Investigating the effectiveness of earthquake risk reduction strategies for readymade garments industry occupants in Chittagong, Bangladesh

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Executive Summary

Bangladesh has inadequate preparedness for earthquakes and associate disasters due to infrequent occurrence and long recurrence interval of this type of hazard. Furthermore, current policies have inappropriately defined emergency responses and disaster preparation in relation to earthquake hazards in Bangladeshi readymade garments (RMG) industries. This research aims to address this gap by analyzing disaster risk reduction policy documents as well as conducting survey in readymade garments industry occupants in Bangladesh. To achieve the aims of this research, multidisciplinary approaches were applied by using qualitative and quantitative data (i.e. policy documents, field observations, structured and semi-structured interviews) collected among factory workers, owners, fire services and civil defense officials, key executives, experts and administrators in Chittagong, Bangladesh. By collecting and collating key initiatives on seismic zoning, risk reduction activities, Bangladesh national building code, policy and plan relating to building constructions, earthquake preparation and emergency response, this research suggests that current policies have adequately addressed for structural integrity of buildings. The research reviewed workplace safety acts, rules, policies, programmes and initiatives relating to dock labourers, child labour protection, maternity benefit, fire prevention and labour rights in Bangladesh. Following Rana Plaza collapse in 2013, these were updated and strengthened to ensure workplace safety in RMG industries. However, these initiatives were still concentrated on fire hazard and safety. Although some industries incorporated earthquake preparation activity in their training manual, the majority industries had not undertaken preparation for any future earthquake occurrence. *The research suggests that the industries may strengthen earthquake preparation by incorporating this within current workplace safety manual particularly fire training without incurring much extra cost for this new approach.*

This research conducted survey among 178 workers across 20 industries. Of the 178 respondents, 76 respondents (42.7 percent) perceived that their workplace could face fire and 97 respondents believed that they are at risk of both fire and earthquake. Only four respondents trust that they are only at risk of earthquake because the industries they worked for have zero tolerance for fire hazard. The industry workers who worked with sewing machine, they could not understand the earthquake because of the vibration of the machine. The other workers suggested that by experiencing the tremor, they run toward the assembly area or took shelter under machine or table. Those RMG industries are highly compliance with workplace safety related acts, rules and polices, they train workers about both fire and earthquake. *They trained workers to get down from the building in a row and took refuge in assembly area or stay near to stronger beam and underneath the stronger table. Some compliance industries suggested that*

they provide alarm and open all gates to evacuate from the building immediately after understanding earthquake occurrence. Thus, they allow workers to evacuate the building during earthquake occurrence. They informed that they could evacuate from the building in two minutes if any hazard alarm provided. *Dissemination of these findings with experts suggest that the RMG owners should not train and allow workers to empty building during earthquake occurrence because this will heighten chance of deaths and injuries at that moment.* The respondents identified evacuation problems those include: (1) the provision of the main entrance and exit on the ground floor that is not wide enough for the mobility of workers in the factory; (2) narrow exit gate; (3) passages, aisles, corridors, stairways are blocked by packages; (4) no fire door installed; (5) no exit sign; (6) blocked exit gate etc.

In response to what to do if an earthquake occurs at workplace, 79 percent respondents suggest that they have general knowledge about earthquake preparation. Of the workers, 82 percent suggest that they are aware of not to be adjacent to metal elements/electric wires/gas oven, mirrors, glasses or other similar items during the earthquake. They learnt about these risk elements from workplace training, co-workers, informal discussions, electronic and print media. Of the participating 178 workers, 79 percent know that they may take comparatively safe refuge by standing along the side of strong beam and underneath stronger table during an earthquake occurrence. An overwhelming majority worker, 94 percent have clear idea about the location of exit/evacuation gate during any emergency event.

It is noted that the ownerships of buildings have significant impact on disaster preparedness. Of the surveyed 178 industries, 105 and 74 are located rental and own buildings respectively. Those buildings located in rental building face comparatively higher challenges to comply with structural integrity and disaster preparation. Discussions with the key executives of the RMG industries located in rental buildings suggest that they have to get approval from the building owners to make any structural change. It is unlikely that the owners will readily provide approval for such changes even if it causes strengthening the buildings. The owner might think that if the RMG owner leaves the building after agreement period, the building may be useless for other purposes. On the other hand, the most of the RMG industry owners who operate from rental buildings thought that it is useless attempting to spend money for rental buildings because they might have to leave any time. The most of the RMG industries locating in rental buildings have stairs in two sides and two exit gates whereas they should have stairs in four sides and have four gates. Some owners who operate business from rental buildings suggest that following inspection by the National Tripartite Plan of Action (NTPA), they attempted to increase exit gates but they failed to receive approval from the owners of the buildings.

A key learning from this research is that a disaster resilience industry trains its workers, supervisors, officials and top executives equally through formal and informal training initiatives about hazard, disaster preparedness and evacuation procedure. On the other hand, a non-resilience industry may have enough or limited preparatory/policy documents but its disaster preparation knowledge is limited within top executive without passing down to lower level officials and workers. The research suggests that the key inspection authorities of the RMG industries, Alliance, Accord and NTPA, may share their inspection experiences, good/bad examples and any model to enhance future monitoring activities for workplace safety in Bangladesh.

Qualitative data obtained through survey and discussion with workers and key informants suggest generating awareness among workers about scientific nature of earthquake and its associated damage through discussions, meetings and videos. It would require frequent direct training activities among workers how to become calm and firm during earthquake in order to take refuge during earthquake. Refreshment training can be conducted year round through distributing leaflet, poster, banner and manual. Each worker should have adequate knowledge about building space particularly stairs, gates, lifts and rescue windows. There should be at least 4 gates in the factory building according to the ILO instruction. Discussions with key informants, representatives from BGMEA, BKMEA and lessons learnt from workshops suggest that key findings of this research are very useful for RMG industries. However, the findings further need to be disseminated to top level government officials and ministers of the Ministry of Labour and Employment, Department of Inspection for Factories and Establishment (DIFE), Ministry of Disaster Management and Relief (MoDMR) and Ministry of Industries, the GoB to develop implementation strategies.

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Acronyms

ACCORD The Accord on Fire and Building Safety in Bangladesh

ALLIANCE Alliance for Bangladesh Workers Safety

BGMEA Bangladesh Garments Manufacturers and Exporters Association

BKMEA Bangladesh Knitwear Manufacturers and Exporters Association

DDM Department of Disaster Management

BNBC Bangladesh National Building Code

BUET Bangladesh University of Engineering and Technology

CCC Chittagong City Corporation

FSCD Fire Services and Civil Defense

GFDRR Global Fund for Disaster Risk Reduction

GoB Government of Bangladesh

ICCR-DRR International Centre for Collaborative Research on DRR

IEB Institute of Engineers in Bangladesh

LGED Local Government and Engineering Department

MMI Modified Mercalli Intensity

NTPA National Tripartite Plan of Action

NGOs Non Governmental Organisations

OHS Occupational Health and Safety

PWD Public Works Department

RMG Readymade garments

UNISDR United Nations International Disaster Risk Reduction Strategies

1. Introduction

Bangladesh is currently ranked as one of the world's most disaster prone countries. Approximately ninety-seven percent of the total land area and all inhabitants are at risk of multiple hazards including tropical cyclones, earthquakes, floods, droughts, riverbank and coastal erosion (World Bank 2005). Bangladeshi communities have significant experience of frequent tropical cyclones and floods and the government of Bangladesh (GoB) has a well-planned disaster response and mitigation mechanism for these hazards (As-Salek, 1998; Haque et al., 2012; Paul, 2009). However, the recurrence interval of great earthquakes and tsunamis is very long in the northern Bay of Bengal region (Cummins, 2007; Gupta and Gahalaut, 2009; Khan, 2012; Sukhtankar et al., 1993). Two historical earthquakes, the 1762 Arakan earthquake (M_s8.7) and the 14 July 1885 Bengal earthquake (M_s 7) originating within Bangladesh, caused significant damage in Chittagong and Dhaka respectively (Alam and Dominey-Howes, 2014; Khan and Hossain, 2005). Khan and Hossain (2005) estimated that the recurrence interval of the latter earthquake was at 132 years. As such, the next earthquake adjacent to Dhaka may occur around 2017 with a probable maximum magnitude of 7.3. It has been suggested that earthquakes with a magnitude of 6 and over could significantly damage huge vulnerable infrastructure and cause human casualties in Dhaka (Stone, 2011).

The readymade garment (RMG) industry is the largest employing and foreign currency earning sector in Bangladesh. Although the sector has huge potential for further growth, it receives international attention due to the loss of factory workers' lives by factory building collapse and fire hazards. Currently over 80% of foreign currency in Bangladesh comes from this sector. Notably, one third of the factory workers are women who mostly come insolvent family background. In Bangladesh approximately 33% of textile industries are located in Chittagong. Many industrial and commercial buildings in Bangladesh were not built by considering the Bangladesh National Building Code (BNBC). Consequently, a building of ready-made garment factory was collapsed which killed over 1,138 people on 24 April 2013. Furthermore, a moderate earthquake (Mw 5.8) occurring in Assam, India resulted in cracking of five buildings in Dhaka

on 25 April 2013. Furthermore, a recent survey suggests that local residents in Chittagong perceived very low risk of earthquake and almost had taken no preparation to reduce future risks that may occur due to this type of event (Alam, 2016). Bangladeshi cities lack proper policy and implementation of the existing policies for disaster risk reduction (Rahman, 2011).

United Nations International Disaster Risk Reduction (UNISDR) defined "disaster risk reduction as the concept and practice of reducing disaster risks through systematic efforts to analyse and manage the causal factors of disasters, including through reduced exposure to hazards, lessened vulnerability of people and property, wise management of land and the environment, and improved preparedness for adverse events". Current literature review did not reveal any research relating to disaster preparation and response for earthquake hazards in RMG industries in Chittagong; although, disaster governance should be based on informed knowledge derived from research (Douglass, 2013). Many countries have improved disaster preparation and response system from the learning of past disaster experiences. For example, China has improved its disaster governance system by active learning from past rapid onset disasters (i.e., November 2002 SARS (Severe Acute Respiratory Syndrome), February 2008 southern snowstorm and May 2008 Wenchuan earthquake)) (Zhang, 2012).

2. Previous earthquake studies in Bangladesh

An earthquake disaster risk index for world cities suggests that Dhaka is one of the top twenty seismic prone cities due to the fragility of the built environment (i.e. buildings, roads, transport, water and power lines, etc.), high population density and poor emergency response and recovery capacity (Cardona et al., 1999). Akhter (2010) provided a list of earthquakes from 1548 to 2009 originating between Sumatra and Bhutan and which affected Dhaka with varying degrees of intensity. Alam and Dominey-Howes (2015) suggested that between 810BC and 2012, 562 earthquakes were experienced in the Bay of Bengal and

Bangladesh. It has been suggested that earthquakes with a magnitude of 6 and over could significantly damage huge vulnerable infrastructure and communities in Dhaka (Stone, 2011). There is a hidden fault under Dhaka that is believed to be accruing stress (Akhter, 2010). Therefore, the next earthquake could cause more significant damage to Dhaka (Akhter, 2010; Stone, 2011).

