A SURVEY AND ANALYTICAL STUDY OF EARTHQUAKE PREPAREDNESS AND RISK RECEPTION IN AN URBAN AREA: THE CASE OF DHAKA CITY, BANGLADESH

Md. Asaduzzaman*[1], Md. Zubayer Zakaria Sajib[2], Sanjida Sharmin[3] and Mehedi Hasan[4]

[1] *Student, Department of Building Engineering & Construction Management, Rajshahi University of Engineering & Technology, Bangladesh, e-mail: 1812003@student.ruet.ac.bd*
[2] *Student, Department of Building Engineering & Construction Management, Rajshahi University of Engineering & Technology, Bangladesh, e-mail: sajib18ruet@gmail.com*
[3] *Student, Department of Building Engineering & Construction Management, Rajshahi University of Engineering & Technology, Bangladesh, e-mail: sanjida.sharmin2000@gmail.com*
[4] *Assistant Professor, Department of Building Engineering & Construction Management, Rajshahi University of Engineering & Technology, Bangladesh, e-mail: mehedi@becm.ruet.ac.bd*

***Corresponding Author**

ABSTRACT

Bangladesh is located in a seismically active region. Dhaka, one of the world's most densely inhabited and urbanizing regions, is especially susceptible to seismic disasters because of its position and poor infrastructure. After the earthquakes in Turkey and Syria on 6 February 2023, it is now even more likely that the city will experience a significant earthquake soon. This paper presents the results of an investigation carried out to identify the level of quake preparedness and risk perception among Dhaka people by the needs assessment method. The investigation was designed using a set of questionnaires by analyzing the available secondary data and data was collected through a self-reported online survey. This study tries to examine the risks, attitudes, viewpoints, behavior of people, casualty awareness, building facilities for safe exit, and current efficiency of rescue units and provide effective solutions for risk mitigation and finds a significant distinction in earthquake preparation knowledge among people, lack of facilities and poor efficiency of rescue units. From this survey, more than 72% of the participants reported having no prior experience with earthquake preparedness programs. Only 36% of people are aware of the emergency response procedures and acquired knowledge. 76% of people claimed not having advice from their building management about escape routes in the event of an earthquake, making it the worst-case scenario as people try to escape without proper discipline and face chaos. It is important to emphasize the importance of being prepared as part of daily living in the city. It is imperative to institutionalize preparedness to lower the risk that extreme natural disasters pose to citizens. This paper concludes by stating that there is a lack of amenities in structures, insufficient public preparedness for earthquake events, and a lack of adaptation and application of new technology for which effective education and holistic earthquake preparedness programs are typically needed.

Keywords: *Earthquake, preparedness, seismic hazards, awareness, emergency response*

1. INTRODUCTION

Bangladesh is incredibly vulnerable to natural disasters, particularly tornadoes, cyclones, earthquakes, and floods. Bangladesh's capital city, Dhaka, is home to more than 19 million people and is a megacity that is expanding quickly, because of its location on a tectonic plate that is actively moving (CDMP, 2009; Hossain et al., 2022; Szmigiera, 2023). The city is very vulnerable to earthquakes. A significant earthquake in Dhaka might have disastrous effects, resulting in extensive damage to infrastructure and buildings as well as a high death toll. The city is situated on a geologically active tectonic plate and is therefore at high risk of earthquakes. A significant earthquake in Dhaka might have disastrous effects, resulting in extensive damage to infrastructure and buildings as well as a high death toll. This study explores how people in Bangladesh's densely populated metropolis of Dhaka City prepare for and respond to earthquakes.

On 6 February 2023, southeastern Turkey and northern Syria faced a massive earthquake (M7.8). As a result, 6,000 deaths were reported in Syria and 45,089 deaths were reported in Turkey (Akhoondzadeh et al. 2023; Cinar et al. 2023). There would be disastrous effects if an earthquake of that magnitude occurred in Bangladesh. In this instance, raising people's awareness may help to enhance the survival rate while also lowering the death toll.

Bangladesh's capital and commercial center, Dhaka City, is situated at the intersection of rapidly increasing urbanization and seismic hazards. Bangladesh's geo-tectonic configuration, which places it near two of the planet's active plate borders, indicates that there is a chance of both infrequent but very strong earthquakes that could cause damage far from their epicenters and a high probability of damage following earthquakes (Rahman, 2019). This is becoming more and more significant because a recent GPS study of Bangladesh, India, and Myanmar (Burma) has discovered shocking evidence that the Indian subcontinent's northeastern corner is actively colliding with Asia. This might put one of the world's most populous regions at serious risk for earthquakes (Ahmed et al. 2017).

In a previous study in 2019, it was found that public awareness of seismic risk perception and mitigation is poor (Rahman, 2019). In recent years, we have had a lot of small and medium-sized earthquakes in Bangladesh and neighboring countries (Earthquake Track, n.d.). As the frequency of earthquakes is increasing day by day, how the people of Dhaka city are taking this incident into account and acting is changing too. This also includes whether public awareness of seismic risk perception and preparedness is increased or not. There are some existing surveys on this topic already. But as the preparedness condition or experiences is a kind of dynamic procedure, we tried to find out what the current condition of preparedness among people and how aware they are about earthquake preparedness at the current time.

