EVALUATING VULNERABILITY AND RESILIENCE IN THE FACE OF EARTHQUAKE AND FIRE RISKS

By

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A thesis submitted to the Department of Architecture in partial fulfillment of the requirements for the degree of Master in Disaster Management

Postgraduate Program in Disaster Management (PPDM),
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DECLARATION

It is hereby declared that-

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3. The thesis does not contain material accepted or submitted for any other degree or diploma at a university or other institution.
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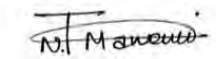

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APPROVAL

The thesis titled "(**EVALUATING VULNERABILITY AND RESILIENCE IN THE FACE OF EARTHQUAKE AND FIRE RISKS)**" submitted by Nishat Tasnim Manami (ID: 21368002) of Summer, 2021 has been accepted as satisfactory in partial fulfillment of the requirement for the degree of master in disaster management on April 28, 2023.

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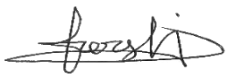

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ETHICS STATEMENT

This paper has followed every legal standard and was conscious of any sort of decision-making. The survey was conducted in two parts: one during the author's early study period and the rest during the thesis. Every single photograph, data, and information was collected with the permission of the relevant authority. The questionnaire surveys were conducted with participants' permission and kept their details anonymous.

The research and surveys were not conducted in violation of any rules or causing discomfort for the participants. Any intellectual property used for the research has been given the required credit, followed by the required citation.

ABSTRACT

The economic and cultural center of Bangladesh is Dhaka, the capital and biggest city of the country. Old Dhaka, the area's older section, is very significant to Bangladesh since it functions as a thriving center for cultural history and valuable resources. It presently causes problems because of its high population density and unplanned urban growth. Dhaka is under earthquake zone 2 and in 100 years it hasn't faced a major earthquake. With this concern, according to seismologists, a powerful earthquake is expected to hit Dhaka soon. Fire service division of the Dhaka Tribune reveals a magnitude 7 earthquake would cause 500,000 buildings, or over 60% of the city's buildings, to collapse.

Old Dhaka is especially vulnerable to earthquakes and fire threats because of the unorganized land use plan, faulty construction, limited spacious roads, and unequal distribution of utilities. The post-earthquake fire is another troubling development that calls for immediate attention and treatment. Gas pipelines and electrical cables are often ruptured by strong seismic shaking, which may start fires. Buildings that are near to one another, buildings that share a wall, and narrow streets may all increase the losses.

The physical vulnerability and societal adaptability to earthquake and fire hazards in Ward 29 in Old Dhaka are the main topic of this paper. Industrial structures, warehouses, and factories with mixed-use structures are its defining features.

Through field surveys, the research included an analysis of the present road networks and urban amenities. To determine how vulnerable individuals are and their conception of fire and earthquakes, key informant interviews, and focus groups were conducted. The author reached a broad conclusion on the

vulnerability of existing buildings to unplanned design, weak structures, unlawful floor extensions, and externally added staircases via 20 building inspections. Valuable insights were gathered by examining the present situation of the community via interviews with 120 locals, their prior experiences with fire and earthquakes, and their current awareness. The results of this study were verified using secondary qualitative data, which improved the paper's reliability and validity.

According to this research, immediate responses and approaches may lessen the effects of earthquakes and fires in Ward 29. These also highlight certain places that should be of concern and some buildings that need immediate attention. This would make it easier as a resource for present and future scholars, students, and public or private organizations to prioritize social resilience and pre-existing constructed structures in their work on Old Dhaka.

Keywords: *Fire Hazard, Resilience, Earthquake, Old Dhaka, Social Vulnerability.*

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER- ONE
INTRODUCTION

1.1 Statement of Problem

Earthquakes and fire hazards are two tragedies that have spread over the world in recent years. According to information on earthquake damage, fire is the second most frequent risk.

Bangladesh is regarded as a high-risk region where earthquakes may have a big impact. Unplanned urban architecture is the cause of earthquake-prone areas. Its infrastructure is subpar, and several examples of illegal construction and poor implementation violate the necessary building codes. The same factors underlie all significant fire events.

Bangladesh has an estimated population of 171 million and a land area of 143,998 km2 (2021). This includes new structures, new job sources, and unplanned urban planning to supply the basic demands of this enormous population and maintain economic stability. According to the fire service division of the Dhaka Tribune, a magnitude 7 earthquake would cause 500,000 buildings, or over 60% of the city's buildings, to collapse.

Bangladesh's capital, Dhaka, is where the vast majority of the population's requirements are satisfied. According to a social watch assessment, the centralization in Dhaka is seen to be to blame for the unsustainable development. Unplanned development produces dense urban areas. For designers and architects, creating more spaces for the community was challenging due to uncontrolled urbanization. According to the Earthquake Disaster Index, Dhaka remains one of the twenty cities in the world with the highest risk of earthquake disaster. The population and building environment in Dhaka are both dense. These requirements pose a major risk to any evacuation during an earthquake since they make areas inaccessible.

One of the most significant economic areas in Dhaka is Old Dhaka, where the city's history is preserved through old buildings and the oldest enterprises that have been run by locals for generations. With a massive increase in people and built environment, this is one of the most notable examples of uncontrolled development.

In urban life, different risks and hazards are always related to the land use types and the lifestyle of urban inhabitants. Chemical, plastic, and factories of electrical goods, as well as printing presses, abound in old Dhaka. Bangladesh's government is attempting to transfer them from here. But still, the people who have been living there for years and the generation who are involved in the same business, are not supportive enough to leave the business or place for the sake of safety.

An earthquake may induce liquefaction, landslides, tsunamis, and other harmful effects, as well as the release of other dangerous substances. Each of these agents is reliant on the local geography. Old Dhaka is a flat area where flames are frequently seen. When an earthquake is imminent, this area is among the most dangerous in the city because any significant quake has the potential to demolish the region. Vehicles find it difficult to access hazardous areas due to the narrow lanes, many of which are too narrow to accommodate the fire brigade.

This paper is going to evaluate vulnerability and resilience regarding earthquake and fire hazards in Old Dhaka.

1.2 Study Area

1.2.1 Area Specification

My study area is Old Dhaka Ward No. 29, which was previously known as Ward No. 75. This ward is located within the newly designated Dhaka City Corporation South and encompasses a part of Lalbagh. It is a diverse ward with people from different cultures, including the original Dhaka inhabitants who have a strong presence in society. The ward is bounded by Chawkbazar to the east, the cremation ground to the west, Lalbagh Fort to the north, and the Buriganga River to the south.

The total area of this ward is 1 sq km. In Figure 1, the red-marked area represents Old Dhaka Road No. 29, situated on the western side of Old Dhaka. The ward border line is adjacent to the Central Jail area and the Buriganga River. Due to its high population density and significant industrial and commercial activity, the people who reside and work in this area are constantly exposed to risks. Fire hazards and earthquakes are common phenomena here, and land-use plans create a favorable environment for these hazards. The focus of this study is to prioritize the assessment of earthquake and fire hazards in this area.