The first record of an earthquake dates back to an event occurring in 1548 (Table 1) that affected both Bangladesh and India (Akhter, 2010; Alam and Dominey-Howes, 2015). The 1548 earthquake may have ruptured large areas within Bangladesh and NE India. Few destructive earthquakes can be identified from the published and unpublished literature (Table 1). However, in historical and recent times, the major cities, Dhaka and Chittagong, (see Fig. 1 for location) have experienced ground shaking with intensities between III and VIII on the Modified Mercalli Intensity (MMI) scale from both distant and local severe earthquakes (Akhter, 2010; Alam and Dominey-Howes, 2015). Earthquakes that occurred in 1897, 1934 and 1950 ruptured large areas adjacent to Bangladesh. The 1762 and 1897 earthquakes severely shook the Chittagong region and northern Bangladesh respectively, and caused landslides and liquefaction in Bangladesh (Ambraseys and Bilham, 2003; Verelst, 1763). Thus, earthquakes in Bangladesh are low-frequent catastrophic events and the vast majority of people have lack of experiencing significant earthquakes in their lifetimes.

Table 1: The occurrence of large earthquakes in and around Bangladesh

Date	Name of earthquakes	Latitude /Longitude	Affected areas	Magnitude	Death/ Injuries
1548	-	26/ 92	India and Bangladesh	-	-

02-04-1762	Chittagong Earthquake	22/ 92	India, Bangladesh and Myanmar	7.8?	200
10-01-1869	Cachar Earthquake	24.75/ 93.25	India and Bangladesh	7.5	-
14-07-1885	Bengal Earthquake	24.8/ 89.5	Bangladesh and India	7.0	75
12-06-1897	Great Indian Earthquake	26/ 91	India and Bangladesh	8.7	1626
18-07-1918	Srimangal Earthquake	24.3/ 91.7	Bangladesh and India	7.6	9
02-07-1930	Dhubri Earthquake	25.8/ 90.2	India and Bangladesh	7.1	1
15-01-1934	Bihar-Nepal Earthquake	26.5/ 86.5	Nepal, India and Bangladesh	8.3	13772

Source: Compiled from Akhter (2010), Sharfuddin(2010) and NGDC (2011)

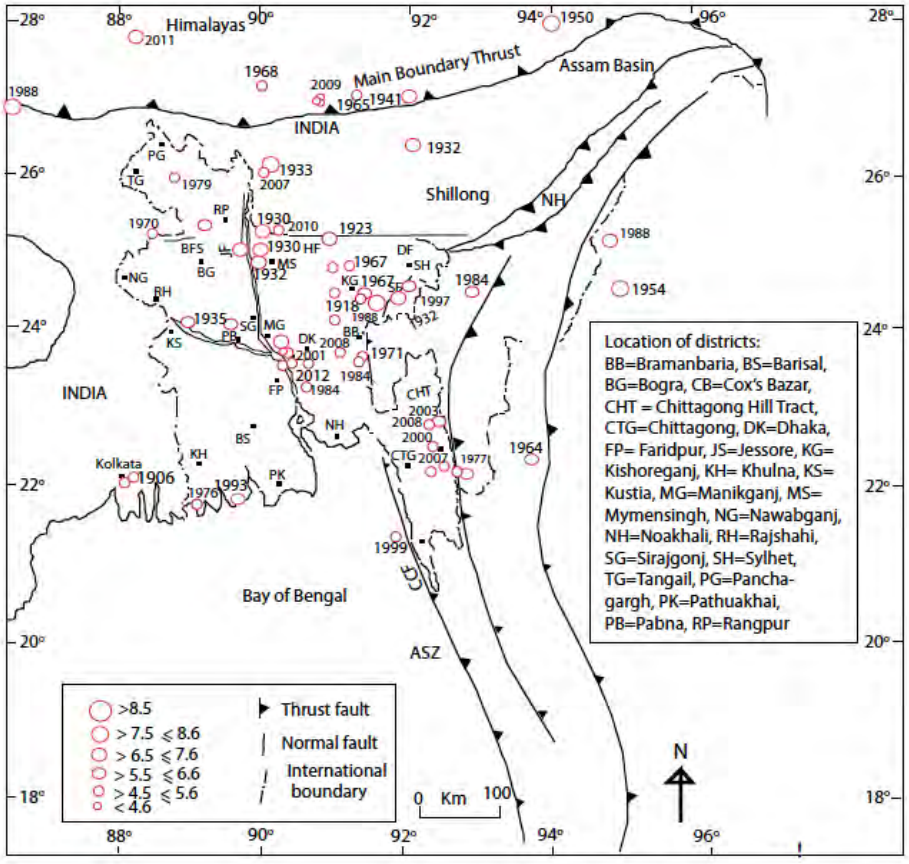


Figure 1: Earthquake distribution in Bangladesh and adjacent regions areas from 1900 to 2012.The dates of all of the major events are labeled on the map. High magnitude earthquakes are located in the active seismic areas in Bangladesh and adjacent India and Myanmar. Key features include ASZ= Arakan Subduction Zone, BFS= Bogra Fault System, CCF= Chittagong Cox's Bazar Fault; DF=Dauki Fault, HF=Haluaghat Fault, JF=Jamuna Fault and SF=Sylhet Fault. (Source: base map adapted from Mukherjee et al., 2009).

The 1898 great Assam earthquake, one of the most damaging historical earthquakes in the world, caused severe damage in most of the districts in northern Bangladesh. This earthquake uplifted the

northern edge of the Shillong plateau by 11 m (Fig. 1; Bilham and England, 2001). In the last 2-5 million years, the uplift of the plateau has caused the Indian Plate to shrink approximately 4±2 mm yr^{-1} lessening seismic risk in Bhutan but enhancing the risk in northern Bangladesh (Bilham and England, 2001). The return period of giant plateau-building earthquakes is over 3000 years (Bilham and England, 2001). Sarkar et al. (2010) identified areas of high liquefaction in Mymensingh (Fig. 1) using borehole data collected from different organisations about the 1897 earthquake. With a recurrence of the 1897 earthquake, Mymensingh town might experience ground shaking with an MMI of VIII.

The 14 July 1885 Bengal earthquake (M_s 7) caused devastation in northern Bangladesh. The epicentre of this earthquake occurred on the Madhupur Fault, 50 km northwest of Dhaka. Khan and Hossain (2005) estimated the recurrence interval of this earthquake at 132 years. As such, the next earthquake adjacent to Dhaka was to be occurred around 2017 with a probable maximum magnitude of 7.3. Although it did not occur, if this occur it could cause huge infrastructural damage to the eastern and western parts of Dhaka City (Khan and Hossain, 2005).

Of all the earthquakes recorded in Bangladesh, the 1762 earthquake originating in Chittagong (Fig. 2) was the most destructive in terms of damage and deaths and injuries (Alam and Dominey-Howes, 2014). Through field visits and investigations, Alam and Dominey-Howes (2014) confirms the locations of liquefaction, compaction, landslides, co-seismic subsidence, deaths and injuries using the descriptions of historical documents (Oldham, 1883; Verelst, 1763) as a guide. The earthquake triggered land level changes where the soil is young and soft and these areas are located adjacent to the coast of the Bay of Bengal and along the banks of the Karnafuli, Halda and Meghna rivers. The earthquake probably generated several submarine sediment slides that triggered local tsunamis that struck different locations (Bansbaria, Bharchhara and Burumchhara) along the Chittagong coast.

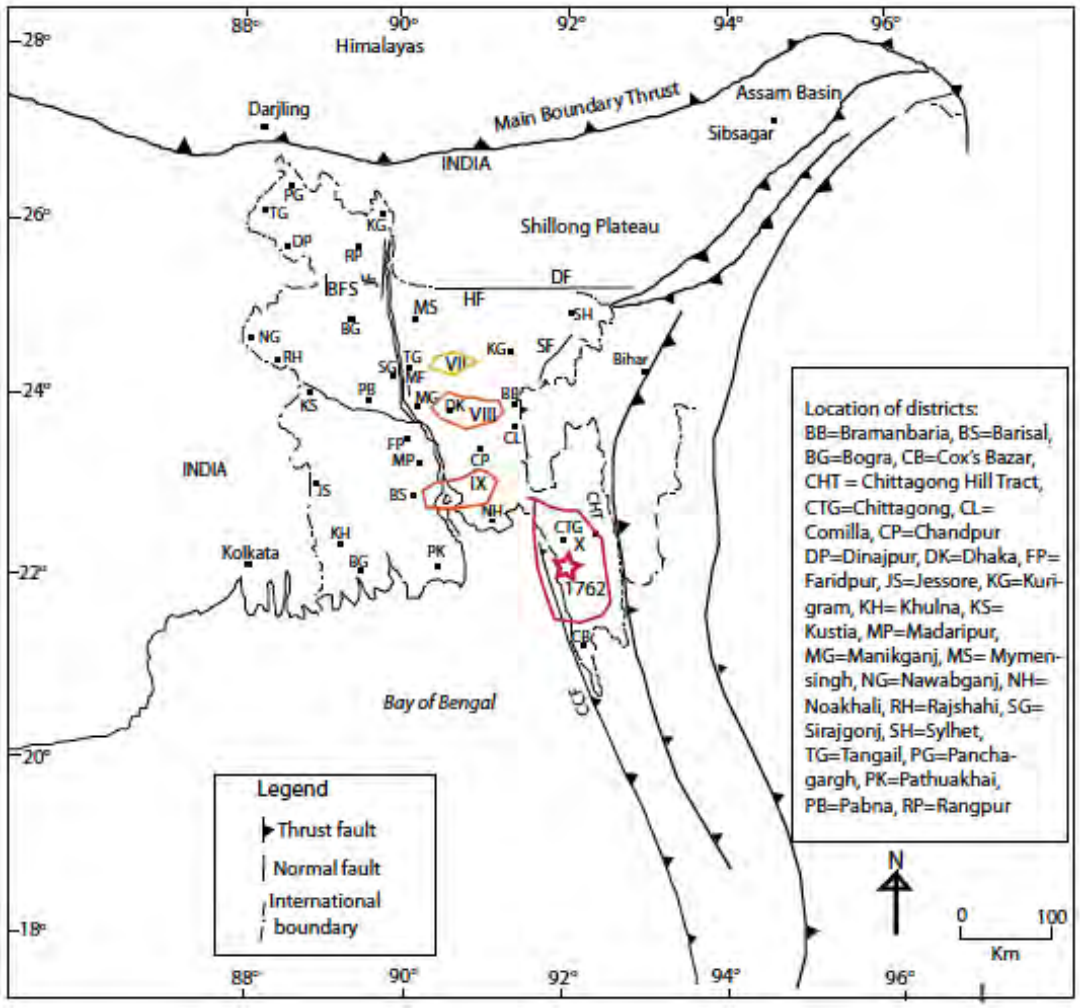


Figure 2: Isoseismal map of the 2nd April 1762 Chittagong earthquake. The red star shows the epicenter of the 1762 earthquake. The Roman numerals indicate the MMI values. The solid lines show isoseismals separating regions of different intensity.