To get a more complex understanding, the study takes a multimodal approach, combining qualitative and quantitative techniques. We explore the complexities of public perceptions of earthquake risk, government measures, and individual and community preparedness using surveys, interviews, and empirical data analysis. Through a focused examination of earthquake preparedness and risk reception in Dhaka City, this study aims to shed light on the intricacies of addressing seismic vulnerability in rapidly growing urban environments, ultimately fostering resilience and safeguarding the lives and well-being of the city's inhabitants.

2. STUDY AREA

Bangladesh's Dhaka was selected as the study area. Bangladesh's capital city, Dhaka, is situated on the banks of the Buriganga River in the country's center and lies between the latitude 23°35' N - 23°54' N and the longitudes 90°19' E - 90°30' E. Given its location within the Indo-Burman subduction zone high seismic zone, the city is thought to be at a high risk of earthquakes (Debnath, 2013). With a population of more than 19 million, Dhaka is the world's most densely populated metropolis. Reconnaissance field visits were made to Dhaka, Bangladesh. Dhaka was selected as the study region for several reasons. A stroll around Dhaka's streets reveals a city with serious structural weaknesses: many buildings are made

potentially dangerous because of inadequate construction standards, lax enforcement, and poor upkeep (Rahman, 2019). Given its size and the concentration of people, structures, and businesses there, Dhaka would be the area in Bangladesh most affected by a large-magnitude earthquake. Due to the city of Dhaka's rapid population increase, new structures had to be built quickly and haphazardly in every available place. It is widely accepted that many new buildings lack sufficient seismic protection since there is no efficient enforcement mechanism in place (Paul et al. 2010). According to some studies, large cities in the nation, especially Dhaka, are extremely vulnerable to earthquakes of even a moderate size. These factors led to the decision to survey Dhaka.

2.1 Objectives of The Study

This study's main goal is to look at how Dhaka people perceive seismic danger to find out how much they know about earthquake preparedness. Risk perception is defined as each person's unique evaluation of the seriousness of threats and level of risk (Rahman, 2019). The purpose of this study was to determine how attitudes, beliefs, and behaviors vary as the frequent earthquake are occurring worldwide. This study attempted to investigate and contrast the perceptions of risk and levels of readiness among various age, gender, and educational groups (Rahman, 2019). Consequently, the following are the study's precise goals:

1. To evaluate the state of preparation of government and general people for earthquakes.
2. To assess public awareness and perception of earthquake risks.
3. To assess people's conduct and level of awareness regarding the possibility of earthquakes in Dhaka.

3. MATERIALS AND METHODOLOGY

Scientific study is logically guided by methodology. This study employs primary and secondary data with a descriptive study design. As for secondary data, the methodology employed for this study comprises many sequential steps, including defining the problem and the study area, collecting data from various websites and published journals, and arranging and evaluating the data according to the investigation's objectives. To do this, initially, a conceptual understanding of the study problem and theoretical framework was constructed. This was followed by an analysis and identification of the causes, vulnerabilities, risk zones, readiness, and impacts of the earthquake. At last, all of the examined material and data had been processed and arranged.

Based on secondary data, a questionnaire survey with closed-ended questions was used to determine how prepared Dhaka City residents were for earthquake disasters. The study collected quantitative data to enhance the awareness and preparation of Dhaka city people for earthquakes. To gather data for an online study, 521 individuals filled out the Google form, and respondents were selected using social media platforms mainly Facebook, and WhatsApp respondents who filled out the form were also encouraged to share it with friends and families.

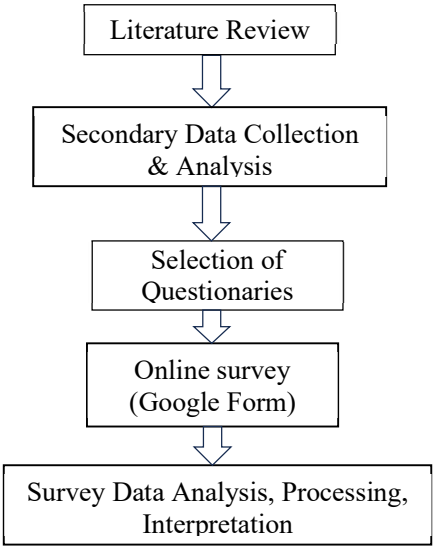

Figure 1: Flowchart showing the sequential steps of the work

4. MAJOR CAUSES OF EARTHQUAKES IN BANGLADESH

Since Bangladesh is situated in a seismically active area, earthquakes pose a serious threat to the nation. Tectonic plate movement is the main source of earthquakes in Bangladesh. The country is situated at the junction of three tectonic plates: the Indian Plate, the Eurasian Plate, and the Burmese Plate. The Indian Plate and the Eurasian Plate meet as they advance northward, buckling and slipping past one another on their margins.

