building response. The fragility curves take into account the variability and uncertainty associated with capacity curve properties, damage states, and ground shaking.

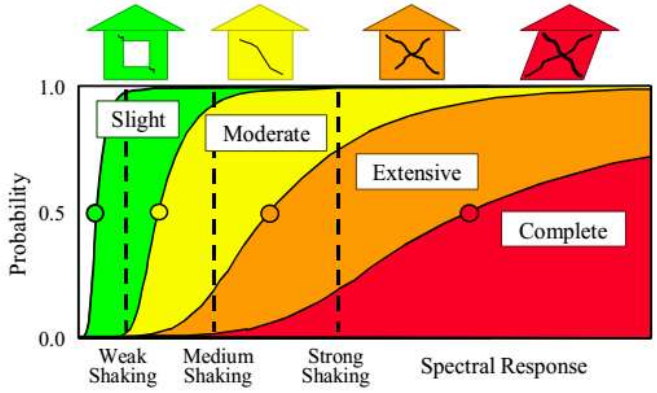


Figure- Example of fragility curves for different structural damage levels

Once the probability of complete damage has been determined, the probability of collapse can be calculated by applying a collapse factor.

$$P[COL] = P[COL|Complete\ Damage] \times P[Complete\ Damage]$$

where:

$$P\left[COL|Complete\ Damage\right] = Collapse\ Factor$$

HAZUS TM provides collapse factors for each Model Building Type. The collapse factor is small for light wood frame single or multiple-family dwellings (W1) (3%) and larger for Model Building Types more prone to collapse, such as unreinforced masonry bearing-wall buildings (URM) (15%).

At this strategy HAZUS has correlated the observations from past earthquakes and limited experiments to the analytical results. Observations of the buildings failure probability and correlating the probability of the collapse to the overall characteristics of the buildings and also to the analytical models is the fundamental of the FEMA methodology. Finally the portion of each characteristic of the building to the probability of collapse is estimated by statistical methods and is presented as a score for the collapse risk. However it should be noted that as there are limited observations, there may be a high level of uncertainty in the RVS methods.

The collected data allows us to identify more critical structural weaknesses and to evaluate the non-structural elements that most influence the functionality of buildings. The hazard is a function of the seismicity or level of flooding intensity in term of the production of flood depth and velocity of the area where the structures are built and of the soil type. The exposure depends on the importance of the buildings; the exposure is related to the usage of buildings and number and duration that population is in the building.

Three indices are called the Primary Indices and are evaluated using the three main sections of the proposed form (Structural elements, I_{STR} ; Non-structural elements, I_{NSTR} ; Organizational aspects, I_{ORG}). The other three indices combine the results of the Primary Indices with Hazard and Exposure, assigning different weights to each result. For instance, the level of risk posed by foundations is associated with their typology (beam, plinth, or pile foundation) and with the connection between the foundation elements. The on-site evaluation of the facility should take no more than 8 hours. During the survey, a meeting with the administrative and technical staff should be scheduled. This meeting enables one to examine the plan of the structure, if available. The prior examination of the plan is of importance in terms of obtaining information regarding structural details that are not viewable during the survey such as foundations. If there are doubts about the level of risk of some elements, the highest level of risk should be assigned.

In particular, the evaluation team should preferably include engineers or architects with expertise in structural engineering and design, a specialist in equipment and an administrator.

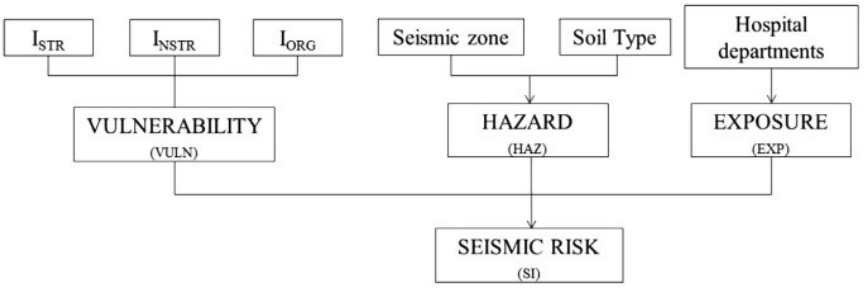


Figure 2 General framework of the RVA scoring

A total of six indices are calculated according to the proposed RVS method. The first three indices enable the identification of the safety level in terms of the fundamental aspects of the building performances (I_{STR}, I_{NSTR}, I_{ORG}). The combination of the Primary Indices produces two additional indices related to the functionality (FUNC) and the vulnerability of the building (VULN). Finally, the Safety Index (SI) also considers the hazard (HAZ) and exposure (EXP). Seismic vulnerability factors for any given building can be treated independently. For any given factors corresponding to each aspect,

the following value function can be determined if and only if the criteria are mutually preferentially independent:

$$Index\ (\text{Item } 1, \text{Item } 2, \dots \text{Item n}) = \sum_{i=1}^{n} \text{Index(Item i)}$$

Having employed the RVA procedure and determined the building's Final Score, S, which is based on the Basic Score and Score Modifiers associated with the various performance attributes, the it is important to understand of what these S scores mean. Fundamentally, the final S score is an estimate of the collapse probability if an earthquake occurs with ground motions called the risk-targeted maximum considered earthquake, MCER. These estimates of the score are based on limited observed and analytical data, and the probability of collapse is therefore approximate. A Final Score, S, of 3 implies there is a chance of 1 in 103, or 1 in 1,000, that the building will collapse if such ground motions occur. A Final Score, S, of 2 implies there is a chance of 1 in 102, or 1 in 100, that the building will collapse if such ground motions occur.

It should be noted that although we are using the FEMA methodology for RVA of the buildings, it is not the only factor in our calculations and decisions and will be a layer in the database that is to be provided. Other important and influential data such as flood risk and organizational aspects will be considered in the processing step by using the information that will be added later to the current list. The organizational and resiliency aspects and the related indices and attributes will be evaluated according to guidelines proposed by the World Health Organization (WHO) for hospital buildings and CRPT (City Resiliency Profiling Tool) tool of United Nations, etc. and in situ investigations of the staff for facilities.

In this project, the RVA stage of the assessments is planned to be performed on approximately 4000 structures of the Dhaka and due to the results of this stage 20% of the structures which are representative for the overall statistical population will be selected for the further PEA stage with approximately. Similarly, 30-40% of the structures in the PEA stage will be selected for the DEA stage.

4.4.1.5 REPORTING

An individual Report for each Facility including all the structures on the facility will be provided once the studies are completed. The template of the report prior to submission will be shared with stakeholders for verification and approval. These individual reports will cover at minimum following information:

- General information of the structures and context
- Location Map
- Soil Map
- Hazard Map
- Pictures from all sides
- Structural plan of the building
- Actual Vs. Theoretical Max. Structural Vulnerability indices
- Actual Vs. Theoretical Max. Non-Structural Vulnerability indices
- Key findings in form of SVI, NSVI, RVI and Operation Vulnerability indices
- Relative structural and non-structural Vulnerability
- Prioritization
- Engineering Recommendations and mitigation actions
- Emergency Preparedness Measures

A Synthesis report will be provided for All Structures under the scope of the consultancy works as per the requirement of the ToR.

ANNEX1: SUMMARY LIST OF THE STRUCTURES UNDER THE SCOPE

Summary of Zonewise All Critical Facility Lists of URP/RAJUK/S-4

Dhaka Division Zone	No. of Zones	Name of the Zones	School & College			Madrasa			Hospital			Bangladesh Bank			BUET			RAJUK			Civil aviation			Police station			Total
			No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	No. of Facilities	No. of Buildings	Area Covered (Sqm)	
Dhaka South Zone	1	Dhaka Metro_South	300	680	902,256.41	33	74	99,029.28	97	140	483,402.94	1	16	113,837.61	1	56	203,410.11	1	5	23,655.78	None	None		44	44	48,874.71	
	2	Keraniganj	72	237	93,753.04	6	15	12,822.56	7	16	11,565.77													3	3	224.34	
	3	Narayanganj	61	180	137,226.55	20	64	61,562.97	6	12	15,541.76																
	4	Bandar	16	44	29,838.46	1	1	1,665.61	3	3	5,977.70													1	1	46.43	
	5	Sonargaon	6	20	13,474.13	3	7	5,530.75	2	2	2,503.24																
Dhaka North Zone	6	Dhaka Metro_North	411	828	1,242,426.51	26	52	82,076.81	98	154	475,833.97							1	1	2,487.85	1	258	269,379.76	62	62	88,357.05	
	7	Savar	79	280	203,041.73	8	23	23,262.54	17	27	79,730.73													9	9	2,168.89	
	8	Gazipur	104	332	203,076.83	20	98	56,079.31	13	33	53,464.81													4	4	2,122.63	
	9	Rupganj	31	96	45,200.70	2	10	3,788.33	5	18	11,040.91													1	1	256.47	
	10	Kaliganj	6	17	9,200.24				2	2	4,556.10													1	1	692.92	
Total No. of Facilities			1086			119			250			1			1			2			1			125			1585
Total No. of Building				2714			344			407			16			56			6			258			125		3926
Total Areas (Sqm)					2,879,494.60			345,818.16			1,143,617.92			113,837.61			203,410.11			26,143.62			269,379.76			142,743.43	5,124,445.21

ANNEX2: CHECKLISTS

BUILDING INFO

Building Identification Information:

Seismicity/Zone:	Based on the Codes Classifications		
Zip Code:	.....		
Latitude:	fills automatically by the application		
Longitude:	fills automatically by the application		
Date/Time	fills automatically by the application		
Entrance Allowed	a) Yes b) No		
Owner's Name			
Holding No.			
Heritage Building	a) Yes b) No		
Court Case	a) Yes b) No		
No. of Dwellers	General People Old People Female & Children	Total=	
Width of the adjacent Road of Building			
In accordance with B.C. Rule 2008, accessibility of Fire Engine sufficient?	a) Yes b) No		
RAJUK Land use Clearance available?	a) Yes b) No		
RAJUK Approval Drawing available?	a) Yes b) No		
Architectural Design available?	a) Yes b) No		Name of Architect: IAB No:
Structural Design available?	a) Yes b) No	Name of	

		Engineer: IEB No:
Soil test Report available?	a) Yes b) No	Company : Address:
RAJUK Occupancy Certificate available?	a) Yes b) No	

Technical Information

Structural Modification	a) Yes b) No		
Fire Hydrant	a) Yes b) No		
Stair/ Fire Escape	a) Yes b) No		
Vertical load carrying System Logical or not?	a) Yes b) No		
Lateral load carrying System Logical or not?	a) Yes b) No		
Excessive floor loading or material storage overloading been found in any location			
Efflorescence , Dampness , Water Ponding	Efflorescence	a) Yes	b) No
	Dampness	a) Yes	b) No
	Water Ponding	a) Yes	b) No
Type of load Path?	a)Regular b) Irregular		
The foundation of the building is satisfactory or not?	a) Yes b) No		
Based on the preliminary inspection, the load bearing capacity of the columns for the building adequate or not?	a) Yes b) No		

Other Hazards:

Chemical and/or technological:	
Explosions Fires	….

Hazardous material spills	

Hydro-meteorological:
Hurricanes Territorial rains River flooding

Geologic Information

Geologic Hazard:
Liquefaction Landslide Surface Fault Rupture

Soil Type

Soil Type (Based on BNBC2015- table 6.2.13):	Select from list below
Rock or other rock-like geological formation, including at most 5 m of weaker material at the surface. Vs(m/s)>800	Type (SA) Rock
Deposits of very dense sand, gravel, or very stiff clay, at least several tens of metres in thickness, characterized by a gradual increase of mechanical properties with depth. Vs=360-800m/sec or Avg. SPT Value N > 50	Type (SB) Very Dense Sand, Gravel, or Very Stiff Clay
Deep deposits of dense or medium dense sand, gravel or stiff clay with thickness from several tens to many hundreds of metres. Vs=180-360m/sec or Avg. SPT Value 15 < N < 50	Type (SC) Medium Dense Sand, Gravel or Stiff Clay
Deposits of loose-to-medium cohesionless soil (with or without some soft cohesive layers), or of predominantly soft to firm cohesive soil. Vs<180m/sec or Avg. SPT Value N < 15	Type (SD) Loose To Medium Cohesionless Soil, Soft-To-Firm Cohesive Soil

A soil profile consisting of a surface alluvium layer with Vs values of type SC or SD and thickness varying between about 5 m and 20 m, underlain by stiffer material with Vs > 800 m/s.	Type (SE)
Deposits consisting, or containing a layer at least 10 m thick, of soft clays/silts with a high plasticity index (PI > 40) and high water content. Vs<100m/sec	Type (S1)
Deposits of liquefiable soils, of sensitive clays, or any other soil profile not included in types SA to SE or S1.	Type (S2)
	No report available or Do Not Know (select SD)

Photography

Photography of North:	
Photography of East:	
Photography of West:	
Photography of South:	

Sketch

Sketch:	

No. Stories:

Below Grade:	….
Above Grade	….
Number of Floors	….
If not applicable please comment	

Building General Characteristics

Year Built: (Year of Const)	…. (ex. 2016)
Code Year: (Design Code Version)	Before 1996
	1996-2006
	After 2006
Each Floor Area (m^2):	…..

Total Construction Area (m^2):	.....
Additions:	Select from list below
	No
	Yes
	N/A
Multiple Parts:	Select from list below
	No
	Yes
	N/A
Alterations:	Select from list below
	No
	Yes
	N/A
Type of building:	Select from list below
	Kutcha
	Semi-pucca
	Pucca
	Comment
Building General Comment:	...

Building Occupancy (Building Occupancy)

Building Occupancy:	Select from list below
	Government
	Historic
	Others
Building Type: (Building Type)	Select from list below
	Commercial
	Assembly

	Emergency Services
	Industrial
	Residential
	Mixed Use
	Educational Facilities
	Utility
	Office
	Warehouse
	Airport
	Civil Aviation
	Others
Building Subtype: (Building Subtype)	Select from list below
	Retail business
	Wholesale business
	Financial institution
	restaurant
	bank
	Parking structure
	Others
Total No. Of Units: (Of Units)	.....

STRUCTURAL

Structural System

1) Material Type (GravitySystem)	Select from list below
	a) Wood b) Steel c) Masonry d) Concrete e) Bamboo f) Dual system

2) Seismic Force Resisting System.	Select from list below a) Frame b) Braced frame c) Bearing wall d) Dual system
3) Building Type (Building Type System)	Select from list below (Based on FEMA 154)

W1	S1	C1	PC1	RM1	Other
W1A	S2	C2	PC2	RM2	
W2	S3	C3		URM	
	S4			MH	
	S5				

Redundancy

4) Building has at least two bays of seismic force resisting elements on each side of the building in each direction.	a) No b) Yes c) N/A

Adjacency / Pounding

5) Ratio of the separation gap between adjacent buildings to the height of the shorter building (shorter of the adjacent building and the target building)? (Separation Gap Adjacent)	
6) Floors separated vertically by more than two feet (65 cm) (floors not aligning vertically).	a) No b) Yes c) N/A
7) One building two or more stories taller than the adjacent building.	a) No b) Yes c) N/A
8) The building at the end of a row of three or more buildings.	a) No b) Yes c) N/A

Falling Hazards from Taller Adjacent Building

9) No. of Chimneys:
10) No. of Parapets:
11) No. of Walls:
12) No. of Appendages: (Appendages)
13) No. of Signs:
14) No. of Tanks:

15 Other falling hazards	

Plan Irregularities

16) Torsion: Lateral system does not appear relatively well distributed in plane in either or both directions. (PlanIrregularitiesImgQ1)	a) No b) Yes c) N/A
17) Non-Parallel Systems: There are one or more major vertical elements of the lateral system that are not orthogonal to each other. (PlanIrregularitiesImgQ2)	a) No b) Yes c) N/A
18) Reentrant Corners: Both projections from an interior corner exceed 25% of the overall plan dimension in that direction. (PlanIrregularitiesImgQ3)	a) No b) Yes c) N/A
19) Diaphragm Opening: There is an opening in the diaphragm with a width over 50% of the total diaphragm width at that level. (PlanIrregularitiesImgQ4)	a) No b) Yes c) N/A
20) For C1 and C2 buildings: Beams do not align with columns in plan.(BeamsAlignColumn)	a) No b) Yes c) N/A

Structural Elements

21) Column section type: (ColumnSectionType)	- I-shaped - Double I-shaped - Box - Hollow Circuclar - Rectangular - Circular - Others
22) Dim depth of the smallest column (m):	
23) Dim depth of the largest column (m):	
24) Dim width of the smallest column (m): (ColumnDimWidthSmallest)	
25) Dim width of the largest column (m): (ColumnDimWidthLargest)	
26) Beam section type: (BeamSectionType)	- I-shaped - Double I-shaped - Box - Hollow Circuclar - Rectangular - Circular - Others

27) Dim depth of the smallest beam (m):	
28) Dim depth of the largest beam (m):	
29) Dim width of the smallest beam (m):	
30) Dim width of the largest beam (m):	
31) Bracing section type:	
32) Dim depth of the smallest bracing (m):	
33) Dim depth of the largest bracing (m):	
34) Dim width of the smallest Bracing (m):	
35) Dim width of the largest Bracing (m):	
36) Thickness of the smallest wall (m):	
37) Thickness of the largest wall (m):	
38) Deck type: (DeckType)	Select from list below a) Wood b) Concrete slab c) Composite d) bamboo e) pitched f) Truss g) Gable frame h) comment
39) Deck thickness (m): (DeckThickness)	
40) The Schmidt hammer test has been done for this building: (SchmidtHammerTest)	Select from list below a) No b) Yes c) N/A d) If yes, what is the result of the test?

Vertical Irregularities

40) **Sloping site:** There is at least a full story grade change from one side of the building to the other.	a) No b) Yes c) N/A
41) **Weak and/or soft Story**: For W1 Buildings on the cripple walls: An unbraced cripple wall is visible in the crawl space. (WeakSoftStoryQ1)	a) No b) Yes c) N/A
42) For W1 house over garage: Underneath an occupied story, there is a garage opening without a steel moment frame, and there is less than 8' (250 cm.) of wall on the same line (for multiple occupied floors above, use 16'	a) No b) Yes c) N/A

(500 cm) of wall minimum). (WeakSoftStoryQ2)	
43) For W1A buildings: There are openings at the ground story (such as for parking) over at least 50% of the length of the building. (WeakSoftStory Q3)	a) No b) Yes c) N/A
45) Length of lateral system at any story is less than 50% of that at story above or height of any story is more than 2.0 times the height of the story above. (WeakSoftStory Q4)	a) No b) Yes c) N/A
44) For Non-W1 buildings: Length of lateral resisting system at any story is between --- of that at story above or height of any story is between --- times the height of the story above. (WeakSoftStory Q5)	a) between 50% and 75% - between 1.3 and 2.0 b) less than 50% - more than 2.0 c) N/A
45) **In-plane Setback:** There is an in-plane offset of the lateral elements that is greater than the length of the elements.	a) No b) Yes c) N/A
46) **Out-of-plane Setback:** Vertical elements of the lateral system at an upper story are outboard of those at the story below causing the diaphragm to cantilever at the offset. (OutOfPlaneSetbackQ1)	a) No b) Yes c) N/A
49) Vertical elements of the lateral system at upper stories are inboard of those at lower stories. (OutOfPlaneSetbackQ2)	a) No b) Yes c) N/A
47) **Short Column / Pier:** For C1, C2, C3, PC1, PC2, RM1, RM2 buildings: At least 20% of columns (or piers) along a column line in the lateral system have height/depth ratios less than 50% of the nominal height/depth ratio at that level. (ShortColumnPierQ1)	a) No b) Yes c) N/A
48) For C1, C2, C3, PC1, PC2, RM1, RM2 buildings: (ShortColumnPierQ2) A. The column depth (or pier width) is less than one half of the depth of the spandrel B. There are infill walls that shorten the column C. There are adjacent floor that shorten the column	a) No b) Yes c) N/A a) No b) Yes c) N/A a) No b) Yes c) N/A
49) **Split Level:** There is a split level at one of the floor levels or at the roof.	a) No b) Yes c) N/A
50) There is another observable vertical irregularity that	a) Moderate

obviously affects the buildings seismic performance (e.g. change of bracing system, removing bracings at higher stories, etc.) 53) Any other aspects that can affect the structural behavior of the building?	b) Severe C) No Comment

Other Structural Info:

51) For S2 buildings: "K-bracing" geometry is visible.	a) No b) Yes c) N/A
52) For C1 building: Flat plate serves as the beam in the moment frame.	a) No b) Yes c) N/A
53) For PC1/RM1 building: There are roof-to-wall ties that are visible or known from drawings that do not rely on cross-grain bending.	a) No b) Yes c) N/A
54) For PC1/RM1 building: The building has closely spaced, full height interior walls (rather than an interior space with few walls such as in a warehouse).	a) No b) Yes c) N/A
55) For URM buildings: Gable walls are present.	a) No b) Yes c) N/A
56) For MH buildings: there is a supplement seismic bracing system provided between the carriage and the ground.	a) No b) Yes c) N/A
57) Comprehensive seismic retrofit is visible or known from drawings.	a) No b) Yes c) N/A

MASONRY BUILDING

Seismic force resisting system

1)Kind of structural system (KindOfStructuralSystem)	a) Masonry wall b) Masonry wall and beam c) Masonry Column system d) Masonry Shear Wall e) Other
2) Any comments about kind of structural system? 3) Number of shear walls in X direction? (ShearWallsNumberX) 4) Number of shear walls in Y direction? (ShearWallsNumberY) 5) Height-to-thickness ratio of the shear walls ? (ShearWallsHeightThickness) 3) Thickness of the masonry walls (m) 4) The critical ratio of Length to width	

5) The dimensions of walls (such as thickness, height and average length) at typical spans	Thickness: ---- Height: ----- Length:-----
6) Kind of Diaphragm	a) reinforced concrete joist b) steel joist c) wooden joist d) concrete slab e) wooden slab
7) Any comments on the kind of diaphragm? (DiaphragmKindComment)	
8) Condition of connection between wall to slab joist and wall to wall? (WallConnectionCondition)	a) weak b) moderate c) good
9) Opening-to-total area ratio of the diaphragm at each story(OpeningTotalAreaDiaphragm)	a) low b) moderate c) high
11) opening-to-total area ratio of the shear walls at each story(OpeningTotalAreaWalls)	a) low b) moderate c) high
10) For wood & clay roofs: Are there any horizontal bracing elements between the joists?	Yes No N/A
11) The average distance of vertical tie spans (in centimeters)	

Material

8) kind of mortar material	a) cement mortar b) lime mortar c) mud mortar d) other
9) kind of units material	a) clay brick b) stone brick c) concrete block d) other
10) kind of foundation material (FoundationKindMaterial)	a) Brick b) Concrete c) Stone d) Lime e) Wood f) other
11) Quality of material	a) weak b) moderate c) good
12) Any other comments about Masonry structure?	

ADDITIONAL INFORMATION

Life Safety System

1) Fire Suppression Piping: Fire suppression	a) No

piping is anchored and braced. (LifeSafetySystemQ1)	b) Yes c) N/A
2) Flexible Couplings: Fire suppression piping has flexible coupling.	a) No b) Yes c) N/A
3) Emergency Power: Equipment used to power or control Life Safety systems is anchored or braced.	a) No b) Yes c) N/A
4) Stair and Smoke Dust: Stair pressurization and smoke control ducts are braced and have flexible connections at seismic joints.	a) No b) Yes c) N/A
5) Sprinkler Ceiling clearance: Penetrations through panelized ceilings for fire suppression devices provide clearances. (LifeSafetySystemQ5)	a) No b) Yes c) N/A
6) Emergency Lighting equipment is anchored or braced.	a) No b) Yes c) N/A

Hazardous Material

7) Hazardous Material Equipment: Equipment mounted on vibration isolators and containing hazardous material is equipped with restraints or snubbers.	a) No b) Yes c) N/A
EMERGENCY LIGHTINGighting equipment is anchored or braced: (HazardousMaterialQ2)	a) No b) Yes c) N/A
8) Hazardous Material Storage: Breakable containers that hold hazardous material, including gas cylinders, are restrained by latched doors, shelf lips, wires, or other methods. (HazardousMaterialQ3)	a) No b) Yes c) N/A
9) Hazardous Material Distribution: piping or ductwork conveying hazardous materials is braced or otherwise protected from damage that would allow hazardous material release.	a) No b) Yes c) N/A
10) Flexible Couplings: Hazardous material ductwork and piping, including natural gas piping, have flexible couplings.	a) No b) Yes c) N/A
11) Piping or Ducts Crossing Seismic Joints: Piping or ductworks carrying hazardous material that either crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic	a) No b) Yes c) N/A

displacements. (HazardousMaterialQ6)

Partitions

12) UNREINFORCED MASONRY: Unreinforced masonry or hollow-clay tile partitions are braced at a spacing of at most 10 ft (3.0 m) in Low or Moderate Seismicity, or at most 6 ft (1.8 m) in High Seismicity.	a) No b) Yes c) N/A
13) HEAVY PARTITIONS SUPPORTED BY CEILINGS: The tops of masonry or hollow-clay tile partitions are not laterally supported by an integrated ceiling system. (PartitionsQ2)	a) No b) Yes c) N/A
14) DRIFT: Rigid cementitious partitions are detailed to accommodate the following drift ratios: in steel moment frame, concrete moment frame, and wood frame buildings, 0.02; in other buildings, 0.005. (PartitionsQ3)	a) No b) Yes c) N/A
15) LIGHT PARTITIONS SUPPORTED BY CEILINGS: The tops of gypsum board partitions are not laterally supported by an integrated ceiling system. - STRUCTURAL SEPARATIONS: Partitions that cross structural separations have seismic or control joints. (PartitionsQ4)	a) No b) Yes c) N/A
16) TOPS: The tops of ceiling-high framed or panelized partitions have lateral bracing to the structure at a spacing equal to or less than 6 ft (1.8 m). (PartitionsQ5)	a) No b) Yes c) N/A

Ceilings

a) No (No option will be show)

b) If Yes (option will show)

13) SUSPENDED LATH AND PLASTER: Suspended lath and plaster ceilings have attachments that resist seismic forces for every 12 ft^2 (1.1 m^2) of area.	a) No b) Yes c) N/A
14) SUSPENDED GYPSUM BOARD: Suspended gypsum board ceilings have attachments that resist seismic forces for every 12 ft^2 (1.1 m^2) of area.	a) No b) Yes c) N/A
15) INTEGRATED CEILINGS: Integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) and ceilings of smaller areas that are not surrounded by restraining partitions are laterally restrained at a spacing no greater than 12 ft (3.6 m) with members attached to the structure above. Each restraint location has a minimum of four diagonal wires and compression struts, or diagonal members capable of resisting	a) No b) Yes c) N/A

compression.	
16) EDGE CLEARANCE: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) have clearances from the enclosing wall or partition of at least the following: in Moderate Seismicity, 1/2 in. (13 mm); in High Seismicity, 3/4 in. (19 mm).	a) No b) Yes c) N/A
17) CONTINUITY ACROSS STRUCTURE JOINTS: The ceiling system does not cross any seismic joint and is not attached to multiple independent structures.	a) No b) Yes c) N/A
17) EDGE SUPPORT: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) are supported by closure angles or channels not less than 2 in. (51 mm) wide.	a) No b) Yes c) N/A
18) SEISMIC JOINTS: Acoustical tile or lay-in panel ceilings have seismic separation joints such that each continuous portion of the ceiling is no more than 2,500 ft2 (232.3 m2) and has a ratio of long-to-short dimension no more than 4-to-1.	a) No b) Yes c) N/A

Light Fixture

- **a) No (No option will be shown)**
- **b) If Yes (option will show)**

19) INDEPENDENT SUPPORT: Light fixtures that weigh more per square foot than the ceiling they penetrate are supported independent of the grid ceiling suspension system by a minimum of two wires at diagonally opposite corners of each fixture.	a) No b) Yes c) N/A
20) PENDANT SUPPORTS: Light fixtures on pendant supports are attached at a spacing equal to or less than 6 ft. Unbraced suspended fixtures are free to allow a 360-degree range of motion at an angle not less than 45 degrees from horizontal without contacting adjacent components. Alternatively, if rigidly supported and/or braced, they are free to move with the structure to which they are attached without damaging adjoining components. Additionally, the connection to the structure is capable of accommodating the movement without failure.	a) No b) Yes c) N/A
21) LENS COVERS: Lens covers on light fixtures are attached with safety devices.	a) No b) Yes c) N/A

Cladding and Glazing

a) **No (No option will be shown)**
b) **If Yes (option will show)**

22) CLADDING ANCHORS: Cladding components weighing more than 10 lb/ft2 (0.48 kN/m2) are mechanically anchored to the structure at a spacing equal to or less than the following: for Life Safety in Moderate Seismicity, 6 ft (1.8 m); for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 ft (1.2 m).	a) No b) Yes c) N/A
23) CLADDING ISOLATION: For steel or concrete moment-frame buildings, panel connections are detailed to accommodate a story drift ratio by the use of rods attached to framing with oversize holes or slotted holes of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02, and the rods have a length-to-diameter ratio of 4.0 or less.	a) No b) Yes c) N/A
24) MULTI-STORY PANELS: For multi-story panels attached at more than one floor level, panel connections are detailed to accommodate a story drift ratio by the use of rods attached to framing with oversize holes or slotted holes of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02, and the rods have a length-to-diameter ratio of 4.0 or less.	a) No b) Yes c) N/A
25) THREADED RODS: Threaded rods for panel connections detailed to accommodate drift by bending of the rod have a length-to-diameter ratio greater than 0.06 times the story height in inches for Life Safety in Moderate Seismicity and 0.12 times the story height in inches for Life Safety in High Seismicity and Position Retention in any seismicity.	a) No b) Yes c) N/A
26) PANEL CONNECTIONS: Cladding panels are anchored out of plane with a minimum number of connections for each wall panel, as follows: for Life Safety in Moderate Seismicity, 2 connections; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 connections.	a) No b) Yes c) N/A
27) BEARING CONNECTIONS: Where bearing connections are used, there is a minimum of two bearing connections for each cladding panel.	a) No b) Yes c) N/A
28) INSERTS: Where concrete cladding	a) No

components use inserts, the inserts have positive anchorage or are anchored to reinforcing steel.	b) Yes c) N/A
29) OVERHEAD GLAZING: Glazing panes of any size in curtain walls and individual interior or exterior panes more than 16 ft2 (1.5 m2) in area are laminated annealed or laminated heat-strengthened glass and are detailed to remain in the frame when cracked.	a) No b) Yes c) N/A

Masonry Veneer

35) TIES: Masonry veneer is connected to the backup with corrosion-resistant ties. There is a minimum of one tie for every 2-2/3 ft2 (0.25 m2), and the ties have spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 36 in. (914 mm); for Life Safety in High Seismicity and for Position Retention in any seismicity, 24 in. (610 mm) SHELF ANGLES: Masonry veneer is supported by shelf angles or other elements at each floor above the ground floor. (MasonryVeneerQ1), (MasonryVeneerImgQ1)	a) No b) Yes c) N/A
36) WEAKENED PLANES: Masonry veneer is anchored to the backup adjacent to weakened planes, such as at the locations of flashing. (MasonryVeneerQ2), (MasonryVeneerImgQ2)	a) No b) Yes c) N/A
37) UNREINFORCED MASONRY BACKUP: There is no unreinforced masonry backup. (MasonryVeneerQ3), (MasonryVeneerImgQ3)	a) No b) Yes c) N/A
38) STUD TRACKS: For veneer with coldformed steel stud backup, stud tracks are fastened to the structure at a spacing equal to or less than 24 in. (610 mm) on center. (MasonryVeneerQ4), (MasonryVeneerImgQ4)	a) No b) Yes c) N/A
39) ANCHORAGE: For veneer with concrete block or masonry backup, the backup is positively anchored to the structure at a horizontal spacing equal to or less than 4 ft along the floors and roof. (MasonryVeneerQ5), (MasonryVeneerImgQ5)	a) No b) Yes c) N/A
40) WEEP HOLES: In veneer anchored to stud walls, the veneer has functioning weep holes and base flashing. (MasonryVeneerQ6), (MasonryVeneerImgQ6)	a) No b) Yes c) N/A
41) OPENINGS: For veneer with cold-formed-steel stud backup, steel studs frame window and door openings. (MasonryVeneerQ7),	a) No b) Yes c) N/A

(MasonryVeneerImgQ7)	

Masonry Chimneys

42) URM CHIMNEYS: Unreinforced masonry chimneys extend above the roof surface no more than the following: for Life Safety in Low or Moderate Seismicity, 3 times the least dimension of the chimney; for Life Safety in High Seismicity and for Position Retention in any seismicity, 2 times the least dimension of the chimney. (MasonryChimneysQ1), (MasonryChimneysImgQ1)	a) No b) Yes c) N/A
43) ANCHORAGE: Masonry chimneys are anchored at each floor level, at the topmost ceiling level, and at the roof. (MasonryChimneysQ2), (MasonryChimneysImgQ2)	a) No b) Yes c) N/A
STAIR ENCLOSURES: Hollow-clay tile or unreinforced masonry walls around stair enclosures are restrained out of plane and have height-to-thickness ratios not greater than the following: for Life Safety in Low or Moderate Seismicity, 15-to-1; for Life Safety in High Seismicity and for Position Retention in any seismicity, 12-to-1: (MasonryChimneysQ3), (MasonryChimneysImgQ3)	a) No b) Yes c) N/A
44) STAIR DETAILS: The connection between the stairs and the structure does not rely on post-installed anchors in concrete or masonry. (MasonryChimneysQ4), (MasonryChimneysImgQ4)	a) No b) Yes c) N/A

Parapets, Cornices, Ornamentation, and Appendages

30) URM PARAPETS OR CORNICES: Laterally unsupported unreinforced masonry parapets or cornices have height to thickness ratios no greater than the following: for Life Safety in Low or Moderate Seismicity, 2.5; for Life Safety in High Seismicity and for Position Retention in any seismicity, 1.5.	a) No b) Yes c) N/A
31) CANOPIES: Canopies at building exits are anchored to the structure at a spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 10 ft (3.0 m); for Life Safety in High Seismicity and for Position Retention in any seismicity, 6 ft (1.8 m).	a) No b) Yes c) N/A
32) CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 have vertical reinforcement.	a) No b) Yes c) N/A