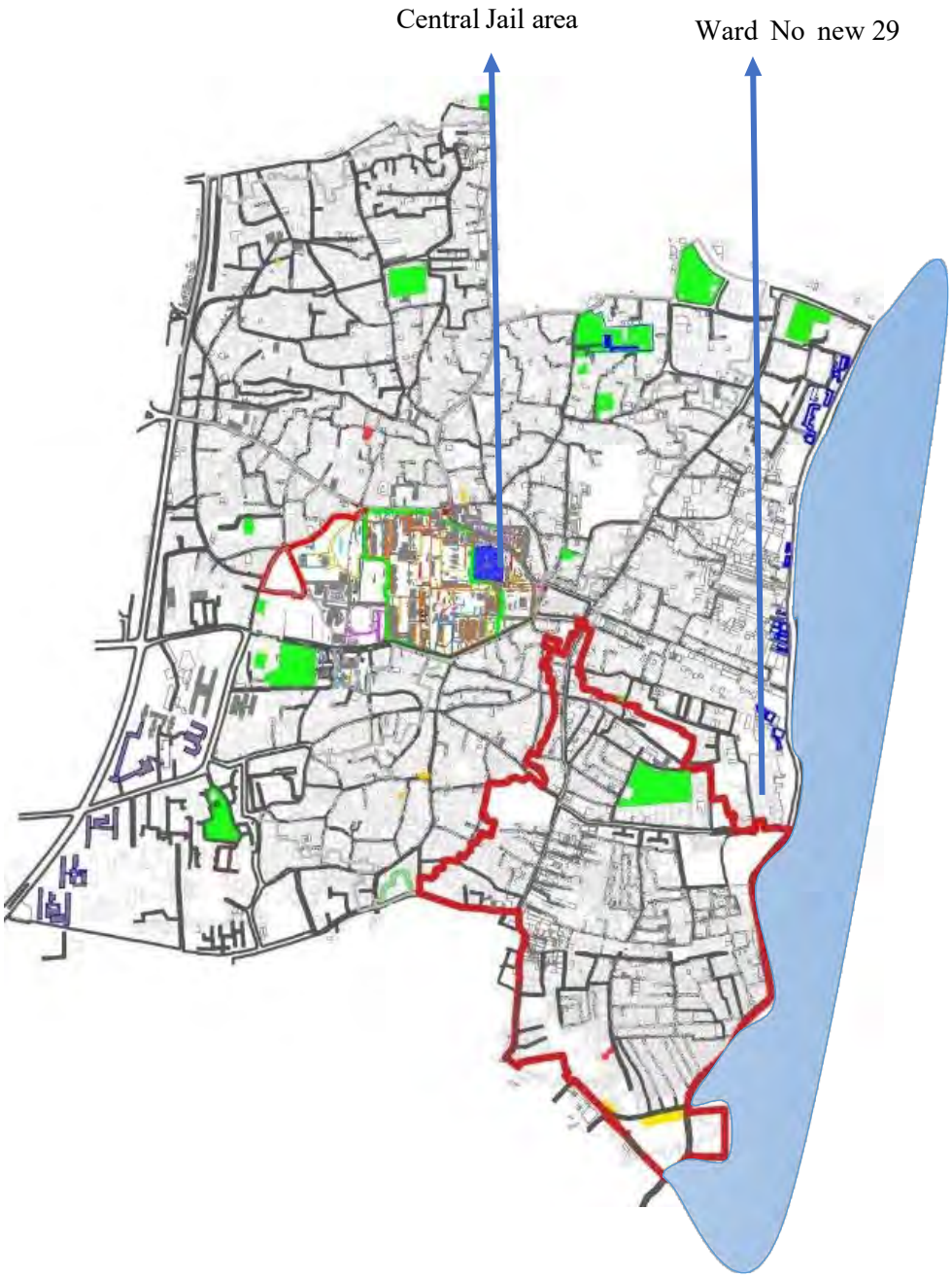


Figure 1 Study Area- Ward 29, Old Dhaka.

1.2.2 Description of the Location

Ward 29 has several significant characteristics that distinguish it from other wards. It shares proximity to Dhaka Old Central Jail. The ward is traversed by historical road networks such as Water Works Road and Alir Ghat Road. There are also notable landmarks in the area, including Haji Selim Medical College, Islambagh Eidgah Ground, Kellar Mor Bazar, Islambagh Ashraf Ali High School, Islambagh Baitul Aman Mosque, and Faridpur Mosque. The ward is primarily connected by Sadarghat Gabtali Road and is adjacent to the Buriganga River. Additionally, it is connected to various ghats, including Chairman Ghat, Alir Ghat, and Chandir Ghat. The total area of the ward is approximately 60,000 hectares, with a population of around 70,599.

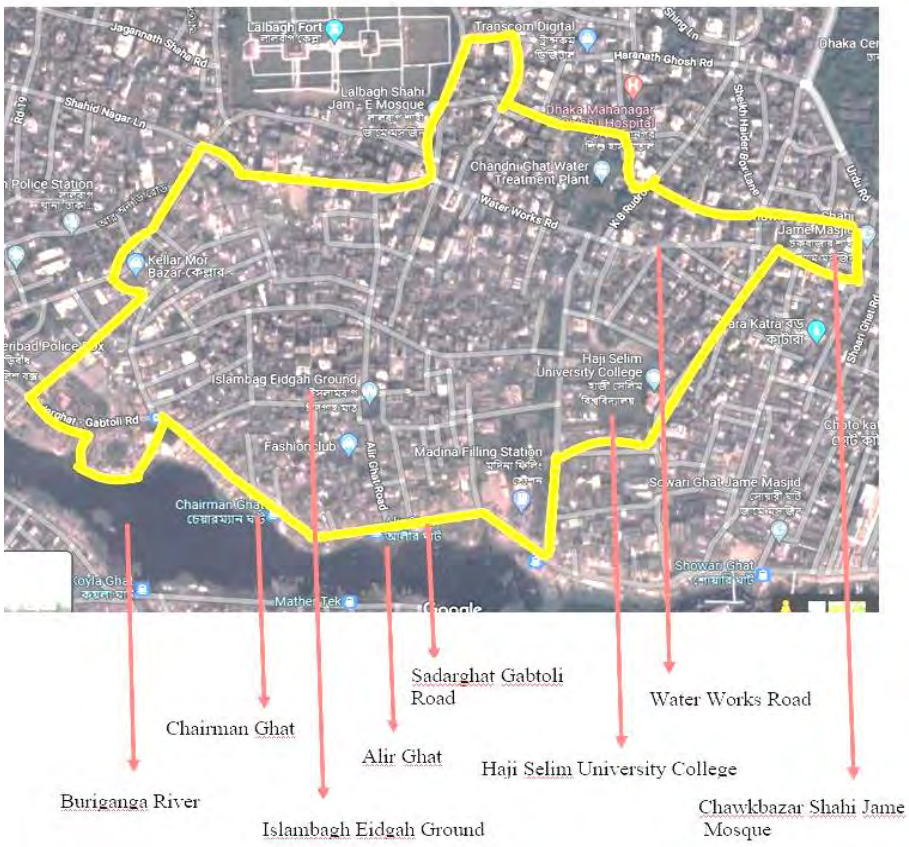


Figure 2 Some major parts of ward 29, Old Dhaka.

Figure 2 illustrates the locations of various significant areas and structures in Ward 29. The ward is bordered by the Buriganga River, which poses a significant risk due to its high level of pollution. Although the Bangladeshi government initiated a river restoration project in 2010, progress has been extremely slow, resulting in a delay in obtaining clean water. The chemical waste from Ward 29 contributes to the pollution of the area, affecting the local population.

Chairman Ghat and Alir Ghat are two ghats operated by businessmen in Ward 29. These ghats facilitate the transportation of factory materials and have become densely populated areas due to the stringing of factory materials.

The Islambagh Shahi Mosque is in the Chawkbazar neighborhood. This popular neighborhood in Ward 29 becomes the busiest area every Friday and during Eid prayers, attracting many cars and people. If appropriately utilized, the Eidgah site could serve as a suitable location for people to seek refuge in the event of a crisis.

Ward 29 also includes Hazi Selim University College, which has an open field that could potentially serve as a refuge during disasters. These are some of the most well-known and popular areas in the region.

1.3 Objectives

The limited designs and land use plans in Old Dhaka impose significant limitations, leading to unfavorable living conditions concerning the risks of earthquakes and fires. The focus of this dissertation is to investigate the physical and social vulnerabilities of Ward 29 to earthquakes. The author aims to identify the existing issues within this ward that contribute to its vulnerability. By comparing the findings with previous studies, the author assesses the

capabilities of both the residents and available resources. This evaluation aims to determine the necessary actions that should be undertaken by the government and private sectors to effectively address potential disasters.