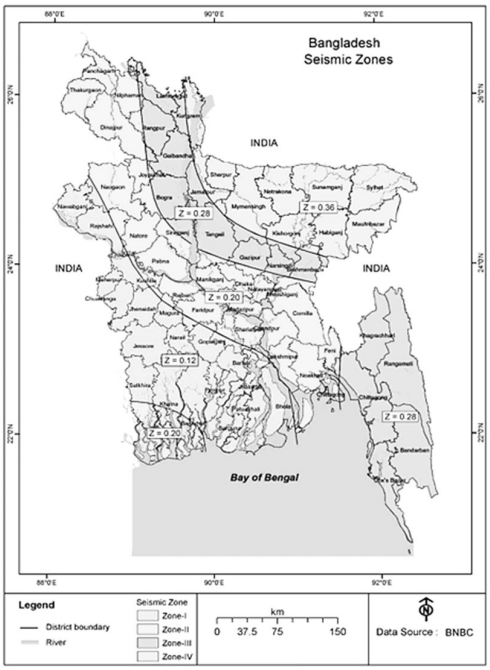

Figure 2: Bangladesh seismic zone map according to BNBC 2020 (GoB, 2021)

Three main fault lines in Bangladesh are responsible for most of the earthquakes in the country (Islam et al. 2016) :

- The Madhupur fault: This fault is located in central Bangladesh and runs from north to south.
- The Sylhet fault: This fault is located in northeastern Bangladesh and runs from east to west.

- The Chittagong-Myanmar fault: This fault is located in southeastern Bangladesh and runs from north to south.

A fault's likelihood of experiencing an earthquake is dependent on its velocity of motion and how long it has been since its last rupture. Bangladesh and its surroundings are home to active regional-scale faults that have the potential to produce moderate to large earthquakes.

Several elements raise the possibility of earthquakes in Bangladesh's rural and urban areas. Bangladesh's metropolitan centers have grown quickly to house the country's growing population, which has led to the massive development of multistory buildings. Many multi-story buildings have been built without adequate earthquake consideration since the country does not have a construction code that is legally enforced and there is a dearth of knowledge about earthquakes (Islam et al., 2016).

Apart from geological movements, human endeavors like large-scale dam construction, geothermal drilling, fracking, and underground mining can also result in earthquakes in Bangladesh.

4.1 Bangladesh's Earthquake Risk Factors

Bangladesh is situated in a seismically active area and has some characteristics that increase the danger of earthquakes, even though the nation is not typically renowned for having regular, large-magnitude earthquakes. Some of these factors include:

• High population density and construction without proper adherence to the building code's seismic design requirements.
• Bangladesh is crossed by several active fault lines, mostly in the northeast and southeast (Islam et al., 2016).
• Bangladesh is located where the Eurasian and Indian plates converge. There is tremendous pressure and friction along the border as the Indian plate pushes northward and collides with the Eurasian plate. There are tremors in the area, including Bangladesh, as a result of this continuous collision.
• Certain sections are inaccessible to rescue operations and firefighting vehicles due to inadequate road width and space between buildings (Islam et al., 2016).
• The hazards are further increased by low awareness and insufficient government and public earthquake preparedness measures.
• Low-quality building supplies and inappropriate building techniques (Islam et al., 2016).
• Insufficient road width and building spacing hinder the ability of rescue operations and firefighting trucks to access certain places.
• Lifeline facilities, such as power plants, power stations, bridges, communication control stations, gas and water supply stations, etc., are not designed to withstand earthquakes.
• Lack of facilities, including medical personnel, facilities, rescue gear, and trained people, as well as lack of readiness for earthquake recovery and emergency response (Islam et al., 2016).

4.2 Most Vulnerable Zone

The Madhupur, Dauki, and Eastern Plate boundary faults are the three main fault lines that run across Bangladesh; the Eurasian and Indian Plate boundaries are situated just outside the nation's eastern border. The probability of a powerful earthquake happening in the future has grown due to these fault lines and geological plate boundaries, past catastrophic earthquakes that have struck the nation and its surroundings, long-term silences of potential earthquakes (seismic gaps) throughout the region, and more.
According to Figure 3, there have been several earthquakes over the past 23 years (2000–2023), with the majority of their magnitudes falling between 4.00 and 5.00. However, the majority of the 2022–2023 earthquakes had a magnitude of 5.0 at the Bangladesh–India border (on 21/08/2023) to 5.5 near Ramganj, Chittagong, Bangladesh (on 04/12/2023), and so on (Earthquake Track, n.d.). There could be a major earthquake in the area at any time because the earthquake's amplitude and intensity are growing daily. The epicenter of the earthquake will be close to Dhaka, therefore if this occurs, it will be a big

calamity. Even though earthquakes are unpredictable, people who are at risk can benefit from increased understanding of this terrible phenomenon by having their structural and non-structural needs met as well as being less vulnerable to earthquakes.