33) APPENDAGES: Cornices, parapets, signs, and other ornamentation or appendages that extend above the highest point of anchorage to the structure or cantilever from components are reinforced and anchored to the structural system at a spacing equal to or less than 6 ft (1.8 m). This evaluation statement item does not apply to parapets or cornices covered by other evaluation statements.	a) No b) Yes c) N/A

Mechanical and Electrical Equipment

- **a) No (No option will be shown)**
- **b) If Yes (option will show)**

49) FALL-PRONE EQUIPMENT: Equipment weighing more than 20 lb (9.1 kg) whose center of mass is more than 4 ft (1.2 m) above the adjacent floor level, and which is not in-line equipment, is braced. (MechanicalElectricalQ1), (MechanicalElectricalImgQ1)	a) No b) Yes c) N/A
50) IN-LINE EQUIPMENT: Equipment installed in line with a duct or piping system, with an operating weight more than 75 lb (34.0 kg), is supported and laterally braced independent of the duct or piping system. (MechanicalElectricalQ2), (MechanicalElectricalImgQ2)	a) No b) Yes c) N/A
34) TALL NARROW EQUIPMENT: Equipment more than 6 ft (1.8 m) high with a height-to-depth or height-to-width ratio greater than 3-to-1 is anchored to the floor slab or adjacent structural walls.	a) No b) Yes c) N/A
35) MECHANICAL DOORS: Mechanically operated doors are detailed to operate at a story drift ratio of 0.01.	a) No b) Yes c) N/A
36) SUSPENDED EQUIPMENT: Equipment suspended without lateral bracing is free to swing from or move with the structure from which it is suspended without damaging itself or adjoining components (for example: Air Conditioner (AC)). (MechanicalElectricalQ5), (MechanicalElectricalImgQ5)	a) No b) Yes c) N/A
54) VIBRATION ISOLATORS: Equipment mounted on vibration isolators is equipped with horizontal restraints or snubbers and with vertical restraints to resist overturning. (MechanicalElectricalQ6), (MechanicalElectricalImgQ6)	a) No b) Yes c) N/A

55) HEAVY EQUIPMENT: Floor supported or platform-supported equipment weighing more than 400 lb (181.4 kg) is anchored to the structure. (MechanicalElectricalQ7), (MechanicalElectricalImgQ7)	a) No b) Yes c) N/A
56) ELECTRICAL EQUIPMENT: Electrical equipment is laterally braced to the structure. (MechanicalElectricalQ8), (MechanicalElectricalImgQ8)	a) No b) Yes c) N/A
57) CONDUIT COUPLINGS: Conduit greater than 2.5 in. (64 mm) trade size that is attached to panels, cabinets, or other equipment and is subject to relative seismic displacement has flexible couplings or connections. (MechanicalElectricalQ9), (MechanicalElectricalImgQ9)	a) No b) Yes c) N/A

Contents and Furnishings

58) TALL NARROW CONTENTS: Contents more than 6 ft (1.8 m) high with a height-to-depth or height-to-width ratio greater than 3-to-1 are anchored to the structure or to each other. (ContentsFurnishingsQ1), (ContentsFurnishingsImgQ1)	a) No b) Yes c) N/A
59) FALL-PRONE CONTENTS: Equipment, stored items, or other contents weighing more than 20 lb (9.1 kg) whose center of mass is more than 4 ft (1.2 m) above the adjacent floor level are braced or otherwise restrained. (ContentsFurnishingsQ2), (ContentsFurnishingsImgQ2)	a) No b) Yes c) N/A
60) ACCESS FLOORS: Access floors more than 9 in. (229 mm) high are braced. (ContentsFurnishingsQ3), (ContentsFurnishingsImgQ3)	a) No b) Yes c) N/A
61) EQUIPMENT ON ACCESS FLOORS: Equipment and other contents supported by access floor systems are anchored or braced to the structure independent of the access floor. (ContentsFurnishingsQ4), (ContentsFurnishingsImgQ4)	a) No b) Yes c) N/A
62) SUSPENDED CONTENTS: Items suspended without lateral bracing are free to swing from or move with the structure from which they are suspended without damaging themselves or adjoining components. (ContentsFurnishingsQ5), (ContentsFurnishingsImgQ5)	a) No b) Yes c) N/A

Ducts

a) No (No option will be shown)
b) If yes (option will show)

37) DUCT BRACING: Rectangular ductwork larger than 6 ft2 (0.56 m2) in cross-sectional area and round ducts larger than 28 in. (711 mm) in diameter are braced. The maximum spacing of transverse bracing does not exceed 30 ft (9.2 m). The maximum spacing of longitudinal bracing does not exceed 60 ft (18.3 m).	a) No b) Yes c) N/A
38) DUCT SUPPORT: Ducts are not supported by piping or electrical conduit.	a) No b) Yes c) N/A
39) DUCTS CROSSING SEISMIC JOINTS: Ducts that cross seismic joints or isolation planes or are connected to independent structures have couplings or other details to accommodate the relative seismic displacements.	a) No b) Yes c) N/A

Piping
a) No (No option will be shown)
b) If yes (option will show)

40) FLEXIBLE COUPLINGS: Fluid and gas piping has flexible couplings.	a) No b) Yes c) N/A
41) FLUID AND GAS PIPING: Fluid and gas piping is anchored and braced to the structure to limit spills or leaks.	a) No b) Yes c) N/A
42) C-CLAMPS: One-sided C-clamps that support piping larger than 2.5 in. (64 mm) in diameter are restrained.	a) No b) Yes c) N/A
43) PIPING CROSSING SEISMIC JOINTS: Piping that crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements.	a) No b) Yes c) N/A

Elevators
a) No (No option will be shown)
b) If yes (option will show)

44) RETAINER GUARDS: Sheaves and drums have cable retainer guards.	a) No b) Yes c) N/A

45) RETAINER PLATE: A retainer plate is present at the top and bottom of both car and counterweight	a) No b) Yes c) N/A
46) ELEVATOR EQUIPMENT: Equipment, piping, and other components that are part of the elevator system are anchored.	a) No b) Yes c) N/A
47) SEISMIC SWITCH: Elevators capable of operating at speeds of 150 ft/min (0.30 m/min) or faster are equipped with seismic switches that meet the requirements of ASME A17.1 or have trigger levels set to 20% of the acceleration of gravity at the base of the structure and 50% of the acceleration of gravity in other locations.	a) No b) Yes c) N/A
48) SHAFT WALLS: Elevator shaft walls are anchored and reinforced to prevent toppling into the shaft during strong shaking.	a) No b) Yes c) N/A
49) COUNTERWEIGHT RAILS: All counterweight rails and divider beams are sized in accordance with ASME A17.1.	a) No b) Yes c) N/A
50) BRACKETS: The brackets that tie the car rails and the counterweight rail to the structure are sized in accordance with ASME A17.1.	a) No b) Yes c) N/A
51) SPREADER BRACKET: Spreader brackets are not used to resist seismic forces.	a) No b) Yes c) N/A
52) GO-SLOW ELEVATORS: The building has a go-slow elevator system.	a) No b) Yes c) N/A

Damage and Deterioration

53) Is the building abandoned?	a) No b) Yes c) N/A
54) Are there beams, floors, or roofs that are visibly sagging?	a) No b) Yes c) N/A
55) Are there beams or columns that are visibly broken?	a) No b) Yes c) N/A
56) Are there sloping floors or large exterior	a) No

cracks that indicate significant settlement has occurred? (DamageDeteriorationQ4), (DamageDeteriorationImgQ4)	b) Yes c) N/A
57) Is there visible distress from prior earthquakes that has not been repaired (i.e., the building is leaning slightly or there are large x-cracks in the concrete or masonry walls)?	a) No b) Yes c) N/A
58) Is there visible fire damage that has not been repaired?	a) No b) Yes c) N/A
59) Is there extensive wood rot and/or water staining that is visible?	a) No b) Yes c) N/A
60) Is the mortar eroding away, leaving areas of uneven depth?	a) No b) Yes c) N/A
61) Are there members that are corroded?	a) No b) Yes c) N/A
62) Are there visible foundation elements with large cracks?	a) No b) Yes c) N/A
63) Are foundation elements exposed due to significant erosion of adjacent soil?	a) No b) Yes c) N/A

SUMMARY of Non-Structural Hazard (Exterior)

64) There is an unbraced unreinforced masonry parapet, or unbraced unreinforced masonry chimney.	a) No b) Yes c) N/A
65) There is heavy cladding or heavy veneer.	a) No b) Yes c) N/A
66) There is a heavy canopy over exit doors or pedestrian walkways that appears inadequately supported.	a) No b) Yes c) N/A
67) There is an unreinforced masonry appendage over exit doors or pedestrian walkways.	a) No b) Yes c) N/A
68) There is a sign posted on the building that indicates hazardous materials are present.	a) No b) Yes

	c) N/A
69) There is a taller adjacent building with an unanchored URM wall or unbraced URM parapet or chimney.	a) No b) Yes c) N/A
70) Other observed exterior nonstructural falling hazard.	a) No b) Yes c) N/A

SUMMARY of Non-Structural Hazard (Interior)

71) There are hollow clay tile or brick partitions at any stair or exit corridor.	a) No b) Yes c) N/A
72) There are unbraced/ unanchored mechanical/electrical equipment.	a) No b) Yes c) N/A
73) There are insufficiently braced/ anchored mechanical/electrical equipment.	a) No b) Yes c) N/A
74) Other observed interior nonstructural falling hazard	a) No b) Yes c) N/A

URBAN RESILIENCY

1) Whether the safety standard of critical infrastructure (water/wastewater/electricity etc.) can resist disasters (e.g. earthquakes, floods, fire, and isolation for infectious diseases)? (Low, medium, high, comment). (UrbanResiliencyQ1)	a) low b) medium c) high d) No
2) Whether there is alternative emergency energy and facilities for backup (e.g. power, water, oxygen, and telecommunication)? (UrbanResiliencyQ2)	a) low b) medium c) high d) No
3) Are there any protocols to initiate the plan for the safety of staff and equipment in place (evacuation plans etc.)? (UrbanResiliencyQ3)	a) low b) medium c) high d) No
4) Stock types and quantities for different emergency resources (e.g. clean water, food, blood, emergency medical suppliers, and portable medical equipment)? (UrbanResiliencyQ4)	a) low b) medium c) high d) No
5) Surge capacity of emergency beds, resources and staff (surge rapidity, proportion, and	a) low b) medium

strategies for emergency space and emergency beds)? (UrbanResiliencyQ5)
c) high
d) No

6) Is the access to facility (roads, streets etc.) is reliable and operational?
a) No
b) Yes
c) N/A

7) Has natural environment preserved?
a) No
b) Yes
c) N/A

8) Does the building have a proper permit?
a) No
b) Yes
c) N/A

9) Is it informal settlement?
a) No
b) Yes
c) N/A

10) Is this building and its adjacent buildings comply with the land use plan? (UrbanResiliencyLandUsePlan)

- ☐ Master Plan for Dhaka- 1959
- ☐ Dhaka Metropolitan Area Integrated Urban Development Plan -1981
- ☐ Land Study for Dhaka City- 1993
- ☐ Dhaka Integrated Flood Protection Project- FAP 8A and FAP 8B
- ☐ Dhaka Metropolitan Development Plan (DMDP)- 1995-2015
- ☐ Dhaka Structure Plan (2016-2035)
- ☐ None

11) Identify the environmental problem(s) regarding this building or adjacent ones. (UrbanResiliencyEnvironmentalProblem)	☐ Energy Use (A building's lighting system. Heating and cooling system) ☐ Impact on the Air (Wood ovens) ☐ Water use and wasted water ☐ Construction Materials (using non-sustainable materials) ☐ None

For RVA studies all the buildings should initially be considered as non-ductile buildings

- Non-Destructive Tests (NDT) like Penetration test and Schmidt hammer test only give surface information. To correlate actual strength, it becomes misguiding. Some pullout tests like CAPO test and LOK test will be used which are very popular and reliable concrete test in Europe and other Scandinavian countries however during the PEA studies. During RVA schmitth Hammer testing and Nail test will be used.
- Regarding assessment of irregularities like torsional irregularity, sometimes stair cores may be eccentrically located in the building which may be considered a torsional irregularity. But in reality they may not be concrete cores. They are may be columns with infill walls which do not give much stiffness. Visually it might create confusion during RVA. Our engineers will carefully consider this during the field tests and data gathering.
- For soft story, in some buildings in upper floors infill walls are not from column to column because of glass, windows and doors. They don't give much stiffness. But they should not be considered soft stories. Our engineers will carefully consider this during the field tests and data gathering.

FEMA 356 guidelines for masonry buildings will be used as stated in the RVA methodology. For PEA ASCE-41/17 will be used.

4.5 Preliminary Assessment Methodology

4.5.1 Preliminary Engineering Analysis

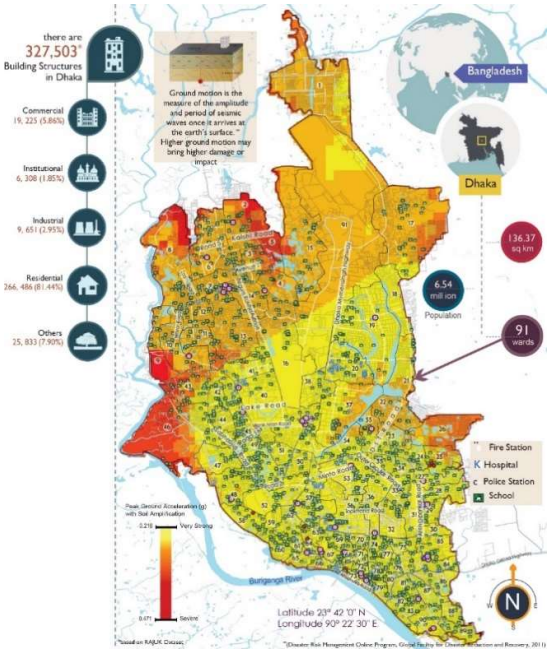
4.5.1.1 Introduction

Bangladesh with a population more than 164 million is the eighth most populous and the most densely-populated country in the world. Natural calamities, such as floods, tropical cyclones, tornadoes, and tidal bores occur almost every year, combined with the effects of deforestation, soil degradation and erosion.

In September 1998, Bangladesh witnessed the most severe flooding in modern world history. As the Brahmaputra, the Ganges and Meghna spilt over and swallowed 300,000 houses, 9,700 km (6,000 mi) of road and 2,700 km (1,700 mi) of embankment, 1,000 people were killed and 30 million more were made homeless; 135,000 cattle were killed; 50 km2 (19 sq mi) of land were destroyed; and 11,000 km (6,800 mi) of roads were damaged or destroyed. Effectively, two-thirds of the country was underwater. Bangladesh is now widely recognized to be one of the most vulnerable countries to climate change. Natural hazards that come from increased rainfall, rising sea levels, and tropical cyclones are expected to increase as climate changes, each seriously affecting agriculture, water and food security, human health, and shelter. There is also evidence that earthquakes pose a threat to the country and that plate tectonics have caused rivers to shift course suddenly and dramatically which stands for existence of highly tectonic activities in the past. Such historical evidences pose a considerable seismic hazard to the Bangladesh cities.

The risk assessment process is one of the initial steps for developing cost-effective mitigation strategies to achieve URP's overall goal. The critical facilities within the concept of the consultancy that are expected to be more than 2000 facilities and infrastructure in Dhaka region. The facilities include schools, hospitals, health centers, warehouse, residential units etc., and this infrastructure is located in highly seismic areas. Thus, there is an urgent need to assess the structural and nonstructural components of these facilities and ensure the long-term sustainability of future development.

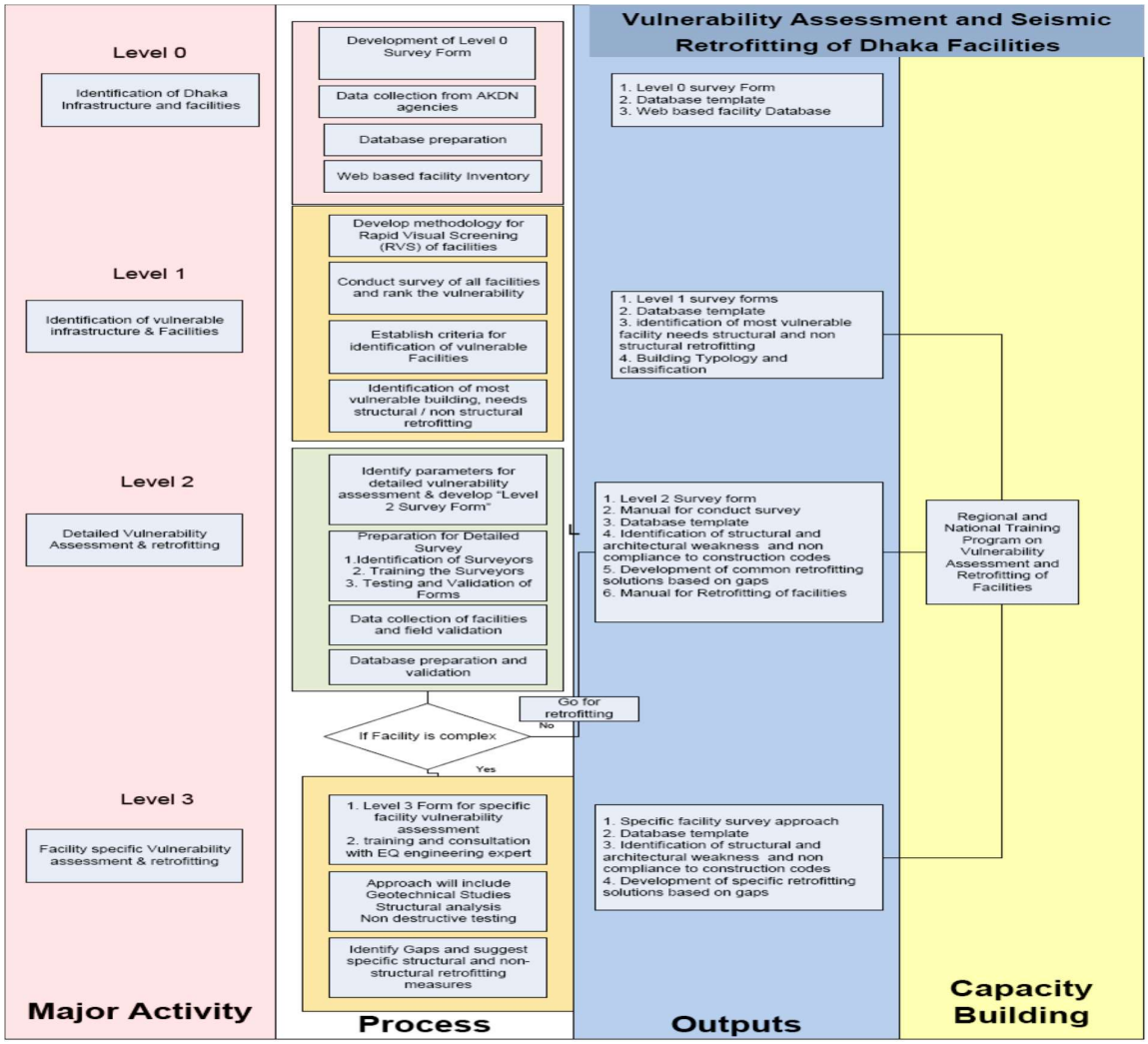
Earthquake risk assessment and safety planning usually recommends a two-pronged approach. First, assess the existing facilities and strengthen them as needed. Second, introduce seismic consciousness among the organizations to mainstream earthquake safety in their respective development planning.



Within the context of Urban Resilience Project: RAJUK Part and under a loan from IBRD Loans and IDA Credits & Grants by World Bank, a number of public service buildings; water, gas, electricity & transmission systems; essential infrastructure components & complexes will be selected to be assessed for possible improvement, decommissioning, or retrofitting; which are required to provide support and shelter to disaster response and recovery operations.

Funded by the World Bank, the Project for Improving the resilience includes extensive surveys and analyses with due consideration for structural, non-structural, architectural, mechanical and electrical equipment. The project also includes several capacity development activities and consultations to elaborate diverse guidelines employing innovative methodologies and technologies. These will then serve as the basis for sustained investments in retrofitting and rehabilitation of essential assets.

The proposed project will initiate a set of procedures that aims at transforming the vulnerable and prone to hazards Dhaka in the next 5 to 20 years into a resilient concept to major earthquakes and other natural disasters. The overall goal of the proposed project is taking first step to save lives and reduce the social, economic and financial impacts in the event of future earthquakes. The specific objective of the project is to establish the foundations toward disaster preparedness and enhancement of response capacity, post-disaster recovery and disaster risk reduction associated with natural hazards in facilities. The overall stages of the studies are outlined as following:



4.5.1.2 Codes and Standards

In this methodology several codes and standards are used to perform difference stages of the studies as following:

- BNBC06
- BNBC17
- FEMA
- ASCE-41

4.5.1.3 PEA limitations and differences with other methods

Title of "Preliminary Engineering Analysis" has selected for accurate goals that depends on data, knowledge measure, and information of the building and amount of controls and checking items.

Each reference of performance-based assessment and design includes scope of data and investigation. The scope of studies might increase to the large evaluation process for all the building condition which is not desired in this project. On the other hand, regarding the limitation of time, budget and other consideration, some main criteria shall be evaluated in this project while the other are ignored.

Furthermore, uncertainties and varieties in the material properties in existing buildings is key point for PEA studies. Data on the as-built condition of the structure, components, site, and adjacent

buildings shall be collected in enough detail to perform the selected analysis procedure. In the detailed study, the extent of data collected shall be consistent with minimum, usual, or comprehensive levels of knowledge as specified. The required level of knowledge shall be determined considering the selected Performance Objective and analysis procedure. But in this methodology knowledge requirement is as follow:

Information shall be obtained from construction documents including design drawings, specifications, material test records, and quality assurance reports covering original construction and subsequent modifications to the structure. The design drawings shall show, as a minimum, the configuration of the gravity load system and seismic-force-resisting system and complete connection details for the seismic-force-resisting system with enough detail to carry out the selected analysis procedure. Where construction documents are available, information shall be verified by a visual condition assessment.

4.5.1.4 PEA requirements

This chapter contains general requirements for seismic evaluation and retrofit, including data collection, requirements for Benchmark Buildings, the evaluation and retrofit procedures, and limitations on their use in demonstrating or achieving compliance with the Performance Objectives specified in this methodology

4.5.1.4.1 Data collection

Before beginning an evaluation or retrofit in accordance with this standard, enough general information about the building shall be obtained to determine the permitted evaluation or retrofit procedures.

In this way, general requirement of PEA including list of required documents, data and information include following items:

- Soil characteristic such as capacity, stiffness module,
- Soil and geological problems such as liquefaction, subsidence, landslide etc.
- Seismic specifications
- Material properties
- Structural system and configuration
- Component properties and element sections

4.5.1.4.2 Immediate Occupancy Structural Performance Level (S-1)

Structural Performance Level S-1, Immediate Occupancy, is defined as the post-earthquake damage state in which a structure remains safe to occupy and essentially retains its pre-earthquake strength and stiffness. A structure in compliance with the acceptance criteria of this standard for Immediate Occupancy is expected to achieve this post-earthquake state.

4.5.1.4.3 Life Safety Structural Performance Level (S-3)

Structural Performance Level S-3, Life Safety, is defined as the post-earthquake damage state in which a structure has damaged components but retains a margin against the onset of partial or total collapse. A structure in compliance with the acceptance criteria specified in this standard for this Structural Performance Level is expected to achieve this state.

4.5.1.4.4 Damage Control Structural Performance Level (S-2)

The Enhanced Structural Performance Range is defined as the continuous range of damage states between the Life Safety Structural Performance Level (S-3) and the Immediate Occupancy Structural Performance Level (S-1).

Structural Performance Level S-2, Damage Control, is defined as a post-earthquake damage state between the Life Safety Structural Performance Level (S-3) and the Immediate Occupancy Structural Performance Level (S-1). Acceptance criteria for evaluation or retrofit based on the Damage Control Structural Performance Level shall be taken halfway between those for Life Safety Structural Performance (S-3) and Immediate Occupancy Structural Performance (S-1).

4.5.1.5 Hazard Levels

The seismic hazard caused by ground shaking shall be based on the location of the building with respect to causative faults, the regional and site-specific geologic and geotechnical characteristics, and the specified Seismic Hazard Levels. Probability of exceedance and mean return period for the different earthquake level are shown in table.

Probability of Exceedance	Mean Return Period (years)
50%,50 years	72
20%,50 years	225
10%,50 years	475
05%,50 years	975
02%,50 years	2475

In this methodology, three earthquake hazard levels applied in performance control of facilities and structures:

- **Hazard level 1:** Response spectra acceleration parameters for Seismic Hazard Level 1 shall be taken as values from probability of exceedance 10%,50-year or earthquake with return period 475 years.
- **Hazard level 2:** Response spectra acceleration parameters for Seismic Hazard Level 2 shall be taken as values from probability of exceedance 05%,50-year or earthquake with return period 975 years.
- **Hazard level 3:** Response spectra acceleration parameters for Seismic Hazard Level 3 shall be taken as values from probability of exceedance 02%,50-year or earthquake with return period 2475 years.

4.5.1.6 EVALUATION PROCEDURES

Seismic evaluation or retrofit of the building shall be performed to demonstrate compliance with the selected Performance Objective in accordance with the requirements of the following sections.

In this methodology, three levels of evaluation are considered to control and check the structure in diverse conditions.

- Level 1 is defined to determine, the status of the structure than the ideal condition.
- In level 2 of evaluation, amount of vulnerability of the structural component are determined by performing the dynamic linear procedure.
- Level 3 will include nonlinear static/dynamic procedures.

At the end of each level number of the elements which satisfy these criteria shall be determine. This procedure causes to identify an index or a score of the vulnerability of the structure in the related level.

4.5.1.6.1 Level 1 evaluation

The first level of evaluation is appropriated to the general control of the structure based on traditional force-based design.

Details and items of controls are as follows:

- Seismic hazard level 1 for the evaluation shall be considered.
- Very high Importance factor shall be taken for all building.
- 3d finite element model shall be used for structural analysis.
- Linear dynamic analysis shall be performed.
- Control of structure shall be done in “Strength level”.
- A reduction factor of the strength of the material shall be assigned to the elements.
- Multidirectional and vertical seismic effects shall be applied if necessary.
- Redundancy factor shall be assigned to the earthquake coefficient.
- No need to control the structure in service level.

Soil and foundation control
For the foundation control, items below shall be responded:

- Does the soil stress locate under the structure is in the acceptable limitations?
- Does different part of the foundation satisfy requirements?

Building displacement and drift control
For the Building displacement control, items below shall be responded:

- Does displacements and drifts of the stories are in acceptable range?
- Does distance from adjacent structures are in acceptable range?

4.5.1.6.2 Level 2 evaluation

In this level structural controls shall be done in accordance performance-based design methods with considering principles below:

- Seismic hazard level 1 shall be appropriated for this evaluation level.
- For primary structural component, immediate occupancy performance shall be satisfied.
- Site-specific response spectrum shall be used in accordance with the related guideline.
- 3d finite element model shall be used for structural analysis.
- The linear dynamic analysis shall be performed.
- Multidirectional and vertical seismic effects shall be applied if necessary.
- Deformation-Controlled and Force-Controlled actions expected and lower-bound strengths, material properties, component capacity modification factor, deformation and strength capacity of the components shall be performed.
- Acceptance criteria must be determined in accordance with performance levels by considering items above.
- All determined force and deformation shall be checked by acceptance criteria.

Soil and foundation control
For the foundation control, items below shall be responded:

- Does the soil stress locate under the structure is in the acceptable limitations?
- Does different part of the foundation satisfy requirements?

Building displacement and drift control
For the Building displacement control, items below shall be responded:

- Does displacements and drifts of the stories are in acceptable range?
- Does distance from adjacent structures are in acceptable range?

4.5.1.6.3 Level 3 evaluation

In this level structural controls shall be done in accordance with performance-based design methods with considering principles below.

- Seismic hazard level 3 shall be appropriated for this evaluation level.
- For primary structural component, life safety performance level shall be satisfied.
- Site-specific response spectrum shall be used in accordance with related guideline.
- 3d finite element model shall be used for structural analysis.
- P-Δ effects shall be included in analysis procedures.
- Nonlinear static/dynamic analysis shall be performed.
- Multidirectional and vertical seismic effects shall be applied if necessary.
- Deformation-Controlled and Force-Controlled actions expected and lower-bound strengths, material properties, component capacity modification factor, deformation and strength capacity of the components shall be performed.
- Acceptance criteria must be determined in accordance with performance levels.
- All determined force and deformation shall be checked by acceptance criteria.

Displacement and drift control

- Does displacements and drifts of the stories are in acceptable range?
- Does distance from adjacent structures are in acceptable range?

4.5.2 Retrofit design

4.5.2.1 Retrofit strategy

Improving the structural performance of buildings in earthquake may be achieved by adopting one or more strategies outline in this section of this methodology. Designers are required to carefully consider issues of relative stiffness and relative ductility between the existing structure and new strengthening elements. Strategies include identification of weak or brittle elements that form part of the seismic resisting structure for strengthening. Other strategies involve structural improvements mitigate poor building global behavior such as soft story mechanism or highly torsional responses. Ideally, un-strengthened and/or strengthened buildings will have an adequate level of redundancy so that localized failure or overload of a few elements will not precipitate overall instability or collapse of the building.

4.5.2.1.1 Local Modification of Components

While some existing buildings have substantial strength and stiffness, often some of their structural components are under-strength or they have inadequate deformation capacity. A strategy for this type of building, could involve local improvements to those components that are inadequate while retaining the basic form of buildings lateral force resisting system. Local improvement that can be considered include improving component connectivity, component strength, and/or component deformation capacity.

This strategy can be a cost-effective method to improve the seismic performance of a building when only a limited number of components are inadequate. Local strengthening could include measures such as adding a plywood overlay diaphragm over an existing timber floor or by adding concrete facings to the column elements of heavily perforated wall-type of structures.

Local improvements that improve the deformation capacity or ductility of components can allow them to survive large displacements without necessarily increasing the component strength. For example, placing steel jackets around reinforced concrete columns can allow the columns to deform without loss of strength through spalling, degrading flexural reinforcement splices or shear failure in plastic hinge zones.

4.5.2.1.2 Removal or Lessening of Irregularities and discontinuities

Stiffness, mass and strength irregularities are common causes of inadequate seismic performance of buildings. Checking seismic displacements and forces often identifies high concentrations of forces within one story or on one side of a building. Similarly, when checking mode shapes and building deformations, unbalanced displacements will indicate the presence of a discontinuity in the structure. For example, shear wall type buildings with shear walls of differing heights will generally develop very high floor (transfer) diaphragm shear stresses. Removal or separation of the structural element causing an irregularity or discontinuity may be enough to reduce seismic demand on the overstressed elements to acceptable levels.

Sometimes, building performance can be improved by deliberately weakening some elements. For example, with a highly torsional shear wall type of building carefully selected walls may be split vertically to reduce their flexural capacity and lower the shear demand on those walls. By splitting the walls in that manner, the torsional response of the building can be reduced to achieve benefits of reduced displacement ductility demand on many of the structural elements.

4.5.2.1.3 Global Structural Strengthening

Some flexible structures will have poor seismic performance because critical components or elements do not have adequate ductility to resist the large seismic deformations usually associated with that type of structure. For structure with many such element a cost-effective way to improve performance is to stiffen the structure to reduce the ductility demand on those critical components. By stiffening the structure, the building period will be reduced, and the elastic strength demands on the lateral force resisting system will typically increase. Stiffening a structure is usually accompanied with an increase in seismic strength. Construction of new braced frames, moment resulting frames or shear walls within an existing structure are effective method for adding both additional stiffness and strength. By providing supplementary strength to the lateral force resisting systems, it is possible to raise the threshold of seismic intensity at which the onset of damage occurs. Care is needed to ensure that the new strengthening elements are compatible with the stiffness of the existing elements to avoid premature or brittle failure of those elements.

4.5.2.1.4 Retrofit techniques

There are differences techniques for structural retrofitting corresponding to structural system, environmental and implementation conditions, cost of retrofit etc. Some techniques for strengthening building elements, covering the following:

For steel structures

- Add Steel Braced Frame
- Add Steel Cover Plates or Box Existing Steel Member
- Provide Collector in a Concrete Fill on Metal Deck Diaphragm
- Enhance Connection of Steel Column to Foundation

- Enhance Beam-Column Moment Connection
- Enhance Column Splice
- Add Steel Plate Shear Wall
- Add Reinforcement Concrete Shear Wall
- Convert an Existing Steel Gravity Frame to a Moment Frame

For concrete structures

- Add Steel Braced Frame
- Add Reinforcement Concrete Shear Wall
- Enhance Column with Fiber-Reinforced Polymer Composite Overlay
- Enhance Concrete Column with Concrete or Steel Overlay
- Enhance Concrete Moment Frame
- Enhance Beam-Column Moment Connection

4.5.2.1.5 Retrofit design steps

To do retrofit design, following steps shall be performed:

- Architectural, electrical and mechanical limitation shall be considered for introducing retrofit solution.
- Retrofit strategies shall be introduced based on deficiencies of the structure.
- The global retrofit options and the local options shall be introduced.
- Retrofit techniques shall be provided based on structural system, deficiencies and strategies.
- Conditions and characteristic of retrofit solution and effects on components shall be controlled.
- Cost of the retrofit solution shall be derived roughly.
- Evaluation Level2 and 3 shall be performed for retrofitted structure and its elements.
- Acceptance criteria for each level shall be satisfied for all components completely.

After controlling all items of evaluation reports and after ensuring that all design criteria are met, the documents of the retrofit design shall be completed as required. This document consists of the analysis results, calculation report, detail design drawing etc.