The primary goals of this study are to tackle the following objectives by examining the frequency of occurrences, hazards, and risks within the Old Dhaka region.

• To assess the vulnerability of the research region to fire disasters and earthquakes.

• To evaluate the current capabilities of the people in the study area in responding to fire disasters and earthquakes.

To achieve these objectives, the author of this dissertation has developed seven methodologies in response to specific research challenges. To fulfill the aims of this research, the author has employed various strategies, and research methods, and utilized the pressure and release model. The following is a brief overview of their achievements:

1.3.1 Assessing the vulnerability of the research region to fire disasters and earthquakes.

The author of the study aimed to identify two types of vulnerabilities in the study area: physical vulnerability and social vulnerability. Physical vulnerability, as defined by UNISDR, encompasses factors such as population density, location remoteness, and the quality of infrastructure and housing design and materials. To analyze these vulnerabilities, the author conducted a comprehensive analysis using both photographic evidence and observations throughout the ward. A specific zone with interconnected lanes was selected for

an in-depth analysis. By employing purposive sampling, the author surveyed 10 buildings within this zone, leading to the identification of common criteria and design flaws present in the buildings of Old Dhaka. Additionally, conversations with architects, structural engineers, and civil engineers provided further insights into the vulnerabilities of these structures. The paper also utilized observation and photographic analysis to produce maps depicting the road networks and overall landscape of the ward, revealing the physical vulnerabilities present in the area.

Furthermore, in terms of social vulnerability, this research delved into the living and working conditions of the residents in the study area. Through interviews conducted as part of the research process, this paper provides an overview of the inhabitants' limited capabilities to cope with future disasters. The interview and questionnaire survey yielded valuable insights into the residents' knowledge about fire and disasters, as well as their preparedness for the post-disaster period. This information played a crucial role in identifying and understanding the social vulnerabilities present in the area.

1.3.2 Evaluating the current capabilities of the people and resources in the study area in responding to fire disasters and earthquakes.

This study has evaluated the current capabilities of individuals to respond to fire and earthquake incidents. It has also identified the existing resources that can be utilized in dealing with future disasters. To gather information about these resources, the author conducted key informant interviews with fire station managers in Lalbagh thana. These interviews provided insights into the various available water sources that can be utilized during fire occurrences. The paper also explores the availability of fire brigades and their limitations in handling major fire hazards. Through observations, photographic analysis, and landscape

analysis, the author identified open spaces and buildings that can potentially serve the community in the post-disaster period. As a result, this objective was effectively accomplished comprehensively.

In line with the objective, the author has identified several research questions that need to be addressed. The research questions are as follows:

• What are the reasons behind the vulnerability of the study zone to earthquake and fire hazards?

• Do the residents in this area possess the necessary capabilities to handle such situations effectively?

• What are the primary factors that contribute to the study area being an unsafe place to reside in?

This paper will extensively discuss the achievement of the objectives and address the research questions that have been identified.

1.4 Research Methodology

The methodology component involved several procedures. Initially, the ward was examined through observation and photo analysis. Some maps were obtained from the counselor's office. Following the physical survey, various maps were created, including the Land Use Plan, Ward 29 Building Age, Ward 29 Building Materials, Adjacent Roads, Fire Stations, Water Bodies, and others.

This study employed both qualitative and quantitative methods, collecting both primary and secondary data. Questionnaires were set up, and 120 individuals of different genders and occupations participated in the questionnaire part. The questions and findings are briefly described in the methodology chapter.

Key informant interviews were conducted with seven different individuals from various areas to gain an overall understanding. Among them were two architects who provided information on existing land use patterns and Rajuk rules. Two fire station managers provided updates on training and existing safety standards in Old Dhaka, Ward 29. Two police sub-inspectors from Lalbagh Thana helped identify government initiatives and necessary steps that need to be taken urgently.

Additionally, two focused group discussions (FGDs) were conducted, with participants from different professions. One FGD included two architects, a fire station manager, and a business owner (printing press), while the other FGD included a building owner, a businessman (chemical factory), a police sub-inspector, a student, and a truck driver. The questions and brief discussions from the FGDs are described in the methodology section.

Various documents were collected from fire stations, the counselor's office, and the police station. Additionally, informal discussions were held to gather overall data, which was then sorted, organized, prioritized, and specified. Figure 3 shows the objectives and methodology of the research.

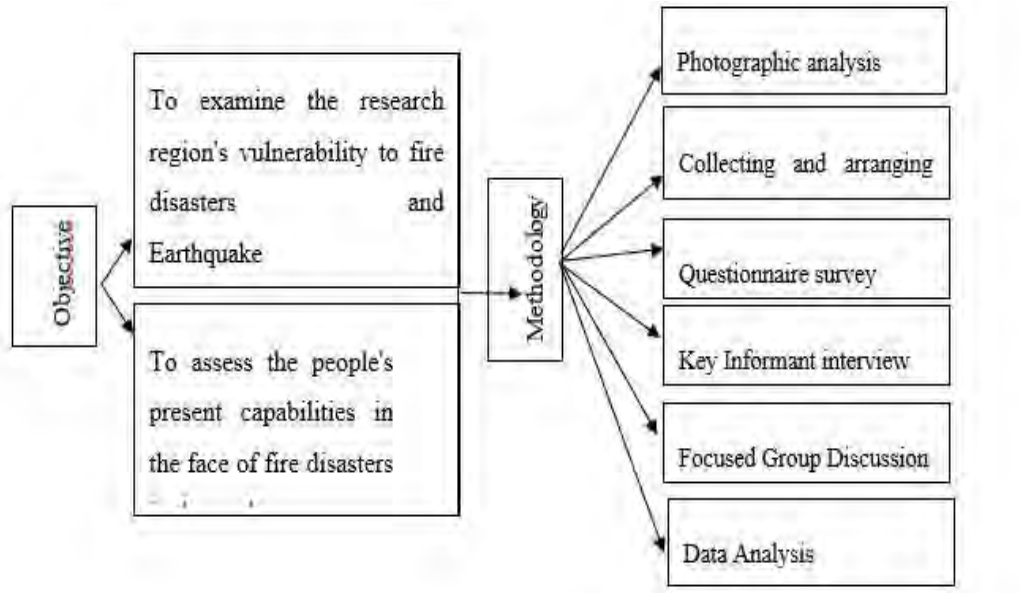


Figure 2 Objectives and Methodology Diagram.

1.5 Scope of Research

The overarching goal of this study is to examine the situation of Old Dhaka Ward 29 and determine why it presents concerns in terms of fire and earthquakes. The study aims to identify the causes of these hazards, analyze the social response to them, and propose preparedness measures for similar catastrophes in the future. Additionally, the study assesses the current state of Ward 29 and highlights the key issues that require attention from the government, residents, and other organizations. Therefore, this study can contribute to:

- Prompting the government, public, and private agencies to take necessary steps for specific areas.

- Establishing laws and regulations by government bodies to mitigate risk factors.
- Developing tools and training materials required for the community.
- Serving as a resource for future students engaged in academic and scientific endeavors.

1.6 Limitation

Because of its abundance of opportunities and hazards, Old Dhaka is currently a top concern for scholars. The residents are now extremely concerned because any calamity here has the potential to destroy the entire region in a matter of hours.

Since this is a hot topic, numerous studies on this locality and the greater Dhaka region have been conducted.

The fact that most studies focused on the reasons and urban layout of Old Dhaka but provided little information on coping mechanisms is highly notable. These studies do not reveal the details of the fire brigades and other amenities that can directly assist during any fire incidents. Apart from Musabber & Mizanur, 2020, few studies examined the causes and consequences without conducting extensive material-based investigation.

Most of the research focused on Old Dhaka rather than on each ward, which required in-depth analysis. Six wards comprise Old Dhaka, and Ward 30 was the focus of a debt investigation because it is one of the most prominent areas in terms close to the Buriganga River and is home to many historical buildings. In addition to these, there is a high risk of fire and earthquakes, but little research

has been done in this area. To prevent any risk in the future, a thorough understanding of this ward is essential.