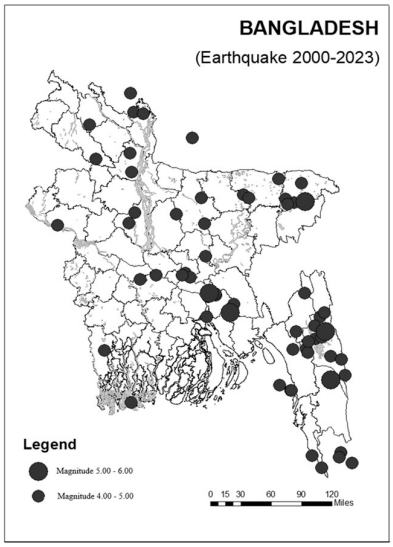

Figure 3: Earthquake in Bangladesh Form 2000-2023 (Author's Source)

Dhaka is a highly populated area where the majority of the buildings were constructed without adhering to the BNBC and DAP codes. The density of buildings is extremely close to one another, as Figure 4, makes evident. Approximately 10% of commercial, 9% of industrial, and 6% of residential buildings in Dhaka City were constructed in conservation areas (such as open spaces, water bodies, and areas prone to flooding). Of the 6.1 million buildings that make up the city, 67% of commercial and 51% of industrial structures do not follow the Detailed Area Plan (DAP) (Rahman et al., 2021). Additionally, most buildings near roads are constructed without adhering to BNBC regulations, which makes Dhaka city particularly vulnerable to earthquakes and may eventually cause traffic obstructions if one of them collapses during an earthquake.

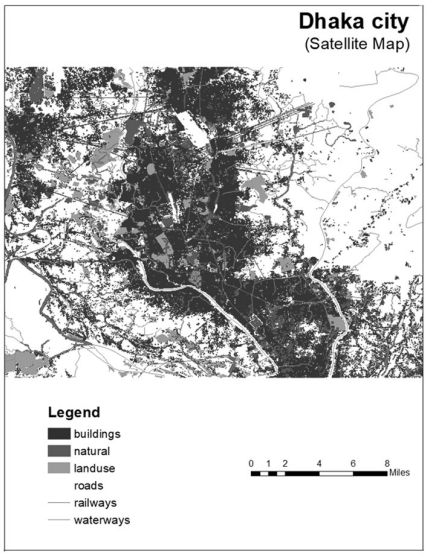

Figure 4: Building density in Dhaka City. (Author's Source)

5. DATA COLLECTION

The survey was conducted in September-October 2023 in Dhaka city as the main region.

5.1 Questionnaire

The survey was conducted in September-October 2023 in Dhaka city as the main region. In this study, the perception and awareness of seismic risk in the Dhaka region were evaluated. A 14-item questionnaire was created with two main sections: the general public's risk perception of earthquakes and other disasters, and demographic parameters including gender and education. The questionnaire form asked questions regarding personal information, place of residence, fundamental understanding of seismic activity, respondents' perceptions of disasters, preparedness for disasters, involvement, awareness, and behavior analysis. Every question was constructed with multiple-choice options. The questionnaire survey was created on a Google spreadsheet and it was shared with people through different social media platforms to gather data to assess the public's level of knowledge regarding the earthquake's characteristics. There were no in-person conversations or interviews just the delivery of questionnaires to the subjects for their answers. Individuals were allowed to reply as they pleased.

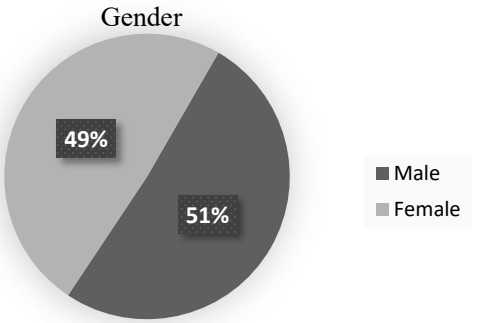

Figure 5: Frequency of the respondents

Figure 5, shows the frequency of the respondents of 1-14 questions. Of the 521 respondents, 266 (51 percent) were male and 255 (49 percent) were female. The age of the respondents was divided into a few categories where most of the respondent's age were in the range of 19-28 years old in Figure 6.

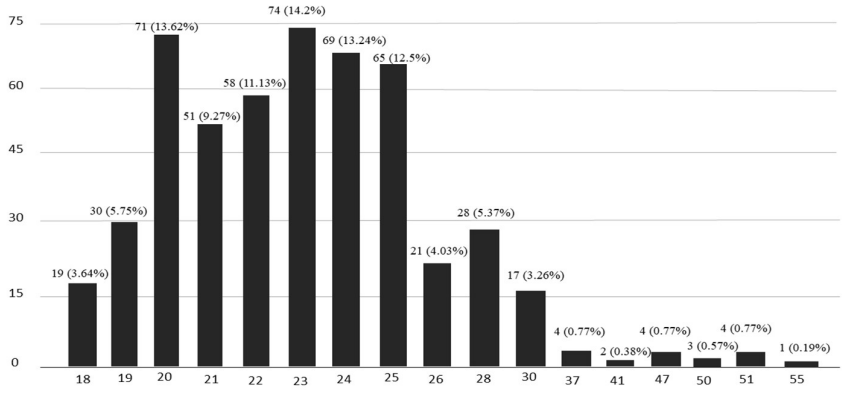

Figure 6: Age-based respondents

6. RESULTS

The questionnaire aimed to assess the knowledge level of the respondents on earthquake risk. Results were treated statistically, analyzed thoroughly, and commented on. Frequency analysis was done to present the characteristics of the study. The main results obtained from the survey are shown in Figure 7 (a) - Figure 7 (n).