4.5.3 Report of PEA

At the end of studies, details of each step such as performance objective, performance levels, hazard levels, analysis, calculations and details of each evaluation level, how to analyze vulnerability index and retrofit design procedure, shall be presented as a PEA report.

4.6 Detailed Assessment Methodology

4.6.1 Context and Background

The procedure for the assessment of seismic structural performance given herewith allows the engineer to look in more detail at the characteristics of the building and its response to earthquake

shaking. The focus is the determination of the demand on structural elements, resulting from the response of the building, and the assessment of the capacity of such elements to meet the demand without causing loss of structural integrity.

Dealing with existing buildings involves a wide range of structural types, materials and details. As in the present case, situations may vary from small simple buildings to large complex ones. Furthermore, the risk posed by existing buildings not designed according to seismic codes is readily apparent. The prime characteristic of these buildings is that wind loading was the only (if any) lateral force considered in their design. While most buildings designed before the publication of seismic codes have often been designed to similar levels of strength as modern structures, they typically do not have either the level of ductility or appropriate hierarchy of failure mode required by current design standards.

This section describes the key steps and procedures involved in assessing existing buildings of various material types and configurations.

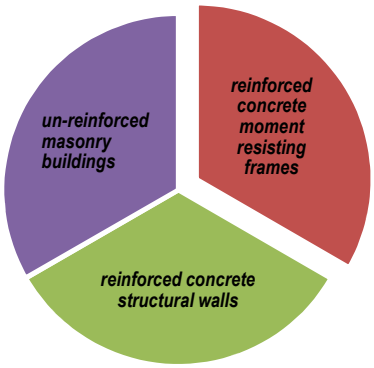
Particular efforts have been made to present material in order of increasing sophistication and complexity. This is intended to help adopt the simplest available approach consistent with the circumstances. For cases where an assessment indicates that an inadequate level of seismic performance is likely, guidance for improving the performance of the structure is given.

4.6.2 Objectives

The primary aim of this procedure is to prevent the risk of death or injury that may result from the effects of a significant earthquake on buildings.
The objectives of these procedures are:

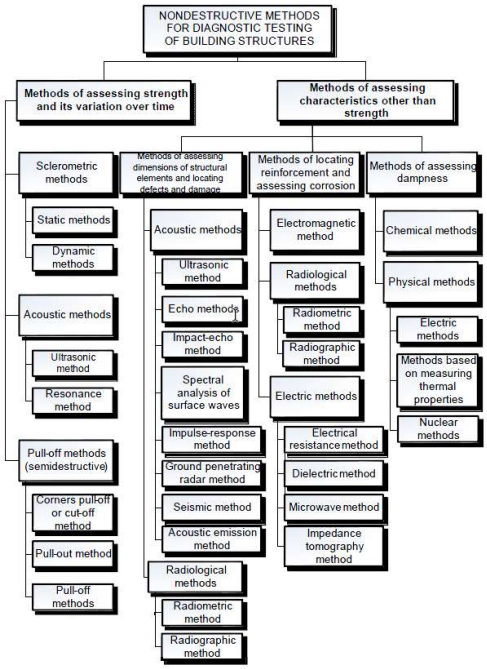
- *to provide a means to assess the strength and stability of existing buildings during earthquakes;*
- *to determine whether or not a building will reach or exceed its ultimate limit state when subjected to earthquake shaking relevant to its reference life;*
- *to provide information and guidance to assist in the assessment of strength and ductility of component structural elements.*

Emphasis is placed on the most common structural configurations that are considered to pose the greatest risk. The seismic resisting elements treated in this document are as follows:



4.6.3 Diagnostic Testing

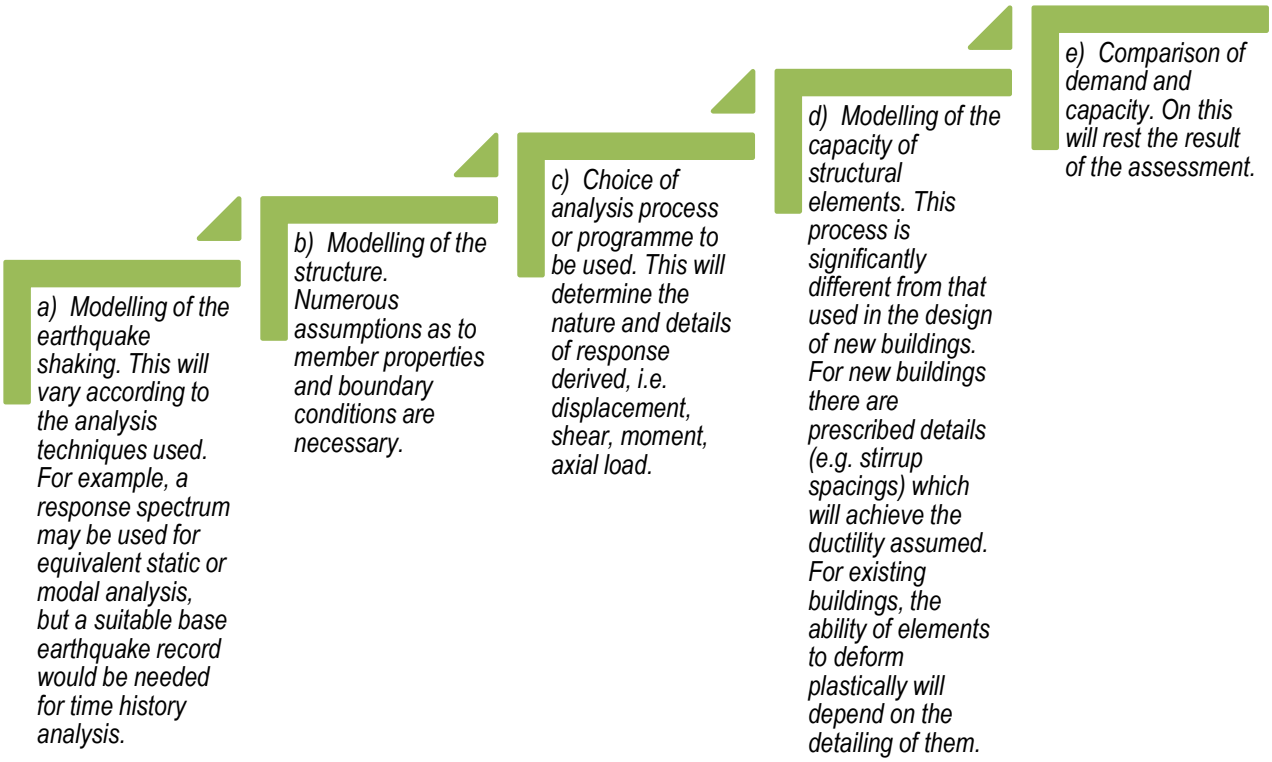
The methods used in the diagnostic testing of building structures are divided into destructive, semi-destructive and non-destructive methods. Destructive tests can be applied to samples and natural-scale structural elements. Both are destroyed in the tests. For this reason, only a few representative natural-scale elements are subjected to such tests. Semi-destructive tests are also applied to samples and natural-scale elements and structures and they involve a small (usually superficial) intrusion into the structure of the material, resulting in local loss of service properties and requiring repair. There is no such intrusion in the case of non-destructive tests which are applied to mainly natural-scale elements and structures. Moreover, non-destructive tests can be applied to the same elements and structures many times and at different times whereby such methods are suitable for the diagnostic testing of building structures during both their erection and the many years of their service life. The latter are being intensively developed and there is a distinct trend to acquire unequivocal information about the tested element or structure not on the basis of raw acoustic signals registered by the testing equipment, but on the basis of signals processed by appropriate software using complex mathematical algorithms, artificial intelligence or wavelet transformations. Such software is part of the offered measuring sets. The paper also presents the anticipated development trends in RVA, PEA and DEA.



4.7 Approaches for Performance Assessment

The approaches chosen to perform the assessment will vary considerably according to actual circumstances. Many buildings will not require or justify the use of sophisticated analysis. The underlying objective of the legislation is to ensure that physical action is taken to improve the earthquake performance of existing buildings. It should be borne in mind that, whatever analysis and assessment techniques are used, all involve assumptions about the earthquake shaking, the building characteristics, analysis methods, and the likely performance of structural components.

The usual steps are as follows:



4.7.1 Demand On and Capacity of Structure

Given the possible existence of critical structural weaknesses, the following aspects of overall structural response should receive particular attention:

a) Potential for pounding. For many existing buildings, compliance with the current requirements for building separation have not been met. With insufficient building separation, there is a high risk that building-to-building impact or pounding will greatly impair the performance of both structures.

b) Horizontal irregularity. Existing buildings may have severe horizontal irregularities. The twisting of the building as it responds to earthquake motions can give rise to higher than normal ductility demands on perimeter elements, and requires special consideration.

c) Vertical irregularity. Vertical irregularity is a major threat to structure integrity. It can drive up ductility demands on key structural elements, particularly columns, and in some circumstances, compound horizontal irregularity and other critical structural weaknesses. It is vital that assessment of ductility demand on key elements takes full account of the effects of the irregularities and the displacements generated in the structural members.

d) Short columns. It is vital that both overall analysis and assessment of ductility demand take proper account of the characteristics of short columns. Displacements generated in the structure can have a severe effect on the integrity of these elements by driving up shear forces beyond the capability of the sections.

e) Diaphragms and their interconnection with primary structural elements. For concrete diaphragms, the added complication of transfer diaphragms, particularly when not originally designed as such, should be noted.

4.7.2 Strategies for Improving Structural Performance

Improving the structural performance of buildings in earthquake may be achieved by adopting one or more of the strategies outlined hereafter.
Issues of relative stiffness and relative ductility between the existing structure and new strengthening elements will be carefully considered.
Strategies include identification of weak or brittle elements that form part of the seismic resisting structure for strengthening.
Other strategies involve structural improvements to mitigate poor building global behavior such as soft story mechanisms or highly torsional responses.
Ideally, unstrengthen and/or strengthened buildings will have an adequate level of redundancy so that localized failure or overload of a few elements will not precipitate overall instability or collapse of the building.

4.7.3 Nonstructural Systems and Components

4.6.3.1 Assessment of the existing conditions

An in-depth examination of existing conditions is a fundamental part of any architectural/technological redevelopment project. The methodology to be pursued is composed of the following phases and the understanding of the current conditions will be based on the subsequent steps:

- *Acquisition and analysis of existing technical documentation;*
- *Discussions with systems management and maintenance personnel, focused on gathering specific information about the building systems and contents;*
- *The direct examination and technical description of the various typologies of existing systems, including a verification of their state of conservation and maintenance;*
- *Verification of primary specific regulations and legislation, with particular reference to issues of safety;*
- *Preparation of technical survey charts for the various typologies of systems currently installed, including the description of general technical characteristics and individual components and equipment, as well as the preparation of functional diagrams for each typology;*
- Identification of urgent interventions related to the activity conducted;
- Identification and description, complete with parametric budgeting, of technical interventions subdivided by typology and representation, as part of a specific synoptic schedule of deadlines in relationship to the critical path as identified.
- The technical survey charts will be accompanied by specific and detailed photographic documentation. For particularly complex spaces it will be possible to proceed with three-dimensiol surveys using the laser-scan technique, which allows for the definition, using polar coordinates, of the space being surveyed.

4.7.3.2 Seismic Protection of non-structural systems and components

The control of the damage to internal contents of buildings also represents a fundamental objective of the seismic retrofitting design. In order to guarantee the functionality of the building systems, even under post-earthquake conditions, the installation of the technological systems (mechanical and electrical) will adopt the following measures, in addition to using heavy componentry:

- *All systems will be anchored to the load bearing structure to protect against considerable movements induced by seismic action;*
- *Anti-vibration bases for particular equipment such as chiller groups, cooling towers, etc. should be adopted;*
- *Protection measures against the overflow or loss of liquids from reservoirs and tanks should be taken;*
- *Special fixings to minimise lateral movements of equipment such as chiller groups, cooling towers, boilers, air handling units, primary electrical panels, etc. should be adopted;*
- *Necessary precautions against fire, chemicals and explosions for isolation devices shall be implemented.*

4.7.3.3 Mechanical and electrical systems retrofitting design

The design team for mechanical and electrical studies shall commence the design work as per the project management requirements and shall ensure systems compatibility with the Design Documentations and Guideline for design. The work shall be completed in a coordinated and responsible manner.

The mechanical design consists of (but not limited to):

- *Disposal systems*
- *Ventilation/Air Conditioning Systems*
- *Piped Supply Systems*
- *Seismic Restraint*
- *Mechanical Heating & Cooling Systems*
- *Control Systems*

HVAC systems shall be responsive to the relevant facility demands. HVAC Systems are required to establish:

- *Infection control practices to minimize airborne contaminants;*
- *Air distribution effectiveness within spaces served by the ventilation/HVAC systems;*
- *Air quality requirements;*
- *Noise and objectionable odors*
- *Air movement*
- *Total and outdoor air ventilation requirements;*
- *Room pressure relationships;*
- *Temperature and humidity design criteria;*
- *Filtration practices;*
- *Selection of air-handling systems, distribution systems and control strategies for effective operation;*
- *System reliability and redundancy recommendations;*
- *Energy-conservative design practices for the healthcare environment*

According to the specific exigencies, the electrical design may consist of:

- *MV and LV Distribution Systems (MV cubicles, transformer, LV switchgear, panel boards, MCC panels and feeders)*
- *Emergency Generator Set*
- *Uninterruptible Power Supply*
- *Lighting and Small Power (fixture selection, lighting calculations, control systems, internal and outdoor distribution, branch circuits)*
- *Grounding (grounding network, grounding sets, lightning protection)*
- *Elevators (traffic calculations, machine room and shaft design, preliminary design)*
- *Communications (voice and data structured cabling system, intercom, EPABX)*
- *Low Current Systems (MATV/R, central clock, nurse call, infant protection)*
- *Fire and Security (fire alarm, public address & emergency evacuation, CCTV, access control, intrusion detection)*
- *Conference Hall Systems (video projection, special sound, special lighting, lighting control-automation)*
- *Special Systems (if any, Client required systems design and/or cabling infrastructure)*

Design and specification of all work shall be in accordance with latest standards, codes and publications.

4.7.3.4 Fire Protection Approach

In consideration of the specific requirements of the buildings' users, special attention will be focused on the design of fire protection systems, including the correct assessment of all risks and the opportune definition of emergency escape routes, the attribution of fire resistance classes and the planning of correct procedures for carrying out health services activities. Architectural, structural, mechanical and electrical designs shall be covered concerning the fire safety approach from the concept design stage to finalization of the designs. Basic principle for fire safety approach is first to prevent start of fire, and then to ensure safety in case of fire. The basic principles to be covered are:

- *Fire prevention means*
- *Automatic Intervention means*
- *Passive prevention means*
- *Fire alarm system*
- *Life safety measures against fire*
- *Comple mentary system*
- *Manual Interventi on means*
- *Emergency manageme nt and Planning*

In order to respond to the reduced mobility of the buildings occupants, retrofitting design will include safe static gathering points, where users can await the arrival of assistance under safe conditions. Progressive horizontal exiting of all occupants should be consented. The adequacy of the

road network around the buildings will be ensure access by safety equipment and vehicles to all sides of the buildings themselves.

4.7.4 Sustainability and Energy Efficiency for Retrofitting

The advantages of a sustainable building are tied to the fact that sustainability, in addition to ensuring respect for the environment, is synonymous for quality construction and in particular of long-lasting quality: sustainable buildings offer reduced running costs and increased indoor environmental quality.

There are many design solutions for ensuring environmental sustainability and energy savings, all characterised by elevated levels of integration between construction systems, building systems and the surrounding environment, an approach that strongly characterises the renewed buildings in a highly innovative and technologically advanced manner. The proposed retrofitting interventions will be in line with all required standards and capable of ensuring elevated energy savings and comfort for buildings occupants, as well as respect for all fundamental hygiene-sanitary issues. What is more, retrofitting will also guarantee elevated levels of visual, temperature and humidity and acoustic comfort in all spaces. The cooling and heating of all spaces using low temperature and high air speed systems, in other words using radiant technologies, will ensure climatic comfort.

Various systems of environmental sustainability evaluation now exist in the world, including LEED (United States), BREEAM (United Kingdom), HQE (France), CASBEE (Japan) and SBC (International). The design of the Project will follow the protocol guidelines for sustainability agreed upon with the Client. In particular, the Project will respect the following criteria:

- a) reduction of energy consumption for winter climate control;
- b) reduction of consumption for summer climate control;
- c) reduction of energy consumption for the production of sanitary hot water;
- d) diminution of annual consumption of electrical energy;
- e) control of solar radiation;
- f) use of natural illumination;
- g) use of renewable materials;
- h) used of recycled/recovered materials;
- i) reduction of water consumption for irrigation;
- j) reduction of water consumption for indoor uses;
- k) maintenance of performance characteristics of the building envelope;
- l) minimisation of greenhouse gases released into the atmosphere;
- m) differentiated waste collection; minimisation of the quantity of liquid waste produced;
- n) maintenance of permeability of external areas.

The evaluation will be made based on calculations of technical/economic convenience referred to summer and winter profiles of accumulated frequency of heating and cooling loads.

4.7.5 Final Designs

The buildings which are found feasible for retrofitting by using the most efficient solution alternative shall be designed in detail. Detailed structural and architectural drawings will be prepared and submitted for the new, added structural members, and the strengthened structural and non-structural members. These sets of drawings will include all architectural, mechanical and electrical services before and after retrofitting.

At the end of final designs, cost estimations and comparisons, the Consultant shall submit a Final Design Stage Report indicating findings and designs with respect to the services outlined below, to the satisfaction of the Client. It will indicate the scope of the study, the findings with regard to building performance and the recommendations.

Level III contains modernization, upgrading, and renovation of electrical and mechanical building services by taking into account related code and standard's requirements. Terms of Reference states clearly the expectations for building services renovation in addition to the retrofitting designs. The Consultant is aware of needs and will prepare the mechanical and electrical detailed designs as per the requirements. This would also apply architectural aspects of the buildings as also stated in the same Item such as comparative drawings before and after retrofitting and all others.
Following the interviews with the Building Authorities, modernization and upgrading the electrical system will be done according to related standards and codes.
Where the national codes are not found sufficient, electrical system planning will also consider and follow some international standards and manufacturer technical specifications such as NEC, EN, DIN, VDE, and IEC.
At the end of final designs, in addition to Individual Building Final Design report, design drawings will be submitted for each building to be retrofitted.
Based on our previous two experiences in similar projects, bidding document preparations must be made in two stages:

a) Preparatory Studies prior to Tender Documents: Following final design drawings and reports, final bills of quantities relevant to final cost comparison analysis will be prepared.	
b) Finalization of Tender Documents: Tender documents will include, but not limited:	• *Conditions of Contract* • *Form of Bid* • *Technical Specifications* • *Bill of Quantities* • *Pricing Preambles* • *Final Design and detailed drawings, etc.*

After the preparation of the above documents by the Consultant, an expert Contract Engineer will review all of them. All these documents shall not only be examined by itself but documents shall be compared with each other in order to see if they are appropriate to each other or not.
Also a Synthesis Report will be prepared to resume the recommendations of the Consultant for retrofitting and demolition of the buildings assessed in the project. Report will at least cover all requirements of the TOR Item "Preparation of Synthesis Report".

4.8 Long Term Investment Plan

DHAKA City development planning identifies potential capital investment needs and often is a source of projects for the CIP process. At least two components of city development planning should be distinguished. The first is regular urban planning, which deals with spatial aspects and is practiced, in some form, by almost all cities. Forms of spatial planning range from long-term development plans (typically, 10–20 years), such as a Master Plan, which usually are developed for an entire city; to shorter term detailed spatial plans for specific urban areas. All of these forms address the planning of urban growth and development and the redevelopment of certain areas. Spatial plans usually have components related to the infrastructure—both physical (roads, public transportation, water, sewage) and social (schools, healthcare facilities) required to implement these plans. Therefore, implementation of urban plans implies that new infrastructure, for which the JV team or its enterprises are responsible, should be built, which, in turn, requires capital investment. Urban planning also may include an infrastructure retrofit for areas previously developed formally or informally. There are several challenges related to incorporating the infrastructure stipulated by a spatial development plan such as a Master Plan into projects for a capital investment plan.

First, when it comes to suggesting projects for capital investment, most of the "real" planning is done by line departments or enterprises responsible for services such as roads, water supply, sewage, or public transit systems. required to implement the spatial plan will be built,5 as in Singapore. However, in many cities, the actions of different departments and enterprises are inconsistent with stated long-term spatial plans. In addition, often lag far behind in providing infrastructure according to their own planning documents.

Moreover, urbanization in developing countries often occurs so rapidly that even a well-prepared Master Plan becomes irrelevant. In these cases, land development by the private sector often goes ahead with varying degrees of informality without public infrastructure. In turn, such development makes it necessary later to retrofit the infrastructure.

In summary, to avoid gaps between what is planned and what is built, JV team need to secure:

1. Good institutional coordination both within the government and with external stakeholders to ensure that a real link exists from a Master Plan to the implementation of infrastructure investment that it stipulates
2. Increased capacity to physically deliver the infrastructure projects in a timely manner, at a pace consistent with urban growth. In this regard, a simple solution that can work in some countries is to engage the private sector to design and build infrastructure according to plan specifications instead of relying on the government's own capacity.

In addition, often get caught between the complex and demanding requirements of the spatial plans and zoning regulations imposed by a central government and these limited capacity to develop such plans and regulations locally and enforce them when they exist. If these multiple entities all act consistently by following the spatial concept of a Master Plan, the infrastructure. In contrast, Strategies that rely on mobilizing the resources under a jurisdiction's control can be especially promising.

Asset management is the prime area of this activity that supplies projects for the CIP process. The capital assets include property and infrastructure such as buildings, roads, parks, water and sewage systems, city landfills, and vehicle fleets. Among other things, asset management means managing each property or facility for its entire life, as long as it is owned or controlled or its entities (institutions, enterprises). Asset management addresses the costs associated with property's life cycle: the acquisition cost, operation and maintenance and repair costs during the life of the asset, and replacement or disposition cost of replacing it when the property exhausts its useful economic life.

Which life cycle costs are included in DHAKA capital investment planning; and which, instead, are a part of operating budgets vary across countries, even among cities in one country (for instance, depending on city size). Which costs are included also can vary depending on accounting rules. Often, this division between capital and operating expenses is a subject of convention, locally or nationally. However, some of these costs—buying land for a new building, building a new facility, conducting major repair or modernizing an existing facility, or replacing long-lived components of a building which usually are included in capital investment planning. Most importantly, regardless of the specifics of exactly what is considered capital investment, there are deep connections between asset management and capital investment planning, which must consider.

The objective of this engagement is to develop the consensus-driven analytical foundation required for longer-term investments to reduce risk in the built environment of Dhaka. It will concentrate on two main activities: i) assessment of the vulnerability and risk of the built environment (including city extensions) in greater Dhaka to earthquakes and floods, focusing on essential and critical facilities, lifelines and infrastructure by means of microzoning studies; and ii) development of a prioritized list of retrofitting and rehabilitation investments to strengthen critical facilities for the critical facilities lifelines and infrastructure in the transport, water and public building sectors.

The vulnerability assessment and the prioritization of assets to be strengthened will be based on a framework and methodology proposed by the consultant and agreed upon by an oversight committee comprising the relevant government stakeholders with the consideration of the existing studies conducted at national and international level in particular the modules and methodologies carried out for Hazards Vulnerability and Risk Assessment (HVRA) studies for Dhaka undertaken by the Comprehensive Disaster Management Programme (CDMP) and by the Bangladesh Urban Earthquake Resilience Project (BUERP).

This engagement aims to identify at-risk public infrastructure, including critical and essential facilities and lifelines (attributes (structural type/age/number of stories) of critical buildings such as schools,

hospitals, police stations, religious buildings, fire stations, city halls and government buildings), assess their vulnerability to earthquakes, floods and other hazards and develop a city-wide vulnerability reduction program including priorities and budget required for physical retrofitting/rehabilitation, occupancy change or replacement. The assessment will establish the patterns of vulnerability of the city, identify the hotspots, and serve as a basis for a long term vulnerability reduction in greater Dhaka.

This engagement shall integrate several levels of surveys, analytical studies and structural engineering techniques (i.e. several rapid visual surveys, risk/hazard assessment and advanced engineering analysis, needs and situation analysis, condition assessment and building material testing) to collect critical construction data about the identified facilities in Greater Dhaka and establish their level of vulnerability and safety.[3] This data will be used to set up the strengthening and retrofitting recommendations.

The water transmission and distribution system for Greater Dhaka, currently administered by DWASA, is one of the lifelines which will be evaluated. Potential breaks in the piping system due to various levels of earthquake shaking, as well as, structural and functional failures of water treatment plants, reservoirs, and pumping stations will be assessed. Downtime for restoration of the water system for each ward is also to be estimated. The dependency of water and power distribution systems will be investigated to understand the potential impact of power failure on the water distribution system. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the water system should be determined. The assessment will be used to develop a program for reducing downtime and improving reliability of the water system.

Structural Measures for retrofitting and rehabilitation of Water and Sanitation Facilities should be identified taking into account the vulnerability and feasibility studies including development of hazard and risk maps, failure mechanisms due to different type of the hazards, possible measures and methods of retrofitting and rehabilitation. Mitigation measures should be prioritized based on vulnerability, importance, and assessed cost of mitigation measures and mitigation plan should have a balance between reducing life safety risk and maximizing post-disaster service levels.

Similarly, the earthquake and flood vulnerability assessment of the gas transmission and distribution system, currently administered by TITAS Gas, will be investigated. Potential breaks in the piping system should be established according to severity of ground shaking and potential for soil failure such as liquefaction. Potential for fire ignitions will also be assessed. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the gas system should be determined. A program for reducing the vulnerability of the gas distribution system should be developed.

Finally, the earthquake and flood vulnerability assessment of the transportation and traffic system focusing on the road network (including key large-scale bridges, flyovers, open-cut and embankment), telecommunication and power network, metro and railways should be investigated. Dhaka International Airport Facilities are also included. Potential breaks in the main road network should be established according to severity of ground shaking and potential for soil failure such as liquefaction. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the gas system should be determined. A program for reducing the vulnerability of the transportation network system will be developed.

The output of the vulnerability assessment should be used to develop a rehabilitation and recovery framework (Resiliency) and long term risk reduction investment program that combines various

[3] ***Essential and Critical facilities*** are needed for emergency response such as hospitals, fire stations, emergency centers, police stations, certain public buildings that house functions needed by the public, data centers, food distribution centers, communication centers, and power plants.

building and lifeline vulnerability reduction strategies. This includes techniques and methodologies for such as retrofitting of critical structures, building abatement and replacement to reduce the number of unsafe, substandard and dangerous buildings and lifeline pipelines and facilities strengthening to ensure that infrastructures are resilient to extreme environment stresses. The lifeline strategies include developing redundant distribution system and improve their reliability through system analysis. The focus is primarily to address them in areas highly susceptible to earthquake hazards and flood hazards. This will be done in coordination with DCCs and other organizations and Ministries owning properties, or operating within RAJUK jurisdiction, such as the Ministry of Education, the Ministry of Health, and the Ministry of Home Affairs among many others.

Consulting Firm should refer to *Dhaka Profile and Earthquake Risk Atlas, Bangladesh Earthquake Resilience Project, World Bank, February 2014* for a description of the following data related to Dhaka:

1. Administrative, Physical and Socio-Economic Profile;
2. Earthquake Hazards;
3. Earthquake Vulnerability (Physical and Social Vulnerability),
4. Risk Analysis and Earthquake Loss Data;
5. Urban Disaster Risk Index.

A relevant reference lists of past studies, data resources, and urban vulnerability context will also be provided during the consultancy works. In Annex- 3 the detailed area plan for Dhaka is provided showing the relevant information on the critical infrastructure will be assessed during the consultancy works.

The ultimate goal of this engagement is the design of US $1 billion of prioritized assets to be strengthened, including critical facilities, water systems, gas systems and the road network. The strengthening of these assets would be financed by future Urban Resilience Investment Program (URIP) phases.

4.9 Training and Capacity Development

Within the context of the responsibilities defined in the TOR JV will develop and train RAJUK's related specialists on a well-illustrated and structured step-by–step approach on Rapid visual assessment process, Preliminary engineering analysis and detailed engineering analysis to show how to utilize technical assessments, interpret results and integrate disaster risk reduction parameters and objectives
into urban resiliency. A total of 8 capacity development trainings will be conducted as per TOR.

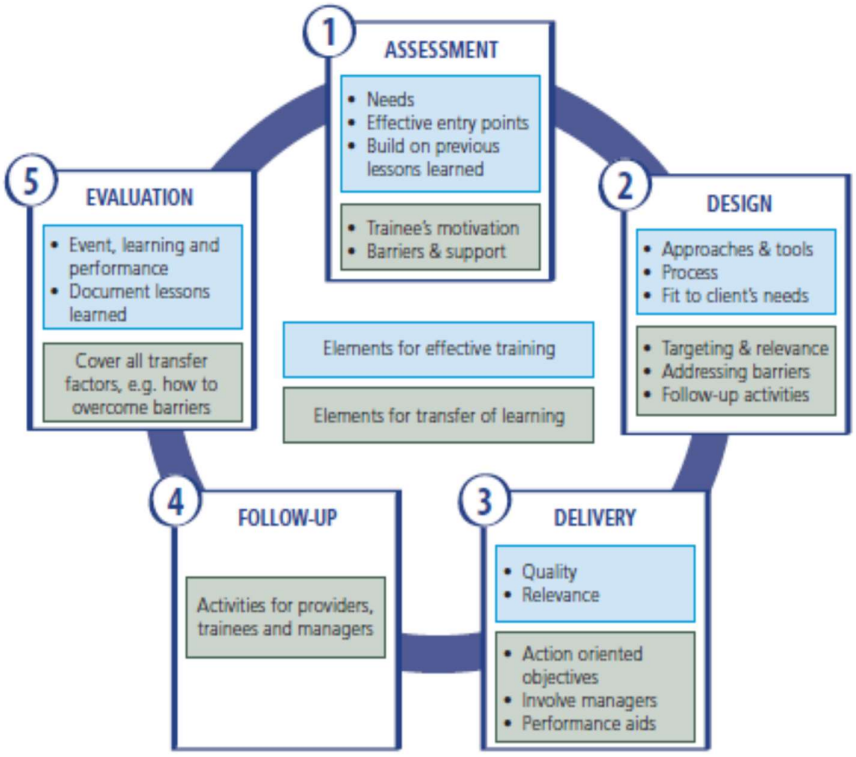
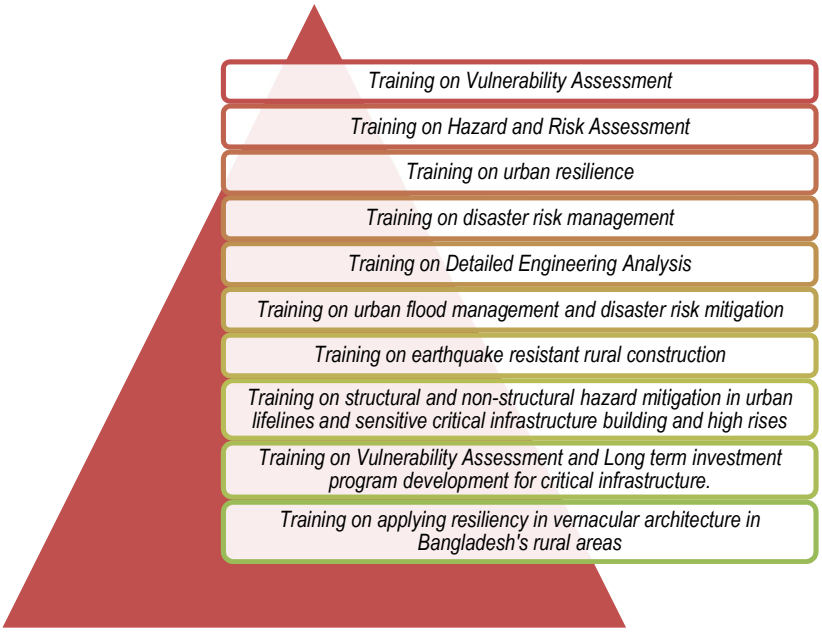


Figure :4-3

4.9.1 TRAININGS TO BE PROVIDED

NKY+PROTEK + SHELTECH JV has already developed the Training Program Implementation Report aiming to train RAJUK's town-planning professionals and related specialists on following topics:



1. Monthly Progress Reports

Monthly progress reports shall be submitted after each monthly progress meetings in the beginning week of the next month to inform the Client for the progress done in the previous month and planned activities for the next month.

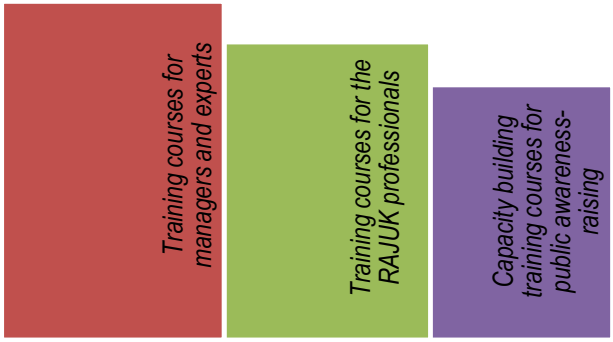
2. *Monthly Progress Meetings (Project Team/the Client)*

The Consultant's lead structural engineers, architects and building services engineers, engineering and design teams together with the design reviewers, verifiers and cost and planning experts are chaired by a Project Manager based in Dhaka at monthly basis. The Client will be invited to attend the meetings (or via internet) of this group that will consider on a building-by-building basis the recommendations of each discipline. The group will have available to it the financial estimates of the seismic strengthening and the associated renovation/maintenance for each option. The group will make an overall recommendation to the Client for the building under consideration.

3. *Indicative Map for Planning of Retrofit Construction Bid Packages*

To the ease of Client, locations of the structures to be retrofitted are recorded on a map and submitted to the Client, if requested. This would be similar to the given map but classifications will be made with the purpose of package planning.

The JV will hold courses to following stakeholder's categories:



It is worth noting that the training courses will be interactive and based on mutual learning. In each

course the participants are required to have related educational background and professional experience.