Yet, while almost all studies provide a general explanation of Old Dhaka, they rarely describe how prepared or capable everyone is to deal with a potential calamity, particularly in Old Dhaka. According to Mostafizur, et al., 2022, 60% of the people under study in Dhaka city did not participate in any fire preparedness programs. Although not focused on any one neighborhood, the survey covered the entire city of Dhaka. The link between the people of Old Dhaka and their readiness for any potential fire or earthquake catastrophes must be better understood.

Also, research already demonstrates how people react as well as the risks and hazards that are there. Yet only a few of those studies provided a thorough assessment of the existing structures that are the source of risk and hazard. Further research should be done on the surrounding road details, risky constructions, and unlawful structures so that it will be simpler to do future examinations. The process can be made faster and more effective by doing thorough research. On the other side, after those studies, the fire hazard team and the emergency team will be able to rescue or act quickly.

The study will significantly affect Ward 29 and its residents. The government and various agencies can use the data for future research and to function more effectively. It can assist in locating the supplies required to organize community gatherings as well as other services like hospitals, fire stations, police stations, counselor offices, and so forth. Since the fire station hosts training sessions for several residents each month, it can assist them in making sense of the data and paperwork. Even future researchers, teachers, and students who are researching hazardous areas, sensitive environments, as well as earthquake and fire hazards, can get resources from it.

The study has a wide range of applications, but it is not without constraints. Some limitations that were encountered throughout the survey and data collection had an impact on the study methodologies.

The first constraint of this study is the local population's disinterest in participating in questionnaire surveys. That also had an impact on the photographic analysis. The majority of the locals have lived in this area for many generations, which has left them particularly reliant on their fixed businesses, whether factories or other types of businesses. So, they are keenly aware of the consequences and unwilling to discuss the current situation.

The acquisition of data and documents was once again quite difficult because some of them were extremely sensitive, and the authorities forbade the release of some documents due to public sentiment and governmental policy. The analysis attempted to identify the precise building that is most at risk and requires urgent care, but due to restrictions from authorities, this was not possible to do.

More resources would have made the research more insightful. However, due to specific constraints, this was not always possible. Because of the budget restrictions, the recurring survey and inquiries were a little challenging. It was challenging to schedule interviews with businessmen and other employees at a specific time due to Old Dhaka's identity as one of the busiest areas.

1.7 Research Design

The study is divided into several chapters, each with its significance. In total, six chapters contribute to the overall understanding of the research topic.

Chapter 1 presents the problem statement, outlining the specific details of the ward and its immediate surroundings. The study scope and constraints are discussed in this chapter, along with a brief overview of the methodology employed. The research goals are also mentioned in this chapter.

Chapter 2 focuses on the literature study, delving into the history of fire and earthquakes. It briefly explains the relationship between issues with existing structures, urban amenities, and the risks associated with earthquakes and fires. Community participation, education, and involvement in various areas are also covered in this chapter.

Chapter 3 is dedicated to methodology and covers the research approaches, analysis units, and data collection methods. It provides a brief overview of the pressure and release model.

Chapter 4 presents the comprehensive results of the study, including map studies, tables, and charts displaying percentages derived from various questionnaires.

Chapter 5 focuses on the social vulnerability assessment, thoroughly exploring the respondents' responses and their implications.

Chapter 6 discusses the study's findings, provides recommendations, and compares them to other journal publications. It also includes debates and concludes the study.

Overall, these chapters contribute to a comprehensive understanding of the topic and provide valuable insights for future research and action.

CHAPTER-TWO
LITERATURE REVIEW

The word "vulnerability" is typically used negatively and to describe a bad quality. The main factors determining a system's vulnerability are the stress it is exposed to, its sensitivity, and its capability for adaptation. According to UNDRR- vulnerability is a state where an individual, a community, assets, or systems are more susceptible to the effects of risks due to physical, social, economic, and environmental factors. Only in the context of relationships between humans and their environment does vulnerability have a common, albeit debatable, definition. Human geography and human ecology have theorized susceptibility to environmental change. Physical vulnerability, economic vulnerability, social vulnerability, and environmental vulnerability are the distinct categories of vulnerability that can be categorized based on the various sorts of losses.

Physical vulnerability and social vulnerability are frequently closely related. For example, if a component of social vulnerability is access to the educational system, one must consider the physical location of the educational institution and the institution provider. Again, if the component of social vulnerability is access to building safety, the building location, materials, and structures must be considered as a physical location.

Following these connections, this essay has explained Old Dhaka Ward 29's physical and social vulnerabilities.

According to the American Psychological Association APA, resilience is the process and result of overcoming difficult or demanding life situations, particularly through mental, emotional, and behavioral flexibility and adaptation to internal and external challenges. It is challenging to quantify resilience because it varies on so many different variables.

There are a few factors that are connected to resilience:

- The perspectives and interactions people have with the world.
- The quantity and caliber of available social resources
- Specific coping strategies.

The shocks and pressures that the social-ecological system encounters, the system's response, and the capability for adaptive action are common research topics in vulnerability and resilience studies. The ability to take an impact, learn to adapt, respond, and recover from a calamity are all aspects of resilience. As two sides of the same coin, susceptibility, and resilience are both observed. Resilience is one advantage, but vulnerability is one drawback.

This report focused on earthquake and fire risk while considering the study area's vulnerability and resilience. This research has attempted to investigate how these two can operate as a threat in the study area since fire following earthquakes is a very widespread concern nowadays.

This research has been conducted studying five types of main themes:

- History of Fire and Earthquake incidents in Bangladesh.
- Post-earthquake fire and Fire following Earthquake.
- Structure issues regarding fire hazard and Earthquake.
- Connection of urban amenities with disasters.
- Community participation in fire hazards and Earthquakes.

2.1 History of Fire and Earthquake Incidents in Bangladesh

In Bangladesh, the fear of fire has become an everyday concern. The lack of attention from authorities and the haphazard urban architecture further exacerbates the current problems.

Over the past 70 years, Bangladesh has experienced several earthquakes. In 1997, a 7.1-magnitude earthquake struck the district of Bandarban. In 2004, a 7-magnitude earthquake hit Cox's Bazar, with the epicenter located in the Indonesian province of Banda Aceh. Additionally, in 2007, Cox's Bazar faced a tsunami following an 8.5-magnitude earthquake originating from Bengkulu, Sumatra. These three significant earthquakes occurred in the region, with an average interval of 24.33 years between each event. However, it is noteworthy that only ten years after the 1997 earthquake, another major earthquake occurred in 2007.

Based on GPS and deformation data, the Indo-Myanmar fold belt is considered a potential source of earthquakes. If all the accumulated energy within this belt were to be released simultaneously, it could result in enormous earthquakes of magnitudes that have not been recorded in recent centuries. Estimates suggest that a severe earthquake could occur soon. Therefore, we must be adequately prepared to face such disasters and minimize potential losses.

Old Dhaka, with its numerous mixed-use buildings and chemical industries, is particularly vulnerable to fire incidents. One notable fire incident occurred in Nimtoli, Old Dhaka, in 2010, claiming the lives of 124 individuals. The primary cause of the incident was an explosion of a transformer. The narrow streets and staircases of Old Dhaka made it challenging for fire department equipment to access the affected areas, exacerbating the damage. The high population density in residential areas further complicates the situation.

Another area prone to fire incidents is Chawkbazar in Old Dhaka. This neighborhood, characterized by unlicensed buildings housing plastic factories, chemical warehouses, and recycling workshops, is densely populated, increasing the likelihood of fire occurrences. In 2022, a fire broke out in Chawkbazar, Old Dhaka. Due to the same factors - narrow roads and densely populated areas - it took nearly two hours to extinguish the fire in the polythene factory.