Damage reports are available for at least three instrumentally recorded earthquakes occurring within SE Bangladesh (Fig. 3). The 21 November 1997 earthquake with a magnitude of M_w 6.1 killed 23 people in Chittagong and Bandarban (Akhter, 2010). The earthquake also induced liquefaction and caused a five-story building in the City of Chittagong to subside. The 1999 Moheskhali Island earthquake with a magnitude of M_s 4.2 had its epicentre near Moheskhali Island and occurred on 22 July at 4.22 pm. Three aftershocks occurred on the same island on the following night (Ansary et al., 2000). The earthquake caused to collapse over 900 mud houses (Fig. 4a) and cracks were evidenced in some brick built houses. However, bamboo and wooden houses were not affected (Ansary et al., 2000). This

earthquake killed 7 people (Alam et al., 2006) and injured several hundred people (Ansary et al., 2000). Cracks developed in an earthen embankment surrounding the island. Cracks developed in a hill slope (Fig. 4b) and the earthquake triggered several landslides.

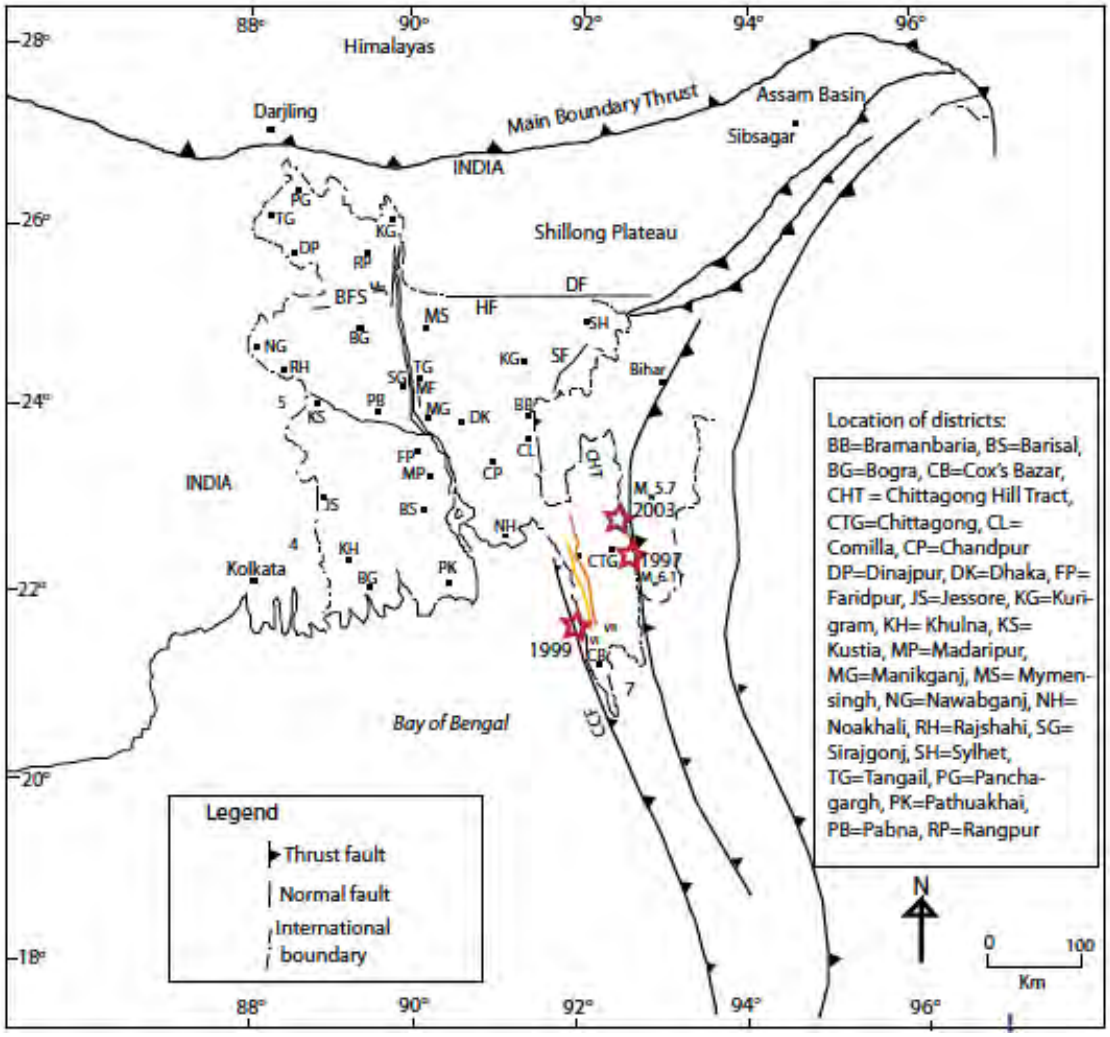


Figure 3: The red stars show the epicentres of the 1997, 1999, and 2003 earthquakes in SE Bangladesh. The solid coloured lines show isoseismals of the 1997 earthquake separating regions of different intensity.

a

b

Figure 4: The effects of the 1999 earthquake in the Moheskhali Island: a) Cracks in a mud wall in Moheskhali Island by the earthquake, b) Cracks in a hill slope in Moheskhali Island by the earthquake (Source: Ansary et al. 2001).

The 27 July 2003 Borkal earthquake with a magnitude of M_w 5.7 had its epicentre at the eastern bank of the Kaptai reservoir 217 km southeast of Dhaka City and 90 km northeast of Chittagong City (Fig. 3). The earthquake caused surface ruptures and ground deformation in Chittagong and Chittagong Hill Tracts. This earthquake killed 3 people and injured a further 24 people. Over 100 masonry buildings developed cracks whilst about 500 buildings in Chittagong and the Chittagong Hill Tracts were badly damaged (Alam et al., 2006; Khan, 2004b). The Chittagong public library building was severely damaged. For the first time the power supply to some areas was cut because of the explosion of a transformer in Chittagong (Akhter, 2010).

To facilitate more accurate seismic hazard assessments, Kamal (2008) classified the surface geology of the peri-urban Chittagong city corporation areas using aerial photographs and high resolution IRS-1 D PAN images. This exercise identified the existence of nine geomorphic units in the city including: hills, valley fills, alluvial fans, piedmont, tidal flat, fluvial terrace, point bar, natural levee and beach deposits. Kamal (2008) estimated that the observed damage from past earthquakes was strongly correlated with the calculated ground response of microtremors in different geomorphic units. Therefore,

by recording an adequate number of microtremors, Kamal (2008) developed a seismic microzonation of the Chittagong city corporation for earthquake risk reduction.

The local residents in Chittagong were aware of the sudden onset nature of earthquake hazards that leave people with limited time to prepare and evacuate (Alam, 2016). They knew the term *Bhumikompo. Bhumikompo* is the Bengali term for earthquake, which consists of two words *Bhumi* (land) and *kompo* (shaking) (Alam, 2016).Though community consultation, Alam (2016) suggests that the local residents have low risk perception and taken no preparation in absence of their direct experience of earthquakes. Paul and Bhuiyan (2010) conducted a quantitative survey of 444 residents of Dhaka to understand risk perceptions and preparedness about earthquakes. Over 75% of the population and 80% of buildings in Dhaka are susceptible to earthquake hazard (Paul and Bhuiyan, 2010). By applying Chi-square and t tests, they identified ten variables as statistically significant determining factors in earthquake preparedness. These variables are: respondents' past earthquake experience, previous property loss due to an earthquake, ownership of the residential unit in which a person is currently residing, number of floors in residential unit, marital status, duration of residency in Dhaka City, value of residential unit, and respondent age, education and monthly household income. The findings suggest that 83% of the residents were not prepared for a future major earthquake.

The review of the literature on the earthquake hazards in Bangladesh shows that several studies were conducted to understand the morphology and seismic risk in Dhaka and Chittagong cities and Mymensingh town. Bangladesh is highly susceptible to earthquakes due to its proximity to active faults and geomorphology and socio-political factors (i.e. limited preparedness, fragile building structures, high population exposure). However, no effort has been made to understand earthquake risk reduction strategies in RMG industries in Bangladesh. This research attempts to fill up this gap in knowledge by assessing institutional policies and factory occupants' hazard knowledge, perception, disaster preparation

and responses for emergency events. The findings may help developing effective response mechanisms to better prepare for future hazard events.

3. Research questions and objectives

This research seeks to progress disaster risk reduction by asking an overall question what is the current policies and practices of emergency response and factory occupants' vulnerability to earthquake hazards. It analysed both the government of Bangladesh and other institutional responses to mitigate hazards and factory occupants' risk perception and preparation in relation to earthquake hazards. It engages a growing community of scholars, civil servants, emergency management officials, and policy makers who are dealing with disaster governance in Bangladesh. This project seeks to increase disaster resilience of Bangladeshi factory occupants by saving lives, reducing financial losses and strengthening safe work environment. As such, the findings may help to develop a sustainable business for readymade factory owners, entrepreneurs, executives and workers in Bangladesh.

The following research objectives have been identified that support the aims.

Research objective 1: to assess the effectiveness of current earthquake risk reduction policies, practices and procedures in readymade garment factory occupants in Chittagong, Bangladesh;

Research objective 2: to assess readymade garment factory occupants' knowledge, risk perception and preparedness to earthquake hazards in Chittagong;

Research objectives 3: to develop a manual for effective earthquake preparation procedures through a participatory consultation with factory workers, owners, civil protection officers, key executives, experts and administrators in Chittagong;

Research objectives 4: to develop a policy brief for the Government of Bangladesh, Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and Bangladesh Knitwear Exporters Association (BKMEA) to undertake effective earthquake risk preparation procedures for factory occupants in Bangladesh.

4. Methods and materials

In order to fulfill the objectives, the research is organised in 4 workpackages (WPs) and address and resolve a number of specific scientific and technical issues related to the diverse disciplinary fields of 1) policy and strategic analysis (**WP1**); 2) disaster preparation (**WP2**); 3) manual development for improved disaster preparation and emergency response **(WP3)**; and 4) policy brief to improve institutional capacity dealing with earthquake hazards and emergency response (**WP4**). In order to achieve the first of objective of this research, earthquake risk reduction and management policies, key programmes, activities, practices and procedures were collected from the Government of Bangladesh, Bangladesh Garments Manufacturers and Exporters Association (BGMEA), Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA),Bangladesh University of Engineering and Technology (BUET) and industrial units (Table 2). Bangladesh national building code, policy and plan relating to building constructions, earthquake preparation and emergency response were collected and reviewed. A critical review of workplace safety acts, policies, programmes and initiatives in Bangladesh before, and after Rana Plaza collapse was carried out to understand their relevance to earthquake risk reduction strategies. Apart from this, much understanding was gained through field observations of RMG factories, workplace environment and earthquake hazard preparation if they have any to identify problems relating to emergency response.