Figure 7 (a) shows that 17% of people (89) participated in earthquake preparedness training or drills in the past, and 11% of people (57) partially participated in it. From this data, it can be said that only a few people in Dhaka can take safety measures during an earthquake. Figure 7 (b) shows that of people who know the importance of staying calm and comforting others when an earthquake happens 17% of people (89) created a family emergency plan that includes earthquake-specific actions while 70% of people (365) didn't take any measures which represents that most of the people are in direct danger.

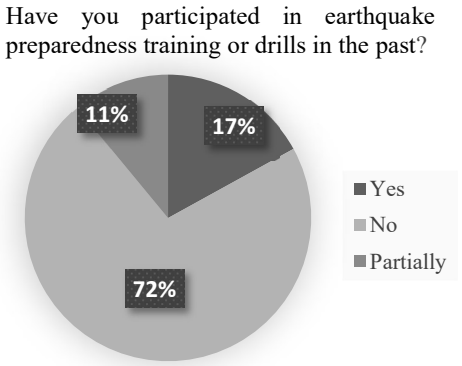

Figure 7 (a): Question no. 1

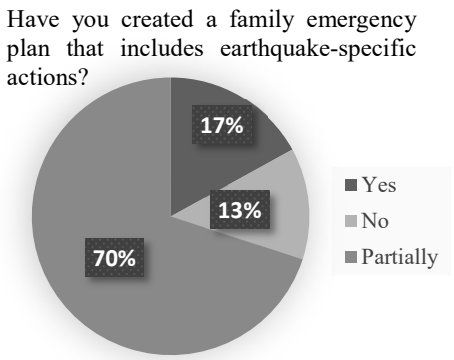

Figure 7 (b): Question no. 2

Figure 7 (c) shows that 21% of people (110) assembled an emergency kit with essential supplies like food, water, first aid, flashlights, and batteries and 77% of people (402) didn't care about that. This data shows that a large number of people are not even aware of being in problems and scarcities during an earthquake. Figure 7 (d) shows that 51% of people (266) know how to "Drop, Cover, and Hold On" during an earthquake for personal safety and 15% of people (78) have partial information on that which represents only half of the population knows about the urgent measures taken during an earthquake.

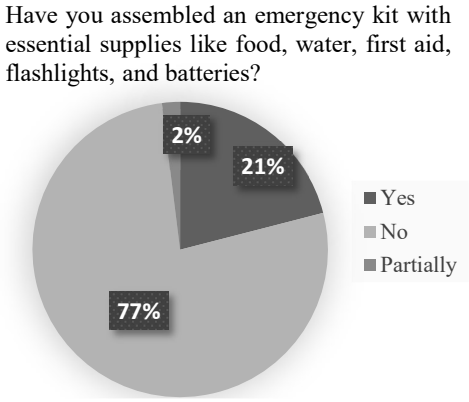

Figure 7 (c): Question no. 3

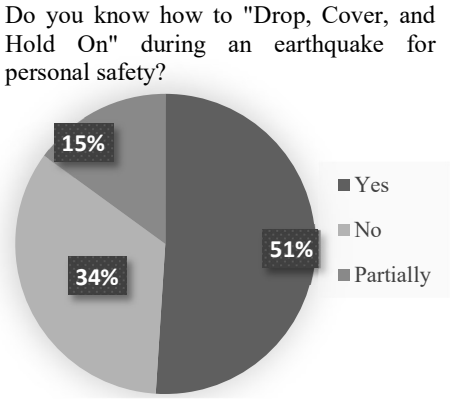

Figure 7 (d): Question no. 4

Figure 7 (e) shows that 55% of people (287) considered how to shut off utilities (gas, water, and electricity) in their homes to prevent hazards during and after an earthquake and 26% of people (136) didn't. This data shows that most people don't know the urgent measures that should be taken just after the earthquake. From Figure 7 (f) we see that 45% of people (234) are aware of the locations of safe

zones or shelters in their community in case they need to evacuate their homes and 47% of people (245) are unaware which represents that most of the people don't even know about their escape route.