According to fire records from Lalbagh Fire Station, there were fire incidents in two thanas (Chawkbazar and Lalbagh) between January 2022 and December 2022, with various causes. The records indicate that there were 5 accidents related to stoves (gas, electric, and clay) in 2022. Additionally, there were 44 incidents of electrical line fires during the same year. Furthermore, there were 4 cases attributed to burning cigarette remnants.

Table 1 provides an overview of these fire incidents in the respective areas during the mentioned period. There were 10 cases involving gas lines, and 18 remain unsolved.

Losses from each of those occurrences were over 53,00000 BDT. Here, it appears that an electrical line was one of the main contributing factors to the severe financial and material losses endured by the residents of these Thanas. Six persons lost their lives in a fire caused by a gas leak this year.

No	Property	Number of Fires	Amount of Loss(taka)	Salvage Amount (tk)
1	House/Residential Buildings Fire	15	12,50,000	40,20,000
2	Market Fire	08	70,000	15,00,000
3	Fire in Shops, Grocery Shops	05	2015000	1,20,000
4	Fires in Factories (other than Garments)	19	19,55,000	75,10,000
5	Fires in Educational Institutions	02	5000	20,00000
6	Fires in Religious Institutions	01	-	-
7	Hotel-Motel-Restaurant Fire	02	-	-
8	Vehicle Fire (all Land vehicles)	01	-	-
9	Gas line, Gas Cylinder Fire	10	-	-
10	Other Fires	18	5000	800000
	Total =	**81**	**53,00000**	**2,54,50,000**

Table 1 Fire incident and the number of losses in 2022
(Source: Lalbagh Fire Station).

According to the data provided by Lalbagh Fire Station, there were 15 fire occurrences in homes or other residential structures, while 19 fire incidents took place in factories. Additionally, 8 of the total events occurred in marketplaces, compared to 5 incidents that happened in stores and grocery shops. In total, there were 81 fire incidents across various locations in 2022.

Based on the recent updates from Old Dhaka, specifically Lalbagh and Chawkbazar Thanas, it is evident that the fire accidents in this area have specific and identifiable causes. Urgent action should be taken to investigate and address these causes. Table 2 shows the number of incidents, their causes, and losses in 2022 at Lalbagh and Chawkbazar thana.

No	Causes of Fire	Number of Fires	Amount of Loss (in Taka)	Salvage Amount (in Taka)	Didn't Have to Work	Number of Injured or Death	
						Injured	Death
1	Stove (Electric, Gas, Clay, etc.)	5	250000	500000	2	-	-
2	Electrical	44	4045000	22650000	19	-	-
3	Burning bits of Cigarettes	4	1000000	2000000	3	-	-
4	Gas Line Fire	10	-	-	6	-	6
5	Unknown/Other Reasons	18	5000	800000	11	-	-
Total =		**81**	**53,00000**	**2,54,50,000**	**41**		**6**

Table 2 Number and causes of fire 2022 (Source: Lalbagh Fire Station).

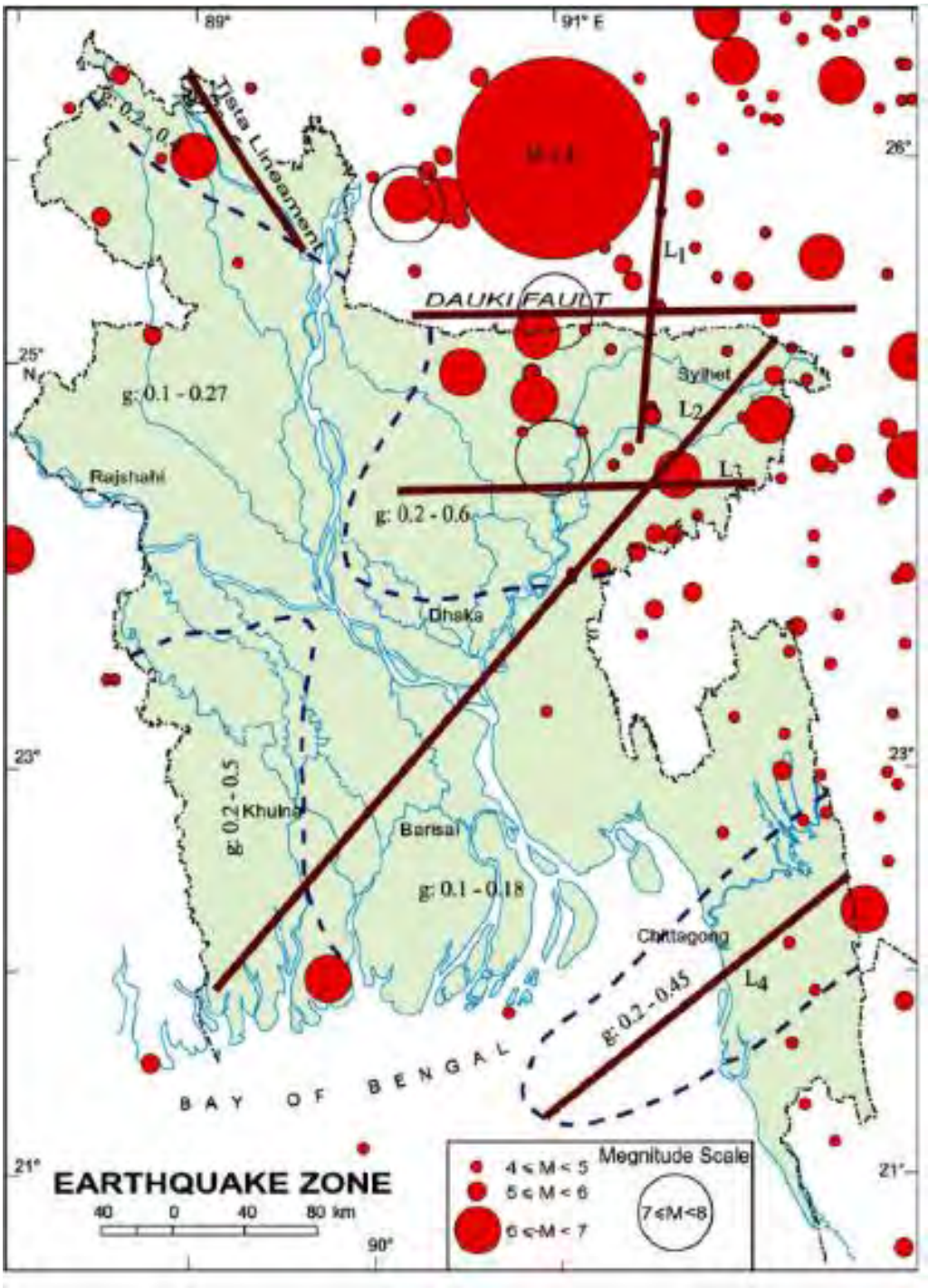


Figure 3 Earthquake History in Bangladesh (Source: Khan, 2004).

2.2 Post-Earthquake Fire and Fire Following Earthquake

An earthquake of significant magnitude can pose a risk of fire incidents. It is not uncommon for serious fires to occur after a major earthquake. The damage caused to buildings and other structures during an earthquake increases the risk of fire incidents. During such emergencies, immediate action is crucial. Ward No. 29, with its numerous factories producing combustible materials such as chemicals, plastics, and printing supplies, is particularly vulnerable in this regard. A survey conducted by Bangladesh's fire service and civil defense indicates that over 400 hospitals are at risk of fire incidents.

A three-day fire threat occurred in San Francisco following a severe 8-magnitude earthquake. The devastating aftermath included building demolitions, loss of life, and displacement of approximately 200,000 people. Surprisingly, the earthquake itself accounted for only 10% of the overall damages, while the fire was responsible for 90% of the destruction, according to a report.