In order to gain a better understanding of community perception of hazard and risk, and their preparedness (Alam and Collins, 2010; Dominey-Howes and Minos-Minopoulos, 2004) in SE Bangladesh, both quantitative and qualitative methods were utilized in this research. Both approaches have limitations (Gregory et al., 2009). However, mixed methods may bring in more robust evidence than either qualitative or quantitative approaches provide when they are used separately (Creswell, 2009). In order to understand, RMG work environment, hazard perception, disaster preparedness and challenges

for workplace safety, over 40 factories were visited in Chittagong, Bangladesh. However, only 20 industries allowed us to interview workers, officials and top executives on questions limited to this research objectives only. Of these factories, in order to check structural integrity of the buildings, Alliance, Accord and NTPA inspected 6, 3 and 2 factories respectively. The remaining nine factories were not inspected by any authority.

Table 2: Summary of research methods

Methods and key activities	Purpose	Sources, participants and implementation strategies
Exploratory literature review and sourcing	a) Understand how current policies, practices and disaster governance are interpreted for RMG factories	–Workplace safety acts/policies/programmes/initiatives in Bangladesh before and after Rana Plaza collapse – Collect and review of compulsory and non-compulsory policies and practices of earthquake risk mitigation programme in Bangladesh
Document and map analysis	a) Identify barriers to effective disaster preparation	– Archive records, district gazetteers, local reports, peer review papers and other documents – Critical review of Bangladesh national building code and its implementation strategies – Policy, plan and layout of RMG factories
Field observation	a) Gain contextual understanding of physical landscape, RMG building structure and neighborhoods in selected areas to identify barriers to effective earthquake preparation b) Identification of respondents for consultation	– RMG factory visits and observations – Unstructured recording and observations will be recorded on a daily basis in fieldwork diaries, sketching and photographs
Semi-structured and open ended questionnaire survey	a) Understand current earthquake knowledge, risk perception and preparation	– A total of 178 Interviews and discussion with RMG factory workers
Open ended questionnaire survey	a) Interview with key respondents on emergency response, disaster governance and disaster risk reduction	– 25 interviews with factory workers, owners, civil protection officers, key executives, experts and administrators – A progress report providing findings from literature review, document and map analysis, field observation and data review
Data analysis	a) Data analysis and synthesis b) Vulnerability analysis c) Risk mapping	–Translating and transecting field data. Thematic delineation of the evidences
		– Summarising of data
Workshop to develop a manual for effective earthquake preparation	a) Cross-checking results with wider stakeholders b) Development of a manual for disaster governance and preparation in RMG building	– Scoping study of all local and national stakeholders
		– Consultation with academics and policy makers
		– Circulation of summary analysis information to local, national and international ‘peer group’ for consultation
		– Dissemination and discussion of results with local community and wider group through workshops, presentations, leaflets, strategy and journal papers
Final report preparation and submission	a) Final report preparation, binding and submission	– First research paper to *the Australian Journal of Emergency Management* – Final research report to ICCR-DRR

To assess RMG occupants' knowledge, risk perception and preparedness to earthquake hazards in Chittagong, a combination of semi-structured and open ended questionnaire were administered to collect data from 178 workers of RMG factory in Chittagong, Bangladesh (see Annexure 1). Of these workers, male and female were 119 and 59 respectively. Approximately 73 percent of the workers belong to age group 21-35 (Table 3). Only 3 percent workers were above 45 age and below 20 age were 10 percent. Approximately 33 percent of the workers were illiterate (Table 4) and below Secondary School Certificate (SSC), SSC and Higher Secondary Certificate (HSC) passed workers were 43, 14 and 11 percent respectively. The average service experience of the workers in RMG industries were 5.46 years. The maximum 36.5 percent of the workers have between 4 and 7 years of service experience (Table 5). Some 10 percent workers have over 10 years of working experience in RMG industries.

Table 3: The age group of the surveyed workers

Age group	Frequency	Percent
<20	18	10.1
21-25	48	27.0
26-30	50	28.1
31-35	33	18.5
36-40	12	6.7
41-45	12	6.7
46-50	01	0.6
50+	04	2.2
Total	178	100.00

Table 4: Education of the workers

Education	Frequency	Percent
Illiterate	58	32.58
<SSC	76	42.70
SSC	24	13.48
HSC	20	11.24
Total	178	100.00

Table 5: Years of experience in RMG industries

Years	Frequency	Percent
>1	13	7.3
1-3	57	32.0
4-7	65	36.5
8-10	25	14.0
10+	18	10.1
Total	178	100.00

The questionnaire includes two sections. The first section is consisted of a series of questions designed to address the second objective of this research. The questionnaire includes about general knowledge about earthquake hazard, past experiences of earthquakes, risk perception, emergency response, preparation and evacuation procedure. The second section includes questions about how to develop an effective earthquake preparation procedures in readymade garment factories in Chittagong. A total of 25 key informant interviews were conducted to develop effective earthquake risk reduction strategies through a participatory consultation with factory workers, owners, key executive officers and administrators in Chittagong. This questionnaire was pre-tested in the field to determine its adequacy, ascertain applicability, and to address any deficiencies found.

Photo 1: Interview session with RMG workers and owner. a) Dr Edris Alam, the Principal Investigator interviewing RMG workers; b) Rukya Zaman Juthi, Research Associate, interviewing RMG officials; c) Mahmuda Hossain, Data Collector, interviewing RMG workers; d) Dr Edris Alam, the Principal Investigator, interviewing RMG industry top executive.

WP4: The research aimed at developing a manual for effective earthquake preparation procedures through a participatory consultation with factory workers, owners, fire services and civil defense officials, key executives, experts and administrators in Chittagong and Dhaka. For this purpose, the results obtained from field questionnaire surveys and key informant discussions were shared at a two-day long workshop (22-23 July 2017) involving participants from factory workers, owners, fire services and civil defense officials, key executives, experts, administrators and representatives from the BGMEA and

BKMEA. This helps us in order to develop policy brief for the GoB, BGMEA and BKMEA. The effort to develop manual for effective earthquake preparation procedure has been presented in Annexure 2.

WP5: The combined results of this research obtained through questionnaire surveys, key informant consultations and workshops were shared with a wide body of academic, emergency management, disaster and health specialists using the web and personal contacts in Chittagong and Dhaka. Finally, the results obtained through **WP1-WP5** were developed as a policy brief for the Government of Bangladesh, Bangladesh Garment Manufacturers and Exporters Association (BGMEA) and Bangladesh Knitwear Manufacturers and Exporters Association (BKMEA) to undertake effective earthquake risk reduction strategies for RMG factory occupants in Bangladesh (see Annexure 3).

5. Results and discussions

In the following sections, key findings are provided that ought to be of interest to RMG industries, BGMEA and BKMEA for developing earthquake risk mitigation strategies and for assisting the government of Bangladesh to determine the appropriateness of its preparedness strategy. Sequentially, this research explores the following:

- Results from documentary analysis;
- Earthquake hazard knowledge and risk perception;
- Experience of earthquake occurrence at workplace;
- Challenges faced at workplace during past earthquake events;
- Knowledge about earthquake preparedness;
- Evacuation problems following earthquake;
- Ownerships of RMG building and disaster preparedness;
- Suggestions to improve earthquake preparation;
- Future plan to improve earthquake preparedness;
- Institutional training activities among workers; and
- Feasibility and applicability of integrated disaster risk reduction strategies in RMG industries

5.1Results from documentary analysis

In the following sections, results obtained through analyzing earthquake risk reduction strategies, workplace safety, occupational health and safety issues are discussed.

5.1.1 Results from obtained from earthquake risk reduction programmes/initiatives/activities

Key initiatives on seismic zoning, risk reduction activities, Bangladesh national building code, policy and plan relating to building constructions, earthquake preparation and emergency response were collected and analysed (Tables 6 and 7). The GoB enacted Bangladesh National Building Code (BNBC)

in 2006. The majority of the readymade and textile industries were constructed before enacting of the BNBC 2006. Thus, they lacked of compliance with fire and electrical safety provided in the building code. After Rana Plaza collapse in 2013, the National Tripartite Plan of Action (NTPA) directed to construct new RMG factory buildings following the BNBC or new version of the code. It stated that buildings, structures and components shall be investigated to test whether they have effective design to support all loads, including dead loads, without exceeding the specified strengths (under applicable factored loads) for the materials of construction in the structural members and connections. Additionally, the NTPA endorsed methodology for structural assessment of existing RMG buildings: preliminary visual assessment; detailed engineering assessment; design of retrofit scheme. The NTPA emphasises on life safety during fire hazards without providing due attention to safety property provided in the BNBC. Current practices and policies mostly provide guide for structural resistance of the RMG factory buildings. It also provides guidance for mitigating fire risk in the RMG factory buildings. However, it significantly lacks of guidance to prepare for any earthquake risk in RMG buildings.

To improve the disaster risk reduction culture, the GoB adopted the Comprehensive Disaster Management Programme (CDMP) phase in 2003 for the period between January 2003 to December 2007 in partnership with the United Nations Development Program (UNDP). During its first phase, the CDMP did not provide adequate attention to risk associated with earthquake and tsunami occurrence in Bangladesh (Choudhury, 2005). However, the CDMP phase two adopted in 2009 for a five-year period between 2010 and 2014, had acknowledged earthquake and tsunami events as potential threats.