The intended goal within the project course of duration is to train 160 experts and decision makers in the fields of urban resilience, disaster risk management and sustainable development or any of selected 5 topics mentioned above. We will mutually decide on this issue with RAJUK.

	Traning Matrix	STAKEHOLDERS S04 Main for S04											
		1	2	3	4	5	6	7	8	9	10	11	
		Ministry of Disaster Management & Relief	Programming Division, Planning Commission	Rajdhani Unnayan Kartripakkha (RAJUK)	Public Works Department (PWD)	Local Government Engineering Department (LGED)	Department of Disaster Management (DDM)	Bangladesh Meteorological Department (BMD)	Education Engineering Department	Fire Service & Civil Defense (FSCD)	House Building & Research Institute (HBRI)	BUET Department of Urban & Regional Planning	
1	Introduction of VA and PI Plan for Critical Assets in Dhaka	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
1	MODULE-1-HAZARDS AND DISASTERS	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
2	MODULE-2-BUILDING TYPE, FAILURES & SAFE CONST	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
3	MODULE-3-MASONRY STRUCTURES RVA, PEA & DEA	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
4	MODULE-4-CONCRETE STRUCTURES RVA, PEA & DEA	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
5	MODULE-5- RECOMMENDATIONS & QA - QC	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	
6	MODULE-6 Best Practices	Workshop	Seminar	Seminar & Workshop	Seminar	Workshop	Seminar	Seminar	Seminar	Seminar	Workshop	Workshop	

Traning Matrix

		S04 & S05												
		12	13	14	15	16	17	18	19	20	21	22	23	24
		Department of Architecture	Department of Health	Dhaka North City Corporation (DNCC)	Dhaka South City Corporation (DSCC)	Department of Civil, BUET	Urban Resilience Project: DNCC Part	Urban Resilience Project: DDM Part	Urban Resilience Project: PCMU Part	Institute of Engineers, Bangladesh (IEB)	Institute of Architects, Bangladesh (IAB)	Bangladesh Institute of Planners (BIP)	Bangladesh Land Developers Association (BLDA)	Bangladesh Association of Structural Engineers (BASE)
1	Introduction of VA and PI Plan for Critical Assets in Dhaka	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
1	MODULE-1-HAZARDS AND DISASTERS	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
2	MODULE-2-BUILDING TYPE, FAILURES & SAFE CONST	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
3	MODULE-3-MASONRY STRUCTURES RVA, PEA & DEA	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
4	MODULE-4-CONCRETE STRUCTURES RVA, PEA & DEA	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
5	MODULE-5- RECOMMENDATIONS & QA - QC	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar
6	MODULE-6 Best Practices	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar	Seminar

4.9.2 Submission of Reports, Drawings and Documents

All reports, drawings and documents as Final Deliverables of the project will be submitted to the Client in the number and format and at the times as stated in the Schedule No.1 of the TOR.
Additionally, we propose followings to monitor project effectively:

4.10 Project Management and Organization

The main objectives of the services offered by the Proponent Group can be summarized as follows:

- *management approach structured and based upon an organized planning, programming and control process (Project Management, PM);*
- *respect of planned deadlines, costs and quality levels;*
- *management of the activities planned for the achievement of the objective, favouring the efficient interaction of resources;*
- *monitoring of the ongoing activities and timely reporting of problems that may emerge in order to prevent delays and malfunctioning;*
- *availability of the technical and organizational support needed for the management and control of the activities provided;*
- *guaranteeing Partners and Client with the required technical assistance during al phases of implementation of the Program, including activities linked to technical and administrative assistance, with the aim of perfecting the end product;*
- *guaranteeing Partners and Client the possibility of supervising ongoing initiatives constantly and intervening in solving any problems that may arise, through dedicated resources and structures during the various phases provided.*

Nowadays project complexity requires the elaboration of a General Plan of Interventions, aimed at planning the activities of all the Actors involved in the realization of interventions. In addition to those responsible for Project Management and Construction Management and for the various Design and Execution phases, it will also involve the Competent Bodies and Institutional subjects involved, local and non-local. The General Plan of Interventions includes technical and administrative activities and procedures approved. It constitutes the definitive reference point for Management in terms of managing and coordinating all the Actors involved. The complex nature and the multidisciplinary character of the Program require a system of procedures, operational methods and codified rules, provided by the Companies' Quality Assurance Systems, in order to integrate the various functions which, constitute Project Management, in particular, the Quality Assurance Management is aimed:

4.10.1 Tools in Project Management

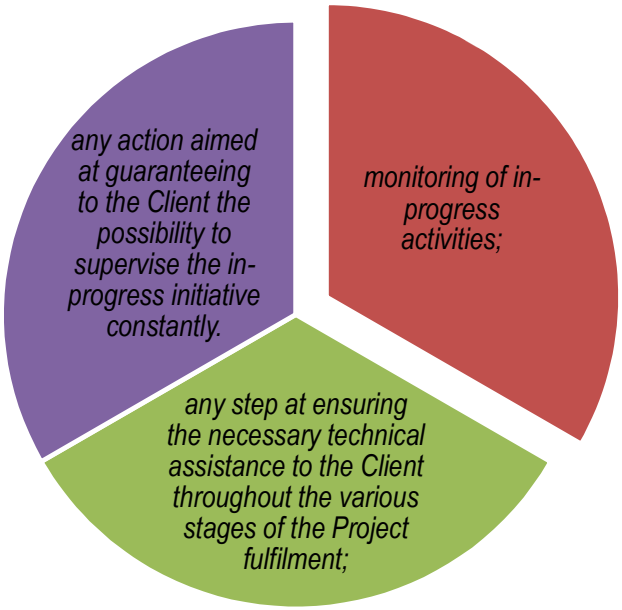
The organizational complexity intrinsic to a PM structure and the simultaneous presence within the working group of different professional figures who may be in different places with different requirements and the need to interact with other entities lead to the necessity to follow pre-established procedures codified within the organization. These procedures can be best used, distributed and managed if they are planned using network technology, through the use of specific software all requirements. Thus definitively accelerating approval procedures and informative and decision-making processes.

These software tools constitute an infrastructure capable of increasing the productivity and organizational efficiency of a complex system, connecting all the figures interacting among each other on a network and in real-time. A management system based on network technology and integrated with a suitably studied and implemented platform, the PM Workspace, will enable the possibility of constantly interacting within the Working Group and with any other Subject and/or Local Body involved in the management and control of the initiative, through technological tools such as discussion forums and video conferences. This structure will also enable the various concerned Subjects to constantly access the working documentation during the definitive phase and in intermediate review phases, according to the access profile of the system for each phase. The functions of the Project Workspace in the coordination of Project Management will enable the various involved Actors to communicate between each other through the user interface, and thus be simultaneously involved in the realization of the Program, with the following advantages:

As a matter of fact, the PM Workspace constitutes a consolidated management tool capable of making the actions and assessments made by the Project Manager more efficient, and favouring both interaction between resources and respect of the project deadlines and costs.

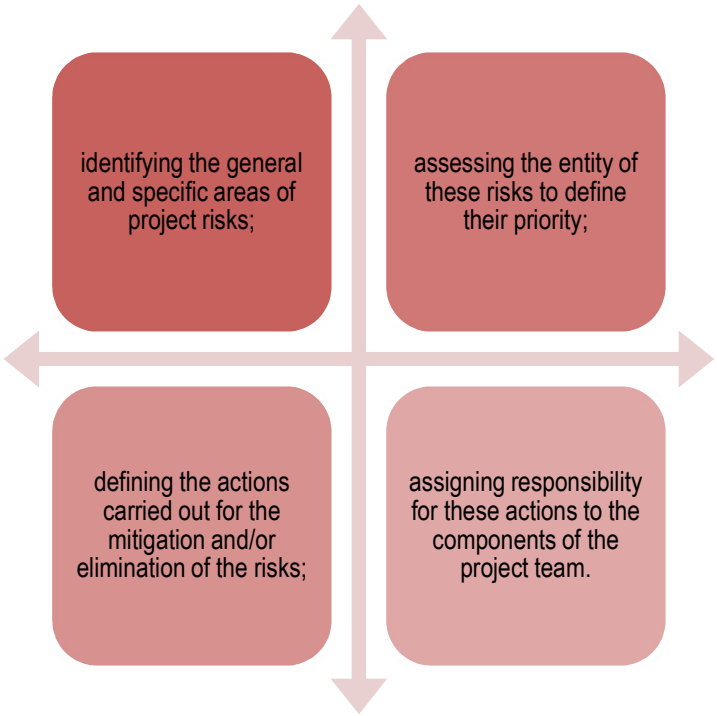
4.10.2 Coordination between the Consultant and the Client

It is planned that Project Manager, within his own role, be in charge of managing and taking care of the relations with the Client, Final Inspections Commissions, competent Bodies and Institutions, providing any required information, support and advice. Within such a complex intervention, an effective management of the services mentioned above cannot leave the problem of dealing with all those aspects connected with the modalities of communication, coordination and sharing of information and documents aside. Resorting to the Management System introduced previously, i.e. the PM Workspace, made available to the Client and also easily accessible from electronic platforms eventually set up by the Client itself, will allow the PM Team to interact with the Client. AS a matter of fact, the PM Workspace will allow the Client and other authorized Subjects, both inside and outside the work group, the opportunity to have access to project documentation at any revision stage, be it intermediate or definitive. Through such a powerful tool of information sharing it will be possible to carry out successfully:

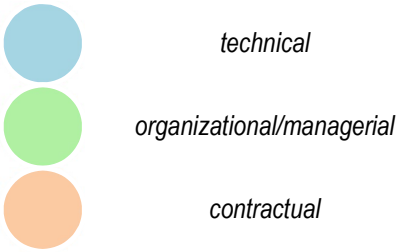


4.10.3 Risk Identification, Analysis and Management

The prevention and management of the possible critical aspects is beyond doubt one of the most significant parts of a complex Program and, in general, the more delicate aspects involved in exercising the role of Project Manager. The critical aspects must be managed in respect of the project goals in terms of times and costs. The working methodology and approach to problems, the planning of activities, constant supervision and assessment of activities are of fundamental importance for the achievement of these goals. The management of risks and critical aspects will be preliminarily carried out through the implementation of a Risk Matrix, for the purpose of:



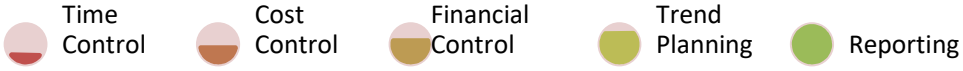
Each risk typology is evaluated with reference to its probability and severity occurrence. Risk analysis also involves the identification of mitigating actions aimed at the reduction/elimination of the risks in question. Dependently upon the category of the risk identified, the mitigating action could be of the following natures:



Risk management is carried out at a local level, and it therefore has the operational capacity to *intervene directly and successfully in processes for the solving of problems connected to the* management of relations with relevant Institutions and Bodies.

4.10.4 Control of Interventions

Control of the interventions will be carried out through a series of activities structured in Consultant's Project Control System, and involving:



The Project Control System will be integrated in the PM Workspace. In addition to the usual Office Automation features,the following tools will be adopted:

- *Relational databases*
- *CPM (Critical Path Method) programming tool*
- *Cost Control tool*
- *Reports generation and management tool*

4.10.5 Verification Methods to Assess the Fulfilment of the Program

4.10.5.1 Objectives

The primary objective of PM is the elaboration of the Clients objectives. These are summarized under these terms:

- *Operational objectives of the project*
- *Economical objectives of the project*
- *The Project Brief will be shared by parties involved in order to confirm the projects primary and secondary objectives as well as to define specific operational processes. This will present the basis for the Project Quality Plan, PQP*

The PQP defines the governing rules of the project and must be released as soon as possible so as to ensure smooth coordination of all the parties involved in the realization of the project. It is a dynamic document divided into a section dealing with procedures and a section concerning project updates and management of any variations. Shared by key personnel, the PQP enable availability of project procedures that are well planned, structured and yet simple.

4.10.5.2 General planning and control of the interventions (Project Control)

After receiving the assignment, the Consultant initiates, a series of meetings with the Client's team, with any consultants and authorities responsible for collecting data, reviewing, testing the feasibility and optimizing the General Plan of Interventions. The Consultant will proceed to verify all the information necessary for the document's definition including the mandatory permissible practices. The General Plan of Interventions will constantly be updated and shared. Coordination Meetings

among the concerned parties will be held at least monthly, in order to ensure a joint verification of the reliability of current information and the consistency of updates with the deadlines and costs objectives. Coordination Meetings will be scheduled appositely on the basis of the exigencies identified by the General Plan of Interventions. The General Plan of Interventions will form the basis upon which the progress of the project could be assessed at any given time during the design phases, offering the Client a coherent and mutual basis concerning the project activities as well as their sequence and duration.

The General Plan of Interventions establishes milestones and objectives of the project including:

4.10.5.3 Cost Planning and Control

4.10.5.3.1 Initial Cost Plan, Market Survey and Local Construction Environment Profile, Target Budget

Once the assignment has been accepted, the Consultant will start calculating the Initial Cost Plan and the Market Survey and Local Construction Environment Profile, making sure that all opportunities to reduce costs or to accelerate the means of achieving the goals are identified. On the basis of the available design information, this process requires a breakdown of the Project into easily identifiable elements depending on the various WBS levels, and each one will be traceable to the sub-categories of the CBS (Cost Breakdown Structure). The structure adopted for the Initial Cost Plan and for the Target Budget will be binding in terms of any subsequent estimates or accounts. It will therefore be possible to make more accurate estimates of the components of the Project according to the existing parameters and, where possible, to make analytical estimates both for the construction costs (Hard Costs) and for the indirect costs and consultancy fees for the Project (Soft Costs). The aspect of

reconstructing the information requires close collaboration with the Consultant, and the departments of the Client involved. This must be carried out during specific, structured and inter –disciplinary meetings (Value Engineering meetings). The Initial Cost Plan will then be shown to the Purchaser and, once the unforeseen costs have been calculated and included, the Plan will be formally approved and entitled Initial Target Budget.

4.10.5.3.2 Design Costs Control System

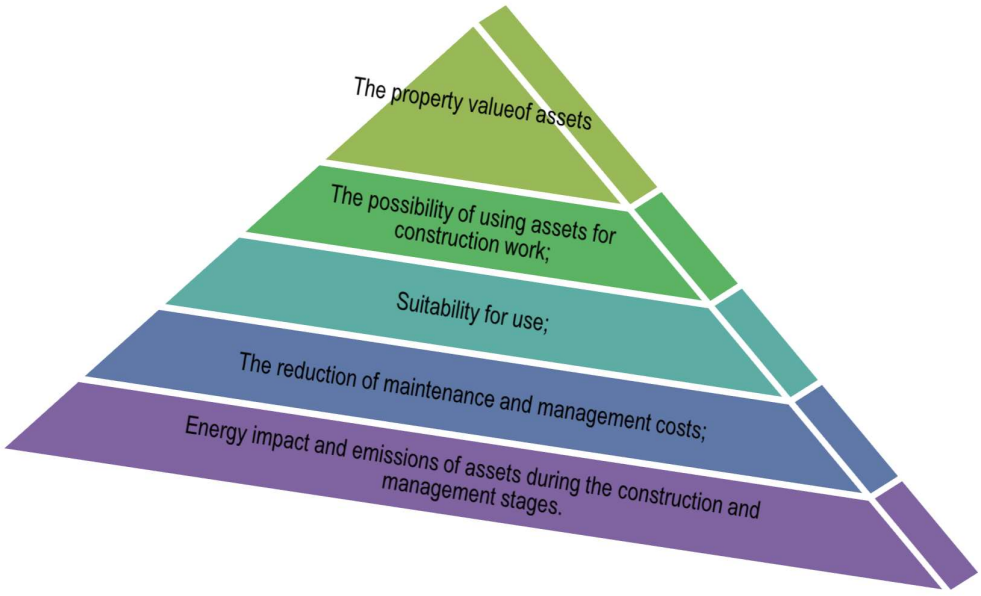
The Cost Control System is a management tool used by the Consultant for planning, assessing and controlling all the economic aspects of the project. After the task has been assigned, the Consultant will begin mobilizing and setting up the system, thus improving the Cost Control System. Initial emphasis will be on the development and the re -evaluation of the estimate for the entire project, starting with the Initial Cost Plan. The cost reports will be prepared simultaneously to the release of numerical calculations. They provide continuous updates on the basis of the information made available during the various phases, the current construction costs and the costs required for the completion of the project. The reports will be drafted so that they take into account possible trends which could have an effect on the original construction budget. The monthly cost report will enable the proper and accurate administration of the cash flows and management of the budget. Briefly, the Cost Control System enables:

- The estimation, monitoring and controlling of the project budget;
- A summary of the real costs incurred to date and a prediction of the future value of contracts;
- The Customer to be provided with an updated forecast of the funds required in every fiscal month and year.

The Cost Control System is updated constantly and enables the re-assessment of the status of the current costs for each single element (during the planning stage and during the executive phase), thereby providing rapid decision -making support. It allows for the easy identification of potential additional factors - costs, impact of potential modifications and deviations from the budget.

4.10.5.4 Design Management

The Design Management services, which are merely proposals and aimed at the economic and construction optimization of technical proposals, can be effectively integrated with the Concept Development of the preliminary and executive projects. These are therefore control procedures applied to ensure that planning is either carried out directly by the Consultant or, as in this case, by suitable third parties. All the ongoing *control activities are designed to avoid expensive re-designing and to safeguard the* economic interests of the Client as well as the congruity of the project in relation to the estimate of the costs. Design Management therefore enables the assessment of the project and ensures that all the aspects deemed vital for the success of the operation are controlled by the appropriate Consulting Team:



4.10.5.4.1 Evaluation of the Design Program

The evaluation of the Design Program should be considered, given the timeframe for the completion of the project, as one of the most important aspects for the success of the project and occupying the property complex. The assessment and evaluation of the Design Program, which is carried out together with the Client's team, enables the calculation of the time required for the definitive and executive design phases.

Depending on the information which is progressively produced by the planning team, the Consultant can develop and study construction methods which are suitable for other members of the Project, as well as drafting estimates of costs, and planning the construction stages properly. The result is a Design Program which is up to date with the targets and a shared system which enables progress to be assessed. Confirming the Customer's preliminary plan, recommending useful changes to optimize times and costs and carrying out Value Engineering in a timely manner are easily enabled.

4.10.5.4.2 Project Organization, Communication and Documentation at Design Stage

The Project in question is characterized by the need to punctually determine the overall needs of the Customer so that they can be provided with the project documentation drafted by the Consulting Team. In order to identify the individuals delegated to represent the parties so that they can discuss their roles and responsibilities, the PM provides a useful tool for the control, organization and subdivision of the duties to be carried out; a Responsibility Matrix. The Responsibility Matrix interfaces with the Design program including approvals and/or activities which are the responsibility of individuals involved in the development of the Project. Activities such as “document drafting", "reviewing" and "approvals" which are included in the Responsibility Matrix are determined by the access hierarchies and the use of the IT Platform previously introduced, the PM Workspace. It provides the Project Team with clear responsibility guidelines disciplining the production of information and documentation.

4.10.5.4.3 Design Coordination Periodic Meetings

The Consultant will draft a program of meetings for the co- ordination and progress of the project on at least a fortnightly basis and prepare and distribute an agenda of the most important topics to

discuss. The co-ordination meetings are chaired by the Design Manager. During these meetings, possible non-conformities which could, if identified at the end of the planning development, cause delays to the project will be identified in advance. Periodic meetings constitute a collaborative and transparent approach to planning with frequent opportunities for interdisciplinary assessments. The meetings for planning co-ordination provide the possibility of foreseeing opportunities, identifying problems and finding solutions at an early and timely stage. This enables the precise monitoring of various events, dates and responsibilities.

4.10.5.4.4 In-progress Design Control

Design verification is an activity which is unique in that it enables the integration of the pertinent assessments by the Client with those of the Design Management department of the PM. This specific activity, during the completion of the different stages of planning (Preliminary Design and Final Design), focuses on aspects such as:

Verifying that the benchmark technical rules are being currently applied in the drafting of the project;

Verifying that the specific regulations regarding the methodologies adopted by the designers are being properly implemented;

Verifying that the hypothetical designs proposed are coherent with the calculations regarding their technical, environmental, architectural, structural, installation and safety properties.

Thoroughness and suitability

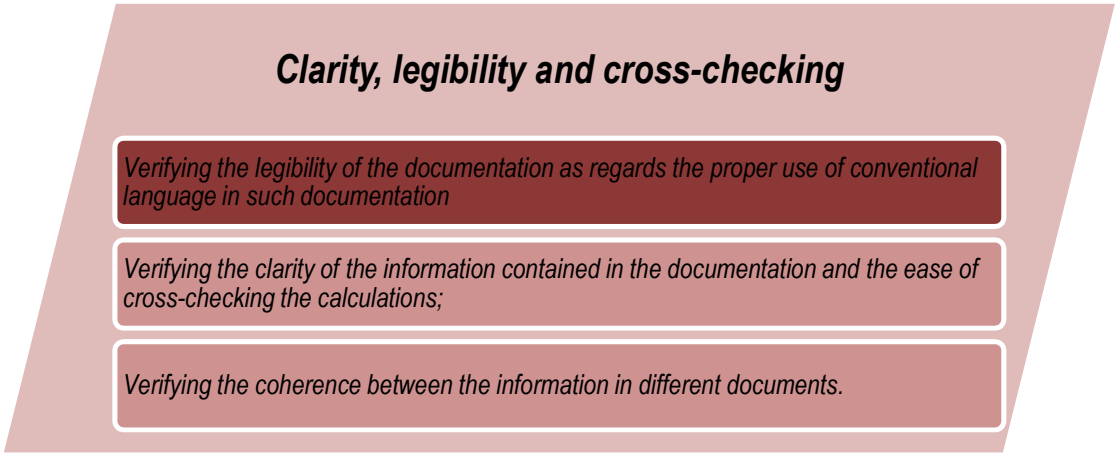
Verification of documentation: checking the existence of all the documents to be examined that are required by the project;

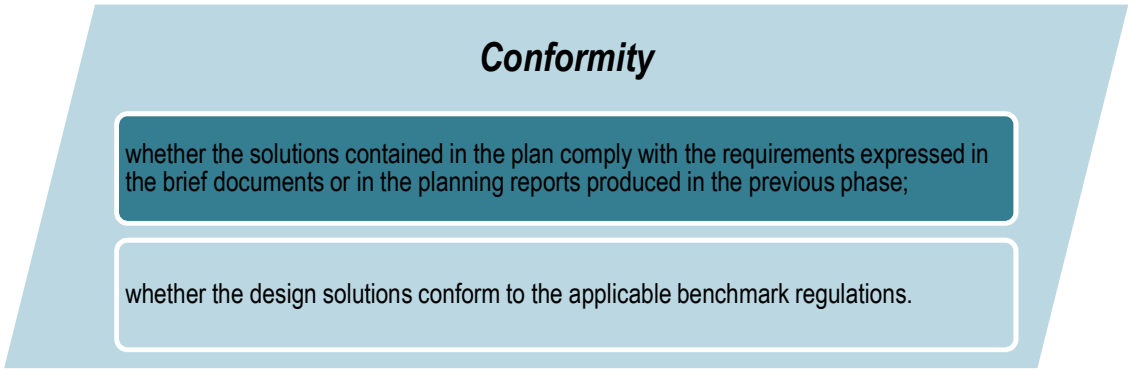
Verification of whether the calculations used in the drafting up of the project are exhaustive on the basis of the project requirements;

Verification of whether the information contained in reports is exhaustive;

Verification of whether the modifications to the project following previous assessments are exhaustive;

Verification that the commitments provided in the regulations disciplining the awarding of the design tender are being fulfilled.





- **Design Compatibility with Construction Methodologies**

The Consultant will work in collaboration with the Client in order to verify whether the technical choices for the project are coherent with the decisions made for the realization, delivery and use of the real estate property in question, with specific focus on:

Articles and systems for the long-term supply of goods which could cause delay in the construction plans (long-lead items):

- *Specific market conditions, availability of materials and company workloads,Prefabrication, special items*
- *Commercial sub-division of the main supplies and subcontracts*
- *Safety*
- *Lifting loads*
- *Storage of material, logistics*
- *Environmental compatibility*

In carrying out these assessments during the course of the works, and with specific focus on matters such as safety and the environment, the Consultant will use the consolidated ROAD (Risks and Opportunities at Design) procedure.

Design Progress Report

The report is drafted on a monthly basis, together with the planning team. It should reflect the project requirements and particularly the documentation used in the contract tender and take into account the subjects and the assessments to be carried out during the Validation phases. The report, which includes tables of the ROAD assessment, is issued after the above-mentioned Periodical Project Co-ordination Meetings. The progress report for the planning includes the following items:

Report Items

- *Completeness of the designs and percentage of works completed in relation to the General Plan of the Intervention and, in particular, procurement activities;*
- *Adequate use of the measures aimed at environmental protection on the work-site and during the completion phase;*
- *Minimizing the risk of making changes and causing disputes;*
- *The presuppositions for the durable quality of the construction work;*
- *The consistency of all aspects of the economic situation and any possible intervention regarding Value Engineering in relation to the different types of works stipulated in the budget;*
- *Whether the chosen design solution is relevant to the tender.*

4.10.6 Tender Management

All necessary documents (technical specifications, bills of quantities, final designs, system/detailed drawings and etc.) constituting the tender documents related with the construction contracts in accordance with the World Bank Guidelines and Standard bidding documents will be prepared in parallel to the Preliminary Design Stage and Final Design and System/Detailed Drawings Stage stipulated above. The Consultants will prepare the documents in close cooperation with the Client and make all the documents ready for tendering. The documents will be prepared with due care and diligence so that any of the items must not contradict to each other, and the World Bank procurement rules and all material specifications shall be in accordance with the specifications of the first class materials satisfying the Bangladesh standards and applicable EU Legislation, if not international standards.

The Consultant will submit its construction and other cost estimates for various project parts together with any report or other documents that it will be submitted during the performance of the services and tasks envisaged within the scope of this work. The cost estimates will be as detailed as necessary and shall be submitted together with the data, which will constitute basis for controlling the presented values when required. A complete description of the works required for the execution of the contract, coordinated and completed in all respects will be produced. The contractual documentation for the tender will provide the Client with a clear overview and a transparent procedure for selecting and awarding the appropriate offer and minimizing the risk of legal disputes during the tender and reservation by Contractors during the executive phase of the contract.

The Client shall be assisted during the tender stage, such as issue of Addendum (if any needed) in the evaluation of bids particularly with detailed analysis and recommendations in respect of the received proposals by the Consultant. The Consultant will manage the tender stage on behalf of the Client through the analysis and tabulation of offers, providing advice for the assignment of the works.

4.11 Project Schedule / Work Plan

4.11.1 The Basis for an Efficient and Feasible Work Plan

The Work Plan elaborated for this venture derives from a detailed analysis of Term of Reference and objectives given in tender documents aiming to guarantee the best services for the Client.

The Term of Reference has been analyzed, studied and shared by the writer and, through the Work Plan, the intention is to translate its contents at various stages in a practical manner. Through the work Plan the Consultant identify the key activities, the interconnections among them, timing and deadlines.

To describe the prepared Work Plan better and in a consistent manner with what is stated in the tender documents, the date of commencement of works 1st January 2019 has been taken as reference. It is thus of clear understanding that should the activities start after the date above mentioned, the entire program schedule would be moved forward. Following represents our JV approach for stage 2-Phase-II and III Preliminary and Detailed Engineering Studies.

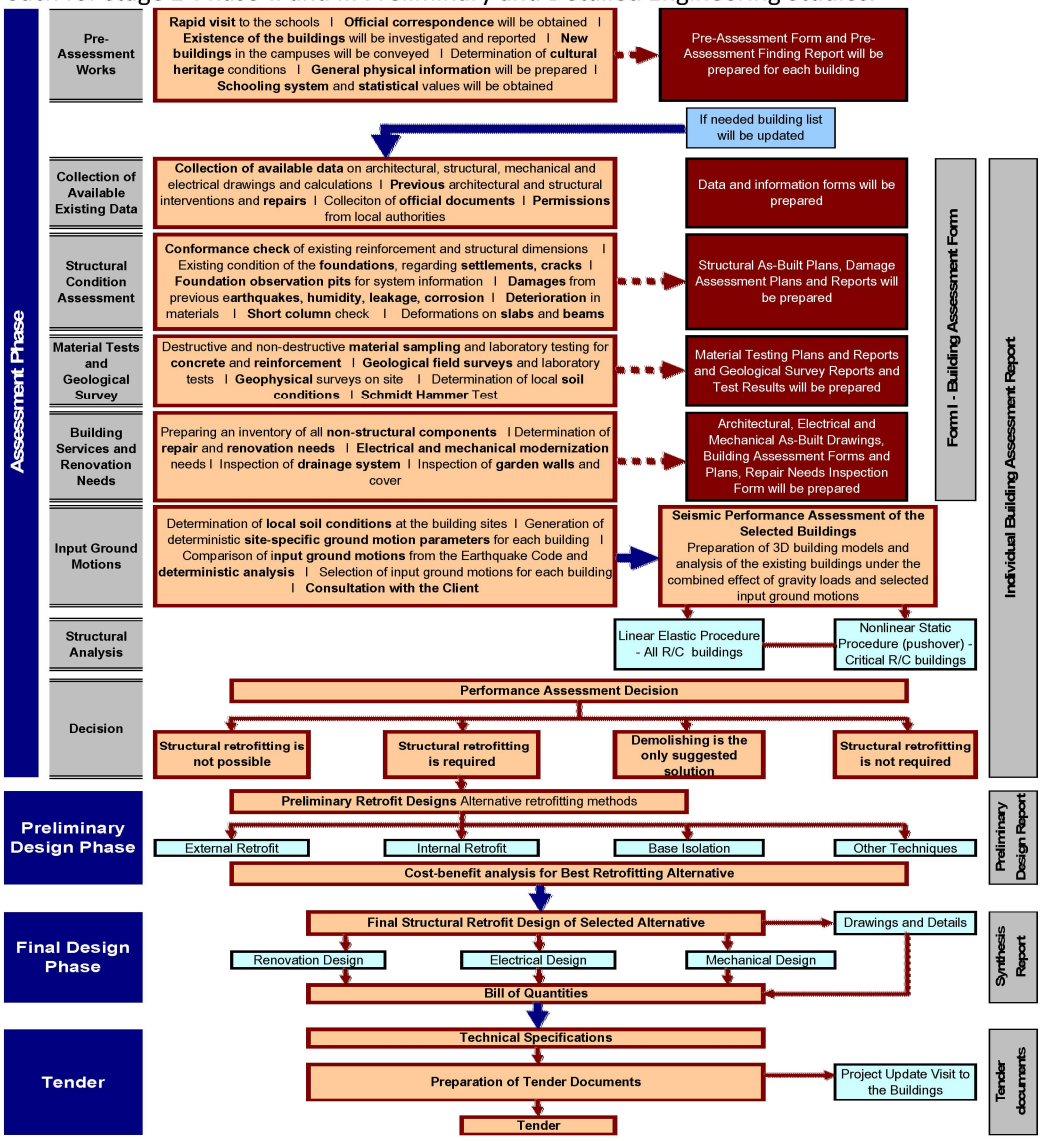


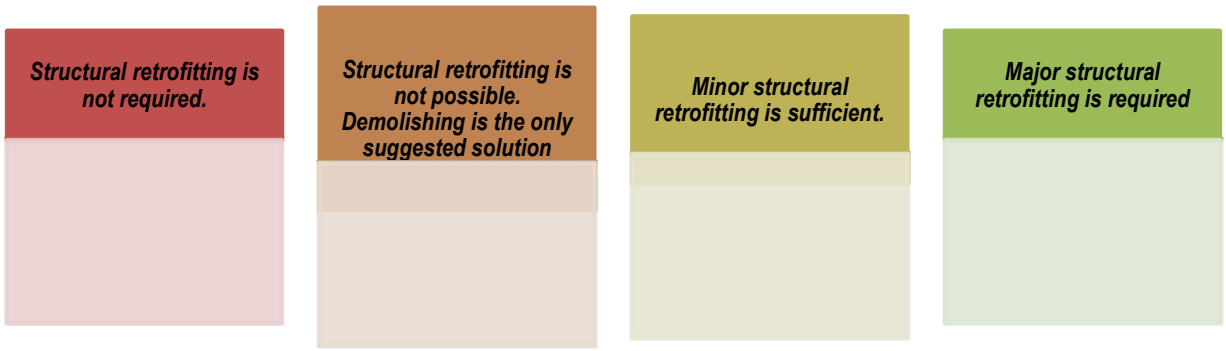
Figure :4-4

4.11.2 Seismic Performance Assessment of the Selected Buildings

Preparation of 3D building models and analysis of the existing buildings under the combined effect of gravity loads and selected input ground motions

4.11.3 Performance Assessment Decision

Classification of the buildings into the following categories, based on evaluated performances:



4.11.3.1 Economic Feasibility Analysis

Cost-benefit analysis for each retrofitting design

4.11.3.2 Preliminary Retrofit Designs

Internal retrofit for reinforced concrete buildings by adding concentric concrete shear walls,

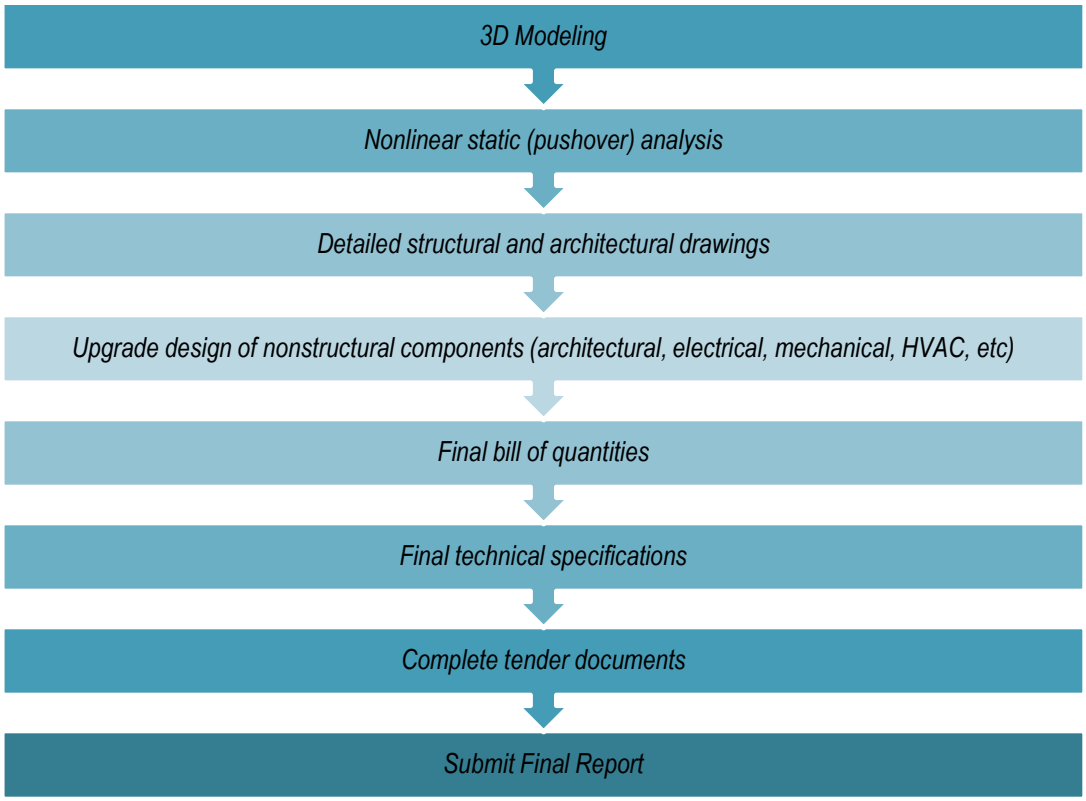
External retrofit for reinforced concrete buildings by adding eccentric concrete shear walls,

Component strengthening by innovative techniques and new materials,

Simple interventions, correction of deficiencies.