On January 17, 1995, Kobe, Japan experienced a powerful earthquake that claimed nearly 6,000 lives and left around 45,000 people homeless. Following the earthquake, a fire tragedy severely damaged the city's entire water supply system. Firefighters faced challenges in combating the fires that broke out. Fire incidents after an earthquake are not uncommon and can often cause more damage than the earthquake itself. The intense shaking during an earthquake can rupture water supply pipelines, electric wires, and gas pipelines, hindering firefighting operations and exacerbating the losses.

According to Brian Meacham, the principal investigator for the post-earthquake fire study, the destruction does not cease when the ground stops shaking. Earthquake-induced landslides can ignite fires, which may be further fueled by

flammable gases. The proximity to fault lines suggests the potential for similar catastrophic events in the future.

2.3. Impact of fire and earthquake on the building structure

An earlier damaged structure can be highly susceptible to fire incidents. Moreover, following an earthquake, as the structural integrity deteriorates, fire can exacerbate the extent of the damage. According to Ahmed Ghobarah, certain building characteristics make them particularly vulnerable to earthquake damage, such as short columns, strong columns but weak beam designs, joint problems between beams and columns, and poor construction quality.

A study conducted by Ahmed Ghobarah and his team on December 26 highlighted three different types of structures that were affected by the 2004 tsunami. One building, which had a timber frame and served as affordable housing, appeared to have survived the earthquake. However, several non-engineered concrete structures, prevalent in Thailand and Indonesia, suffered significant damage. These structures lacked sufficient column section capacity, rendering them unstable and prone to disaster during earthquakes. Some of these buildings collapsed because of the earthquakes in Thailand and Indonesia.

Conversely, well-built structures fared well during the earthquake and tsunami. Additionally, the study demonstrates that while low-rise structures sustained minimal damage, those between three and five stories were more affected. The primary cause of structural damage after the 2004 earthquake was attributed to poor construction practices and inadequate design quality.

2.4 Urban Amenities as a Disaster Response Center

In a study, the United Nations Office for Disaster Risk Reduction (UNDRR) demonstrates the significant impact of urban growth on future disasters and how investments in this development can affect disaster risk reduction. The study highlights the correlation between growing populations, concentrations of economic activity, and high-risk zones in many cities. According to the study, urban population exposure is predicted to increase dramatically over the next 30 years, from 370 million to 870 million people.

The UNDRR emphasizes that inadequate infrastructure and services, unsafe housing, and insufficient or nonexistent healthcare can contribute to natural disasters. These catastrophes are increasingly affecting urban populations, resulting in negative consequences for employment, housing, and essential infrastructure such as roads, power, and water supply. The urban poor are particularly vulnerable to climate change and natural disasters due to their location within cities and the lack of reliable basic amenities. Research from 2015 indicated that 90% of urban residents in low-income nations reside in unsafe and exposed homes.

The study also reports that in low- and middle-income countries experiencing significant urban growth, land acquisition, construction, and infrastructure development have primarily occurred through informal means. Urban informality is characterized by low wages and increased exposure to environmental risks, both in the informal economy and in informal settlements.

2.5 Community Participation in Fire Hazard and Earthquake

Ali Ardalan., et al had a study aiming to analyze the success of a participatory community-based intervention for earthquake preparedness in Tehran. In their report, designed a participatory intervention that has a conclusion stating that a community-level participatory intervention significantly increased preparation for disasters and that the participatory approach should be incorporated into public health disaster planning to ensure sustainability.

Barbara Ryan., et al acknowledge that natural hazard preparation by communities reduces disaster-induced physical health problems and adverse experiences, lowers the potential for post-traumatic stress disorders, and aids in faster recovery. The results indicate that a good community involvement strategy incorporates education and capacity-building activities and learning while drawing on community development ideas. Participants in the study thought that encouraging people and communities to take initiative was important.

Douglas and Li identify in their research that despite the focus and funds spent to encourage individuals to participate during the disaster and after the disaster, communities in danger from earthquakes typically have poor levels of preparedness. This lack of preparedness and knowledge increases the risk of disaster and works as an obstacle to reducing the loss.

A report by Shreya Thuso and her team shows that- after the 2016 Kaikoura Earthquake a community was empowered by their engagement and played an important role in post-disaster. Again, in this report, they showed that in the city of Wellington, the authority gave a high priority to community participation, and that worked as a wakeup call following any serious seismic event.

CHAPTER-THREE
METHODOLOGY

3.1 Introduction

Old Dhaka comprises six distinct sectors, each possessing unique characteristics. It is of utmost importance to conduct a comprehensive examination to comprehend the factors and actions that contribute to occurrences of fires and earthquakes. These incidents not only impact individuals but also have physical, psychological, and economic ramifications on communities.

This section provides an overview of the methodologies employed in the present study, encompassing the research approach, unit of analysis, and data collection process. Initially, the author conducted an observational survey encompassing the entirety of Old Dhaka. By correlating the observed conditions with map analysis, the author arrived at certain conclusions and identified specific wards for further investigation.

3.2 Research Approach

In this study, multiple analytical methods are utilized, such as semi-structured interviews, questionnaire surveys, qualitative analysis, and case studies. The research also builds upon previous analyses conducted in the context of Old Dhaka. The research approach encompasses two primary processes: an examination of existing maps that depict the present situations in Ward No. 29 of Old Dhaka, and a social vulnerability assessment.

3.3 Data Collection

This information was gathered using a questionnaire survey, semi-structured interviews, and a literature review that served as secondary data for locating pertinent data and study materials.

3.3.1 Primary Data Collection

Site surveys and questionnaire surveys were used to acquire the primary data. These are the technologies that were utilized to get the primary data.

3.3.1.1 Observation

In Old Dhaka, there are six distinct wards. This paper aimed to determine which ward should be prioritized as a primary concern, requiring immediate action to prevent any potential vulnerability in the future. By conducting a thorough literature review and analyzing observations, this paper has identified specific reasons why a particular ward should be the first focus of attention. Figure 5 illustrates the different wards of Old Dhaka.

The former central jail area in Old Dhaka is strongly related to Ward 27, Ward 33, Ward 31, and Ward 28. This empty area has the potential to be used as a shelter in the event of future catastrophes. There are open spaces in Ward 27 that house schools and hospitals that may be used as resources to respond to earthquakes and fires. In addition, it features the biggest proportion of open space (around 35%) out of all the zones.

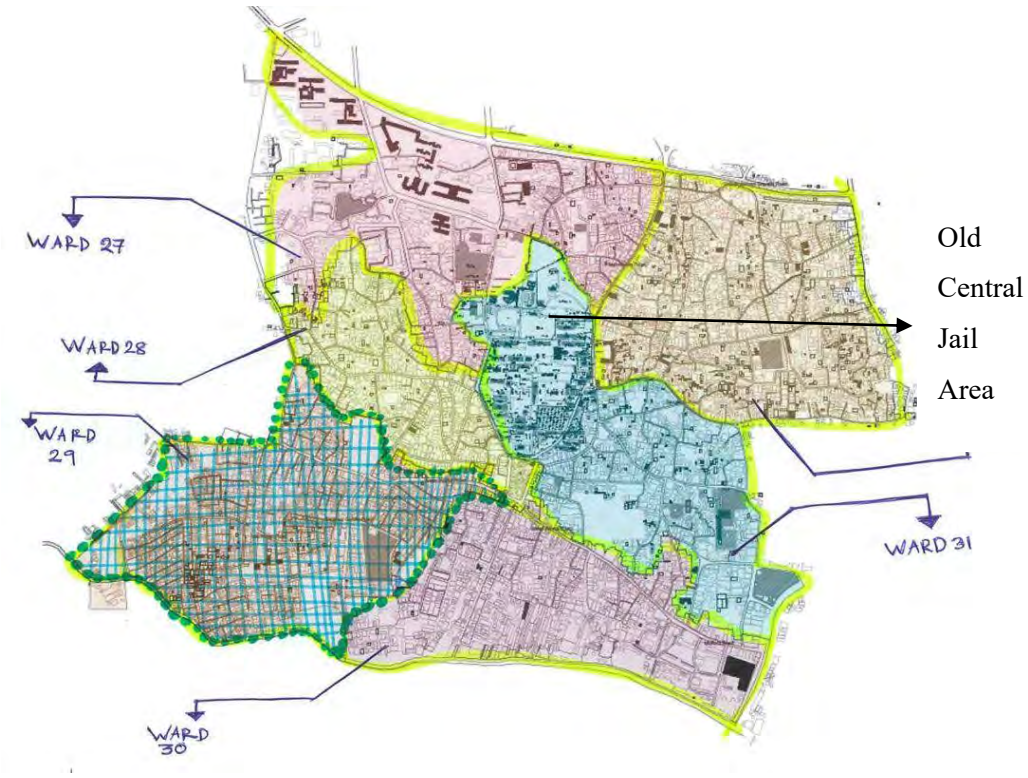


Figure 5 Different wards of Old Dhaka.