Table 6: Milestones of earthquake risk reduction programmes in Bangladesh

Year	Key programmes/activities/outcomes	Comments

1935	The Geological Survey of India (GSI) developed the first seismic zoning map for the sub-continent in 1935 and Bangladesh had been included in the severe seismic risk zone of the GSI map	*
1954	The Bangladesh Meteorological Department (BMD) established an observatory in Chittagong in 1954 with facilities for seismic and geomagnetic observations	*
1977	The GoB formed a committee of experts to undertake seismic zoning of Bangladesh and formulate policy options. The committee reviewed all the available information and prepared a seismic zoning map and outlined the building codes for earthquake resistant designs.	The committee recommended the establishment of three observatories
1992	Both seismic risk map and building codes were revised to provide better guidelines of earthquake resistant design. For this mapping exercise, Bangladesh was divided into three zones: zone 3 (liable to severe damage); zone 2 (liable to moderate damage); and zone 1 (liable to slight damage).	The seismic zoning map was updated
2001	The BMD initiated to set up four broadband seismic stations in Rangpur, Sylhet, Dhaka and Chittagong	
2004	- Following the request from the GOB, the European Commission representative worked between January and February 2004 and conducted a day long workshop on earthquake disaster preparedness in Bangladesh. They identified programmes for earthquake risk management in Bangladesh (see Table 7) - Following the request from the GOB, the Japan International Cooperation Agency (JICA) mission visited for several days and organised a seminar on improving seismology services in Bangladesh in April 2004. - The Geological Survey of Bangladesh (GSB) in collaboration with United States Geological Survey (USGS) and United Nations Educational, Scientific and Cultural Organisation (UNESCO) organised a four-day long workshop on seismic analysis for South Asian region in September 2004.	The commission identified a number of earthquake risk reduction programmes (Table 7), their executive and implementing agencies.
2004-2009	CDMP Phase I: It emphasises to enhance the leadership and core business functions of key disaster management agencies. During this phase, risk assessment of the buildings, essential facilities and lifelines were conducted by using geographical information system (GIS) modeling for Dhaka, Chittagong and Sylhet city corporation areas.	*
2005	Education Engineering Department in assistance with DMB organised a day-long workshop on earthquake management and Building Code for their engineers.	*
2007	Three seismic observatories were set up in Sylhet, Rangpur and Gazipur	It took 30 years to set up observatories following recommendation in 1977
2007-2009	The earthquake risk reduction and recovery preparedness programme (ERRP) funded by the Government of Japan through United Nations Development Programme/Bureau of Crisis Prevention and Recovery (UNDP/BCPR) to develop seismic hazard and vulnerability maps of critical infrastructure including building stocks in Rangamati, Bandarban and Khagrachari municipals areas	*
2009	The GoB purchases equipment for search and rescue operation following an earthquake. However, the equipment was successfully used to undertake search and rescue operation after Rana Plaza collapse.	The GoB formed a committee for this equipment purchase in 2002. The committee suggested purchasing 46 items of equipment.
2010-2014	CDMP Phase II builds upon and expands Phase I achievements by ensuring that the institutionalization of risk reduction and climate change adaptation occurs across all levels of government. This phase initiated seismic risk and damage assessment and subsequent scenario-based contingency planning for municipalities in northern Bangladesh.	*
2011	The Ministry of Disaster Management and Relief (MoDMR) initiated project with a consortium (i.e. Asian Disaster Preparedness Centre-ADPC, Institute of Water Modeling (IWM), Asian Institute of Technology-AIT, Norwegian Geo-technical Institute-NGI and ITC at University of Twenty entitled 'Multi-hazard Risk and Vulnerability Assessment Modelling and Mapping' for disaster risk reduction in Bangladesh	*
2011-2012	A consortium of six NGOs (i.e., Action Aid, Concern Universal, Concern Worldwide, Islamic Relief Worldwide, Oxfam GB and Plan Bangladesh) launch a program called National Alliance for Risk Reduction and Response Initiatives (NARRI). It developed training module and resource materials for earthquake resistance construction, analysed structural safety of 20 buildings, reviewed BNBC, conducted seminar, conference and developed manual for architect, engineers and masons.	*
2011-2015	The Public Works Department (PWD) of the GoB initiated a project between 2011-2015 on disaster resilient public buildings through retrofitting funded by Japan International Cooperation Agency (JICA)	There was to develop a manual for this project which is to be included in next BNBC
2012-2016/ 2017	Bangladesh Urban Earthquake Resilience Project Phase I (2012-2016) supported by the Global Fund for Disaster Risk Reduction (GFDRR) (US$1,772,467) to create a dynamic national earthquake resilience strategy. These includes: i) the operationalization of working groups that	It started emphasizing community risk assessment for earthquake hazards

	will mobilize resources and implement the program; ii) the digitization of earthquake exposure and vulnerability data; and, iii) the establishment of an information, education and communication programme. Building on the foundation created, a first phase of earthquake mitigation elements is planned, including: i) an earthquake hazard, vulnerability, and risk analysis; ii) an assessment of legal and institutional arrangements; and, iii) initiate development processes for a guide to incorporate earthquake risk management into land use planning. Bangladesh Urban Earthquake Resilience Project Phase I (2013-2017) supported by GFDRR (US$900,000) to build on the enabling environment established in the first phase of the Urban Earthquake Resilience Project in order to support the establishment of sector specific seismic resilience strategies for informal settlements, water & sanitation, and emergency management.	
2015-2020	Bangladesh Urban Resilience Project, funded by the World Bank (173.0 US$) to strengthen the capacity of Government of Bangladesh agencies to respond to emergency events and to strengthen systems to reduce the susceptibility of future building construction to disasters in Dhaka and Sylhet.	*

Table 7: Earthquake risk management programme identified for Bangladesh in 2004

No	Sub-programme	Executive agencies	Implementing agencies
1	Earthquake hazard mapping and assessment	Geological Survey of Bangladesh (GSB)	BUET, Department of Geology, Dhaka University and regional universities
2	Earthquake vulnerability assessment	BUET, Rajdhani Unnayan Kartypakho (RAJUK), city corporations and Public Works Department (PWD)	Lifeline companies
3	Improving the building permit process	PWD	City corporations, BUET, Institute of Engineers Bangladesh (IEB), IAB, IDEB, Bangladesh Earthquake Society (BES), BACE etc.
4	Improving policy and legal environment	MoDMR, PWD	GSB, IAB, IEB, BACE, City corporations, BUET
5	Institutionalisation and institutional strengthening	MoDMR and DMB	GSB, IEB, IAB, BACE, city corporations, BUET, and other technical universities
6	Develop earthquake emergency response system and integrate into existing earthquake risk framework	MoDMR and DMB	ADF, Fire Service Department, NGOs, BES and lifeline organisations
7	Develop and implement earthquake vulnerability reduction demonstration projects	PWD and BUET	LGED, City corporations, NGOs and BES
8	Community based disaster preparedness education	LGED, city corporations, municipalities and NGOs	NGOs and INGOs

Source: Ansary, 2014

5.1.2 Workplace safety in RMG industries in Bangladesh

Industries in developing countries have poor safety measures resulting in deaths, injuries and sufferings of millions of workers (Ahsan, 2010; Pingle, 2012). Few years back Bangladeshi RMG industries faced significant challenges in terms of workplace safety and better working conditions for the millions of garment workers (Ahamed, 2012; Ansary and Barua, 2015). The predecessor of the GoB had developed 'the workers' compensation act 1923' for the region (Table 8). There were workplace safety acts, rules, policies, programmes and initiatives relating dock labourers, child labour protection, maternity benefit, fire prevention and labour rights. In 2006, for the first time, the GoB enacted labour law which suggested labour safety relating to machinery handling in workplace along with labour rights (GoB, 2017). Although, the documentary rules and acts were placed in paper, these were practiced limitedly. The incidence of Rana Plaza collapse initiated further acts, rules and polices for workplace safety (Table 8). The buyer groups from western countries engaged in this phase resulting in strengthening national authorities to monitor and execute workplace safety regulations and complying local industries in structural integrity and worker's rights.The GoB enacted 'National Occupational Health and Safety (OHS) policy 2013' on the 05 November 2013. The accident triggered several significant improvements in regulations and monitoring structural building safety, fire safety, OHS and labour rights in Bangladesh being pressured by overseas RMG products importers, global supply chains (e.g., foreign retailers), International Labour Organisations (ILO) and human rights organisations.

Table 8: Workplace safety acts/policies/programmes/initiatives in Bangladesh before and after Rana Plaza collapse

Date	Key programmes/activities/outcomes	Objectives	Comments
Before Rana Plaza collapse			
1923	The Workers Compensation Act 1923	It was for workmen compensation by certain types of employers	*
1934	Dock Labourers Act 1934	It aimed at ensuring safety and right of dock labourers	*
1938	Employment of Children Act 1938	It limited child labour	*
1939	The Maternity Benefit Act 1939	It ensured maternity benefits	*
1948	Dock Labourers Regulations 1948	It updated previous laws for dock labourers	*
1953	The Maternity Benefit Rules 1953	*	*
1961	Fire services rules 1961	*	*
1965	The Shops and Establishments Act 1965	*	*
1983	The Workmen's Compensation Act 1923 as amended in	*	*

	1980 and 1983		
2003	Fire prevention and extinction act 2003	*	*
11/10/2006	Bangladesh Labour Law 2006. The Law has 21 chapters outlining work environment, equipment handling and safety, working hours, wages, payment, trade union, dock labour rules, investigation and administration	It aims to sustain health, safety and right of the workers at workplace	Chapters 6-7 outline safety relating to fire and equipment handling and health safety
01/09/2009	BKMEA established fire safety cell on 1 August 2009. The cell facilitates technical skill to its member factories by following national and international standard	It aims to reduce the risk of fire at workplace and to aware every employer and employee's action at the event of fire	*
	The BKMEA established Factory Capacity Enhancement Cell (FCEC) for a safer industrial architecture and structure	The FCEC of the BKMEA nominated civil engineers aiming at improvement in three core areas: -Environmental engineering (i.e., hydrology, ecological, fire protection and sanitary engineering) -Geotechnical engineering (i.e., grounds foundations that support superstructures) -Structural engineering (i.e., earthquake, wind and architectural)	*
28/05/2012	National Labour Policy 2012	It aims to develop productive, decent, occupation health and safety, and labour right	*
2013	Bangladesh Labour Act (Amendment) 2013		*
After Rana Plaza collapse			
15/05/2013	Bangladesh Accord on Fire and Building Safety (the Accord) was signed by over 190 apparel companies from over 20 countries in Europe, North America, Asia and Australia as well as by two global trade unions, IndustriALL and UNI Global, and eight Bangladeshi trade unions	It is a legal agreement for five years to build a safe and healthy RMG industry (Bangladesh Accord, 2017)	*
25/07/2013	National Tripartite Plan of Action on Fire Safety and Structural Integrity (NTPA). It includes tripartite partners: GoB, RMG employers and RMG workers. It emphasises life safety of the workers rather than property safety.	The NTPA on Fire Safety and Structural Integrity includes 25 commitments divided into the three categories (i.e. legislation and policy, administration and practical activities)	The NPTA on fire safety was first outlined in March 2013 after Tazreen Fashion fire accident. Later, it extended as Fire Safety and Structural Integrity in the RMG Sector in July 2013.
08/07/2013	The Sustainability Compact: compact for continuous improvements in Labour Rights and Factory Safety in the RMG and Knitwear Industry in Bangladesh. The compact identified 29 actions on labour rights and factory safety (Moazzem and Islam, 2015)	The right to collective bargaining, building structural integrity, OHS and responsible business conduct by all stakeholders	Based on NPTA, the EU led the compact in partnership with the GoB and ILO
19/07/2013	The United States Trade Representative (USTR) Bangladesh Action Plan to implement a sixteen-point action plan within one year in order to reinstate Bangladesh's GSP status in the US market	It aims to develop and improve labour, fire and building standards, and improvement of trade union protections and administration in the garment and shrimp processing sectors and EPZs	The USTR Bangladesh Action Plan endorses the Sustainability Compact
09/12/2013	The Alliance for Bangladesh Worker Safety is a five year independent and legally binding agreement, which was founded by a group of North American apparel Companies, retailers and brands	It aims to strengthen Bangladeshi worker safety	*
05/11/2013	Bangladesh Occupational Health and Safety Policy 2013	It outlines duties for the GoB, owners/their associations, trade unions, workers, employers and management authorities	It lacks of discussion about health and safety during emergency events (i.e., fire, earthquake and tropical cyclones)
26/11/2013	Fire Safety Film Project	The BGMEA has been undertaking fire safety project	The training module includes fire prevention,

		since 16 February 2012 across Bangladesh but it started offering a three-day comprehensive training since 26 November 2013. It targets to train 25%-30% of workers and officials of each industry. Following the rules of the GOB, each industry has to conduct two fire safety training session each year.	extinguishment, first aid, emergency rescue and safe evacuation
15/09/2015	National Labour Rules	It aims to guide a comprehensive plan for better workplace and safeguard of workers	*