Preliminary Design Report together with Synthesis report indicating the buildings selected for retrofitting, and their prioritization and all other attachments.

4.11.4 Final Retrofit Designs



4.12 Database for Lifelines & Critical Infrastructure

Dhaka city provide the public with a number of programs and services; critical to these services are infrastructure systems that are vital for counties to operate These lifelines, as they are known, are essential systems that serve residents and businesses throughout the county, often extending into the greater region Without these lifelines, counties would not be able to ensure the public's health and safety, as well as economic security

It is important to distinguish lifelines from what are known as "life support" systems, which include emergency services and public health Lifelines have a set of defining characteristics that separate them from other sectors and services provided in general, there are four main factors that define lifelines:

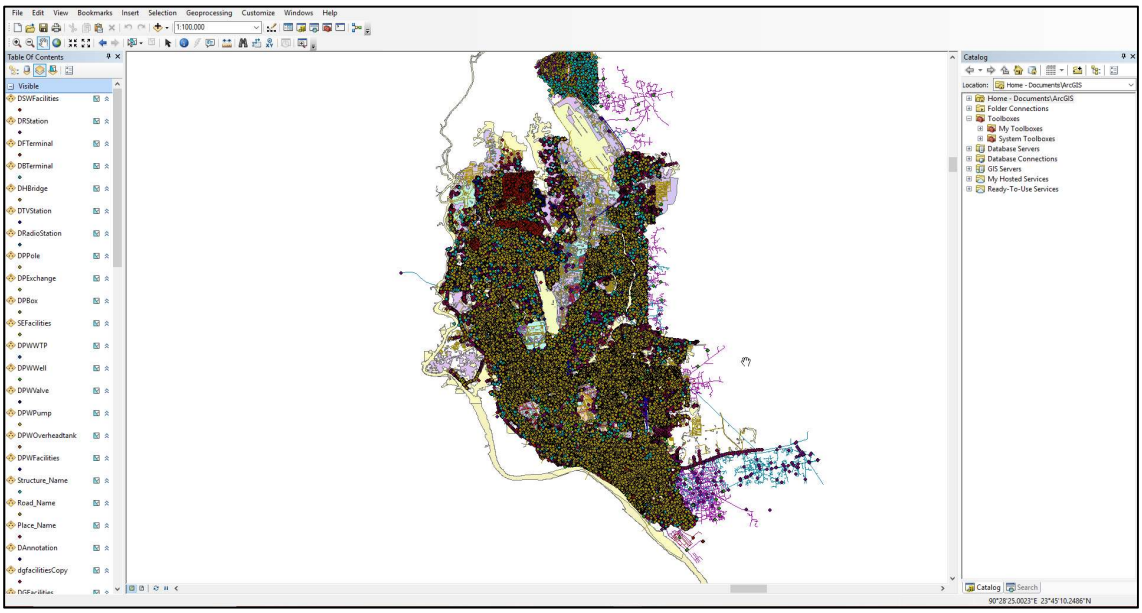
- They provide necessary services and goods that support nearly every home, business and county agency,
- Lifelines deliver services that are commonplace in everyday life, but disruption of the service has the potential to
- develop life-threatening situations,
- They involve complex physical and electronic networks that are interconnected within and across multiple sectors, and

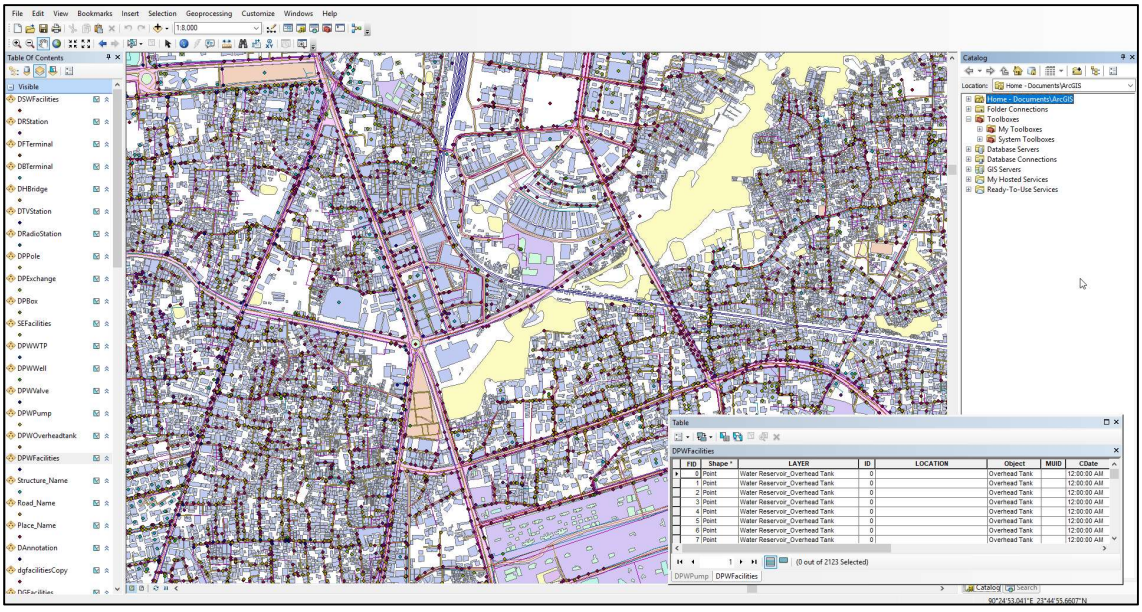
- A disruption of one lifeline has the potential to effect or disrupt other lifelines in a cascading effect

Each county has distinctive characteristics, be they geography and terrain, demographics or economic drivers such as, the needs of a small rural county are going to be different than those of a larger urban county will invariably define lifelines differently from one another, but there are four main lifeline categories that apply to virtually every county across the nation:

- Energy, such as oil, natural gas and electricity,
- Water, including potable water and wastewater systems,
- Transportation, including roads, bridges, rail, airports and ports, and
- Communications, including telephone, satellite and Internet infrastructure

In addition to these four main categories, Dhaka city may consider other areas to be important lifelines, depending on the county's size, population and location. By using GIS systems which illustrated in below figures and be consider to develop practical model





4.12.1 Data Collections

Based on review of data about DHAKA city, it is managed to review ongoing initiatives in Bangladesh related to the package and take learnings from them. For instance, guidelines for building assessments (structural & fire) for existing RMG factory buildings was developed through National Tripartite Plan of Action (NTPA) on Fire Safety and Structural Integrity. By following this, more than 3 thousand buildings were inspected for vulnerability in that case and also Electrical vulnerability. So based on this investigation as literature review many technical subjects which done in previous years review and make points of them to use in this project. List of Data which not officially send by RAJUK and investigated by JV team to prepare for further reports.

#	Name	Subject	Type	Refer to stakeholder
1	DAP_Interim_Report_Final	Preparation of Detailed Area PlanThis report has been prepared as part of the fulfillment of the requirements of the Terms of Reference (ToR) of the project titled 'Preparation of Detailed Area Plan (2016-2035) for DMDP Area'.	PDF	RAJUK
2	Final Survey Report_Dec_2018	Preparation of Detailed Area Plan.The current Survey Report has been prepared, in persuasion of the Section 2.2 of the Terms of Reference of Detailed Area Plan (DAP) project	PDF	RAJUK
3	Draft Dhaka Structure Plan Report (Full Volume)	DHAKA STRUCTURE PLAN. The Structure Plan provides long term strategy for the 20 years to 2035 for the development of Dhaka Metropolitan Region.	PDF	The Structure Plan has been prepared for the whole development control area of RAJUK. The topics covered by the Dhaka Metropolitan Region (DMR) Structure Plan
4	Final Inception Report_RDP	Submission of Survey Report of Regional Development Planning (RDP) Project	PDF	
5	Final Survey Report 05032014	Submission of Survey Report of Regional Development Planning (RDP) Project	PDF	
6	PRINT_Final_INTERIM REPORT_07072014	Submission of Interim Report of Regional Development Planning	PDF	

		(RDP) Project		
7	Satellite Image/GeoEye_BTM_Everest 1830	IMAGE	IMAGE	
8	Satellite Image/GeoEye_BTM_Everest Bangladesh	IMAGE	IMAGE	
9	Satellite Image/GeoEye_Clipped_BTM	IMAGE	IMAGE	
10	Satellite Image/GeoEye_Image_Raw	IMAGE	IMAGE	
11	Satellite Image/GeoEye_Ortho-Rectified__UTM	IMAGE	IMAGE	
12	Satellite Image/GeoEye_UTM	IMAGE	IMAGE	
13	7FYP-Final-Draft_13_10_15	Accelerating Growth, Empowering Citizens	PDF	General Economics Division (GED) Planning Commission Government of the People's Republic of Bangladesh
14	7FYP-Final-Draft_13_10_15_Neaz	Accelerating Growth, Empowering Citizens	PDF	General Economics Division (GED) Planning Commission Government of the People's Republic of Bangladesh
15	5 Bnbc-pt9-ch3(Conservation/CHAPTER 3)	This is the process of retention of existing buildings or groups of buildings, landscapes etc. and taking care not to alter or destroy character or detail, even though repairs or changes may be necessary	WORD	
16	6 BNBC_Part3_Ch4_Sustainability	The purpose of including this chapter in the code is to enhance the design and construction of buildings through the use of building concepts having a positive environmental impact and encourage sustainable construction practices	WORD	

17	DMDP URBAN AREA PLAN, DAP and Other Reviews	Urban Area Plan (UAP) is the second tier of the three stage DMDP plan package. The urban area plan (1995-2005) provides mid-term strategy for ten years from 1995. It defines the geographic boundary that will cover the mid-term proposals that cover metro-Dhaka	WORD	
18	Recommendations for Green Building Bangladesh ver 7	The objectives of this report are to assist the Government of Bangladesh to amend the current Building Code with the purpose of developing mandatory standards to accelerate the development of Green Buildings in Dhaka.	PDF	The report has been written by Consultants from WSP Middle East's Environment and Sustainability team with inputs from a local consultant team at DDC.
19	National Land Policy(English)	Draft National Land Policy/ The government has been taking concrete measures to adress the problems related to land administration and management.	PDF	
20	National urban health strategy	This strategy has been prepared based on some indications. First, rapid urbanization,Second, health care,Third, considering the complexity of the urban system, it is necessary to ensure coordination among activities of different organizations and a permanent arrangement to ensure a proper health system	PDF	
21	National_Urban_Sector_Policy_2011_Bangladesh_(Draft)(1)	Ensure urbanization	PDF	
22	TOD-Delhi-2021	Transit Oriented Development/Growth of many Indian cities over the years has been on the ring and radial pattern with reliance on road based public transport. The development envisaged by the previous Plans was poly nodal	PDF	

		with hierarchy of Commercial Centres located either on ring or radial roads. The proposed MRTS network will bring sizable urban area within walking distance from the proposed stations. This will have an impact on the existing structure of the city and consequently its development		
23	town_improvement_act_1953	THE TOWN IMPROVEMENT ACT, 19531/WHEREAS it is expedient to make provision for the development, improvement and expansion of the 2[Capital of the Republic and Narayanganj and Tongi Municipalities] and certain areas in their vicinity by opening up congested areas, laying out or altering streets, providing open spaces for purposes of ventilation or recreation, demolishing or constructing buildings, acquiring land for the said purposes and for the re-housing of persons displaced by the execution of improvement schemes, and otherwise as hereinafter appearing	PDF	
24	UrbanAndRegionalPlanningAct2015	THE URBAN AND REGIONAL PLANNING ACT, 2015	PDF	
25	WaterAct_2013	An Act to make provisions for integrated development , management , abstraction, distribution ,use, protection and consevation of water resources.	PDF	Government of the peoples Republic of Bangladesh Ministry of law
26	3. Gopalganj Climate Resilient Integrated Urban Plan_Print	The purpose of this “Climate Resilient Integrated Urban Plan” (CRIUP) is to present a cohesive series of interventions that will enable Gopalganj to cope with climate change impacts through integration with its’ urban development plans and policies.The methodology developed for the preparation of this CRIUP has been outlined in	PDF	

		the accompanying “Rapid Urban and Climate Change Assessment Report” (RUCCA)		
27	3. Gopalganj Rapid Urban and Climate Change Assessment_Print	Urbanization is a significant factor in Bangladesh and poses both an opportunity for the country to continue its economic growth and a challenge in the face of expected climate driven impacts. Climate change is an additional stress that only sustainable cities can deal with, as cities need to be fully functioning in order to successfully address challenges and climate change impacts. Once that is achieved, long-term resilience can be created. In this approach, adaptation14 to climate change is an essential strategy required for achieving sustainable urban development in Bangladesh.	PDF	
28	3.Gopalganj First Five Years	This document is an integral part of the larger “Climate Resilient Integrated Urban Plan” (CRIUP) document for Gopalganj pourashava. The CRIUP codifies municipal commitment to respond to current and future climate change challenges based on the findings of the accompanying “Rapid Urban and Climate Change Assessment Report” (RUCCA).	PDF	
29			GIS	
30	BBS DATA/ Manikganj	The population and housing census is the unique source of reliable and comprehensive data about the size of the population of the country, major socio-economic and socio-demographic characteristics. It is the total process of collecting, compiling, evaluating, analyzing and publishing or otherwise disseminating demographic,	PDF/EXCEL	

		economic and social data pertaining, at a specified time, to all persons in a country. The essential features of a population census are individual enumeration, universality within a defined territory, simultaneity and defined periodicit		
31	BBS DATA /Munshiganj	Population and Housing Census 2011 Bangladesh Bureau of Statistics Statistics and Informatics Division Ministry of Planning/ The population and housing census is the unique source of reliable and comprehensive data about the size of the population of the country, major socio-economic and socio-demographic characteristics	PDF	
32	BBS DATA/ Narshindi	The population and housing census is the unique source of reliable and comprehensive data about the size of the population of the country, major socio-economic and socio-demographic characteristics	PDF	
33	Community Report Dhaka Zila/BBS_dhaka	Population and Housing Census 2011/The population and housing census is the unique source of reliable and comprehensive data about the size of the population of the country, major socio-economic and socio-demographic characteristics. It is the total process of collecting, compiling, evaluating, analyzing and publishing or otherwise disseminating demographic, economic and social data pertaining, at a specified time, to all persons in a country. The essential features of a population census are individual	PDF	

		enumeration, universality within a defined territory, simultaneity and defined periodicity. The population and housing census provides information on the geographic and administrative distribution of the population and household in addition to the demographic and socioeconomic characteristics of all the people in the country. The data from the census are classified, tabulated and disseminated so that political leaders, election officials, planners, national organizations including NGOs and civil society, regional and international organizations can use the data in decision-making		
34	BBS/ECONOMIC CENSUS 2013/DHAKA	An Economic Census is the complete enumeration of the full set of economic units belonging to a given population or universe at a particular time with respect to well defined characteristics/The main objective of the Economic Census was to observe the nature of the structural changes taken place in the economy over the last decade, and to provide comprehensive statistical information for policy makers, planners, researchers, business communities and others for policy making, economic, social & business planning, and for other uses	PDF	BANGLADESH BUREAU OF STATISTICS (BBS) STATISTICS AND INFORMATICS DIVISION (SID) MINISTRY OF PLANNING
35	BBS/Dhaka_20at_20a_20glance_20General	Population and Housing Census 2011/The population and housing census provides information on the geographic and administrative distribution of the population and household in addition to the demographic and socioeconomic characteristics of all the people in the country. The	PDF	

		data from the census are classified, tabulated and disseminated so that political leaders, election officials, planners, national organizations including NGOs and civil society, regional and international organizations can use the data in decision-making		
36	BBS/ economic_census_2013_dhaka_thana	Total Establishment number/Electricity, Gas, Steam and Air Conditioning Supply/Construction/Information and Communication/	EXCEL	
37	BBS/Gazipur_20at_20a_20glance	The population and housing census provides information on the geographic and administrative distribution of the population and household in addition to the demographic and socioeconomic characteristics of all the people in the country. The data from the census are classified, tabulated and disseminated so that political leaders, election officials, planners, national organizations including NGOs and civil society, regional and international organizations can use the data in decision-making	PDF	
38	BBS/Narayanganj_20at_20a_20glance	BANGLADESH POPULATION AND HOUSING CENSUS 2011	PDF	
39	BBS/Pages-from-FinalReport-Part-2	Permanent Establishments and Total Person Engaged (TPE) by Major Economic Activity, and by District & Location, 2013	PDF	
40	Earthquake Risk Assessment	This report presents a seismic risk assessment of the buildings, essential facilities and lifelines based on a GIS database that was developed from existing secondary data and field survey in Dhaka, Chittagong and Sylhet City Coproration area	PDF	Comprehensive Disaster Management Programme (CDMP)
41	Seismic Hazard Assessment Dhk, Chg, Syl	The deterministic approach was adopted for the earthquake motion estimation in this study	PDF	Comprehensive Disaster Management

				Programme (CDMP)< Ministry of Flood and Disaster Management (MoFDM)
42	Shapefile		GIS	
43	CDMP_P2	The scenario-based Ward-level Spatial Contingency Plan for Ward No. 01 of Dhaka North City Corporation (DNCC) is prepared under Comprehensive Disaster Management Programme, Phase-II (CDMP II). CDMP was initiated by the Ministry of Disaster Management and Relief of the People's Republic of Bangladesh to reduce country's vulnerabilities to adverse natural and anthropogenic hazards and extremes events	PDF	
44	DNCC		IMAGE	
45	BRTGuidelines/BRT_Report. BUS NET/BUS Rapid Transmission.	The following Design Guidelines are being recommended to the Regional Transit Board of Directors. They will be used to obtain Bus Rapid Transit infrastructure./The association is structured as a joint venture between the two largest engineering and planning firms on the team: /Transportation is one of the major problem issues facing Dhaka, with increasing traffic congestion becoming a serious impediment to mobility and the normal function of the city. The Government of Bangladesh and the World Bank have joined efforts to implement a new transport policy within the CASE projectTransport systems play a crucial role in urban development by providing access for	PDF/EXCEL/GIS	

		people to education, markets, employment, recreation, health care and other key social–economic services(Transport systems)URBAN DEVELOPMENT CONTEXT.REVIEW OF PREVIOUS AND ON-GOING TRANSPORT PLANS		
46	FAP REPORT	Assessment/ Feasibility study on greater Dakha protection project /Priliminary Design of Proposed Facilities	PDF	
47	Geomorphology_Dhaka	Geo-Information for Urban Development, Bangladesh	GIS/ EXCEL/IMAGE/PDF	Geo-Information for Urban Development, Bangladesh (GUD)
48	Halcrow_Plan		IMAGE	
49	Road Master Plan	This plan has been developed in response to the direction provided by the National Land Transport Policy1, which committed the Government to 'develop a long term (20 year) Road Master Plan2	GIS/ IMAGE/PDF	
50	Sixth Five Year Plan	Accelerating Growth and Reducing Poverty	PDF	
51	Asian Development Bank Government of Bangladesh	Strengthening Regional Planning and Governance (SRPG)	PDF	
52	DAKHA Profile and Earthquake Risk Atlas	It is intended to provide a scientifc and systematized presentation of the results and key fndings of the Bangladesh Urban Earthquake Resilience Project (BUERP) by compiling physical, demographic, and socio-economic data with risk information and analyses, then, showing them through maps, tables, and charts. The Dhaka Profle and Earthquake Risk Atlas translates these technical information into a single, straight forward, and easy-tounderstand presentation. This information	PDF	

		could be utilized to provide the scientifc foundation in improving capacity for earthquake resilience of Bangladesh		
53	Dhaka Earthquake Risk/Bangladesh Urban Earthquake Resilience Project	Hazards, Vulnerability and Risk Assessment (HVRA) Guidebook	PDF	
54	Information, Education & Communication Action Plan	Information, Education & Communication Action Plan	PDF	
55	Legal and Institutional Arrangements (LIA) Framework Guidebook	LIA Framework Guidebook	PDF	
56	Risk-Sensitive Land Use Plannning Guidebook	Risk-Sensitive Land Use Planning (RLUP) Guidebook	PDF	
57	Training and Capacity Building Action Plan	Bangladesh Urban Earthquake Resilience Project/Training and Capacity Building Action Plan	PDF	
58	DHUTS	PREPARATORY SURVEY REPORT ON DHAKA URBAN TRANSPORT NETWORK DEVELOPMENT STUDY (DHUTS) IN BANGLADESH	PDF/WORD	
59	DHAKA METROPOLITAN DEVELOPMENT PLAN	Preparation of Structure Plan ,Master plan, Detailed area plan / Dhaka metropolitan Development plan	PDF	
60	DAP_Report_RAJUK	Detailed Area Plan (DAP) is the third and final tier of DMDP (Dhaka Metropolitan Development Plan) 1995-2015. DMDP is a three tier plan package, viz. the Structure Plan, the Urban Area Plan and the Detailed Area Plan	PDF	
61	Report-II (Survey Report)_Location-10	Physical Features Survey Guidelines/Physical Features Survey, Topographic Survey and Land Use Survey Map Index List/List of Maps/The Dhaka Metropolitan Development Plan (DMDP) is a three-tier plan package, viz. the Structure Plan, the Urban Area Plan and the Detailed Area Plan (DAP)./Physical Survey/This chapter contains the findings of topographic survey consisting of	WORD	

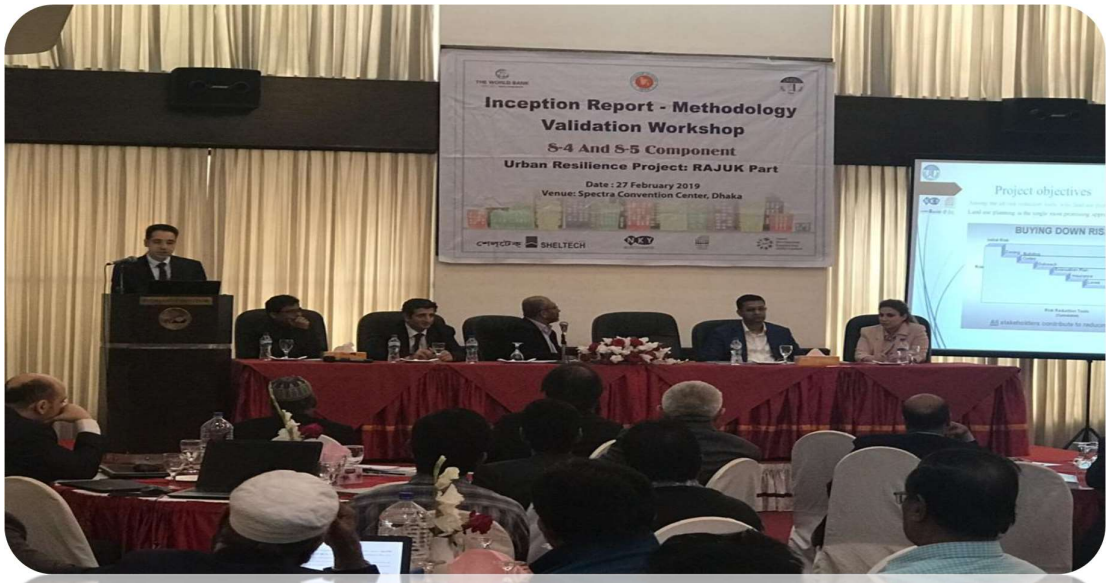
		the alignment and crest level of road/topographic survey /physical features survey /physical infrastructure survey /land use survey /socio-economic status of people living /collection of all the information both primary and secondary regarding the study area./Key task and actual input of consultant expert / Preparation of Detailed Area Plan (DAP) for DMDP/Preparation of Detailed Area Plan for DMDP/Housing is not only a physical commodity including dwellings, utility services and facilities provision, it also emphasize on economic and socio-cultural aspects/		
62	RAJUK_DAP_survey data	Report II (Survey Report) is the most vital part of the preparation of Detailed Area Plan/Table of Contents/As the partial fulfillment of the requirement of Terms of Reference for the preparation of Detailed Area Plan under Dhaka Metropolitan Development Plan Preparation Project, this reports being submitted./List of Maps/List of Tables	WORD/IMAGE/	
63	Final Tex & Map	Plan Implementation/Project Plan /Follow Up Actions /Conclusion/This Final Plan Report is the 6th of the series of the reports submitted under the tasks of DAP assigned to Group-E area.(BACKGROUND)/Table of Contents	WORD/EXCEL/GIS	
64	DMDP		GIS	
65	Group-E Ext Final Plan Report	Critical Planning Issues /Development Plan Proposals /Plan Implementation /Project Plan /Follow Up Actions/Conclusion/Background/ TABLE OF CONTENTS	GIS/WORD	Rajdhani Unnayan Kartripakkha (RAJUK)
66	Location_1 Final Plan Report Revised	Dhaka Metropolitan Development Plan /BACKGROUND/Critical Planning Issues/Development Plan	GIS/WORD	Published By Rajdhani Unnayan Kartripakkha

		Proposal /Plan Implementation/Project Plan /Follow Up Actions/Conclusion/TABLE OF CONTENTS		(RAJUK)
67	Location_2 Final Plan Report	Dhaka Metropolitan Development Plan /BACKGROUND/Critical Planning Issues/Development Plan Proposal /Plan Implementation/Project Plan /Follow Up Actions/Conclusion/TABLE OF CONTENTS	GIS/WORD	Published By Rajdhani Unnayan Kartripakkha (RAJUK)
68	Location_10 Final Plan Report	Dhaka Metropolitan Development Plan /BACKGROUND/Critical Planning Issues/Development Plan Proposal /Plan Implementation/Project Plan /Follow Up Actions/Conclusion/TABLE OF CONTENTS./MULTI SECTORAL INVESTMENT PROGRAMME/Phasing of Development Priority Areas/	GIS/WORD	Published By Rajdhani Unnayan Kartripakkha (RAJUK)
69	SPL_Report_DAP/Draft Plan Report_Extension E	PERMITTED USES IN MIXED LAND USE ZONE/Existing and Projected Population of Group-E Area Extension /Standard for Social Services/Group-E Extension Area is a part of Group-D area allocated to Group-E for preparation of DAP/BACKGROUND/Critical Planning Issues/Development Plan Proposal /Plan Implementation/Project Plan /Follow Up Actions/Conclusion/TABLE OF CONTENTS./	WORD	Project Director Preparation of Detailed Area Plan (DAP) Rajdhani Unnayan Kartripakkha (RAJUK)
70	Final Plan Report_Group-E Ext	/BACKGROUND/Critical Planning Issues/Development Plan Proposal /Plan Implementation/Project Plan /Follow Up Actions/Conclusion/TABLE OF CONTENTS./	WORD	
71	Inception Report_Group-D	Sample Digitized Mauza Map of for Extension Work of Group-E / RAJUK's TMC Sub-Committee and	WORD/EXCEL	

		TMC Meeting Minutes /INTRODUCTION/APPROACH TO PLANNING AND METHODOLOGY/LAND SUITABILITY ANALYSIS BY NEIGHBORHOOD LEVEL/IDENTIFICATION OF MULTI-SECTORAL INVESTMENT PROJECTS/COMPREHENSIVE PLANNING/URBAN DESIGN AND PLANNING PROCEDURE/INSTITUTIONAL AND LEGAL FRAMEWORK/WORK PROGRAM AND MANNING SCHEDULE/COMMENTS ON TERMS OF REFERENCE/OUTPUT AND FORMATS/Correction of Inception Report/ACTIVITY OF PROFESSIONAL PERSONNEL		
72	Interim Report_ Extension	COMMUNICATION PLAN: STAKEHOLDER CONSULTATION/FORMULATION OF PLANNING PRINCIPLES AND STANDARDS/Integrated Planning/Priorities and Phasing/Conclusion/Compliance List/Stakeholders' participation	WORD	
73	Inception Report_Group_E	URBAN DESIGN AND PLANNING PROCEDURE	WORD	
74	Inception Report_Group_E	INSTITUTIONAL AND LEGAL FRAMEWORK	WORD	
75	Inception Report_Group_E	ASSIGNMENT OF PROJECT TEAM	WORD	
76	Inception Report_Group_E	OUTPUT AND FORMATS /TASK OF PROFESSIONAL	WORD/PDF	
77	18.12.23_Inception Report S4_ver00.04.		PDF	
78	ToR		WORD	
79	S4 team roles and responsibilities		WORD	
80	RFP		WORD	

CHAPTER 5

Annex



Annex A-1: Work plan

The duration of 36 months is sufficient enough to carry out all the activities within the responsibility of our JV in accordance with ToR requirements and our methodologies. However, during the kick off meetings and bilateral meetings with PIU a specific request was made if a fast track of the activities would be possible. Our teams have extensively studied the work plan and deliverables and have reached to following conclusion:

1- The duration of the 36 months can be reduced to 30 months- the quality of the outputs and achievements will remain the same- with the understanding and acceptance of following terms:
   a. The data required which has been stated in Chapter 3 of this report including the list of the buildings shall be immediately provided.
   b. The duration for the approval of the reports from the PIU/WB shall be limited to 10days.
   c. The additional staff/individual consultants/sub-contractors may require and the consultant will provide as required. No extra charge for these consultants will be requested however the expectation from PIU is to facilitate their utmost assistance to timely provide the payments in accordance with the revised work plan stated herein.
   d. Facilitation from PIU for getting necessary approval from the relevant building authorities to be able to conduct RVA/PEA/DEA studies. Especially providing necessary permissions have crucial importance.
   e. With the work plan provided we have aimed to have a deliverable/financial progress of at least 40% by July 2019 and 75% by July 2020 while we have aimed to complete project by June 2021.
2- The duration of the 36 months cannot be reduced to 18 months with the understanding of following terms:
   a. This is not useful to start PEA without finishing totally RVA and make decisions about clustering buildings for next step.
   b. This is not practical to run DEA without finishing more than 80% of PEA and make decisions about clustering buildings for next step.
   c. This so practical to write Road Map about Investment after all tasks finish and all analysis complete.
   d. Based on Critical Path Method (CPM) there are too many activities which related to each other and must set as Finish-Start tasks.
   e. There are too many parallel activities which are in CPM and monitoring of them is impossible.
   f. Weather and environmental aspects is this WBS is really affect all activities.
   g. By adding more teams of RVA there is no benefit to run in this time.
   h. There are too many lag, lean and floating time which can extend time more than 18 months.