About ward 31, it looks visually to be the least exposed location when compared to others. This is mainly because of its huge open area that resembles the main jail area. A possible reorganization of this area might be taken into consideration. Furthermore, a thorough investigation carried out by Chisty in 2020 focused on evaluating Ward 30 Wardnity's ability to respond to urban fires.

Ward 29 is one of the most susceptible of the remaining wards, according to the author. Chemical and shoe manufacturers occupy the area. This does not mean that the other two wards are secure, but Ward 29 must be the primary concern when it comes to fire and earthquake threats.

3.3.1.2Photographic survey

The photographic analysis is an integral part of the research, whether it involves built areas such as housing, urban areas, or individual buildings such as institutions, hospitals, and other amenities. The main data collection process commenced with site observation and image processing. Field surveys were conducted, and photographic analysis was employed to document the findings. Sector 29 possesses unique attributes. It encompasses multiple roads with varying widths, including both dead-end roads and interconnected roads that extend into other wards. The prominent roads in Ward 29 include Islambagh, Shayesta Khan Road, Goni Miar Haat, and Hazi Kali Road. To establish a clear understanding of the relationship between these roads and the surrounding buildings, the author visited the roads and the buildings in proximity. Additionally, the author explored secondary or tertiary roads that provide a comprehensive view of the entire study area. The author has picked 6 lanes that are linked to other tiny lanes as well as roads that are often busy, considering the width and movement of the roads. Waterworks Road, Alir Ghat Road, and other roads are included in these six lanes. The author has chosen one significant route, the Waterworks Road, for in-depth examination after conducting an observation survey and photographic analysis.

After conducting an observation study and considering the various areas of this specific ward, the author categorized this area into 7 distinct zones (Figure 6). This research revealed that the zone shown as number five in the image has the riskiest position. The area's weak structures, high-rises with congested streets, and lack of open places for shelter are the primary causes.

For any future research on existing buildings, the author has chosen Water Works Road and Zone 5 after taking these two variables of Zone and the main road into consideration. Through data analysis and recommendations, this investigation has effectively demonstrated the validity of the study.

Figure 6 Different wards of Old Dhaka.

3.3.1.3 Mapping

Through the site survey and analysis, useful data on the existing conditions in Ward 29 was collected. The author has collected information on road width, population density, and building characteristics after 10-day field research. This paper has developed a set of updated maps that provide a clear picture of all the acquired data based on this study. These maps are a valuable tool for analyzing the ward's present situation, pinpointing the vulnerabilities that contribute to it, and suggesting viable solutions to lessen those vulnerabilities. The titles of the numerous maps are shown in Table 3, along with detailed explanations.

Maps showing the existing scenarios of Ward 29	
01	Focusing Study area.
02	Land use Plan of Old Dhaka Ward 29
03	Adjacent roads and surrounded fire stations

Table 3 Different map details have been used in this study.

3.3.1.4 Questionnaire

In this research, a total of 120 respondents were surveyed. The author utilized a purposive sampling method to pick respondents as a sample since there were few resources and findings. One of the main methods of the non-probability sampling approach, where the sample size is not chosen before the investigation, is the purposive sampling method. Most often, it is used in qualitative research. The purposive sampling method included selected criteria to guarantee homogeneity among all respondents. The criteria for this selection are explained herewith.

1. Respondents have been involved with business in this area or have been living here for more than one year.

2. Respondents have some knowledge of this area and are active in community participation.

Focusing on the above criteria, 120 people from Ward no 29, were taken for interviews, and information was collected regarding their knowledge and thoughts on fire hazards and Earthquake. This survey helped to understand the knowledge the people have here and the information or training they are getting

from any related organizations. Table 4 lists the questions that were asked in the interview:

Questions of Questionnaire survey	
01	Are you familiar with what to do in an earthquake?
02	Do you understand how to use a fire extinguisher?
03	Are you aware of your building's security?
04	Do you know of any safe places to seek refuge during an earthquake?
05	Have you participated in any disaster education programs?
For warehouse or factory workers	
07	Are you at ease working here?
08	Why does working here make you feel unsafe?
09	Why is this ward earthquake-prone?
10	What is the primary reason for the significant losses in fire incidents?

Table 4 Questions of Questionnaire Survey.

3.3.1.5 Key Informant Interview

Key informant interviews are commonly used as a research tool to assess the situation in a specific location. They involve interviewing a specific and predetermined group of individuals who are directly or indirectly related to the study and can provide essential information and perspectives on the subject matter. In this study, seven key informant interviews were conducted, which are qualitative interviews involving a small number of participants and focused discussions on a list of related topics.

The author selected seven individuals to represent the key informant interviewees both during and after the survey. Two of them were architects with direct experience working in Old Dhaka, while the other two were managers of

the Lalbagh Fire Station, which serves Ward 29. The remaining two interviewees were sub-inspectors from the Lalbagh Police Station and a structural engineer. The key informant interviews covered various listed issues, along with general discussions.

The engineers and architects were chosen for their comprehensive understanding of the land use plans, building materials, and physical design of Ward 29. The key informant interviews helped me gain insights into building regulations and the actual situation in Old Dhaka Ward 29.

The inclusion of the fire station managers was crucial as they are the primary source of assistance in dangerous situations in Old Dhaka. Understanding their responsibilities during fire hazards, government initiatives, and the main challenges they face during training or dangerous situations provided valuable insights. As most of the buildings in Old Dhaka have severe structural issues, the structure engineer has helped to find out some general findings regarding the buildings of Ward 29.

Similarly, the sub-inspectors were selected to gain an understanding of their roles and the challenges they may encounter in vulnerable situations.

Table 5 shows the basic information that was taken during key informant interviews. It includes the name and profession of the key informants as well. The author arranged separate questionnaires for different professionals. Table 6 illustrates the questions asked to the Architects and Engineers and table 7 illustrates the questions asked to others.

Key Informants	No	Information
Architect	1. Tahzeeb Anwar Sami 2. Anuva Tabassum	Land use details, building design, Rajuk rules, and their application in Ward 29.
Fire station manager (Lalbagh)	1. Md Kajal Miah 2. Abu Saleh Md. Jakaria Khan (Station officer)	Training details, updates on Fire and Earthquake hazards, the situation during any hazard, a government initiative
Structure Engineer	1. Md Shahin Ahmed	Building structure, their safety, gas, and electrical line connection details.
Police sub- inspector Lalbagh Thana	1. Md Rejjakul Haider 2. Anish Mandol	The Government initiative, their contribution to any hazardous situation, people's concern, necessary steps that need to be taken, and the present scenario of Ward 29.

Table 5 Key informant list and questions asked.

Number	Key informant Interview Sample Questionnaire (Fire station manager)
01	What type of resources do you have to face any earthquake and fire hazards?
02	What type of difficulties do you face during any fire hazard?
03	Are the people supportive enough in this area to help you?
04	Do you know what the most common reasons here are behind any fire hazard?