5.1.3 Previous studies on health, safety and hazards in RMG industries

Following Rana Plaza tragedy several researches (i.e., French and Martin, 2013; Wadud et al., 2014; Rashid et al., 2014; Chowdhury and Tanim, 2016) were dedicated to investigate types and causes fire hazards (Table 9). These researches identified root causes of fire hazards and associated deaths in RMG industries in Bangladesh. Ansary and Barua (2015) and Barua and Ansary (2016) discussed the processes of inspection of the structural integrity of the RMG buildings and the progress of monitoring of the building safety in Bangladesh.

Table 9: Key studies on health, safety and hazards in RMG industries in Bangladesh

Focus of studies	References
Structural assessment of RMG factory buildings	Ansary and Barua (2015), Barua and Ansary (2016)
Occupational health and safety (OHS)	Akhter et al. (2010), Rashid, et al. (2014), Tasnim, et al. (2015), Samaddar (2016)
Fire hazards in Tazreen Fashion and collapse of Rana Plaza	Bhadily (2015), Chowdhury and Tanim (2016)
Fire risk assessment	French and Martin (2013), Wadud et al., (2014)

5.2 Earthquake knowledge, risk perception and disaster preparedness

Field research provides real life hazard knowledge, risk perceptions, obstacles for disaster preparation and disaster mitigation strategies in RMG industries. These are discussed in the following sections.

5.2.1 Knowledge about earthquake and risk perception

In order to mitigate the effects of natural hazards, it is essential to understand how people living in places at risk perceive hazards, risk and their knowledge and preparedness in relation to particular hazards (Burton et al., 1993; White, 1974). Enhancement of earthquake hazard knowledge may result in an increase in risk perception and preparedness actions (Hurnen and McClure, 1997) to reduce future vulnerability. Of the 178 respondents, 76 respondents (42.7 percent) perceived that their workplace could face fire and 97 respondents (54.5 percent) believed that they are at risk of both fire and earthquake (Table 10). Only four respondents trust that they are only at risk of earthquake because of the high compliance for fire hazard. By all means of preparation and frequent drills in the buildings, they leant how to minimize and control fire hazards. Being earthquake a natural phenomenon, it is not under control and the industries remain at risk of this hazard. Even one respondent suggested that the industry that person works for is not at risk of any hazard, being earthquake resistant building structure and having higher levels fire risk mitigation system at place.

Those RMG industries are highly compliance with workplace safety related acts, rules and polices, they train workers about both fire and earthquake (Table 11). Key informant discussions suggest that those industries make aware of the earthquake, the workers have higher level of risk perception. Thus, they allow workers to evacuate the building after any earthquake occurrence. It is noted that those factories are being inspected by Alliance for structural integrity and workplace safety, they mainly train workers about fire hazard; simultaneously, they informed workers about possibility of earthquake and what to do during earthquake. The majority workers (59 percent) were trained about fire hazard (Table 12). Some key informants suggest that they shut down/off main switch in case of any earthquake occurrence. They informed that the risks associated with earthquake depend on the number of floors of the RMG factory

buildings. Those industries were located in one or two storied buildings may have lesser risk than multi-storied buildings.

Table 10: The most perceived hazard at workplace

Hazard type	Frequency	Percent
Fire	76	42.7
Earthquake	04	2.2
Fire & Earthquake	97	54.5
None	01	0.6
Total	178	100.0

Table 11: Informed hazard by the management of the industry

Hazard type	Frequency	Percent
Fire	105	59
Fire and earthquake	73	41
Total	178	100.0

Table 12: Perceived occurrence of earthquake at workplace and residential unit

Places	Yes (%)	No (%)	Total
Residential unit	96.1	3.9	100.00
Workplace	78.7	21.3	100.00

5.2.2 Experience of earthquake occurrence at workplace

In historical and recent times, the major cities, Dhaka and Chittagong, (see Fig. 1 for location) have experienced ground shaking from both distant and local severe earthquakes with intensities between III and VIII on the Modified Mercalli Intensity (MMI) scale. As such, of the 178 participants, 147 workers suggested that they have experienced earthquakes at their workplace. The workers mainly faced smaller size earthquakes (Ms 4.5 to 6) those shake a little and finish before understanding their occurrence. They suggested that they did not need to do anything because of their short duration and lesser intensity. On

many times, before the occupants move to the downstairs by facing shaking, the tremble is finished. It happens that because of the vibration of the sewing machine, the workers could not understand the earthquake. However, during earthquake occurrence, the workers' activities depend on their earlier knowledge, earthquake experience and training that they received from the employing industry. The findings revealed that women workers became panicked and started running on the floor. Some workers said that they stood on their own position. The other workers suggested that by experiencing the tremor, they run toward the assembly area or took shelter under machine or table. Those industries are highly compliance with workplace safety, they trained workers about earthquake preparedness within their fire safety training. They trained workers to get down from the building in a row and took refuge in assembly area or stay near to stronger beam and underneath the stronger table. Some compliance industries suggested that they provide alarm and open all gates to evacuate from the building immediately after understanding earthquake occurrence. In these types of industries, the workers get down in a sequence and take shelter in assembly area. The person is in the charge of the floor provides direction and monitors workers to make safe evacuation. Following the earthquake, the site engineer and administrative officer inspect the building to check any fault or damage. Later the management of the industry makes sure that all workers of the day returned to the workplace safely. *Dissemination of these findings with experts suggest that the RMG owners should not train and allow workers to empty building during earthquake occurrence because this will heighten chance of deaths and injuries at that moment.*

5.2.3 Challenges faced at workplace during past earthquake events

Field research suggests that the occupants did not face much challenges during past earthquake events. Qualitative data suggest that the workers did not need to worry because there were enough stairs and they can easily evacuate from the buildings. The most of the workers usually go outside but those who cannot manage to empty buildings, they take shelter beside the pillar or under the table. Those workers are very pious found to sound Allah (God), Allah (God) and Allah (God). Although this doesn't happen widely, few workers become senseless getting panic during earthquake occurrence. It was noted that few

cases whilst attempting to empty from the floor, some workers fell down on the stairs and got injured. The other challenges include competition to evacuate causing congestion in stairs and collision with one another. Some workers found to shout getting panic and the others found to be completely confused what to do. Currently, some industrial authorities do not provide alarm or allow the workers to go outside of the premises because of the security reason during earthquakes.

5.2.4 Knowledge about earthquake preparedness

In response to what to do if an earthquake occurs at workplace, about 79 percent respondents suggest that they have general knowledge about earthquake preparation (Table 13).These findings are in contrary to the earlier research by Alam (2016) who conducted field survey on Bangladeshi coastal communities that suggests that none of the participants have any preparation or knowledge what to do during an earthquake occurrence. Workplace safety training is an important way for disaster preparedness. Although, workers should receive workplace safety and hazard identification training before they start working in RMG industry, about 47 percent workers received training following 28 days of their joining at workplace (Table 14). The second majority approximately 38 percent received training on the very first week of their joining at the industry. Of the industrial workers, 82 percent suggest that they are aware of not to be adjacent to metal elements/electric wires/gas oven, mirrors, glasses or other similar items during the earthquake (Table 15). They learnt about these risk elements from workplace training, co-workers, informal discussions and gossips, electronic and print media. Of the participating178 workers, 79 percent know that they may take comparatively safe refuge by standing along the side of strong beam and underneath stronger table during an earthquake occurrence (Table 16). About 80 percent workers know the location of first aid kit in the floor of their workplace (Table 17) and 90 percent workers know emergency service provider numbers (Table 18). A overwhelming majority worker, 94 percent have clear idea about the location of exit/evacuation gate for any emergency event (Table 19). The non-compliance industries do not have demarcated assembly point following evacuation from the building.

Although some industries are being inspected either by Alliance or Accord or NAP, they do not have demarcated assembly point. As such, only 45 percent workers could identify the location of assembly point following any emergency event (Table 20). A key learning from this research is that a highest compliance industry trains its workers, supervisors, officials and top executives equally through formal and informal training initiatives about hazard, disaster preparedness and evacuation procedure.

Table 13: Knowledge about what to do if an earthquake occurs at workplace

Preparedness	Frequency	Percent
Yes	140	78.7
No	38	21.3
Total	178	100.0

Table 14: Time taken to receive first training about workplace safety

Days	Frequency	Percent
0-7	67	37.6
8-15	17	9.6
16-21	03	1.7
22-28	07	3.9
28+ days	84	47.2
Total	178	100.0

Table 15: Knowledge about risk elements during earthquake

Risk elements	Frequency	Percent
Yes	146	82.0
No	32	18.0
Total	178	100.0

Table 16: Knowledge about comparatively safe place of the building during earthquake

Safe places	Frequency	Percent
Yes	125	70.2
No	53	29.8
Total	178	100.0

Table 17: Knowledge about the location of first aid kit

Location of first aid kit	Frequency	Percent
Yes	142	79.8
No	36	20.2
Total	178	100.0

Table 18: Knowledge about the emergency service provider's numbers

Emergency service numbers	Frequency	Percent
Yes	177	99.4
No	01	0.6
Total	178	100.0

Table 19: Knowledge about evacuation/exit gate of the building

The location of exit gate	Frequency	Percent
Yes	168	94.4
No	10	5.6
Total	178	100.0

Table 20: Knowledge about assembly area following evacuation from the building

Assembly area	Frequency	Percent
Yes	80	44.9
No	98	55.1
Total	178	100.0

5.2.5 Evacuation problems following earthquake

Some industry management claimed that they have highest preparation to mitigate fire and earthquake hazards. Key informant discussions with management authorities of the industries those who are highly compliance with workplace safety suggest that the structural design of the buildings and overall preparation are zero tolerance for any hazard. This resulting in at least 32 workers suggested that they do not have any evacuation problem in their workplace. They informed that they evacuate from the building in two minutes if any hazard alarm provided. Additionally, seven workers suggest that they could not understand about evacuation problem. The rest 139 workers provided multiple responses in relation to evacuation problem at their workplace (Table 21). These include: (1) the provision of the main entrance and exit on the ground floor that is not wide enough for the mobility of workers in the factory; (2) narrow exit gate; (3) passages, aisles, corridors, stairways are blocked by packages; (4) no fire door installed; (5) no exit sign; (6)blocked exit gate etc.