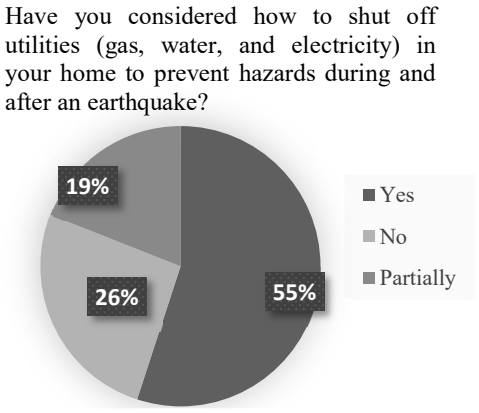

Figure 7 (e): Question no. 5

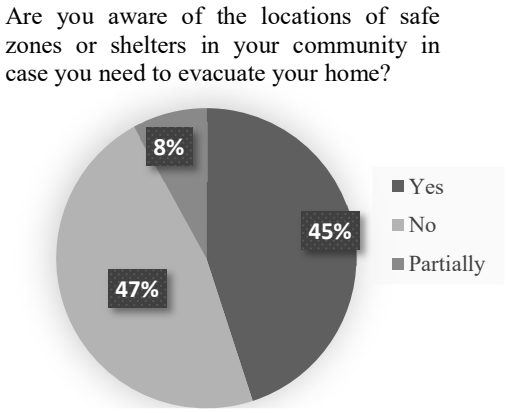

Figure 7 (f): Question no. 6

Figure 7 (g) shows that 45% of people (234) know to provide basic first aid in case of injuries during an earthquake while 34% (177) have no idea. Basic 1st aid knowledge is essential for every person for any type of emergency that is absent among people. Figure 7 (h) shows that 36% (188) community are aware of the emergency response procedures and contact information in their local area or community and 15% of people (78) are partially aware.

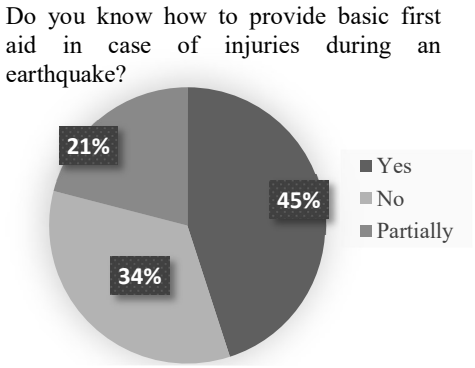

Figure 7 (g): Question no. 7

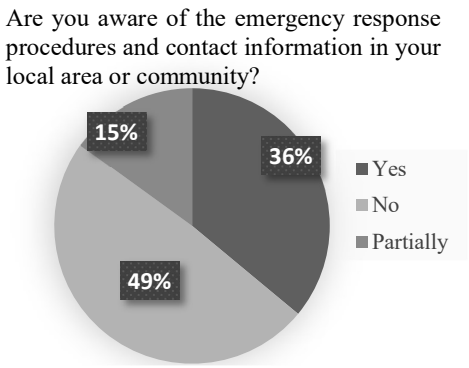

Figure 7 (h): Question no. 8

Among people, 66% (344) of the locality is familiar with the warning signs of a potential earthquake, such as ground shaking, unusual animal behavior, or emergency alerts as found in Figure 7 (i). This shows that at least more than half of people know about the warning signs. From Figure 7 (J), we see that only 25% of people (130) are aware of the resources and support available from local authorities and organizations in the aftermath of an earthquake while 66% of people (344) are unaware of it which is alarming because without securing help from authorities, uncertainties will increase.

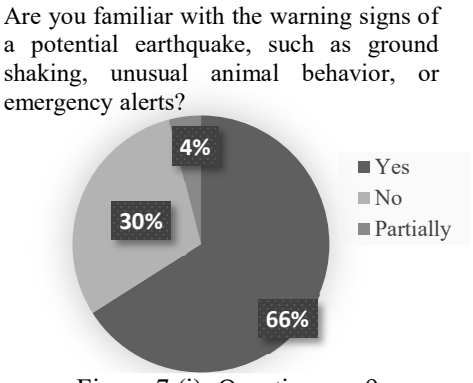

Figure 7 (i): Question no. 9

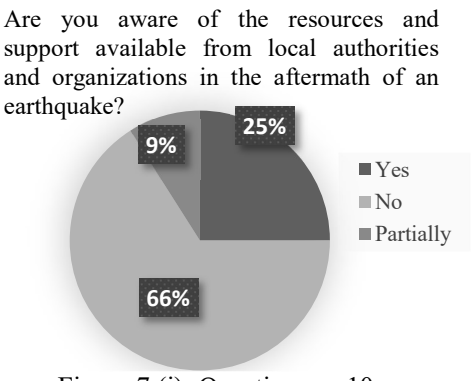

Figure 7 (j): Question no. 10

Figure 7 (k) shows that 20% of people (104) received earthquake-related information or guidance from building management or homeowners' associations and 76% of people (396) didn't receive that. Building owners need to make it more frequent and accessible. Figure 7 (l) shows that about 60% of people (313) have seen or been informed about the building's emergency exit routes and assembly points in case of an earthquake.