Work Plan

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU)
Package No.: URP/RAJUK/S-04, IDA Credit: 55990
Form TECH-5; Timeline

Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
				To	30-Nov-18	31-Dec-18	31-Jan-19	28-Feb-19	31-Mar-19	30-Apr-19	31-May-19	30-Jun-19	31-Jul-19	31-Aug-19	30-Sep-19	31-Oct-19	30-Nov-19	31-Dec-19	31-Jan-20	29-Feb-20	31-Mar-20	30-Apr-20	31-May-20	30-Jun-20	31-Jul-20	31-Aug-20	30-Sep-20	31-Oct-20	30-Nov-20	31-Dec-20	31-Jan-21	28-Feb-21	31-Mar-21	30-Apr-21	31-May-21	30-Jun-21	31-Jul-21	31-Aug-21	30-Sep-21	31-Oct-21
				From	01-Nov-18	01-Dec-18	01-Jan-19	01-Feb-19	01-Mar-19	01-Apr-19	01-May-19	01-Jun-19	01-Jul-19	01-Aug-19	01-Sep-19	01-Oct-19	01-Nov-19	01-Dec-19	01-Jan-20	01-Feb-20	01-Mar-20	01-Apr-20	01-May-20	01-Jun-20	01-Jul-20	01-Aug-20	01-Sep-20	01-Oct-20	01-Nov-20	01-Dec-20	01-Jan-21	01-Feb-21	01-Mar-21	01-Apr-21	01-May-21	01-Jun-21	01-Jul-21	01-Aug-21	01-Sep-21	01-Oct-21
Stage 1: Preparation and Data Collection (Approximate Duration: 4 Months)																																						
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)	ID-1	The ToRs and evaluation criteria	1 Month		1																																	
	ID-2	Evaluation of the experts and result based matrix			1																																	
	ID-3	Preparation of the Organogram			1																																	
	D1	Final Inception report			1																																	
Data Collection and Documentation	ID-4	Situation Analysis Interim Report	3 Months			1	2	3																														
	ID-5	Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)				1	2	3																														
	ID-6	Provide up to date list of the all the critical infrastructure and facilities				1	2	3																														
	ID-7	Urban Profile and Characteristics Report				1	2	3																														
	ID-8	Analysis of Outcomes				1	2	3																														
	D2	Needs Assessment Report				1	2	3																														
	D3	Complete database for all critical infrastructure, superstructures described in the scope of the services				1	2	3																														
	MD1	Comprehensive situation analysis report including Recommendations and way forward solutions			1	2	3	4																														

Urban Resilience Project : RAJUK Part ★ Gulshan-1, Dhaka- 1212, Bangladesh ★ Project Director

JV of NKY-Protek Yapi-Sheltech ★

Figure: A-1-1

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU) Package No.: URP/RAJUK/S-04, IDA Credit: 55990 Form TECH-5; Timeline			Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
			To	30-Nov-18	31-Dec-18	31-Jan-19	28-Feb-19	31-Mar-19	30-Apr-19	31-May-19	30-Jun-19	31-Jul-19	31-Aug-19	30-Sep-19	31-Oct-19	30-Nov-19	31-Dec-19	31-Jan-20	29-Feb-20	31-Mar-20	30-Apr-20	31-May-20	30-Jun-20	31-Jul-20	31-Aug-20	30-Sep-20	31-Oct-20	30-Nov-20	31-Dec-20	31-Jan-21	28-Feb-21	31-Mar-21	30-Apr-21	31-May-21	30-Jun-21	31-Jul-21	31-Aug-21	30-Sep-21	31-Oct-21
			From	01-Nov-18	01-Dec-18	01-Jan-19	01-Feb-19	01-Mar-19	01-Apr-20	01-May-19	01-Jun-19	01-Jul-19	01-Aug-19	01-Sep-19	01-Oct-19	01-Nov-19	01-Dec-19	01-Jan-20	01-Feb-20	01-Mar-20	01-Apr-20	01-May-20	01-Jun-20	01-Jul-20	01-Aug-20	01-Sep-20	01-Oct-20	01-Nov-20	01-Dec-20	01-Jan-21	01-Feb-21	01-Mar-21	01-Apr-21	01-May-21	01-Jun-21	01-Jul-21	01-Aug-21	01-Sep-21	01-Oct-21
Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration																																				
Stage 2: Survey for Structural Vulnerability Assessment (Approximate Duration: 24 Months)																																							
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	ID-9	1. Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide	1 Month					1																															
	ID-10	2. Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities						1																															
	D4	3. Develop a state-of art methodology that meets the comprehensive objectives of the project and forms a decision tool for the government in assisting their investment choices. Detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets will be conducted and reported						1																															
	D5	4. Development of a specific Prioritization Methodology for Seismically Vulnerable Public Buildings						1																															
	D6	5. Preparation of unified and integrated analysis methodology						1																															
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies	ID-11	1. Report on Proceedings of the workshops	1 Month					1																															
	ID-12	2. Report on outcomes of the findings						1																															
	D7	3. Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.						1																															

Project : RAJUK Part * Urban Resilience Project Director * Gulshan-1, Dhaka-1212, Bangladesh

JV of NKY-ProtekYapi-Shelltech

Figure: A-1-2

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU)
Package No.: URP/RAJUK/S-04, IDA Credit: 55990
Form TECH-5; Timeline

Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration
Physical survey and risk and vulnerability assessment of the facilities identified in scope of work	D8	1- Prepare and submit a comprehensive report on the outcomes of the Rapid visual assessment	7 Months
	MD2	2- Prepare and submit individual reports for structures assessed (minimum 2,500,000 Sqm) of Rapid Visual Assessment (RVA)	
	MD3	3- Prepare and submit individual reports for remaining structures assessed and Prepare the synthesis report addressing all the structures along with the prioritization list.	
	D9	Assessment Report (Final Assessment Report for all structures)	
	MD4	1- Prepare and submit individual assessment reports for each structure assessed (upto 500,000 sqm) of Preliminary Engineering Analysis (PEA)	8 Months
	MD5	2- Prepare and submit individual assessment reports for remaining structures assessed, Prepare and submit a comprehensive report on the outcomes of the Preliminary assessment	
	D10	Preliminary Desing Report (Final Preliminary Design Report for all structures)	
	D11	1. Prepare and Submit General Material Test Report adressing all structures	8 Month
	MD6	1- Prepare and submit individual final reports for each structure analyzed upto 250,000 sqm of Detail Engineering Assessment (DEA)	
	MD7	2- Prepare and submit individual final reports for remaining structures analyzed and Prepare the synthesis report addressing all the structures along with the prioritization list.	9 Months
	D12	Final Design Report and Drawings (for all structures)	
	D13	1. Prepare and Submit Tender Documents (in accordance with the World Bank guidelines and standard bidding documents)	

Figure: A-1-3

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU)
Package No.: URP/RAJUK/S-04, IDA Credit: 55990
Form TECH-5: Timeline

Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration	Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
				To	30-Nov-18	31-Dec-18	31-Jan-19	28-Feb-19	31-Mar-19	30-Apr-19	31-May-19	30-Jun-19	31-Jul-19	31-Aug-19	30-Sep-19	31-Oct-19	30-Nov-19	31-Dec-19	31-Jan-20	29-Feb-20	31-Mar-20	30-Apr-20	31-May-20	30-Jun-20	31-Jul-20	31-Aug-20	30-Sep-20	31-Oct-20	30-Nov-20	31-Dec-20	31-Jan-21	28-Feb-21	31-Mar-21	30-Apr-21	31-May-21	30-Jun-21	31-Jul-21	31-Aug-21	30-Sep-21	31-Oct-21
				From	01-Nov-18	01-Dec-18	01-Jan-19	01-Feb-19	01-Mar-19	01-Apr-19	01-May-19	01-Jun-19	01-Jul-19	01-Aug-19	01-Sep-19	01-Oct-19	01-Nov-19	01-Dec-19	01-Jan-20	01-Feb-20	01-Mar-20	01-Apr-20	01-May-20	01-Jun-20	01-Jul-20	01-Aug-20	01-Sep-20	01-Oct-20	01-Nov-20	01-Dec-20	01-Jan-21	01-Feb-21	01-Mar-21	01-Apr-21	01-May-21	01-Jun-21	01-Jul-21	01-Aug-21	01-Sep-21	01-Oct-21
Finalization of outputs and cross-referencing of final results and Validation of assessment results by PWG and POC	ID-13	1. Report on Proceedings of the workshops	1 Month																										1									
	ID-14	2. Report on outcomes of the findings																											1									
	DI4	3. Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.																											1									
Creation of a historical calibration and validation database	ID-15	1. GIS based database for all the activities carried out.	1 Month																											1								
	ID-16	2- Risk Communication Methodology and Report																												1								
	ID-17	3-Independent Peer Review Report																												1								
	ID-18	4- Update of Dhaka City Risk Profile and Atlas (including seismic catalogue)-Linked to outcome of S5 package																												1								
	DI9	5-Full documentation and preparation of reports and deliverables																												1								
Stage 3: Design of Long Term Vulnerability Reduction Investment Plan and related Dhaka Urban Resilience Strategy (Duration: 8 Months)																																						
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	ID-19	1. Report of Prioritization and mitigation strategies	1 Month																												1								
	ID-20	2. Report for Proceedings and outcomes of the consultations																													1								
Development of options for risk reduction and for achieving long term urban resilience in Dhaka	ID-21	1. Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives	1 Month																													1							
Development of an draft Dhaka Urban Resilience Strategy with a vision statement, specific objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators.	DI6	1. Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives	1 Month																														1						

Figure: A-1-4

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU) Package No.: URP/RAJUK/S-04, IDA Credit: 55990 Form TECH-5; Timeline			Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36
			To	30-Nov-18	31-Dec-18	31-Jan-19	28-Feb-19	31-Mar-19	30-Apr-19	31-May-19	30-Jun-19	31-Jul-19	31-Aug-19	30-Sep-19	31-Oct-19	30-Nov-19	31-Dec-19	31-Jan-20	29-Feb-20	31-Mar-20	30-Apr-20	31-May-20	30-Jun-20	31-Jul-20	31-Aug-20	30-Sep-20	31-Oct-20	30-Nov-20	31-Dec-20	31-Jan-21	28-Feb-21	31-Mar-21	30-Apr-21	31-May-21	30-Jun-21	31-Jul-21	31-Aug-21	30-Sep-21	31-Oct-21
			From	01-Nov-18	01-Dec-18	01-Jan-19	01-Feb-19	01-Mar-19	01-Apr-19	01-May-19	01-Jun-19	01-Jul-19	01-Aug-19	01-Sep-19	01-Oct-19	01-Nov-19	01-Dec-19	01-Jan-20	01-Feb-20	01-Mar-20	01-Apr-20	01-May-20	01-Jun-20	01-Jul-20	01-Aug-20	01-Sep-20	01-Oct-20	01-Nov-20	01-Dec-20	01-Jan-21	01-Feb-21	01-Mar-21	01-Apr-21	01-May-21	01-Jun-21	01-Jul-21	01-Aug-21	01-Sep-21	01-Oct-21
Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration																																				
Development of investment programs, projects and activities for vulnerability reduction of essential facilities, with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy	D17	1. Investment Report for the activities to be carried out in phase wise for short, medium and long term objectives identified.	2 Months																															1					
	D18	2. Investment Plan and objective report for buy-in process																																	1				
Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	D19	1. Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	2 Months																																	1	2			
Full documentation and preparation of reports and deliverables.	MD8	1. Final Consultancy Report addressing full documentation	1 Month																																				1
	NOTE:	This Workplan will be updated Quarterly and Based on the Data gathered will be adjusted																																					
	ID	Interim Reports/Deliverable-Will be submitted to PIU, if asked																																					
	D	Deliverable- Will be submitted to PIU for verification and information purposes																																					
	MD	Main Deliverable- Will be submitted to PIU for Approval and Payment																																					

The consultant will provide updated work plan quarterly but execution of any major changes in the original work plan needs prior approval of the client. Reflection in the staffing schedule due to any change in the work plan is the Consultant's obligation. The consultant will provide schematic explanation in a work plan updated with a linkage of work forces.

Project Director

JV of NKY-Protek Yapi-Sheltech

Figure: A-1-5

Annex A-2: REVISED WORKPLAN

"Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU) Package No.: URP/RAJUK/S-04, IDA Credit: 55990 Form TECH-5; Timeline			Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30
			To	30-Jan-19	02-Mar-19	02-Apr-19	30-Apr-19	31-May-19	30-Jun-19	31-Jul-19	30-Aug-19	30-Sep-19	31-Oct-19	30-Nov-19	31-Dec-19	30-Jan-20	01-Mar-20	01-Apr-20	30-Apr-20	31-May-20	30-Jun-20	31-Jul-20	30-Aug-20	30-Sep-20	31-Oct-20	30-Nov-20	31-Dec-20	30-Jan-21	02-Mar-21	02-Apr-21	30-Apr-21	31-May-21	30-Jun-21
			From	01-Jan-19	31-Jan-19	03-Mar-19	03-Apr-19	01-May-19	01-Jun-19	01-Jul-19	01-Aug-19	31-Aug-19	01-Oct-19	01-Nov-19	01-Dec-19	01-Jan-20	31-Jan-20	02-Mar-20	02-Apr-20	01-May-20	01-Jun-20	01-Jul-20	01-Aug-20	31-Aug-20	01-Oct-20	01-Nov-20	01-Dec-20	01-Jan-21	31-Jan-21	03-Mar-21	03-Apr-21	01-May-21	01-Jun-21
Stage 1: Preparation and Data Collection (Approximate duration 4 months)																																	
Tasks and Accomplishments		**List of Reports/ Documents to be submitted or approved**	**Duration**																														
Evaluation of the experts and support to RAJUK on designing the Project Working Group (PWG) and a Project Oversight Committee (POC)	ID-1	The ToRs and evaluation criteria	1 Month	1																													
	ID-2	Evaluation of the experts and result based matrix		1																													
	ID-3	Preparation of the Organogram		1																													
	D1	**Final Inception report**		1																													
Data Collection and Documentation	ID-4	Situation Analysis Interim Report	2 Months	1	2																												
	ID-5	Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)		1	2																												
	ID-6	Provide up to date list of the all the critical infrastructure and facilities.		1	2																												
	ID-7	Urban Profile and Characteristics Report		1	2																												
	ID-8	Analysis of Outcomes		1	2																												
	D2	**Needs Assessment Report**		1	2																												
	D3	**Complete database for all critical infrastructure, superstructures described in the scope of the services**		1	2																												
	MD1	**Comprehensive situation analysis report including Recommendations and way forward solutions**		1	2																												

Figure: A-2-1

Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka

Stage 2: Survey for structural vulnerability assessment (Approximate Duration 24 months)

Tasks and Accomplishments		List of Reports/ Documents to be submitted or approved	Duration
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	ID-9	1. Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide.	1 Months
	ID-10	2. Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities	
	D4	**3. Develop a state-of art methodology that meets the comprehensive objectives of the project and forms a decision tool for the government in assisting their investment choices. Detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets will be conducted and reported**	1 Months
	D5	**4. Development of a specific Prioritization Methodology for Seismically Vulnerable Public Buildings**	
	D6	**5. Preparation of unified and integrated analysis methodology**	
Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies	ID-11	1. Report on Proceedings of the workshops	1 Months
	ID-12	2. Report on outcomes of the findings	
	D7	**3. Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.**	
Physical survey and risk and vulnerability assessment of the facilities identified in scope of work	D8	**1- Prepare and submit a comprehensive report on the outcomes of the Rapid visual assessment**	4 Months
	MD2	**2- Prepare and submit individual reports for structures assessed (minimum 2,000,000 Sqm) of Rapid Visual Assessment (RVA)**	
	MD3	**3- Prepare and submit individual reports for remaning structures assessed and Prepare the synthesis report addressing all the structures along with the prioritization list.**	
	MD4	**1- Prepare and submit individual assessment reports for each structure assessed (upto 500,000 sqm) of Preliminary Engineering Analysis (PEA)**	11 Months
	MD5	**2- Prepare and submit individual assessment reports for remaining structures assessed, Prepare and submit a comprehensive report on the outcomes of the Preliminary assessment**	
	D9	**1. Prepare and Submit General Material Test Report adressing all structures**	8 Months
	MD6	**1- Prepare and submit individual final reports for each structure analyzed upto 250,000 sqm of Detail Engineering Assessment (DEA)**	
	MD7	**2- Prepare and submit individual final reports for remaining structures analyzed and Prepare the synthesis report addressing all the structures along with the prioritization list.**	9 Months
	D10	**3. Prepare and Submit Tender Documents (in accordance with the World Bank guidelines and standard bidding documents)**	
Finalization of outputs and cross-referencing of final results and Validation of assessment results by PWG and POC	ID-13	1. Report on Proceedings of the workshops	1 Month
	ID-14	2. Report on outcomes of the findings	
	D11	**3. Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.**	
Creation of a historical calibration and validation database	ID-15	1. Updated GIS based database for all the activities carried out.	3 month
	ID-16	2- Risk Communication Methodology and Report	
	ID-17	3-Independent Peer Review Report	
	IR-18	4- Update of Dhaka City Risk Profile and Atlas (including seismic catalogue)-Linked to outcome of S5 package	
	D12	**5-Full documentation and preparation of reports and deliverables**	

Figure: A-2-2

Stage 3: Design of long term vulnerability reduction investment plan and related Dhaka Urban Resilience Strategy (duration 8 months)				
Tasks and Accomplishments		**List of Reports/ Documents to be submitted or approved**	**Duration**	
Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets	ID-19	1. Report of Prioritization and mitigation strategies	1 month	1
	ID-20	2. Report for Proceedings and outcomes of the consultations		1
Development of options for risk reduction and for achieving long term urban resilience in Dhaka	ID-21	1. Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives	1 Month	1
Development of an draft Dhaka Urban Resilience Strategy with a vision statement, specific objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators	D13	1. Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives	1 Months	1
Development of investment programs, projects and activities for vulnerability reduction of essential facilities, with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy	D14	1. Investment Report for the activities to be carried out in phase wise for short, medium and long term objectives identified.	2 Month	1
	D15	2. Investment Plan and objective report for buy-in process		1
Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries	D16	1. Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	2 Months	1 2
Full documentation and preparation of reports and deliverables.	MD8	1. Final Consultancy Report addressing full documentation	1 Month	1
	NOTE:	This Workplan will be updated Quarterly and Based on the Data gathered will be adjusted		
	ID	Interim Reports/Deliverable- Will not be submitted to PIU		
	D	Deliverable- Will be submitted to PIU for verification and information purposes		
	MD	Main Deliverable- Will be submitted to PIU for Approval and Payment		

Figure: A-2-3

List of Reports/ Documents to be submitted or approved (Stage-1)	#
The ToRs and evaluation criteria	D1
Evaluation of the experts and result based matrix	D2
Preparation of the Organogram	D3
Final report of the evaluation	D4
Situation Analysis Report	D5
Data Collection Report for all the items stated in ToR (including mapping of all the relevant data sets)	D6
Provide up to date list of the all the critical infrastructure and facilities.	D7
Urban Profile and Characteristics Report	D8
Analysis of Outcomes	D9
Needs Assessment Report	D10
Complete database for all critical infrastructure, superstructures described in the scope of the services	D11
Recommendations and way forward solutions	D12

List of Reports/ Documents to be submitted or approved (Stage-2)	#
Prepare "Preliminary Assessment Report" setting forth the results of the methodologies used worldwide.	D13
Report of analysis on the data sets and activities carried out in last five years related to seismic and disaster risk reduction activities	D14
Develop a state-of art methodology that meets the comprehensive objectives of the project and forms a decision tool for the government in assisting their investment choices. Detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets will be conducted and reported	D15
Development of a specific Prioritization Methodology for Seismically Vulnerable Public Buildings	D16
Preparation of unified and integrated analysis methodology	D17
Report on Proceedings of the workshops	D18
Report on outcomes of the findings	D19
Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.	D20
Prepare and submit a comprehensive report on the outcomes of the Rapid visual assessment	D21
Prepare and submit individual reports for each structure assessed	D22
Prepare the synthesis report addressing all the structures along with the prioritization list.	D23
Prepare and submit a comprehensive report on the outcomes of the Preliminary assessment	D24
Prepare and submit individual assessment reports for each structure assessed	D25
Prepare and submit individual final reports for each structure analyzed	D26
Prepare the synthesis report addressing all the structures along with the prioritization list.	D27
Material Test Report	D28
Assessment Report	D29
Preliminary Design Report	D30
Final Design Report and Drawings	D31
Tender Documents (in accordance with the World Bank guidelines and standard bidding documents)	D32
Report on Proceedings of the workshops	D33
Report on outcomes of the findings	D34
Analysis of the outcomes and framework plan report stating the overall findings and way forward recommendations.	D35
GIS based database for all the activities carried out.	D36
Risk Communication Methodology and Report	D37
Independent Peer Review Report	D38
Update of Dhaka City Risk Profile and Atlas (including seismic catalogue	D39
Full documentation and preparation of reports and deliverables	D40

List of Reports/ Documents to be submitted or approved (Stage-3)	#
Report of Prioritization and mitigation strategies	D41
Report for Proceedings and outcomes of the consultations	D42
Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives	D43
Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives	D44
Investment Report for the activities to be carried out in phase wise for short, medium and long term objectives identified.	D45
Investment Plan and objective report for buy-in process	D46
Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC,	D47
Final Consultancy Report addressing full documentation	D48

Figure: A-2-4

Annexure-B: Validation Meeting

On WEDNESDAY, 27 FEBRUARY 2019, a validation meeting was held. The purpose of this meeting was to present inception report and methodologies for RVA and PEA to be endorsed by POC, PWG and related stakeholders. The workshop was successfully implemented with the participation of more than 60 participants from relevant directories and stakeholders. In following table, the list of the participants is presented.

The meeting minutes is provided herein.

ARCHITECTS & ENGINEERS

MEETING AGENDA

INCEPTION REPORT AND METHODOLOGIES VALIDATION MEETING

February 27, 2019

SPECTRA CONVENTION CENTER LIMITED

The purpose of this meeting is to present inception report and methodologies for RVA and PEA of S-04 component to be endorsed by POC, PWG and related stakeholders. At the end of each session there will be Q/A and comments section.

WEDNESDAY, 27 FEBRUARY 2019

2:00 – 2:35 Session 1: Presentation of Inception Report

- Dr. Md. Monjur Hossain — Inception Report; Q/A and Comments

2:35 - 3:25 Session 2: Presentation of RVA Methodologies

- Mr. Navab Merikhi — Detail RVA Methodologies; Q/A and Comments

3:25 - 4:20 Session 3: Presentation of PEA Methodologies

- Mr. Ahmet Alper Parker — Detail PEA Methodologies; Q/A and Comments

Project Name	Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka (S-04)		
Related Department	**Bangladesh**		
Meeting Subject &Number	**Inception Report and RVA-PEA Methodologies Validation Meeting**		
Location	Spectra Convention Center Limited	Date: 27.2.2019	Time: 2:30 – 4:30
Chairperson / Moderator	Dr. Mehedi Ahmed Ansary, Professor, BUET.		

ATTENDEES

Sr.	Name	Organization	Role / Affiliation
1	B. M. Nural Absar	RAJUK	(S-05) Assistant Engineer (Civil & Geotechnical) - FOCAL POINT
2	Mehmet Emin Akdogan	World Bank	
3	Sadettin Sezer	NKY-PROTEK-SHELTECH	Acting Team Leader S-05
4	Ms. Sarasadat Khosnevis	NKY-PROTEK-SHELTECH	Managing Director
5	Serkan Postaci	NKY-PROTEK-SHELTECH	Senior Engineer (Project Control)
6	Mehmet Yildiz	NKY-PROTEK-SHELTECH	Logistics Manager
7	Dr. Mehedi Ahmed Ansary	BUET	Professor
8	Dr. Raquib Ahsan	BUET-JIDPUS	Director
9	Md. Mahaboob Hassan	RAJUK	Procurement Specialist, URP Project
10	Ahmadul Hassan	SDE	Managing Director
11	Khandakar Md. Wahid Sadique	RAJUK: URP	Executive Engineer
12	Md. Taimur Tanvir	RAJUK	Assistant Engineer, (Civil & Geotechnical – S4) - FOCAL POINT
13	Shahadat Hossain		
14	Md. Khayrul Hasan	RAJUK	Project Coordinator
15	Md. Abdus Samad Azad	SAE (Civil)	
16	Bilash Kumar Ghosh	RAJUK	Assistant Engineer (Civil & Structural)
17	Md. Shahajahan		Sr. Financial Management Specialist

Sr.	Name	Organization	Role / Affiliation
18	Tapan Kumar	RAJUK:URP	Assistant Engineer
19	Abdul Khair	RAJUK:URP	Assistant Engineer
20	Alberto Herrera	International Code Council, USA	
21	Dr. Rahat Sikdar	Human and Institutional Cap. Dev. Euqat	
22	Md. Razib Hasan	RAJUK	Sub- Assistant Engineer
23	Rakibuzzaman Sumon	RAJUK: URP	Sub- Assistant Engineer
24	Ahmet Alper Parker	NKY-PROTEK-SHELTECH	Coordinator S-04
25	Syed Shakib Al Muiez	NKY-PROTEK-SHELTECH	Jr. Engineer
26	Serkan Postaci	NKY-PROTEK-SHELTECH	Sr. Engineer
27	Md. Raznur Rahman	Emkay	Engineer
28	Ifteunar Alam	Emkay	Structural Engineer
29	Md. Sadik Hasan	Emkay	Structural Engineer
30	Md. Babul	Emkay	Structural Engineer
31	Md. Saiful Rahman Joarder	RAJUK: URP	Procurement Specialist
32	Genn Whaley		
33	Md. Emdadul Islam	RIT	Technical Advisor
34	Md. Maruf Hasan	RAJUK: URP	Assistant Engineer
35	Dewan Mohaddes Al Maher	RAJUK: URP	Assistant Engineer
36	Hamidul Ahasan	SDE	Structural Engineer.
37	Nidalia Islam	RAJUK: URP	Asst. Urban Architect
38	Md. Maminul Islam	RAJUK: URP	Sub. Assistant Engineer
39	Andrew Netopsky		Structural Engineer
40	Engineerr. Uttam Deb	JV of BAUM-SEC-PEL	
41	Rechard Costos Worden	M&E/PCMU	Team Leader
42	Dr. Aminul Islam	Practice leader outreach	
43	Marshed Denar Alan Manana	RAJUK: URP (M&E)	Infrastructure Dev. Specialist
44	Mohammad Hasan	RAJUK: URP	Accountant
45	Md. Nasif Hossain Imon	RAJUK: URP	Assistant Engineer
46	Shadia Masud	RAJUK: URP	Assistant Engineer
47	Anwarul Kader	RAJUK: URP	Assistant Engineer
48	Abdur Rahman Khan	RAJUK: URP	Asst. Research Engineer
49	Pretom Sikder Joy	RAJUK: URP	Assistant Engineer
50	Deen Mohammed Helaly	RAJUK: URP	Asst. Research Engineer
51	Saleh Ahmmed Helaly	RAJUK: URP	Tactical officer
52	Dr. Akter Hussain Chaudhury		
53	Khandaker Mehedi Hasan	SDE	Structural Engineer
54	Ms. Musfera Jahan	NKY-PROTEK-SHELTECH	Urban Planner

Sr.	Name	Organization	Role / Affiliation
55	Ms. Ismat Jahan Sharna	NKY-PROTEK-SHELTECH	Office Executive
56	Seyed Siavash Khosnevis	Protek-yapi	
57	Md. Musfiqur Rahman Bhuiya	RAJUK:URP	GIS Specialist
58	Dewan Rakibul Khan	World Bank	DRM consultant
59	Shamaun Al Noor	NKY-PROTEK-SHELTECH	GIS modeling Expert
60	Md. Shahid Alam		
61	Dr. Md. Monjur Hossain	SDE	
62	Navab Merikhi	Protek-yapi	
63	Abbas FathiAzar	JV –S05	Chief Technical Officer

Meeting Records

Project Name	Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka (S-04)				
Related Department	RAJUK, Bangladesh				
Meeting Subject & Number	Inception Report and RVA-PEA Methodologies Validation Meeting				
Location	Spectra Convention Center Limited	Date	27.2.2019	Time	2:00 – 4:30
Chairperson / Moderator					

ATTENDEES

ATTACHED DOCUMENTS

1	Agenda
2	Attendance sheet
3	Photos

AGENDA

	Subjects	Presenter	Duration (mins)
1	Presentation of Inception Report	Dr. Md. Monjur Hossain	35
2	Presentation of RVA Methodologies	Mr. Navab Merikhi	50
3	Presentation of PEA Methodologies	Mr. Ahmet Alper Parker	55

No	Discussion
1	Presentation on Inception Report by Dr. Md. Monjur Hossain 

No	Discussion	
2	Presentation of RVA Methodologies by Mr. Navab Merikhi	
3	Presentation of PEA Methodologies by Mr. Ahmet Alper Parker	
4	**Dr. Mehedi Ahmed Ansary, Professor & Founder Director, BUET-JIDPUS asked** • In your presentation you talked about RVA and PEA. Why DEA was not included in presentation? • In PEA you talked about some non-linear analysis in level-3. Then what analysis has to be done in DEA? • He shared that in Bangladesh RVA is conducted first. Then most of the cases, it is gone directly for DEA. Then it is conducted all sorts of destructive tests like core test, soil investigation, foundation exploration to check footing size, check as-built drawings etc. Most of the cases it is followed linear static, sometimes linear dynamic if the building is irregular in shape. **Replied by JV consultant** • DEA is the next stage of assessment. Here we presented only RVA and PEA for validation. But, DEA is included in the consultancy. • Actually, the main difference between PEA and DEA is that we do non-destructive test in PEA and destructive test for DEA. Some structures in PEA may require non-linear analysis and in DEA	

No	Discussion
	most of the structures will require non-linear analysis. • Sometimes for structures we require performance-based design codes like ASCE etc. We have to perform non-linear analysis which uses more knowledge factors. Knowledge factors require more exact building data.
5	**Dr. Raquib Ahsan, Director, BUET-JIDPUS suggested** • Before going for RVA for seismic assessment, some condition assessments are very essential for the structures. In ACI there is a provision of condition assessment from the view of corrosion and other distress of the structures. Then in addition to seismic vulnerability check, some non-seismic vulnerability assessment (for basic gravity load etc.) is needed. • For RVA, in FEMA there is a code compliance factor in modifiers (Ductile detail). How will you consider them for RVA? Some buildings constructed even after 2006 may not comply with the building codes (BNBC 2006). How will you check for ductility then? **Replied by JV consultant** • Since there is no correlation between year of construction of ductile detailing of buildings in Bangladesh, for RVAs, all the buildings should initially be considered as non-ductile buildings. **Dr. Raquib Ahsan suggested and asked** • You have to reduce the score and then check it in PEA. • For PEA in ASCE 41 tier-2, you don't go for non-linear static analysis like pushover analysis. You do linear dynamic analysis only. So it seems your PEA is likely to be as per ASCE 41 tier-2. It seems your PEA is likely to be as per ASCE 41 tier-2. **Replied by JV consultant** • According FEMA-356, we have a criteria whether we should go for non-linear static analysis or not. May be at PEA stage, we will

No	Discussion
	not include non-linear static analysis. In DEA only. **Dr. Raquib Ahsan's suggestion** • Non-Destructive Tests (NDT) like Penetration test and Schmidt hammer test only give surface information. To correlate actual strength it becomes misguiding. Some pullout tests like CAPO test and LOK test may be used which are very popular and reliable concrete test in Europe and other Scandinavian countries. • Regarding assessment of irregularities like torsional irregularity, sometimes stair cores may be eccentrically located in the building which may be considered a torsional irregularity. But in reality they may not be concrete cores. They are may be columns with infill walls which do not give much stiffness. Visually it might create confusion during RVA. • For soft story, in some buildings in upper floors infill walls are not from column to column because of glass, windows and doors. They don't give much stiffness. But they should not be considered soft stories. • Would you follow FEMA guidelines for masonry buildings? **Replied by JV consultant** • Well noted and agreed. • Well noted and agreed. • Well noted and agreed. • We have more than 36 typologies for masonry buildings. We got help from FEMA 356 Chapter-7. Also, we used several other codes. **Dr. Raquib Ahsan asked** • Is there any RVA methodology for fire hazards? **Replied by JV consultant** • Well noted. Currently there is no methodology for fire hazards. But we are working on it. **Dr. Raquib Ahsan suggested and asked** • For Concrete industrial buildings, we have extensive inspections for fire safety conducted in Bangladesh. You can get some information from it.

No	Discussion
	• For defining hazard level in PEA, you will need soil data. You conducted extensive study of soil in S-5. So are you going to incorporate these findings from S-5 to S-4 component? Do you have to modify your findings? • You said you are going to do some retrofitting designs and also cost estimation. For a single building there may be several retrofitting design options. It will be very much time consuming compared to the huge number of buildings. How will you address it? • A training may be included in urban regeneration. **Replied by JV consultant** • Well noted. • In our application, we have some questions regarding soil type for hazard. We have also several layers of correlation for hazard where inputs from S-5 will be required. • We have to sketch preliminary as well as detail retrofitting design. Along with preliminary design, we also prepare cost estimation and then select for detail retrofitting design. • Well noted. Further discussion will be continued with Dr. Raquib on clear understanding this topic.
6	**Dr. Mehedi Ahmed Ansary, Professor & Founder Director, BUET-JIDPUS suggested** • You may consult with other components you are working with such as Sheltech and SDE regarding retrofitting design since they have good knowledge in this field. • For some buildings, core test which is very popular here as well as CAPO test (if possible) may be conducted. • For RVA, scanning machine is very essential. **Replied by JV Consultancy** • All these three comments are well noted.

No	Discussion	
7	**Mr. Mehmet Emin Akdogan from World Bank said,** • You have not submitted methodology for DEA. • At what stage are we in this project? **Replied by Mr. Ahmet Alper Parker, Coordinator S-04,** • We have already recruited approx. 56 Engineers comprising of 26 teams for RVA. According to ToR, we shall submit our report on RVA by March, 2019. Then we shall go for post processing.	
	Dr. Mehedi Ahmed Ansary asked • You need some soil data for RVA to classify soil type. You might get it from S-5 but S-4 and S-5 won't go simultaneously. So how will you address it? **Replied by JV Consultant** • In RVA application, we have different categories to classify soil types. If there is no soil data, then we consider SD type of soil according to BNBC 2017.	
8	**Md. Maminul Islam, Sub. Assistant Engineer (RAJUK-URP) asked** • Is the software you are planning to use for RVA made by tripartite or have you made it on your own? **Ms. Sarasadat Khosnevis, Managing Director, PROTEK YAPI replied** • The application has been made according to ASCE and FEMA which will be installed in the tablets. The assessors will use these tabs in RVA field visit and give inputs assessing the critical facilities from the building list. • The typology in Bangladesh is very different from other countries they worked. So they need to modify their methodology.	

No	Discussion
9	**Md. Mahaboob Hassan, Procurement Specialist, URP Project, RAJUK discussed about overall presentation and gave following observation,** • All the contractual matters need to be addressed separately for approval. Changing any contractual matters in the inception report will not relief the consultant to fulfil their obligations ie proposal of key staff changes , modifying or omitting the deliverables or tasks . • How RAJUK will be benefited from the project i.e. how RAJUK use the outcome of this consultancy to other consultancies of URP-RAJUK? • Since in the contract, it is agreed to provide updated work plan quarterly. It implies, work plan will be changing in the passage of time. On that point of view, it is advised to keep the work plan in the annexure, not in main chapter. • Main functions of POC would be the guidance to the consultant in light with the contract to allow rapid acceptance of the tasks & deliverables, enables smooth co-ordination in technical sites, effective inspection & testing; • Formation of POC would be from PIU, administrative authority from RAJUK, Legal authority of contract management, other related stakeholders and experts from academia nominated by the Project Director. • PWG will be formed mainly from PIU and they will be the technical staffs of PIU. • In Chapter 4, regarding methodology DEA is missing. **He also gave following technical comments** • Vulnerability assessment of buildings that is one of the lifelines is well explained. But, vulnerability assessment of other lifelines are also very important. So, one assessment report based on the literature review or secondary information for other lifelines, such as gas line, pipeline, electricity line etc. need to be provided as one of the tasks. Indication regarding this issue needs to provide in the inception report. **Replied by JV Consultant** • All comments are well noted and taken into consideration to apply.