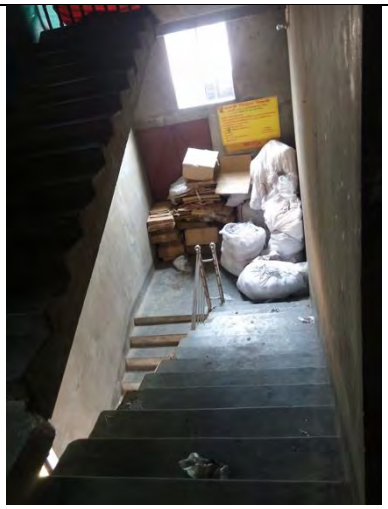
Table 21: Major evacuation problems following earthquake

Ranking No	Evacuation problems	Frequency
1	The provision of the main entrance and exit on the ground floor that is not wide enough for the mobility of workers in the factory	73
2	Narrow exit gate than required	55
3	Passages, aisles, corridors, stairways are blocked by packages	38
4	No fire door installed	31
5	No exit sign	24
6	Blocked exit gate	21
7	Improperly illuminated exit sign	16
8	Locked collapsible gates on different floors	12
9	Fire door does not swing in the direction of travel	10
10	Lack of necessary gates	3
11	No extra stairs	2

A

b

C



d

Photo 2: Evacuation problems in RMG industries. a) Exit gate is blocked by boxes and other items; b) Stairways are partially blocked by hardboard; c) Brick items placed at Assembly Point; d) Stair ways are blocked by boxes and garbage items.

5.2.6 Ownerships of RMG building and disaster preparedness

It is noted that the ownerships of buildings have significant impact on hazard preparedness. Of the surveyed 20 industries, 9 and 11 are located in rental and own buildings respectively (Table 22). Those buildings are located in rental building faced comparatively higher challenges to comply with structural integrity and disaster preparedness. Key informant discussions with the management of the RMG industries those located in rental buildings suggest that they have to get approval from the building

owners to make any structural changes. It is unlikely that they will provide approval for such changes even if it causes strengthening the buildings. The owner might think that if the RMG leaves the building after agreement period, the building may be useless. On the other hand, the most of the RMG industries those operate rental buildings thought that it is useless attempting to spend money for rental buildings because they might have to leave any time. The most of the RMG industries locating in rental buildings have mostly stairs in two sides and two exit gates whereas they should have stairs in four sides and have four gates. Some owners who operate buildings from rental buildings suggest following inspection by the NTPA, they attempted to increase exit gates but they failed to receive approval from the owners of the buildings.

Table 22: Ownership of RMG factory buildings

Ownership type	Frequency	Percent
Own	9	45.00
Rental	11	55.00
Total	20	100.0

6. Suggestions to improve earthquake risk reduction strategies

6.1 Suggestions to improve earthquake preparation

Although current practices and policies mostly provide guide for structural resistance of the RMG factory buildings, it does not have any direction for earthquake risk implementation strategies. As such, the first and the foremost important step in earthquake preparation is recognizing earthquake as a hazard for RMG industries because the region is located within and adjacent to active fault zone. As it was noted that many industries did not include earthquake preparation in their hazard training manual, the GoB should develop appropriate policy and act to include the hazard in their ongoing training activities. Qualitative data obtained through survey and discussion with workers and key informant suggest a number of important steps to improve earthquake preparation. These include:

- Awareness generation among workers about scientific nature of earthquake and its associated damage through discussions, meetings and videos;

- Frequent direct training activities among workers how to become calm and firm during earthquake in order to take refuge during earthquake. Refreshment training can be conducted year round through distributing leaflet, poster, banner and manual;
- Evaluation of workers' behavior after every earthquake and apply this to improve future earthquake preparation;
- New workers should be provided training about workplace safety within first week of joining at workplace; and
- Each RMG industry should be designed and constructed having enough distance from the adjacent building;

6.2 Suggestions to improve evacuation following earthquake

Having lack of unified action plans from the GoB, BGMEA and BKMEA, different RMG industries undertake varying types of evacuation procedures for their industries. Although, some industries train and allow occupants to evacuate from the buildings experiencing the shaking of the earthquakes, the experts suggest that it rather increases the likelihood of further deaths and injuries. Improved evacuation option much depends on building structure, design, floor number, own building or rental building and purpose of building construction, etc. Questionnaire survey and discussion with workers provided some valuable suggestions to improve emergency evacuation during any emergency events. These include:

- Each worker should have adequate knowledge about building space particularly stairs, gates, lifts and rescue windows;
- According to the ILO instruction, there should be at least 4 gates in the factory building.
- There must be enough space among the sewing machine;
- Rescue window should be installed appropriate location for emergency evacuation of the workers on upper floors;
- Ladder must be available at all times for emergency evacuation from upper floors;
- Water should be available properly in every floor;

- Evacuation stairs and ground floor should always be without any obstacle for free movement of people

6.3 Future plan to improve earthquake preparedness

Key informant discussions with factory owners, top executives, human resource management officials and conscious workers provided following plans to improve earthquake preparation.

- Installment of evacuation gates following ILO instructions, building size and workers numbers. There should be at least four gates in each RMG building;
- Building design and construction materials should be earthquake resistance. Buildings must be constructed following the BNBC rules and guidelines;
- Running RMG business in own building allows highest compliance.
- Integration of earthquake training along with ongoing fire training;
- Provision of frequent drills to evacuate from buildings if necessary during earthquake along with fire drill;
- Ensuring quick emergency response to operate smooth rescue if any earthquake occurs;

7. Institutional training activities among workers

Currently RMG industries provide training on fire safety in every two months. The compliance officer of the respective industry organises and conducts the training session for workers. Some industries provide training on fire, earthquake and personal protective equipment (PPE) together. Trainings are also arranged by the FSCD after every three months. Factory representatives attend mandatory training provided BGMEA, BKMEA and FRCD. Later they train up their workers. Although trainings were not much frequently organized before Tazrin Fashion fire incident and Rana Plaza collapse, each RMG industry management is much conscious about its necessity. As such, they initiate more trainings and awareness programme. Of the three inspection authorities, Alliance has included earthquake awareness and safety training to its member industry since December 2015. A few RMG industries got training

from the Department of Environment and the GoB. However, NGOs are not engaged with any sort of workplace safety training for workers in RMG industries.

8. Feasibility and applicability of integrated disaster risk reduction strategies in RMG industries

Discussions with key informants, representatives from BGMEA, BKMEA and lessons learnt from dissemination of findings in workshops suggest that key findings of this research are very useful for RMG industries. Having saying that it could be very tough to implement such important findings because some RMG industry representatives told that they are struggling to comply with ongoing workplace safety plan provided following the Rana Plaza collapse in 2013. As such, they are eagerly waiting to see when current Alliance, Accord and NTPA monitoring activities in RMG industries will expire in June 2018. They consider that a new earthquake risk reduction initiative in RMG industries are rather imposed making their business harder for them. Some industry owners straightforwardly accepted to implement key findings for their business. Those industry representatives showed apathy towards accepting new direction for earthquake risk reduction, had offered to discuss and present findings to them again through BGMEA and BKMEA. With this dual position of the RMG industries to accept and implement directions from this research, the findings need to be disseminated to top level government officials and ministers of the Ministry of Labour and Employment, Department of Inspection for Factories and Establishment (DIFE), Ministry of Disaster Management and Relief (MoDMR) and Ministry of Industries, the GoB.

9. Conclusions

The applied value of the research is providing immediate practical solutions and feeding into policy on how effective people centered emergency response and disaster governance could be developed and implemented for RMG industries. By collecting and collating key initiatives on seismic zoning, risk reduction activities, Bangladesh national building code, policy and plan relating to building constructions, earthquake preparation and emergency response, this research suggests that current policies have

adequately addressed for structural integrity of buildings. However, these policies inadequately addressed about earthquake disaster governance and preparation in RMG industries. The workplace safety acts, rules, policies, programmes and initiatives relating to dock labourers, child labour protection, maternity benefit, fire prevention and labour rights in Bangladesh were collected and analysed. Following Rana Plaza collapse in 2013, these were updated and strengthened to ensure workplace safety in RMG industries. However, these mainly focused on fire hazard and safety. A key learning from this research is that a highest compliance industry trains its workers, supervisors, officials and top executives equally through formal and informal training initiatives about hazard, disaster preparedness and safe evacuation if necessary. The key inspection authorities- Alliance, Accord and NAP may share their inspection experiences, good/bad examples and any model to enhance future monitoring activities for workplace safety in Bangladesh.

The research may help to develop and rectify new policy and practices for emergency response and disaster governance. A combination of these activities will lead to the development of a coordinated and people centred emergency response and disaster governance plan for RMG industries in Bangladesh. The specific audiences of this research will be research academics, government of Bangladesh, NGOs, BGMEA, BKMEA, industrial and commercial units and residents in Bangladesh along with other international developmental organisations working on earthquake risk reduction, emergency response and disaster preparedness in Bangladesh and elsewhere in the world. Discussions with key informants, representatives from BGMEA, BKMEA and lessons learnt from dissemination of findings in workshops suggest that key findings of this research are very useful for RMG industries. However, the findings further need to be disseminated to top level government officials and ministers of the Ministry of Labour and Employment, Department of Inspection for Factories and Establishment (DIFE), Ministry of Disaster Management and Relief (MoDMR) and Ministry of Industries, the GoB to develop implementation strategies.

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Annexure 1: A questionnaire on earthquake risk reduction strategies for readymade garment industries in Bangladesh

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(Survey data will be used academic research purpose only and information provided would be disclose anyway)

1. Demographics and personal information

No	Information/ Level	Information code					
i	Gender	1= Male			2=Female		
ii	Age	Year:					
iii	Education	1=Illiterate	2=<S.S.C	3= S.S.C	4= H.S.C	5=Graduate	6=Postgraduate
iv	Type of work	1= worker	2=supervisor	3=official	4= executive/ management	5= owner	
v	Years of experience						

2. Hazard and risk knowledge, perception and preparedness

1. What type of hazard (i.e. fire, earthquake, cyclone or other events) do you perceive most in your workplace?

2. What type of hazard does the management/owner of your factory informed you to be aware of in this building?
3. Do you remember when did the management/owner of your factory start to inform you to be aware of these hazards in the building?