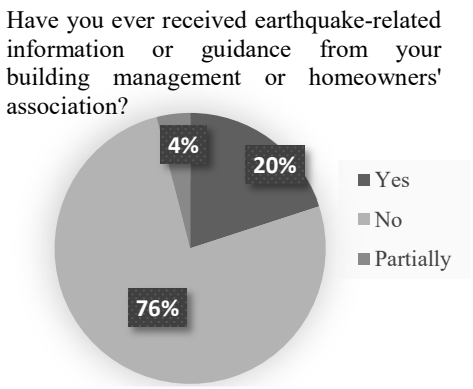

Figure 7 (k): Question no. 11

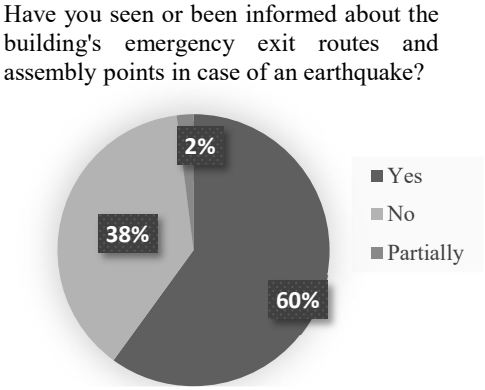

Figure 7 (l): Question no. 12

Figure 7 (m) shows that 51% of people (266) know the location of fire extinguishers, first aid kits, and emergency supplies within the building and 40% of people (208) have no idea about it. This shows that half of the population has no idea about the basic needs processes that should be maintained. Figure 7 (n) shows 49% of people (255) know the location of utility shut-off valves (e.g., gas, water, electricity) and how to turn them off in case of a gas leak or other hazards during an earthquake 45% of people are not aware of it.

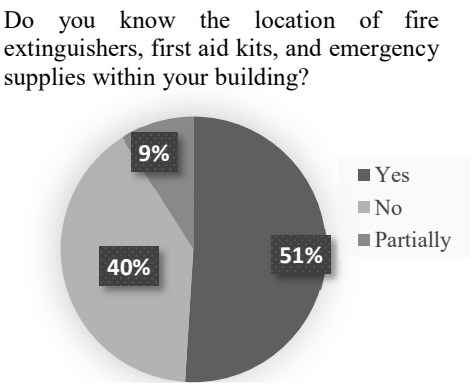

Figure 7 (m): Question no. 13

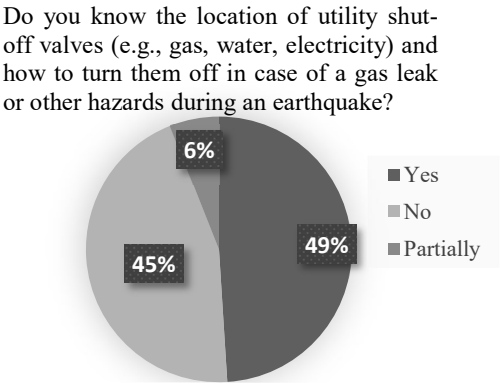

Figure 7 (n): Question no. 14

7. DISCUSSION

The results of this study indicate that there has to be improvement in the public's understanding of basic theory and emergency response, as well as their perception and reduction of seismic risk. The improvement of respondents' technical, informational, and training needs is directly impacted by this questionnaire survey. The purpose of this study is to determine how gender influences approach variations. Regarding the gender issue, this study discovered that female respondents were more prepared for earthquakes and had a greater sense of danger than male respondents. This finding corroborates that of the earlier study, which found that women knew more about earthquake mitigation strategies than did men. It should be highlighted that when it comes to crisis management, both the male and female populations need to be better or more accomplished.

In this study, the target population was the residents of Dhaka who were 18 years of age or older. This study demonstrates that a significant portion of the population is unaware that there are issues and shortages during an earthquake, nor are they aware of the critical actions that must be adopted immediately. The placement and usage of fire extinguishers, first aid kits, and emergency supplies within the building are not well known to the public. Improving people's understanding, awareness, and education is crucial to reducing the harm caused by earthquakes in the future. To effectively encourage adult participation and preparedness in the event of an earthquake, more steps should be taken to improve preparedness for earthquakes. For instance, more lessons should be added to textbooks in schools and colleges; the government and non-governmental organizations should organize activities for children with earthquake hazard education; and parents should be consulted about these issues.
The findings of this study give the government the idea that people's perceptions of danger, levels of awareness, and readiness for earthquake emergency management are appallingly low, and that action needs to be taken to change this.

8. RECOMMENDATIONS

The findings of this study give the government the idea that people's perceptions of danger, levels of awareness, and readiness for earthquake emergency management are appallingly low, and that action needs to be taken to change this:

- Create awareness: People living in cities should have a general understanding of earthquakes. It should also arrange seismic demos to instruct people on how to evacuate in the event of a devastating earthquake. Radio and television should take the appropriate safety measures to provide earthquake preparedness tips and general dos and don'ts.
- Produce government organizations: The impact can be kept within manageable limits by putting into practice sensible disaster management policies and plans, community education and training programs, proper observance of the National Building Code, efficient coordination between governmental and non-governmental organizations, and the expansion of rescue teams with enough personnel.
- Earthquake preparedness programs: still there are a lot of people who don’t have a clear idea about what they should do during and after the earthquake. Awareness programs should be arranged to give them proper guidelines to increase preparedness.