No	Discussion
10	**Engr. Abdul Latif Helaly, Project Director, RAJUK-Project Implementation Unit (PIU) gave an overview of the project and asked,** • When will the team leader of S-4 be available in Bangladesh? **Replied by Mr. Ahmet Alper Parker, Coordinator S-04,** • The team leader of S-4 will be available in Bangladesh within 2 weeks. **Engr. Abdul Latif Helaly said,** • We have developed a checklist for RVA. We are willing to share it when the team leader will join with us. We shall finalize the checklist with them. **Replied by JV Consultant** • Well noted.

Prepared By:	Approved By:
Syed Shakib Al Muiez Jr. Engineer (Structural)	

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Project Implementation Unit (PIU)
Urban Resilience Project: RAJUK Part
RAJUK Commercial Complex cum Car
Parking Building (8th & 9th Floor),
Gulshan-1, Dhaka-1212

Rajdhani Unnayan Kartripakkha (RAJUK)

Memo No: 25.39.0000.154.14.024(Part-2).16/165 Date: 27 March, 2019

To
The Team Leader,
Joint Venture of
i) **NKY Architectural and Engineering Co. (Turkey)**
Address: Asagi Ovecler Mah. Lizbon
Cad. No: 49 Ankara, Turkey
ii) **ProtekYapi Engineering Co. (Turkey) and**
iii) **Sheltech (Pvt.) Limited with**
Smart Development Engineering (SDE) Limited as Sub-consultant (Bangladesh)
(Attention: Mr. Tolga Sahin, Overseas Director, NKY)

Sub: **Urban Resilience Project: RAJUK Part [Credit No: 55990]**: 'No Objection' on the Inception Report of the "Consultancy Services for Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka" for Urban Resilience Unit (URU) under Package Number: URP/RAJUK/S-4.

Dear Mr. Yilmaz Yuva

With reference to the captioned subject, I am to express my gratitude as your JV has provided the Inception Report - one of the key deliverables in the consultancy. In a way to validate the report, i) we have already acknowledged you the couple of comments from the World Bank, BDO and ii) you have received comments from the stakeholders of the consultancy services in the presentation session with them. This is to be noted that the stakeholders are composed of Bank's representative, PCMU officials, Rajuk officials, technical staffs of the project, legal personnel from the contractual aspect, subject matter experts, representative from Institute of Engineers, Bangladesh (IEB), representative from Architects, Bangladesh (IAB), other consultant group of the project to obtain a synergistic effect with their targeted outputs and other personnel related with the consultancy.

Now, based on taking considerations of the technical and legal comments on the approach & methodology and scope of the contract as raised above, we are pleased enough to give "No Objection" on the submitted 'Inception Report' provided that any the contractual issue needs to address separately for approval. This is to be noted that proposing any contractual change in the inception report will not relief the consultant to fulfil their obligations. You are also requested to incorporate comments and suggestions as required in the final version of the 'Inception Report' and re-submit us for our record.

Thanking you.
Sincerely yours.

Attachment:

1. *Participants list of the Presentation Meeting;*
2. *Meeting Agenda;*
3. *Minutes of the Presentation Meeting;*

27/03/2019
Abdul Latif Helaly
Project Director
Urban Resilience Project: RAJUK Part

For kind information:
1. Liaison Officer, RAJUK (For kind information of Chairman, RAJUK)

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Ms. Swarna Kazi, Task Team Leader, URP: RAJUK, World Bank, BDO.

Annexure-C: Terms of Reference

For Vulnerability Assessment and Prioritized Investment Plan for critical assets
Sub-components B1a, B1b, B1c

1. Context

In recent years, Bangladesh has reformed its approach to cyclone and flood risk management and preparedness. Triggered by major loss of life and assets, notably during the cyclones of 1970 and 1991 that killed over 300,000 and 140,000 people respectively, the Government of Bangladesh (GOB), civil society, and international development partners have demonstrated that investment in the systems and structures of flood risk management and cyclone preparedness saves lives, reduces economic loss, and protects development gains. As such, Bangladesh is cited often in the rationale for investment in disaster risk management (DRM) activities globally.

The threat of an earthquake, however, is less visible but significant given that Bangladesh lies on the seismically active Indian plate. Inertia has slowed earthquake awareness because these events occur less regularly and are currently relatively absent from the living memory of the country's inhabitants and leaders. Studies by the Geological Survey of Bangladesh divide the country into three seismic zones, which show that earthquake risk is medium to high throughout the country and increases towards the north and east of the country. Although there is some uncertainty, research suggests that an earthquake of up to magnitude 7.5 is possible, and the nearest fault line runs just 60km from the nation's capital.

A National Plan on Disaster Management (2010-2015) includes an Earthquake Management Plan and a National Earthquake Contingency Plan, which have been developed under the Ministry of Food and Disaster Management. These plans identify response and risk reduction activities with corresponding lead and support agencies. However, the plans lack the comprehensive vision of a national earthquake strategy, and a convincing demonstration of benefits, implementation, and controls. Furthermore, the institutional structure for multi-stakeholder engagement to deal with a problem as complex as urban earthquake risk is also lacking and the existing plans do not engage agencies and organizations in a sustainable way.

2. Background

RAJUK's jurisdiction extends beyond the administrative boundaries of the Dhaka City corporations to adjoining city corporations and municipalities. Among its responsibilities, the Building Construction Rules (2008) provide authority to RAJUK to enforce the national building code in addition to the Construction Rules themselves. Under this broad mandate, RAJUK plays an important role in Oversight the development of Greater Dhaka and impacting the, its urban resilience outcome either positively or negatively. In particular, RAJUK has jurisdiction over legal development enforcement instruments such as zoning ordinances, development control provisions, and building codes and construction rules implementation.

Previous Hazards Vulnerability and Risk Assessment (HVRA) studies for Dhaka undertaken by the Comprehensive Disaster Management Programmer (CDMP) and by the Bangladesh Urban Earthquake Resilience Project (UERP) were limited to the geo-administrative boundary of Dhaka City (South and

North) and Sylhet Corporations. The understanding of hazards, vulnerability and risk of Greater Dhaka with technologies that enable spatial visualization and data sharing will empower RAJUK, and stakeholders with knowledge to create an environment for promoting higher standards and ethics for construction and development. These objectives are critical to sustainable economic growth and poverty reduction by making development plans risk-sensitive and supporting the construction of resilient infrastructure while reducing the vulnerability of at risk populations.

The Dhaka Structure Plan (2016-2035) had focused on finding new satellite areas (i.e. new towns city extensions) for urban expansion; however, the i) core areas with high density building structures (Old Dhaka) or ii) urbanizing areas (near Old Dhaka and periphery) are highly vulnerable (or highly at risk) to earthquake and flood hazards. The older and dense part of Dhaka has a large – but unknown – number of dilapidated buildings and frequently experience collapses. While the vulnerability of the built environment is recognized, a mapping and characterization of these vulnerabilities has not been done.

Currently, RAJUK and other relevant national institutions have not developed a comprehensive understanding of the vulnerability of critical and essential facilities such as hospitals, schools, emergency operation centers, public safety facilities, key public buildings, food distribution centers, including lifelines such as road network, water and sewage network, airports, bridges and infrastructural facilities etc. to natural hazards such as earthquakes. This is also true for the general public at large. The knowledge of risk to critical and essential facilities resides only in the hands of a few experts and is incomplete. Yet, these facilities are relied upon immediately after an event to render core services to the population, to house displaced populations and to enable a fast recovery. It is thus critical to identify, map and assess the vulnerability of these facilities in order to build urban resilience in Greater Dhaka.

3. Scope of Work

The objective of this engagement is to develop a consensus-driven analytical foundation required for longer-term investments to reduce risk in the built environment of Dhaka. It will concentrate on two main activities: i) assessment of the vulnerability and risk of the built environment (including city extensions) in greater Dhaka to earthquakes and floods, focusing on essential and critical facilities/infrastructure; and ii) development of a prioritized list of retrofitting and rehabilitation investments to strengthen critical facilities vulnerable.

The vulnerability assessment and the prioritization of assets to be strengthened will be based on a framework and methodology proposed by the consultant and agreed upon by an oversight committee comprising the relevant government stakeholders. The methodology shall be in line with the consideration of the existing studies conducted at national and international scale particularly the modules and methodologies carried out for Hazards Vulnerability and Risk Assessment (HVRA) studies for Dhaka undertaken by the Comprehensive Disaster Management programmer (CDMP) and by the Bangladesh Urban Earthquake Resilience Project (BUERP).

This engagement aims to identify at-risk public infrastructure, including critical and essential facilities such as schools, hospitals, police stations, religious buildings, fire stations, city halls and government buildings. This can be achieved by assessing their vulnerability to earthquakes, floods and other hazards and develop a city-wide vulnerability reduction program and setting out priorities and budget required for their risk reduction. The assessment will establish the patterns of vulnerability of the city, identify the hotspots, and serve as a basis for a long term vulnerability reduction in greater Dhaka.

Critical facilities include the following:
Schools = 2,149

Police Stations = 54
Hospitals = 487
Fire Stations = 8
Airport= 1

This engagement shall integrate several levels of surveys as defined in different stages, analytical studies and structural engineering techniques (i.e. rapid visual surveys, risk/hazard assessment and advanced engineering analysis, needs and situation analysis, condition assessment and building material testing) to collect critical data about the identified facilities in Greater Dhaka and establish their level of vulnerability and safety.[4] This data will be used to set up the strengthening and retrofitting recommendations.

The output of the vulnerability assessment should be used to develop a rehabilitation and recovery framework (Resiliency) and long term risk reduction investment program that combines various building vulnerability reduction strategies. This includes techniques and methodologies for such as retrofitting of critical structures, building abatement and replacement to reduce the number of unsafe, substandard and dangerous buildings and infrastructures strengthening to ensure that infrastructures are resilient to extreme environment stresses.

Several studies have been conducted by national and international stakeholders with regarding to vulnerability and risk of the lifelines in Dhaka City which the consultant shall collect this information and prepare a comprehensive analysis report upon as described in stage1.

Subject to successful completion of this assignment and availability of fund, the Consultant may be engaged in a downstream assignment which will focus on physical assessing of the vulnerability of other critical and essential facilities and lifelines such as road network including flyover, water and sewage network including overhead water reservoirs, airports, bridges, gas transmission network, electrical transmission network etc. The downstream engagement will include collecting all the past studies; investigating, analyzing, assessing and validating them; conducting actual field studies on representative quantities and providing a strategy and recommendation document for the above mentioned lifelines. lifelines. The lifelines shall cover activities described as following:

1- **The water transmission and distribution system** for Greater Dhaka, currently administered by DWASA, is one of the lifelines will be evaluated. Potential breaks in the piping system due to various levels of earthquake shaking, as well as, structural and functional failures of water treatment plants, reservoirs, and pumping stations will be assessed. Downtime for restoration of the water system for each ward is also to be estimated. The dependency of water and power distribution systems will be investigated to understand the potential impact of power failure on the water distribution system. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the water system should be determined. The assessment will be used to develop a program for reducing downtime and improving reliability of the water system.

Recommendations on Structural Measures for rehabilitation of Water and Sanitation Facilities should be identified taking into account the vulnerability and feasibility studies. This will be done by development of hazard and risk maps, failure mechanisms due to different type of the hazards, possible measures and methods for vulnerability reduction. Mitigation measures should be prioritized based on vulnerability,

4***Essential and Critical facilities*** are needed for emergency response such as hospitals, fire stations, emergency centers, police stations, certain public buildings that house functions needed by the public, data centers, food distribution centers, communication centers, and power plants.

importance, and assessed cost of mitigation measures and mitigation plan should have a balance between reducing life safety risk and maximizing post-disaster service levels.

2- **The gas transmission and distribution system,** currently administered by TITAS Gas, will be evaluated. Potential breaks in the piping system should be established according to severity of ground shaking and potential for soil failure such as liquefaction. Potential for fire ignitions will also be assessed. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the gas system should be determined. A recommendation program for reducing the vulnerability of the gas distribution system should be developed.

3- **The transportation and traffic system** focusing on the road network (including key large-scale bridges, flyovers, open-cut and embankment), telecommunication and power network, metro and railways should be evaluated. Dhaka International Airport Facilities are also included. Potential breaks in the main road network should be established according to severity of ground shaking and potential for soil failure such as liquefaction. Similar assessment should be done for flood hazard where flood susceptibility and it impact on the gas system should be determined. A recommendation program for reducing the vulnerability of the transportation network system will be developed.

The lifeline strategies shall include developing redundant distribution system and improve their reliability through system analysis. The focus is primarily to address them in areas highly susceptible to earthquake hazards and flood hazards. This will be done in coordination with DCCs and other organizations and Ministries owning properties, or operating within RAJUK jurisdiction, such as the Ministry of Education, the Ministry of Health, and the Ministry of Home Affairs among many others.

Consulting Firm should refer to *Dhaka Profile and Earthquake Risk Atlas, Bangladesh Earthquake Resilience Project, World Bank, February 2014* for a description of the following data related to Dhaka: 1) Administrative, Physical and Socio-Economic Profile; 2) Earthquake Hazards; 3) Earthquake Vulnerability (Physical and Social Vulnerability), 4) Risk Analysis and Earthquake Loss Data; and 5) Urban Disaster Risk Index. A relevant reference lists of past studies, data resources, and urban vulnerability context will also be provided during the consultancy works. In Annex- 3 the detailed area plan for Dhaka is provided showing the relevant information on the critical infrastructure will be assessed during the consultancy works.

4. Tasks, Outputs and Deliverables

The ultimate goal of this engagement is the design of US$1 billion of prioritized assets to be strengthened, including critical facilities, water systems, gas systems and the road network. The strengthening of these assets would be financed by future urban resilience investment program phases.

To arrive at this objective, the following tasks, outputs and deliverables are envisioned to be delivered, which are broken into three stages:

Stage 1: Preparation and Data Collection (Approximate duration 4 months)

- Organization of stakeholders to form a Project Working Group (PWG) and a Project Oversight Committee (POC)

- Exposure data collection including documents research and ground truthing to determine actual field conditions and collecting missing data (e.g., exact locations, building characteristics, etc.)
- Hazards data collection (flood and earthquake)
- Complete list and database of the all critical infrastructure, superstructures and lifelines described in the scope of the services
- Collection of satellite imagery and development of urban characteristics patterns
- Development of proxies for missing data
- **Digitization and characterization of exposure data and Preparation of GIS database**[5]
- Digitization and inclusion of water, transport and gas data
- Collection and review of past studies
- Utilization of existing GIS data files;
- Completion of exposure, hazard databases and GIS model
- Harmonization with existing plans and programs.
- Validation of exposure data with PWG, POC, and relevant data providers and agencies.
- Completion of all documentation and preparation of reports and deliverables
- Maps:
    1. Topographic map
    2. Census zone boundary map
    3. District and sub-district boundary map
    4. Traffic zone map
    5. Geological map
    6. Groundwater level

Stage 2: Survey for vulnerability and risk assessment (Approximate Duration 24 months)

- **Development of detailed methodology and framework of survey and assessment studies including the prioritization of the facilities, structures and vulnerable public assets**
    1. Review risk assessment and prioritization studies done by other countries or cities abroad which have similar earthquake risk, geographic or demographic conditions or any such countries or cities that might set an example for the purposes of this assignment.
    2. Provide type of data needed to apply any such prioritization methodologies and assess the availability of any such data
    3. Examine if the current hazard maps are sufficient in detail and in scale, if data on ground and building characteristics are readily available
    4. Review of all retrofitting activities and budget allocations in the last five years, including the sectoral and geographical breakdown.
    5. Prepare and submit a “Preliminary Assessment Report” setting forth the results of the assessments outlined above
    6. Based on the preliminary assessment and benefiting from national and international best examples or practices define the criteria to be used to prioritize the critical structures. Criteria set should represent the vulnerability of each structure in the scope of the consultant in case of a major earthquake and should include but not be limited to: geographic location of the area with respect to the active fault zones, potential risk of a major earthquake, population density and other demographic data, floods, vulnerability of the built-in environment, industrial and economic life, available data, staffing or technical capacity at the provincial level and any other relevant item.

5 The GIS databases for the built environment should be prepared in the format ready for upload into the GEODASH knowledge sharing platform.

7. Define the relative importance of each item in the criteria set and develop a methodology for the prioritization
8. Development of a Prioritization Methodology for Seismically Vulnerable Public Buildings
9. Adoption of clear, practical, state-of-the-art methods;
10. Preparation of unified and integrated analysis methodology;

- **Validation of methodology by PWG, POC and other relevant experts and scientists through workshops and consultation and by conducting pilot studies**
    1. Determination of hazard levels for deterministic and probabilistic analyses
    2. Analysis of ground conditions and seismicity;
    3. Seismic damage analysis and compilation of seismic hazard assessment maps; and
    4. Overall evaluation and preparation of recommendations
- **Physical survey and risk assessment of the facilities identified in scope of work and summarized as following:**
    1. Conduct Rapid Visual Assessment using internationally recognized methodologies tailored to the project case for the critical and essential facilities with approximately 5 million m^2 built-up area (Approximately 3000 structures)
        - Do the data collection from engineering and architectural perspective?
        - Asses the risk of structural and non-structural components
        - Identify the risk and vulnerability score of all the structures
        - Prioritize the most critical facilities among them up to a level of 20%
    2. Conduct Preliminary Assessment using internationally recognized methodologies tailored to the project case for the most critical facilities identified during the rapid visual assessment for approximately 1 million m^2 built up area (Approximately 600 structures)
        - Conduct architectural and structural surveying of the structures
        - Conduct non-destructive testing as required to verify the material characteristics and strength.
        - Conduct basic engineering modelling and analysis by means of qualitative and quantitative approaches for identification of the vulnerabilities associated with each structure
        - Provide basic retrofitting schemes aiming at overcoming the associated vulnerabilities
        - Conduct a preliminary cost estimates and CBA for feasibility of the structures to go for retrofitting, demolishing or safe.
        - Make a recommendation as to whether the structure shall be: (a) demolished and rebuilt; (b) retrofitted; or (c) left untouched.
        - Prioritize the most critical facilities among them up to a level of 50%
    3. Conduct detailed engineering assessment using internationally recognized methodologies tailored to the project case for the most critical facilities identified during the preliminary assessment with approximately 0.4 million m^2 built-up area (Approximately 200 structures)
        - Conduct physical survey of the structure for architectural, structural and MEP systems
        - Identify the geological information of the sites by means of geotechnical investigations
        - Assess each structure along with site specific conditions, existing hazard mappings and expert judgment.
        - Evaluate the earthquake and multi-hazard vulnerability of the structure in a qualitative and quantitative manner, through destructive and non-destructive testing methods, using structural classification and characteristics related to their earthquake response, past earthquake damages, settlements, geotechnical

conditions, existing cracks, existing structural interventions, modification and change of use, degree of maintenance, non-structural components and other observable structural and non-structural indicators

- Assess existing structures, and define the structural performance standard and guidelines to be followed in design,
- Undertake a seismic vulnerability assessment for each selected structure by the means of linear/non-linear analysis and verify the potential vulnerabilities associated with the structural configuration of each structure,
- Assess existing architectural, mechanical, electrical elements and take them into account during design stages,
- Prepare detailed designs and costs estimates for retrofitting/ rehabilitation of the vulnerable structures taking conventional and innovative retrofitting techniques,
- Submit cost comparison and cost benefit analysis for selected high priority and critical facilities considering a viable cost of retrofitting to the cost of replacement ratio
- Make a recommendation as to whether the structure shall be: (a) demolished and rebuilt; (b) retrofitted; or (c) left untouched.
- Prepare tender documents for the structures to be retrofitted.

– **Validation of assessment results by PWG and POC**
– **Finalization of outputs and cross-referencing of final results**
- **Creation of a historical calibration and validation database**
    1. Based on the geographic database, spatial characteristics of natural and social conditions of the Greater Dhaka area to be analyzed.
    2. Development of final accuracy, convergence and benchmark tests and exhibits
    3. Development of maps and exhibits for risk communication
    4. Independent peer review of the model and its outputs
    5. Completion and update of GIS database
    6. Update of Dhaka City Risk Profile
- **Full documentation and preparation of reports and deliverables**

Stage 3: Design of long term vulnerability reduction investment plan and related Dhaka Urban Resilience Strategy (Approximate duration 8 months)

- development of a prioritized list of retrofitting and rehabilitation investments to strengthen critical facilities, and infrastructure in the public building sectors
- Consultations with various agencies and relevant stakeholders on interpretation of risk outputs and indicators on exposure to risk
- Development of options for risk reduction and for achieving long term urban resilience in Dhaka
- Exploring the possibilities for provision of concepts for development/upgrading of the risk maps and emergency preparedness plans
- Providing information on technical skills and institutional solutions specific to disaster situations.
- Development of a draft Dhaka Urban Resilience Strategy with a vision statement, specific objectives and goals, elaboration of the outputs and outcomes, constraints and resources, risk factors, safeguards, and monitoring and evaluation indicators.
- Consultations and workshops to validate proposed Strategy and to finalize.
- Development of investment programs, projects and activities for vulnerability reduction of critical and essential facilities, with a proposed timeline, milestones, priorities, resources and indicative budget to reflect Urban Resilience Strategy
- Extensive validation of investment program with PWG, POC, and relevant agencies and ministries
- Ensuring “buy-in” and from policy makers on the investment program, including PCMU and PIU.

- Development of Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.
- Full documentation and preparation of reports and deliverables.

The stages are not fully sequential. They should overlap by approximately six (6) months making total project duration of 36 months.

Full Documentation

Consulting Firm should develop a comprehensive, secure web-based data and documentation system for the project where all relevant collected exposure data, validation databases, specifications, testing results, sensitivity analysis reports and other pertinent project documentation is organized, filed, and catalogued for access by potential users. A hierarchical data management system should be designed. Soft and hard copies of databases should be provided. Inception, progress and final reports should be provided for each of the three stages. Topical reports should be generated to explain methodology, provide detailed findings, and present analysis and results. Relevant input and output databases should be incorporated into GEODASH for knowledge sharing purposes among Government of Bangladesh institutions.

Participatory Process.

The Consulting Firm is expected to identify structure, engage and remain in communication with the stakeholders through the Project Working Group (PWG) and the Project Oversight Committee (POC). Regular communication should be established with the PWG with face-to-face meetings at least once a quarter. PWG should be used as a platform for data collection, data validation, assumption confirmation, feedback, conflict resolution and consensus development. PWG voice and input in the project should be substantive and meaningful. PWG is also the mechanism for sharing knowledge, building capacity and developing sustainability. PWG meetings can also be used as a platform for workshops and training.

Meetings with the POC should be at least quarterly, to report on progress, to seek guidance and decision. POC meetings are also an opportunity for mainstreaming.

PWG and POC meetings should be organized well in advanced considering government protocols, with stated objectives, complete agenda, and other relevant information. All documentation related to the meeting/workshop should be completed and send sufficiently ahead of the meeting. Meeting minutes should be distributed no later than a week after the meeting. Outputs of workshops should also be communicated within a reasonable time.

The Consulting Firm should demonstrate ability and experience in conducting projects in a participatory manner with a definite and well stated methodology and objectives for effective knowledge sharing, capacity building, sustainability and efficiency.

5. Implementation Arrangements

The Consulting Firm will work closely with RAJUK and associated government ministries to coordinate activities between relevant ministries and agencies. The Consulting Firm should submit an inception report no later than two months after receiving the authorization to proceed. The inception report should include explanation of the scope, general approach, team composition and organization, work plan, milestones, constraints and risk factors.

The Inception report should include a chapter on the Firm's technical approach to Participatory Project Undertaking, explaining the process for identification and organization of the relevant stakeholders, the

meeting and workshop schedules, consultations, and the strategy for sustainability and mainstreaming.

The inception report should cover a detailed schedule and task-flow diagram, Gantt and PERT-CPM Charts which depicts the interrelationship of various tasks in the assignment which lead to the completion works, milestone and mechanism of coordination with the client and other related entities. This would be kept and update throughout the Project duration.

A focal point will be identified at inception that would be the lead representative of Consulting Firm responsible for coordination and all interfaces with RAJUK. The Project Manager of Consulting Firm will be the principal contact and will be expected to be readily available during project implementation. The Consulting Firm shall be responsible for all aspects of performance of services as set forth in the preceding sections of this TOR.

The Consulting Firm is expected to have a strong local presence in Bangladesh to support all the project tasks and more particularly the challenges associated with the data collection, the relationship with the government and other stakeholders, the interpretation of the findings and results, the preparation of the presentations and reports, the organization of meetings, workshops and consultations, and the logistics and operations.

The consultant shall provide/obtain all the necessary equipment, tools and accessories required to carry out activities defined in this TOR.

Moreover, B1 and B2 components of the Urban Resiliency project are semi-integrated and the results of the studies may be used as input for each other. In that sense the practice leaders of both projects shall work in a close coordination.

6. Deliverables and Reporting Requirements:

The main deliverables out of this assignment are following:

- Conducting “preparation and data collection” as requested in stage 1 and submit “comprehensive situation analysis report” covering the deliverables addressed in reporting requirements item 1.1 to 1, 4.
- Conducting Rapid Visual Screening/ Assessment and submitting complete reports on the findings of all the buildings/facilities that have been assessed with prioritization ranking of each building in terms of vulnerability and risk.

- Conducting Preliminary Assessment for all the buildings/facilities identified during the RVS stage and submitting complete analysis reports on all the facilities tested in this stage including prioritization ranking of each building in terms of vulnerability and risk.

- Conducting Detailed Engineering Assessment (DEA) for the most critical and essential facilities identified during the Preliminary Assessment; cost benefit analysis in terms of retrofitting vs. demolishing of the structures; prepare detailed design and cost estimates for retrofitting; and submitting complete reports including drawing, design and cost estimates and tender documents for the building recommended for retrofitting.
- Conducting “Design of long term vulnerability reduction investment plan and related Dhaka Urban Resilience Strategy” as requested in stage 3 and submit “Long Term Investment and Strategy Guideline” covering the deliverables addressed in reporting requirements item 1.1 to 1,4. 3.1 to 3.6 stage 3

The consultant shall refer to Annexure-1 for the reporting requirements in details. Time to time variety of different reports need to be provided by the consultant after completion of all stages mentioned in Annexure-1. Apart from these reports following reports shall be provided by the consultant as well:

1. Inception Report
2. Interim Report
3. Draft Final Report
4. Final Report

7. Selection Procedure and Form of Contract

The firm will be selected following the World Bank's Guidelines: Selection and Use of Consultants by the World Bank for Operational Purposes and form of contract would be Complex Lump Sum Contract.

8. Duration of the Assignment

Duration of the contract would be 36 months from mobilization, at which time the prioritized investment program would be identified and agreed across government line ministries. The staging of the project has been provided earlier.

9. Staffing Requirements

Consulting Firm Qualifications:

The Consulting Firm is encouraged to use the expertise available in Bangladesh to the extent possible and is expected to have a staffed office in Dhaka for the duration of the project. However, international expertise and experience are necessary to carry out this assignment. The consulting firm is free to propose a staffing plan and skill mix necessary to meet the objectives and scope of the works. If all the required skills are not available within the consulting firms, they are encouraged to make joint ventures with other firms. The consulting firm should be able to demonstrate:

- Core expertise and competency in natural hazard and risk assessment and analysis (a minimum of 15 years) with completed similar urban risk assessment projects. Demonstrated competency in exposure data collection, remote sensing, GIS, vulnerability and seismic risk modelling tools;
- Proven ability to problem-solve and to establish a strategic and constructive environment for the promotion and adoption of sensible public policy for urban risk mitigation within complex government setting to build consensus and to ensure a 'win-win' outcome;
- Experience in participatory approach for project execution;
- Familiarity with Bangladesh governance system and with Bangladesh disaster risk management legal, regulatory and institutional setting and past experiences, major initiatives by government and major donors and development institutions;
- Proven global leadership and competency in the field.

Consultant's Personnel and Logistics:

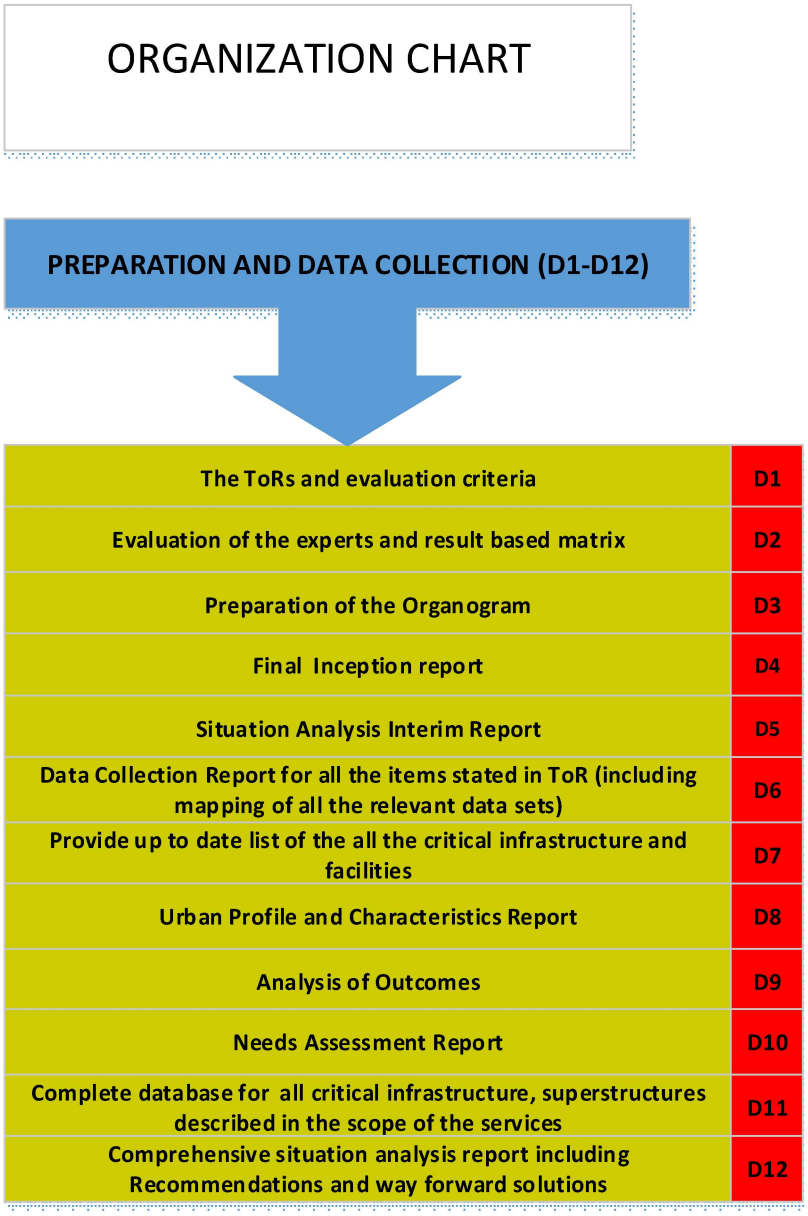
- The consultant shall provide sufficient and qualified personnel for the project. The tentative input of the personnel for the services provided above is 200 man-month for key staffs and 80 man-months for non-key staffs. A sufficient number of backup staffs shall be employed by the Consultant to ensure that the tasks are conducted and as required by the client. In addition, there will be sufficient support staffs in the office for all sorts of administrative and clerical supports, documentation, etc. An indicative staff inputs and TORs for key staffs are attached in Annexure-2.

- Furthermore, for the purpose of conducting assessments of critical facilities/structures at the three levels i.e., Rapid Visual Assessment, Preliminary Assessment, and Detailed Engineering Assessment (DEA), the Consultant shall deploy adequate number of field and office staffs (experts, technicians, support personnel etc.) in addition to the staffs mentioned in the list of indicative staffs in Annexure-2: Composition of Consultant Team (Indicative).
- The Consultant's facilities/logistics should include equipment for field and lab tests, adequate number of computers, laptops, software for modeling and static/dynamic analysis of critical structures etc.

10. Reporting and Management of the Assignment

The assignment has been commissioned by the Government of Bangladesh. The consultant will report to RAJUK PIU Project Director. The project will be monitored and evaluated based on a result-oriented approach.