4. What do you know about earthquake and how do you know about it?

5. Do you perceive ever occurrence of earthquake in your workplace area? 1= Yes, 2= No
6. Do you perceive ever occurrence of earthquake in your residential area?1= Yes, 2= No
7. Do you have any earthquake experiences in workplace? 1= Yes, 2= No
8. If yes, please detail your experiences.

9. Did you ever have experience earthquake/fire drill in this building? 1= Yes, 2= No

10. What problems/challenges do you face in this workplace or other places during past earthquake events?

11. Do you know what to do if you face any earthquake whilst working in this building?

1= Yes, 2= No

12. If yes, what did you do if you face any earthquake whilst working in this building/past workplace?

13. Do you know that you should not touch/stay near the metal elements/electric wires/gas oven, mirrors, glasses or similar item during the earthquake? 1= Yes, 2= No
14. Do you know the evacuation/exit gate of this building in case of fire emergency?

1= Yes, 2= No

15. Do you know the comparatively safe place of this building to take refuge whilst facing earthquake?1= Yes, 2= No

16. Do you know that if you face an earthquake whilst inside the building you should take refuge underneath strong table, pillar or beam?1= Yes, 2= No
17. Do you know the assembly area following evacuating from the building after an earthquake occurrence? 1= Yes, 2= No
18. Are the contact numbers of emergency services providers (fire services, ambulance, hospital, police, gas, electricity) readily available to you?
19. Do you know the location of first aid kit in this floor of the building? 1= Yes, 2= No
20. What do you think about the problems you might face if an earthquake occurs whilst you work in this building?
21. What are major evacuation problem in this building

Types of problems	Types of problems
1= Blocked exit gate	7= Locked collapsible gate on different floors
2= Passages, aisles, corridors, stairways are blocked by packages	8= the provision of one main entrance and exit on the ground floor that is wide enough for the mobility of workers in the factory
3= Narrow exit doors than required	
4= No exit sign	
5= Improperly illuminated exit sign	
5= No fire doors installed	
6= Fire door doesn't swing in the direction of travel	

22. What do you suggest to improve earthquake preparation in your workplace building?

23. What do you suggest to improve evacuation from this building if an earthquake occurs?

24. Do you have any preparedness plan to mitigate earthquake effects?

25. Have any Governmental and non-governmental Organisations (NGOs) worked in this area to generate awareness about earthquakes among workers?

Annexure 2: A manual for effective earthquake preparation and evacuation in RMG industries

No	Preparation activity	Executive/Implementing agencies
	Risk reduction	
1	Identification and acceptance of earthquake as a hazard for RMG industries	DIFE, BGMEA, BKMEA and all industries
2	Construction of buildings by following BNBC and deployment of certified engineers and construction workforce in all phases of building construction	All industries

3	Place electrical and gas lines carefully and securely so that they can be plugged off easily during emergency events	All industries
4	Incorporation of earthquake preparedness within current workplace safety manual particularly fire training	BGMEA, BKMEA and all industries
5	No heavy items should be upper shelves of the wall and place heavy items strongly against the wall	All industries
6	Informed earthquake preparedness to all occupants and frequent earthquake drills (i.e., drop, cover and hold) for effective preparedness	BGMEA, BKMEA, FSCD and all industries
7	Keep emergency service providers' number (i.e., FSCD, hospitals, police, etc.) available to all occupants	All industries
Earthquake preparedness		
1	Training activities among workers how to become calm and firm during earthquake in order to take refuge during earthquake	BGMEA, BKMEA, FSCD and all industries
2	Take comparatively safe refuge by standing along the side of strong beam and underneath stronger table during an earthquake occurrence	All industries
3	Aware industrial occupants NOT to be adjacent to metal elements/electric wires/gas oven, mirrors, glasses or other similar items during the earthquake	All industries
4	Prepare emergency preparedness team providing distinctive rules and responsibilities to perform during an event	All industries
5	Impart first aid kit training for all occupants	All industries
6	Provide all occupants clear idea about the location of exit/evacuation gates during any emergency event if they require to empty the building	All industries

Annexure 3: A policy brief in relation to improving earthquake risk reduction strategies for the Government of Bangladesh, BGMEA and BKMEA

It is my pleasure to introduce key findings of the research project entitled "Investigating effectiveness of the earthquake risk reduction strategies for readymade garment (RMG) industry occupants in Chittagong, Bangladesh". The project includes three collaborating partners: Associate Professor Dr Md Edris Alam (Principal Investigator), University of Chittagong, Bangladesh; Professor LianYou Liu, Beijing Normal University (BNU); Associate Professor Yamuna Kalamuchi, London South Bank University, UK. The project funded from the ICCR-DRR collaborative research grants scheme called 'The project 00084327

Sharing and Learning on Community Based Disaster Management in Asia (Phase II)' which received fund from the UNDP China.

By experiencing frequent tropical cyclones and floods, the government of Bangladesh has developed disaster response and mitigation mechanism for these hazards. However, due to infrequent occurrence and long recurrence interval of great earthquakes, the response mechanism is inadequate for this type of hazard. Furthermore, current policies have inadequately defined emergency responses and disaster preparation in relation to earthquake hazards in Bangladeshi readymade garments (RMG) industries. This research aims to address this gap by analyzing disaster risk reduction policy documents as well as surveying readymade garments industry occupants in Bangladesh. To achieve the aims of this research, it applied multidisciplinary approaches by using qualitative and quantitative data (i.e. policy documents, field observations, structured and semi-structured interviews) collected among factory workers, owners, fire services and civil defense officials, key executives, experts and administrators in Chittagong and Dhaka, Bangladesh. To assess RMG occupants' knowledge, risk perception and preparedness to earthquake hazards in Chittagong, a combination of semi-structured and open ended questionnaire were administered to collect data from 178workers of 20 RMG factories in Chittagong, Bangladesh. Of these workers, male and female were 119 and 59 respectively. A total of 25 key informant interviews were conducted to develop effective earthquake risk reduction strategies through a participatory consultation with factory workers, owners, key executive officers and administrators in Chittagong. The project suggests to include new policy, rectify existing one, remove some current practices for effective earthquake risk reduction mechanism in RMG industries. These include:

The research reviewed workplace safety acts, rules, policies, programmes and initiatives relating dock labourers, child labour protection, maternity benefit, fire prevention and labour rights in Bangladesh. Following Rana Plaza collapse in 2013, these were updated and strengthened to ensure workplace safety in RMG industries. However, these initiatives were still concentrated on fire hazard and safety. Although some industries incorporated earthquake preparation activity in their training manual, the majority industries had not undertaken preparation for any future earthquake occurrence. *The research suggests that the industries may strengthen earthquake preparation by incorporating this within current workplace safety manual particularly fire training without incurring cost for this new approach.*

The majority workers suggested that they did not need to do anything for the past earthquakes because of their short duration and lesser intensity. Ten respondents suggest that because of the vibration of the sewing machine, the workers could not understand the earthquake. The other workers suggested that by

experiencing the tremor, they run toward the assembly area or took shelter under machine or table. Those industries are highly compliance with workplace safety, they trained workers about earthquake preparedness within their fire safety training. They trained workers to get down from the building in a row and took refuge in assembly area or stay near to stronger beam and underneath the stronger table. Some compliance industries suggested that they provide alarm and open all gates to evacuate from the building immediately after understanding earthquake occurrence. *When the findings were shared with national key earthquake risk reduction experts, they asserted that the RMG industries are providing wrong message to workers to evacuate building during earthquake. It rather increases chance of occurrence of deaths and injuries by attempting to evacuate from building during earthquakes.*

Those RMG industries are highly compliance with workplace safety related acts, rules and polices, they train workers about both fire and earthquake. Key informant discussions suggest that those industries make aware of the earthquake, the workers have higher level of risk perception. They informed that they can evacuate from the building in two minutes if any hazard alarm provided. Those respondents identified evacuation problem include: (1) the provision of the main entrance and exit on the ground floor that is not wide enough for the mobility of workers in the factory; (2) narrow exit gate; (3) passages, aisles, corridors, stairways are blocked by packages; (4) no fire door installed; (5) no exit sign; (6) blocked exit gate etc. *The DIFE, BGMEA and BKMEA should take necessary to minimize these evacuation problems during any emergency events.*

In response to what to do if an earthquake occurs at workplace, about 79 percent respondents suggest that they have general knowledge about earthquake preparation. Of the industrial workers, 82 percent suggest that they are aware of not to be adjacent to metal elements/electric wires/gas oven, mirrors, glasses or other similar items during the earthquake. They learnt about these risk elements from workplace training, co-workers, general discussions, electronic and print media. Of the participating 178 workers, 79 percent know that they may take comparatively safe refuge by standing along the side of strong beam and underneath stronger table during an earthquake occurrence. Overwhelming majority workers, 94 percent have clear idea about the location of exit/evacuation gate during any emergency events. *It would require frequent direct training activities among workers how to become calm and firm during earthquake in order to take refuge during earthquake. Refreshment training can be conducted year round through distributing leaflet, poster, banner and manual. The earthquake awareness and preparedness knowledge should be further disseminated through institutional framework of RMG industries, BGMEA and BKMEA.*

It is noted that the ownerships of buildings have significant impact on hazard preparedness. Of the surveyed 178 industries, 105 and 74 are located rental and own buildings respectively. Those buildings are located in rental building faced comparatively higher challenges to comply with structural integrity and hazard preparedness. Discussions with the key executives of the RMG industries those located in rental buildings suggest that they have to get approval from the building owners to make any structural change. It is unlikely that they will provide approval for such changes even if it causes strengthening the buildings. The owner might think that if the RMG leaves the building after agreement period, the building may be useless for other purposes. On the other hand, the most of the RMG industries those operate from rental buildings thought that it is useless attempting to spend money for rental buildings because they might have to leave any time. The most of the RMG industries locating in rental buildings have stairs in two sides and two exit gates whereas they should have stairs in four sides and have four gates. Some owners who operate business from rental buildings suggest following inspection by the National Tripartite Plan of Action (NTPA), they attempted to increase exit gates but they failed to receive approval from the owners of the buildings. *The DIFE, BGMEA and BKMEA should make necessary legal and policy steps to run RMG business only from buildings with authorized safety and compliance framework. There should be at least 4 gates in the factory building according to the ILO instruction. A key learning from this research is that a disaster resilience industry trains its workers, supervisors, officials and top executives equally through formal and informal training initiatives about hazard, disaster preparedness and evacuation procedure.* On the other hand, a non-resilience industry may have enough or limited preparatory/policy documents but its disaster preparation knowledge is limited within top executive without passing down to lower level officials and workers.

Finally, the research suggests that the key inspection authorities- Alliance, Accord and NTPA of the RMG industries may share their inspection experiences, good/bad examples and any model to enhance future monitoring activities for workplace safety in Bangladesh.