9. CONCLUSION

Although a significant earthquake could strike Dhaka City, not much has been done to prepare its citizens for it up to this point. The study has yielded valuable insights into the perception of earthquake danger and preparedness among the cities with over twenty-three million inhabitants. Some findings regarding Dhaka inhabitants' perceptions and awareness of seismic danger are discussed in this study. The responders don't know enough about what to do in the event of an earthquake. The elder people of age above 30 are mostly ignorant of this knowledge. Activities of higher-ups and the government are still not enough to ensure the safety of the inhabitants of Dhaka city and their programs for increasing awareness are not enough. The survey's findings indicate that there has to be improvement in the general

public's understanding of seismic risk and mitigation, as well as their grasp of the fundamental idea and emergency response. As a result, citizens of Dhaka City need to be more alert to earthquakes and prepared for them. It is important to emphasize the importance of being prepared as part of daily living in the city. It is imperative to institutionalize preparedness to lower the risk that extreme natural disasters pose to citizens. To support affected communities and aid in recovery, Dhaka City should implement post-preventive measures like search and rescue operations, medical response, temporary shelters, and rehabilitation initiatives. Preventive measures should also include land-use planning and zoning regulations, education and awareness campaigns, and education.

Further study is necessary to improve the reaction to the recommendations made in our paper. Future studies can also look into how equipped office buildings and retail malls are for earthquakes. The results of this study should be broadly applicable since many large cities in emerging nations are seriously threatened by earthquakes. These results will also contribute significantly to the current understanding of earthquake studies.

REFERENCES

Ahmed, M. S., & Morita, H. (2017). Earthquake disaster management analysis in Dhaka. *IHTC 2017 - IEEE Canada International Humanitarian Technology Conference 2017*, 46–50. https://doi.org/10.1109/IHTC.2017.8058197

Akhoondzadeh, M., & Marchetti, D. (2023). Study of the Preparation Phase of Turkey's Powerful Earthquake (6 February 2023) by a Geophysical Multi-Parametric Fuzzy Inference System. *Remote Sensing 2023, Vol. 15, Page 2224*, *15*(9), 2224. https://doi.org/10.3390/RS15092224

CDMP. (2009). Ministry of Disaster Management and Relief-Government of the People\'s Republic of Bangladesh. Retrieved January 5, 2024, from http://203.76.123.197/egls/documents/318/search-detail

Cinar, E. N., Abbara, A., & Yilmaz, E. (2023). Earthquakes in Turkey and Syria—collaboration is needed to mitigate longer terms risks to health. *BMJ*, *380*, p559. https://doi.org/10.1136/BMJ.P559

Debnath, R. (2013). An assessment of spatio-temporal pattern of urban earthquake vulnerability using GIS: a study on Dhaka City. *Annals of GIS*, *19*(2), 63–78. https://doi.org/10.1080/19475683.2013.782468

Earthquake Track. (n.d.). Today's Earthquakes in Bangladesh. Retrieved January 5, 2024, from https://earthquaketrack.com/p/bangladesh/recent

GoB. (2021). Department of Printing and Publications - Bangladesh Government Press. Retrieved January 5, 2024, from https://www.dpp.gov.bd/bgpress/index.php/document/get_extraordinary/39201

Hossain, S., Numada, M., Timsina, K., Krishna, C., Rahman, Z., & Meguro, K. (2022). *Simplified Engineering Geomorphic Unit-based Seismic Site Characterization of Detailed Area Plan of Dhaka City*. https://doi.org/10.21203/RS.3.RS-2220228/V1

Islam, R., Islam, M. N., & Islam, M. N. (2016). EARTHQUAKE RISKS IN BANGLADESH: CAUSES, VULNERABILITY, PREPAREDNESS AND STRATEGIES FOR MITIGATION. Retrieved December 14, 2023, from https://www.researchgate.net/publication/317558570_EARTHQUAKE_RISKS_IN_BANGLADESH_CAUSES_VULNERABILITY_PREPAREDNESS_AND_STRATEGIES_FOR_MITIGATION

Paul, B. K., & Bhuiyan, R. H. (2010). Urban earthquake hazard: perceived seismic risk and preparedness in Dhaka City, Bangladesh. *Disasters*, *34*(2), 337–359. https://doi.org/10.1111/J.1467-7717.2009.01132.X

Rahman, M. L. (2019). Risk perception and awareness of earthquake: the case of Dhaka. *International Journal of Disaster Resilience in the Built Environment*, *10*(1), 65–82. https://doi.org/10.1108/IJDRBE-04-2018-0020/FULL/XML

Rahman, M. M., Avtar, R., Ahmad, S., Inostroza, L., Misra, P., Kumar, P., … Saito, O. (2021). Does building development in Dhaka comply with land use zoning? An analysis using nighttime light

and digital building heights. *Sustainability Science*, *16*(4), 1323–1340. https://doi.org/10.1007/s11625-021-00923-0

Szmigiera, M. (2023). Most densely populated cities 2023 | Statista. Retrieved January 5, 2024, from https://www.statista.com/statistics/1237290/cities-highest-population-density/