Annexure-D : ORGANIZATION CHART



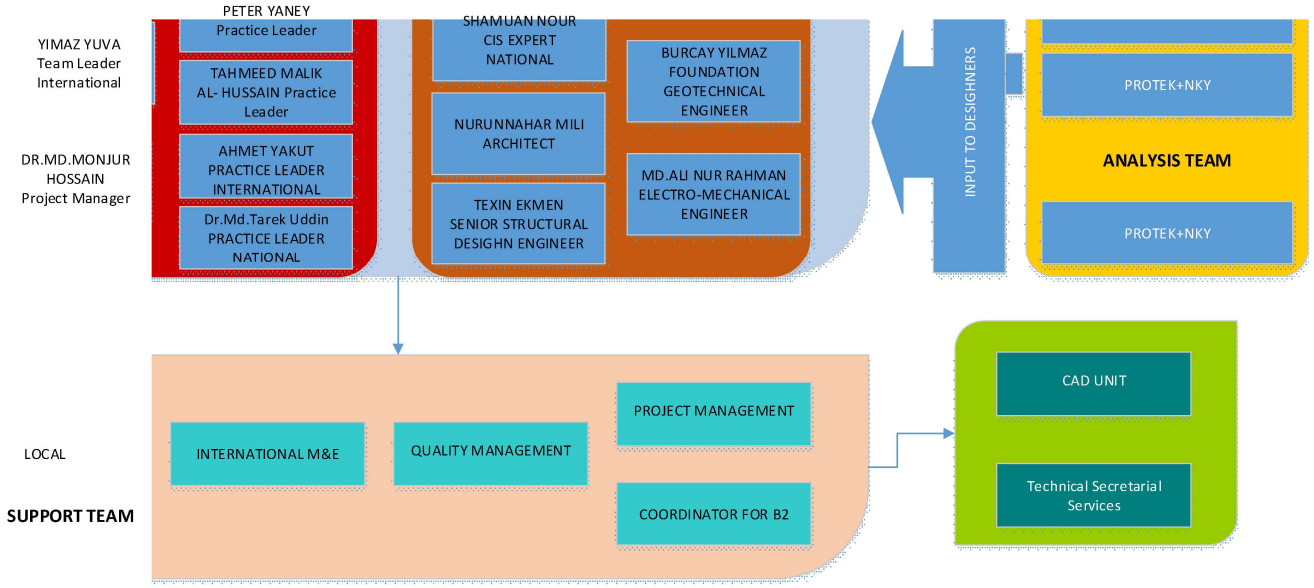
DESIGHN OF LONG TERM VULNERABILITY REDUCTION INVESTMENT PLAN AND RELATED DHAKA URBAN RESILIENCE STRATEGY (D41-D48)

Report of Prioritization and mitigation strategies	D41
Report for Proceedings and outcomes of the consultations	D42
Develop Report on Risk Reduction and Rehabilitation including contingency planning and framework of long term objectives	D43
Draft the Dhaka Urban Resilience Strategy with the vision statement, specific objectives	D44
Investment Report for the activities to be carried out in phase wise for short, medium and long term objectives identified.	D45
Investment Plan and objective report for buy-in process	D46
Report on Implementation Mechanisms, Monitoring and Evaluation Mechanisms and Mainstreaming Mechanisms and validation by PWG, POC, and relevant agencies and Ministries.	D47
Final Consultancy Report addressing full documentation	D48

Vulnerability Assessment and Prioritized Investment Plan for Critical Assets in Dhaka

URP/RAJUK/S-04

SURVEY FOR STRUCTURAL VULNERABILITY ASSESSMENT (D13-D40)



Annexure-E: FORMS

FORM 1: Building Information

Page-1

Identification Information:	
Structure ID :	Inspection Date/Time :
Name of the Structure :	Construction Year :
Address :	Seismicity/Zone:
Zip Code:	Latitude:
No. of floors :	Longitude:
structural system :	Code Year: Before 1996/1996-2006/ After 2006
No of people occupied :	Each Floor Area (m^2):
Entrance Allowed	Total Construction Area (m^2):
Owner's Name	Additions:
Holding No.	Multiple Parts:
Heritage Building	Alterations:
Court Case	
Total No. of Dwellers	General People
	Old People
	Female & Children
Width of the adjacent Road of Building	
In accordance with B.C. Rule 2008, accessibility of Fire Engine sufficient?	
RAJUK Land use Clearance available?	
RAJUK Approval Drawing available?	
Architectural Design available?	Name of Architect:
	IAB No:
Structural Design available?	Name of Engineer:
	IEB No:
Soil test Report available?	Company:
	Address:
RAJUK Occupancy Certificate available?	

Technical Information	
Structural Modification	
Fire Hydrant	
Stair/ Fire Escape	
Vertical load carrying System Logical or not?	
Lateral load carrying System Logical or not?	
Excessive floor loading or material storage overloading been found in any location	
Efflorescence , Dampness , Water Ponding	
Type of load Path?	a)Regular b) Irregular

The foundation of the building is satisfactory or not?	
Based on the preliminary inspection, the load bearing capacity of the columns for the building adequate or not?	

FORM 1: Building Information

Other Hazards	
Chemical and/or technological	
Explosions	
Fires	
Hazardous material spills	
Hydro-meteorological:	
Hurricanes	
Territorial rains	
River flooding	
Geologic Information	
Geologic Hazard	
Liquefaction	
Landslide	
Surface Fault Rupture	
Soil Type (Based on BNBC2015- table 6.2.13):	
Photography	
Sketch	
No. Stories	
Building Occupancy:	
Government Historic Others	
Service Type:	
Commercial/Assembly/Emergency Services/Industrial/Residential/Mixed Use/Educational Facilities/Utility/Office/Warehouse/Airport/Civil Aviation/Others	
Building Subtype:	
Retail business/Wholesale business/Financial institution/restaurant/bank/Parking structure/Others	
Total No. Of Units:	

FORM 2: Structural Information

structural system :	
1) Material Type	
a) Wood b) Steel c) Masonry d) Concrete e) Bamboo f) Dual system	
2) Seismic Force Resisting System.	
a) Frame b) Braced frame c) Bearing wall d) Dual system	
3) Building Type	
W1, S1 ,C1, PC1 ,RM1,W1A, S2 ,C2, PC2, RM2 ,W2 ,S3 ,C3 , URM , S4 , MH, S5 , Other	
Redundancy :	
4) Building has at least two bays of seismic force resisting elements on each side of the building in each direction.	a) No b) Yes c) N/A
Adjacency / Pounding :	
5) Ratio of the separation gap between adjacent buildings to the height of the shorter building (shorter of the adjacent building and the target building)?	
6) Floors separated vertically by more than two feet (65 cm) (floors not aligning vertically).	a) No b) Yes c) N/A
7) One building two or more stories taller than the adjacent building.	a) No b) Yes c) N/A
8) The building at the end of a row of three or more buildings.	a) No b) Yes c) N/A
Falling Hazards from Taller Adjacent Building :	
9) No. of Chimneys:	
10) No. of Parapets:	
11) No. of Walls:	
12) No. of Appendages:	
13) No. of Signs:	
14) No. of Tanks:	
15) Other falling hazards	

FORM 2: Structural Information

Plan Irregularities :	
16) Torsion: Lateral system does not appear relatively well distributed in plane in either or both directions.	a) No b) Yes c) N/A
17) Non-Parallel Systems: There are one or more major vertical elements of the lateral system that are not orthogonal to each other.	a) No b) Yes c) N/A
18) Reentrant Corners: Both projections from an interior corner exceed 25% of the overall plan dimension in that direction.	a) No b) Yes c) N/A
19) Diaphragm Opening: There is an opening in the diaphragm with a width over 50% of the total diaphragm width at that level.	a) No b) Yes c) N/A
20) For C1 and C2 buildings: Beams do not align with columns in plan	a) No b) Yes c) N/A
Structural Elements :	
21) Column section type:	
I-shaped / Double I-shaped / Box / Hollow Circuclar / Rectangular / Circular / Others	
22) Dim depth of the smallest column (m):	
23) Dim depth of the largest column (m):	
24) Dim width of the smallest column (m):	
25) Dim width of the largest column (m):	
26) Beam section type:	
I-shaped / Double I-shaped / Box / Hollow Circuclar / Rectangular / Circular / Others	
27) Dim depth of the smallest beam (m):	
28) Dim depth of the largest beam (m):	
29) Dim width of the smallest beam (m):	
30) Dim width of the largest beam (m):	
31) Bracing section type:	
32) Dim depth of the smallest bracing (m):	
33) Dim depth of the largest bracing (m):	
34) Dim width of the smallest Bracing (m):	
35) Dim width of the largest Bracing (m):	
36) Thickness of the smallest wall (m):	
37) Thickness of the largest wall (m):	
38) Deck type:	
a) Wood b) Concrete slab c) Composite d) bamboo e) pitched f) Truss g) Gable frame h) comment	
39) Deck thickness (m):	

FORM 2: Structural Information

Vertical Irregularities :

40) **Sloping site:** There is at least a full story grade change from one side of the building to the other.	a) No b) Yes c) N/A
41) **Weak and/or soft Story**: For W1 Buildings on the cripple walls: An unbraced cripple wall is visible in the crawl space.	a) No b) Yes c) N/A
42) **For W1 house over garage:** Underneath an occupied story, there is a garage opening without a steel moment frame, and there is less than 8' (250 cm.) of wall on the same line (for multiple occupied floors above, use 16' (500 cm) of wall minimum).	a) No b) Yes c) N/A
43) **For W1A buildings:** There are openings at the ground story (such as for parking) over at least 50% of the length of the building.	a) No b) Yes c) N/A
44) **For Non-W1 buildings:** Length of lateral resisting system at any story is between --- of that at story above or height of any story is between --- times the height of the story above.	a) between 50% and 75% - between 1.3 and 2.0 b) less than 50% - more than 2.0 c) N/A
45) **In-plane Setback:** There is an in-plane offset of the lateral elements that is greater than the length of the elements.	a) No b) Yes c) N/A
46) **Out-of-plane Setback:** Vertical elements of the lateral system at an upper story are outboard of those at the story below causing the diaphragm to cantilever at the offset.	a) No b) Yes c) N/A
47) **Short Column / Pier:** For C1, C2, C3, PC1, PC2, RM1, RM2 buildings: At least 20% of columns (or piers) along a column line in the lateral system have height/depth ratios less than 50% of the nominal height/depth ratio at that level.	a) No b) Yes c) N/A

FORM 2: Structural Information

Vertical Irregularities :	
48) **For C1, C2, C3, PC1, PC2, RM1, RM2 buildings**:	A. The column depth (or pier width) is less than one half of the depth of the spandrel a) No b) Yes c) N/A
	B. There are infill walls that shorten the column a) No b) Yes c) N/A
	C. There are adjacent floor that shorten the column a) No b) Yes c) N/A
49) **Split Level:** There is a split level at one of the floor levels or at the roof.	a) No b) Yes c) N/A
50) There is another observable vertical irregularity that obviously affects the buildings seismic performance (e.g. change of bracing system, removing bracings at higher stories, etc.)	a) Moderate b) Severe C) No Comment:
Other Structural Info :	
51) **For S2 buildings:** "K-bracing" geometry is visible.	a) No b) Yes c) N/A
52) **For C1 building:** Flat plate serves as the beam in the moment frame.	a) No b) Yes c) N/A
53) **For PC1/RM1 building:** There are roof-to-wall ties that are visible or known from drawings that do not rely on cross-grain bending.	a) No b) Yes c) N/A
54) **For PC1/RM1 building:** The building has closely spaced, full height interior walls (rather than an interior space with few walls such as in a warehouse).	a) No b) Yes c) N/A
55) **For URM buildings:** Gable walls are present.	a) No b) Yes c) N/A
56) **For MH buildings:** there is a supplement seismic bracing system provided between the carriage and the ground.	a) No b) Yes c) N/A
57) Comprehensive seismic retrofit is visible or known from drawings.	a) No b) Yes c) N/A

FORM 3: Masonry Building

Seismic force resisting system :	
1)Kind of structural system	a) Masonry wall
	b) Masonry wall and beam
	c) Masonry Column system
	d) Masonry Shear Wall
	e) Other
2) Any comments about kind of structural system?	
3) Thickness of the masonry walls (m)	
4) The critical ratio of Length to width	
5) The dimensions of walls (such as thickness, height and average length) at typical spans	Thickness: ----
	Height: -----
	Length:-----
6) Kind of Diaphragm	a) reinforced concrete joist
	b) steel joist
	c) wooden joist
	d) concrete slab
	e) wooden slab
7) Any comments on the kind of diaphragm?	
8) Condition of connection between wall to slab joist and wall to wall?	a) weak
	b) moderate
	c) good
9) Opening-to-total area ratio of the diaphragm at each story	a) low
	b) moderate
	c) high
10) For wood & clay roofs: Are there any horizontal bracing elements between the joists?	a) No b) Yes c) N/A
11) The average distance of vertical tie spans (in centimeters)	
Material :	
12) kind of mortar material	
a) cement mortar b) lime mortar c) mud mortar d) other	
13) kind of units material	
a) clay brick b) stone brick c) concrete block d) other	
14) kind of foundation material	
a) Brick b) Concrete c) Stone d) Lime e) Wood f) other	
15) Quality of material	
a) weak b) moderate c) good	
16) Any other comments about Masonry structure?	

FORM 4: Additional Information

Page-1

Life Safety System :	
1) Fire Suppression Piping: Fire suppression piping is anchored and braced.	a) No b) Yes c) N/A
2) Flexible Couplings: Fire suppression piping has flexible coupling.	a) No b) Yes c) N/A
3) Emergency Power: Equipment used to power or control Life Safety systems is anchored or braced.	a) No b) Yes c) N/A
4) Stair and Smoke Dust: Stair pressurization and smoke control ducts are braced and have flexible connections at seismic joints.	a) No b) Yes c) N/A
5) Sprinkler Ceiling clearance: Penetrations through panelized ceilings for fire suppression devices provide clearances.	a) No b) Yes c) N/A
6) Emergency Lighting equipment is anchored or braced.	a) No b) Yes c) N/A
Hazardous Material :	
7) Hazardous Material Equipment: Equipment mounted on vibration isolators and containing hazardous material is equipped with restraints or snubbers.	a) No b) Yes c) N/A
8) Hazardous Material Storage: Breakable containers that hold hazardous material, including gas cylinders, are restrained by latched doors, shelf lips, wires, or other methods.	a) No b) Yes c) N/A
9) Hazardous Material Distribution: piping or ductwork conveying hazardous materials is braced or otherwise protected from damage that would allow hazardous material release.	a) No b) Yes c) N/A
10) Flexible Couplings: Hazardous material ductwork and piping, including natural gas piping, have flexible couplings.	a) No b) Yes c) N/A
11) Piping or Ducts Crossing Seismic Joints: Piping or ductworks carrying hazardous material that either crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements.	a) No b) Yes c) N/A

FORM 4: Additional Information

Partitions :	
12) UNREINFORCED MASONRY: Unreinforced masonry or hollow-clay tile partitions are braced at a spacing of at most 10 ft (3.0 m) in Low or Moderate Seismicity, or at most 6 ft (1.8 m) in High Seismicity.	a) No b) Yes c) N/A
Ceilings :	
13) SUSPENDED LATH AND PLASTER: Suspended lath and plaster ceilings have attachments that resist seismic forces for every 12 ft^2 (1.1 m^2) of area.	a) No b) Yes c) N/A
14) SUSPENDED GYPSUM BOARD: Suspended gypsum board ceilings have attachments that resist seismic forces for every 12 ft^2 (1.1 m^2) of area.	a) No b) Yes c) N/A
15) INTEGRATED CEILINGS: Integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) and ceilings of smaller areas that are not surrounded by restraining partitions are laterally restrained at a spacing no greater than 12 ft (3.6 m) with members attached to the structure above. Each restraint location has a minimum of four diagonal wires and compression struts, or diagonal members capable of resisting compression.	a) No b) Yes c) N/A
16) EDGE CLEARANCE: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) have clearances from the enclosing wall or partition of at least the following: in Moderate Seismicity, 1/2 in. (13 mm); in High Seismicity, 3/4 in. (19 mm).	a) No b) Yes c) N/A
17) CONTINUITY ACROSS STRUCTURE JOINTS: The ceiling system does not cross any seismic joint and is not attached to multiple independent structures.	a) No b) Yes c) N/A
18) EDGE SUPPORT: The free edges of integrated suspended ceilings with continuous areas greater than 144 ft^2 (13.4 m^2) are supported by closure angles or channels not less than 2 in. (51 mm) wide.	a) No b) Yes c) N/A

FORM 4: Additional Information	Page-4		
Cladding and Glazing :			
25) MULTI-STORY PANELS: For multi-story panels attached at more than one floor level, panel connections are detailed to accommodate a story drift ratio by the use of rods attached to framing with oversize holes or slotted holes of at least the following: for Life Safety in Moderate Seismicity, 0.01; for Life Safety in High Seismicity and for Position Retention in any seismicity, 0.02, and the rods have a length-to-diameter ratio of 4.0 or less.	a) No	b) Yes	c) N/A
26) THREADED RODS: Threaded rods for panel connections detailed to accommodate drift by bending of the rod have a length-to-diameter ratio greater than 0.06 times the story height in inches for Life Safety in Moderate Seismicity and 0.12 times the story height in inches for Life Safety in High Seismicity and Position Retention in any seismicity.	a) No	b) Yes	c) N/A
27) PANEL CONNECTIONS: Cladding panels are anchored out of plane with a minimum number of connections for each wall panel, as follows: for Life Safety in Moderate Seismicity, 2 connections; for Life Safety in High Seismicity and for Position Retention in any seismicity, 4 connections.	a) No	b) Yes	c) N/A
28) BEARING CONNECTIONS: Where bearing connections are used, there is a minimum of two bearing connections for each cladding panel.	a) No	b) Yes	c) N/A
29) INSERTS: Where concrete cladding components use inserts, the inserts have positive anchorage or are anchored to reinforcing steel.	a) No	b) Yes	c) N/A
30) OVERHEAD GLAZING: Glazing panes of any size in curtain walls and individual interior or exterior panes more than 16 ft2 (1.5 m2) in area are laminated annealed or laminated heat-strengthened glass and are detailed to remain in the frame when cracked.	a) No	b) Yes	c) N/A

FORM 4: Additional Information	Page-5
Parapets, Cornices, Ornamentation, and Appendages :	
31) URM PARAPETS OR CORNICES: Laterally unsupported unreinforced masonry parapets or cornices have height to thickness ratios no greater than the following: for Life Safety in Low or Moderate Seismicity, 2.5; for Life Safety in High Seismicity and for Position Retention in any seismicity, 1.5.	a) No b) Yes c) N/A
32) CANOPIES: Canopies at building exits are anchored to the structure at a spacing no greater than the following: for Life Safety in Low or Moderate Seismicity, 10 ft (3.0 m); for Life Safety in High Seismicity and for Position Retention in any seismicity, 6 ft (1.8 m).	a) No b) Yes c) N/A
33) CONCRETE PARAPETS: Concrete parapets with height-to-thickness ratios greater than 2.5 have vertical reinforcement.	a) No b) Yes c) N/A
34) APPENDAGES: Cornices, parapets, signs, and other ornamentation or appendages that extend above the highest point of anchorage to the structure or cantilever from components are reinforced and anchored to the structural system at a spacing equal to or less than 6 ft (1.8 m). This evaluation statement item does not apply to parapets or cornices covered by other evaluation statements.	a) No b) Yes c) N/A
Mechanical and Electrical Equipment :	
35) TALL NARROW EQUIPMENT: Equipment more than 6 ft (1.8 m) high with a height-to-depth or height-to-width ratio greater than 3-to-1 is anchored to the floor slab or adjacent structural walls.	a) No b) Yes c) N/A
36) MECHANICAL DOORS: Mechanically operated doors are detailed to operate at a story drift ratio of 0.01.	a) No b) Yes c) N/A

37) SUSPENDED EQUIPMENT: Equipment suspended without lateral bracing is free to swing from or move with the structure from which it is suspended without damaging itself or adjoining components (for example: Air Conditioner (AC)).	a) No b) Yes c) N/A

FORM 4: Additional Information

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Ducts :	
38) DUCT BRACING: Rectangular ductwork larger than 6 ft2 (0.56 m2) in cross-sectional area and round ducts larger than 28 in. (711 mm) in diameter are braced. The maximum spacing of transverse bracing does not exceed 30 ft (9.2 m). The maximum spacing of longitudinal bracing does not exceed 60 ft (18.3 m).	a) No b) Yes c) N/A
39) DUCT SUPPORT: Ducts are not supported by piping or electrical conduit.	a) No b) Yes c) N/A
40) DUCTS CROSSING SEISMIC JOINTS: Ducts that cross seismic joints or isolation planes or are connected to independent structures have couplings or other details to accommodate the relative seismic displacements.	a) No b) Yes c) N/A
Piping :	
41) FLEXIBLE COUPLINGS: Fluid and gas piping has flexible couplings.	a) No b) Yes c) N/A
42) FLUID AND GAS PIPING: Fluid and gas piping is anchored and braced to the structure to limit spills or leaks.	a) No b) Yes c) N/A
43) C-CLAMPS: One-sided C-clamps that support piping larger than 2.5 in. (64 mm) in diameter are restrained.	a) No b) Yes c) N/A
44) PIPING CROSSING SEISMIC JOINTS: Piping that crosses seismic joints or isolation planes or is connected to independent structures has couplings or other details to accommodate the relative seismic displacements.	a) No b) Yes c) N/A
Elevators :	

45) RETAINER GUARDS: Sheaves and drums have cable retainer guards.	a) No	b) Yes	c) N/A
46) RETAINER PLATE: A retainer plate is present at the top and bottom of both car and counterweight	a) No	b) Yes	c) N/A
47) ELEVATOR EQUIPMENT: Equipment, piping, and other components that are part of the elevator system are anchored.	a) No	b) Yes	c) N/A

FORM 4: Additional Information

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Elevators :

48) SEISMIC SWITCH: Elevators capable of operating at speeds of 150 ft/min (0.30 m/min) or faster are equipped with seismic switches that meet the requirements of ASME A17.1 or have trigger levels set to 20% of the acceleration of gravity at the base of the structure and 50% of the acceleration of gravity in other locations.	a) No	b) Yes	c) N/A
49) SHAFT WALLS: Elevator shaft walls are anchored and reinforced to prevent toppling into the shaft during strong shaking.	a) No	b) Yes	c) N/A
50) COUNTERWEIGHT RAILS: All counterweight rails and divider beams are sized in accordance with ASME A17.1.	a) No	b) Yes	c) N/A
51) BRACKETS: The brackets that tie the car rails and the counterweight rail to the structure are sized in accordance with ASME A17.1.	a) No	b) Yes	c) N/A
52) SPREADER BRACKET: Spreader brackets are not used to resist seismic forces.	a) No	b) Yes	c) N/A
53) GO-SLOW ELEVATORS: The building has a go-slow elevator system.	a) No	b) Yes	c) N/A

Damage and Deterioration :

54) Is the building abandoned?	a) No	b) Yes	c) N/A
55) Are there beams, floors, or roofs that are visibly sagging?	a) No	b) Yes	c) N/A
56) Are there beams or columns that are visibly broken?	a) No	b) Yes	c) N/A

57) Are there sloping floors or large exterior cracks that indicate significant settlement has occurred?	a) No b) Yes c) N/A
58) Is there visible distress from prior earthquakes that has not been repaired (i.e., the building is leaning slightly or there are large x-cracks in the concrete or masonry walls)?	a) No b) Yes c) N/A
59) Is there visible fire damage that has not been repaired?	a) No b) Yes c) N/A
60) Is there extensive wood rot and/or water staining that is visible?	a) No b) Yes c) N/A

FORM 4: Additional Information

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Elevators :	
61) Is the mortar eroding away, leaving areas of uneven depth?	a) No b) Yes c) N/A
62) Are there members that are corroded?	a) No b) Yes c) N/A
63) Are there visible foundation elements with large cracks?	a) No b) Yes c) N/A
64) Are foundation elements exposed due to significant erosion of adjacent soil?	a) No b) Yes c) N/A
SUMMARY of Non-Structural Hazard (Exterior) :	
65) There is an unbraced unreinforced masonry parapet, or unbraced unreinforced masonry chimney.	a) No b) Yes c) N/A
66) There is heavy cladding or heavy veneer.	a) No b) Yes c) N/A
67) There is a heavy canopy over exit doors or pedestrian walkways that appears inadequately supported.	a) No b) Yes c) N/A
68) There is an unreinforced masonry appendage over exit doors or pedestrian walkways.	a) No b) Yes c) N/A
69) There is a sign posted on the building that indicates hazardous materials are present.	a) No b) Yes c) N/A
70) There is a taller adjacent building with an unanchored URM wall or unbraced URM parapet or chimney.	a) No b) Yes c) N/A

71) Other observed exterior nonstructural falling hazard.	a) No b) Yes c) N/A
SUMMARY of Non-Structural Hazard (Interior) :	
72) There are hollow clay tile or brick partitions at any stair or exit corridor.	a) No b) Yes c) N/A
73) There are unbraced/ unanchored mechanical/electrical equipment.	a) No b) Yes c) N/A
74) There are insufficiently braced/ anchored mechanical/electrical equipment.	a) No b) Yes c) N/A
75) Other observed interior nonstructural falling hazard	a) No b) Yes c) N/A

FORM 5: Urban Resiliency	**Page-1**
1) Whether the safety standard of critical infrastructure (water/wastewater/electricity etc.) can resist disasters (e.g. earthquakes, floods, fire, and isolation for infectious diseases)? (Low, medium, high, comment).	a) low b) medium c) high d) No
2) Whether there is alternative emergency energy and facilities for backup (e.g. power, water, oxygen, and telecommunication)?	a) low b) medium c) high d) No
3) Are there any protocols to initiate the plan for the safety of staff and equipment in place (evacuation plans etc.)?	a) low b) medium c) high d) No
4) Stock types and quantities for different emergency resources (e.g. clean water, food, blood, emergency medical suppliers, and portable medical equipment)?	a) low b) medium c) high d) No
5) Surge capacity of emergency beds, resources and staff (surge rapidity, proportion, and strategies for emergency space and emergency beds)?	a) low b) medium c) high d) No
6) Is the access to facility (roads, streets etc.) is reliable and operational?	a) No b) Yes c) N/A

7) Has natural environment preserved?	a) No b) Yes c) N/A
8) Does the building have a proper permit?	a) No b) Yes c) N/A
9) Is it informal settlement?	a) No b) Yes c) N/A

FORM 5: Urban Resiliency

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10) Is this building and its adjacent buildings comply with the land use plan?	☐ Master Plan for Dhaka- 1959
	☐ Dhaka Metropolitan Area Integrated Urban Development Plan -1981
	☐ Land Study for Dhaka City- 1993
	☐ Dhaka Integrated Flood Protection Project- FAP 8A and FAP 8B
	☐ Dhaka Metropolitan Development Plan (DMDP)- 1995-2015
	☐ Dhaka Structure Plan (2016-2035)
	☐ None
11) Identify the environmental problem(s) regarding this building or adjacent ones.	☐ Energy Use (A building's lighting system. Heating and cooling system)
	☐ Impact on the Air (Wood ovens)
	☐ Water use and wasted water
	☐ Construction Materials (using non-sustainable materials)
	☐ None

Annexure-F: QUESTIONARIES

Rajdhani Unnayan Kartripakkha (RAJUK)

1) Are you following a City Development strategy (CDS) or another kind of urban development plan based on vulnerability assessment? Please list them.
2) Why did you create a City Development Strategy (CDS) based on vulnerability assessment and development?
3) Did you enforce a vision statement reflecting unique and singular values of your city? Did it help you to make strategic choices?
4) When and why did your city realize the necessity to establish a diagnosis to identify the main problems?
5) Could you describe the most important methodological instruments you employed and why they were useful to carry out the strategy?
6) Why did your city realize the necessity to establish a diagnosis to identify the main problems? Was it related to ongoing reforms in your country?
7) Are you mobilizing a team to define and implement your CDS? What is the balance between local and international inputs?
8) Is your country (and city) undergoing a decentralization process, aimed at empowering institutional and technical capacities of Local Governments?
9) What are the planning competences of local governments (urban planning/budget planning)? Are planning tasks and institutions of local and national governments related?
10) Did you enforce a vision statement reflecting unique and singular values of your city? Did it help you to make strategic choices?
11) Did the strategic plan generate new/specific institutional structures (such as agencies for strategic planning or economic promotion)? Could you shortly describe it?

Public Works Department (PWD)

12) What is the overall quality of services provided by Public Works, which maintains Town roads, parks, and cemeteries and provides water, sewer, and solid waste collection services based on vulnerability assessment?
13) Is there any plan for satisfaction with the maintenance of Town roads based on vulnerability assessment and development?
14) Is there any plan for satisfaction with the maintenance of satisfaction with the Town's rain or snow plowing and winter maintenance based on vulnerability assessment and development?
15) How would you rate your satisfaction with the Town's water service based on vulnerability assessment and development?

Ministry of Disaster Management & Relief

16) What organizations keep records of past disasters?
Earthquakes:
Floods:
Drought:
Landslides/ avalanche:
Epidemics:
Others:

17) Is there a national disaster management policy, actor related legislation? Specify.
18) What is the disaster management training strategy and/or plan of the country with regards to disaster management?
19) What is the structure/ organigram for disaster management in the country? What is the number of personnel in each organization/ agency?
20) What are the functions of the provincial and local authorities in disaster management?
21) How are various sectors such as (agriculture, health, infrastructure, education, Water resources, Interior) engaged in risk management issues?
22) Is there an information management system for disasterresponse management? What organization manages the system?
23) What early warning systems are in place? Where?
Flood, mudflow, hazardous meteorological events:
Seismic hazard:
Drought:

House Building and Research Institute(HBRI)

24) Are there any experimental studies to form a basis for revision of the structure and buildings? If yes, how much can they upgrade the quality of buildings based on development and prioritized investment?
25) Have you included a copy of the Town / Village Zoning Permit based on new technology on researches?
26) Have your engineered System plans been completed or been scheduled if so please attached to your Building permit application?
27) Have you included site plan showing property lines, well location and septic location based on development and prioritized investment?
28) What are the most structural system which works in local?
29) Do you use new system like LSF,3D panel and etc. to develop building construction based on vulnerability assessment, development and prioritized investment?
30) What are the most type of structural systems and martials which use?
31) Do you research on new technology devices like TMD and dampers for seismic zones? If you so you use them in projects based on development and prioritized investment?

Fire Services and Civil Defense(FSCD)

32) Identify the hazards and risks that could lead to an emergency for the ECE service based on vulnerability assessment.
33) Complete a hazards list or add to your existing Fire Services and Civil Defense system:
34) Identify consequences and likelihood
35) Identify what steps the ECE service
36) Determine the management structure you will use for emergencies based on vulnerability assessment and development.
37) What types of measures should be taken by the authority to eliminate the risks?
38) what are the major factors that increase the risks of hazards?
39) Do you have any action plan to consider civil defense by new technology systems and new communication technologies?
40) Do you have online fire services to set hazard by GPS locations and defense people by automated system for any help to monitor by administrator based on vulnerability assessment and development?

Education Engineering Department

41) Is process engineering research and education affected by needs of industrial process development based on development and prioritized investment?
42) Do you have any educational courses to consider topics about vulnerability assessment, development and prioritized investment?
43) Do you have public courses for engineers about crisis management and vulnerability assessment.
44) Do you have booklets about risk management and related topics which engineers should use them?
45) Are there any governmental certifications to verify engineers which pass related courses in this topic?
46) Do you set any courses which all engineers must pass during university about these topics?

Bangladesh Meteorological Department(BMD)

47) List the potential National Centers, in addition to the current NMC, that would be within your NMHS, and the relevant types and formats of data (e.g. climate, water).
48) List other National Centers outside the NMHS and their main disciplines covered (eg. seismology, agriculture, atmospheric research).
49) Is your country considering or planning to operate DCPC(s)?
50) List the type and format of data and products as well as areas covered, that the potential DCPCs located in your country would collect and produce (eg. Seismology, climate, agriculture)
51) Is your Service already active in developing software to operate a DCPC? If yes, what technologies are being used?
52) Are your software and tools available to other NMHS? If yes, who is the contact point and what are their contact details?
53) Is your country planning to develop capabilities to provide functions and services of a GISC? If yes, briefly indicate your implementation priorities (e.g. Internet portal, Metadata cataloguing, etc.)
54) Is your Service already active in developing software required to provide the functionalities and services of a GISC? If yes, what technologies and software are being used? If yes, are your software and tools available to other NMHS? If yes, who is the contact point and what are their contact details?

Department of Disaster Management(DDM)

55) To what degree do DDM are able and updated in identifying and predicting probable difficulties in crises?
56) To what degree are DDM successful in setting up or developing a crisis committee, in executing periodical maneuvers and training quantitatively and qualitatively staff about crisis management?
57) To what extent are managers successful in efficiently planning actions to timely evacuate or permit patients and provide physicians preparedness in crises?
58) To what degree have managers proceeded on automating routine or complex acts? (software and hardware systems)
59) To what extent do managers ignore procurement of maintenance services and health and safety at work caused by expensiveness (of economic)?
60) To what extent do managers successful read the reports of events and near miss?
61) To what degree is staff participation by management beneficial? (Each employee is responsible for the safety).
62) To what extent do managers take actions to coordinate and communicate with the various departments of hospital, cut paperwork and long administration process in crises?

63) To what extent are systematic programs or software system well defined to register and keep patient's information for the patient's pursuit in all the treatment steps?
64) To what extent are managers able to reduce the risk of communication with people and give suitable information to media in crises?
65) To what degree do you evaluate medicine operational management in the step before the entrance of patients to the hospital? (including sending physician and transmission of facilities to the location of crisis)
66) To what extent do managers take proper actions to set up a health and safety system and to evaluate the risk management?
67) To what extent does hospital use qualify and experienced workforces in crises?
68) To what extent does organization pay attention to maintenance or reformation and inspection in lieu of denying of events and ignoring equipment imperfections?
69) Does the hospital pay attention to similar/dissimilar occurrences and events in other hospitals in local, national and international levels and use their ideas and measures in crises? To what degree sharing information occurs?
70) To what degree is data gathering from individuals' quantified and qualified performance, knowing how to perform personnel duty in crises?
71)
72) To what degree is data gathering from quality and quantity view of safety equipment in crises?
73) To what degree do you evaluate data gathering and information about the range and extension of crisis occurrence and documentation?
74) To what degree is sharing information from managers to personnel and vice versa?
75) To what degree is waiver from routine surveys and contravention each instruction by personnel?
76) To what degree do you evaluate gathering data related to crisis management from organizations and the communication and coordination with them?
77) To what degree do you evaluate personnel safety instructions in responding well to crisis?
78) Does planning facilities and obtaining them affect response to crisis?
79) To what extent is hospital able to match and solve the complex and new problems without any interruption in its routine performance in crises?

local Government Engineering Department(LGED)

80) What is your Active Action Plan (AAP) local level rural urban and small scale water resources infrastructure development programs based on vulnerability assessment, development and prioritized investment?
81) What is your AAP for labor-based technologies to create employment opportunity at local level and uses local materials in construction and maintenance to optimize the project implementation cost with preserving the desired quality?
82) What is your AAP for labor-based technologies based on vulnerability assessment, development and prioritized investment?
83) What is your plan for local level rural urban based on vulnerability assessment, development and prioritized investment?
84) What is your inspections based on DB, PPP or other contracts to improve quality of structures based on vulnerability assessment and prioritized investment?

Annexure-G: CVs of Additional Staff

রাজধানী উন্নয়ন কর্তৃপক্ষ
রাজউক

NKY

Protek-Yapı

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