05	How do you access any water sources during any fire hazard?
06	Do you have any yearly training programs to make people aware and prepared enough to face any future disaster?
07	How can this area be reorganized to be safe from future disasters?

Table 6 KII Questionnaire for Architects and Engineers.

		Key informant Interview Sample Questionnaire (Architect and structure engineer)
01	Urban Planning	• What problems did you discover with OLD Dhaka Ward 29's urban planning? • How can these be redesigned or reorganized? • Do you believe that the urban infrastructure in Old Dhaka is balanced properly?
02	Building Structure	• How is Old Dhaka Ward 29 becoming unsafe due to building structures? • How are the building owners breaking the law here? • How are materials affecting here in the building structure? • Are the building owners obeying building codes?
03	Fire and Earthquake	• How this ward can be affected by fire hazards or Earthquakes? • Which problems make the situation worse? • How can the problems get immediate solutions to minimize risk? • How can the local people and leaders reduce the disaster risk?

Table 7 KII Questionnaire for Fire Station Manager.

Figure *7* KII with Lalbagh fire station Manager

Figure *8* KII with Police sub-inspector Lalbagh thana.

3.3.1.6 Focused Group Discussion

Focused group discussions are a component of qualitative research practice. Here, a group of individuals engages in a conversation on a certain issue. The topic under study is unique, and it plays a significant part in the research process by aiding in the data collection from different sorts of individuals that are either directly or indirectly connected to the topic under research.

Four narrowly focused group discussions have been set up by the author. The groupings were homogeneous, which made it easier to understand the circumstances in this specific ward. The group was made up of individuals with very comparable demographic traits to explore certain findings. The author interviewed architects and engineers in the first group to talk about the ward's current situation. The second group consisted of four housewives who used to live in this area for more than two years. The manager of the fire station and a police sub-inspector was in the third group. The fourth and last category consisted of some regular individuals who visit this region for work or study frequently, including students, businessmen, truck drivers, and rickshaw pullers. This focused group discussion's primary goal is to find out what individuals from varied backgrounds think generally about a certain issue.

Table 8 shows the Participants' details, their gender, and the topic discussed in the Focused Group Discussion.

	Participation	Gender	Topic
FGD 1	Architect 1	Male	The existing situation of Old Dhaka, Ward 29 issues, the required steps, Government initiative, Ward 29 fire incident, cause, and loss.
	Architect 2	Female	
	Structural Engineer	Male	
	Electrical engineer	Male	
FGD 2	Housewife 1	Female	
	Housewife 1	Female	
	Housewife 1	Female	
	Housewife 1	Female	
FGD 3	Fire Station Manager 1	Male	
	Fire Station Manager 2	Male	
	Police sub-inspector 1	Male	
	Police sub-inspector 1	Male	
FGD 4	Student	Female	
	Truck Driver	Male	
	Businessman 1 (Printing Press)	Male	
	Businessman 2 (Chemical Factory)	Male	
	Rickshaw puller	Male	

Table 8 The participant's details and topic of focus group discussion.

In a focused group discussion, numerous questions were asked related to the group of people. Table 9 illustrates the details of the question asked to the participants. The author has arranged different questions for four groups of FGD so that the questions are relevant to professionals. Table 9 gives the details of the questionnaire that was used during group discussions.

FOCUS GROUP DISCUSSION QUESTIONNAIRE		
FGD1	Architect and Engineers	What can be the possible scenario in fire hazards and Earthquake you think?
		How the problems can be identified you think?
		What can be the possible solutions you suggest for avoiding future disasters in this ward?
		How can those unplanned wire connections affect earthquakes or fire hazards?
FGD2	Housewife	Have you attended any training regarding earthquake and fire hazards?
		What is the main social barrier you think is against progress in this ward?
		Have you experienced any fire hazard in this Ward 29 and if yes what was the situation, then?
		How is your relationship with your neighbors?
		Do you feel safe living in your building?
FGD3	Fire station manager and Police	What is the main social barrier you think is against progress in this ward?
		Here what sort of problems do people face during any disaster?
		What is the probable gap between the businessman, local people, and authorities?
		How the local leaders be a part of this progress you think?
		How do you get support from Govt and private sector regarding earthquake or fire hazards?
FGD4	General people	How the local leaders be a part of this progress do you think?
		Have you attended any training regarding earthquake and fire hazards?
		What is the main social barrier you think is against progress in this ward?
		Have you experienced any fire hazards in Ward 29 and if yes what was the situation, then?
		What is the probable gap between the businessman, local people, and authorities?

Table 9 Focus Group Discussion Questionnaire.

3.3.1.7 Assessment and Examination of building design and structural evaluation

The author has chosen a certain lane and a particular zone for more research, as was specified in the photographic analysis. According to Google Earth View, there are around 107 structures in total inside the specific lane's zone and surroundings. It was challenging to inspect every building in one take due to a lack of resources, time, and research. To acquire a broad perspective of the structures in this ward, the author used the simple random sample method (SRD) to analyze some of the buildings.

The simple random sampling method involves the random selection of samples by the author. In this study, the author assigned random numbers from 1 to 107 to each building within the zone. The first sample was selected based on the building with the number 7. Subsequently, the author chose a series of buildings using an arithmetic progression with a common difference of 10. This resulted in the selection of buildings with the numbers 7, 17, 27, 37, 47, 57, 67, 77, 87, 97, and 107. Consequently, the author surveyed a total of 11 buildings within the specific zone, analyzing their designs and identifying significant characteristics. The findings of this analysis are elaborated upon in the results section.

3.3.1.8 Data Analysis

Before incorporating the information gathered from the tools in the subsequent chapter on the discovery, their authenticity was verified. They were linked to the current situation through photographic analysis and observation. The key informant interviews (KII) and focus group discussions (FGD) were combined to extract overall concerns and issues from the conversations. The results and

findings derived from all the collected data were presented in the following chapter as land maps, building maps, various percentage charts, and more.

3.3.2 Secondary Data Collection

The sources of secondary data are related journals, previous studies, books, different websites, and official records. Some documents were collected from the fire station manager, and some were collected from some Architects and police stations.

CHAPTER-FOUR
RESULTS AND FINDINGS

4.1photographic Analysis

The author initially sought to understand the current state of affairs in Old Dhaka Ward 29 through careful observation and photo analysis. By conducting a thorough observation and utilizing photo analysis, the author identified the key characteristics of Ward 29.

Through this investigation, it was discovered that the area is traversed by several important routes, including Chairman Ghat, Kellar Mor, Islambagh, Chawkbazar, and Shreshta Khan Road. The buildings in the area have a mixed-use nature, housing both industries and residences. The prominent industries include toy manufacturing, shoe manufacturing, plastic production, and printing presses.

While smaller roads have a width of 7 to 10 feet, significant roads such as Islambagh, Chawkbazar, and Water Works Road have a width of 15-20 feet. The residents of the Islambagh and Alir Mor neighborhoods predominantly work in the area's factories. Due to the presence of numerous restaurants, industries, and printing presses that require easy access for customers and loading/unloading purposes, most mixed-use buildings are located along these roads. These fundamental findings emerged from the observations and image analysis conducted.

Figure 9-23 are some building images of ward 29. Figure 9-12, the roads are wide enough that are less vulnerable to any hazard. In Figure 19-23, the roads are narrow, congested, and unplanned wire connections as well. Figure 22 shows, this road has some tall buildings with narrow roads that are vulnerable to earthquake and fire hazards as well.

Some images of Ward 29 that were taken during photographic analysis are attached here:

Figure 09 Shoari Ghat

Figure 10 Madina Filling Station

Figure 11 Alir Ghat

Figure 12 Chairman Ghat

Figure 13 Beribadh Police box

Figure 14 Plastic Industry

Figure 15 Rahim Box Lane

Figure 16 Shreshta Khan Road

Figure 17 Chawkbazar Shahi Mosque

Figure 18 Posta Pharmacy

ty

Figure 19 Atoshkhana Lane

Figure 20 Islambagh Lane

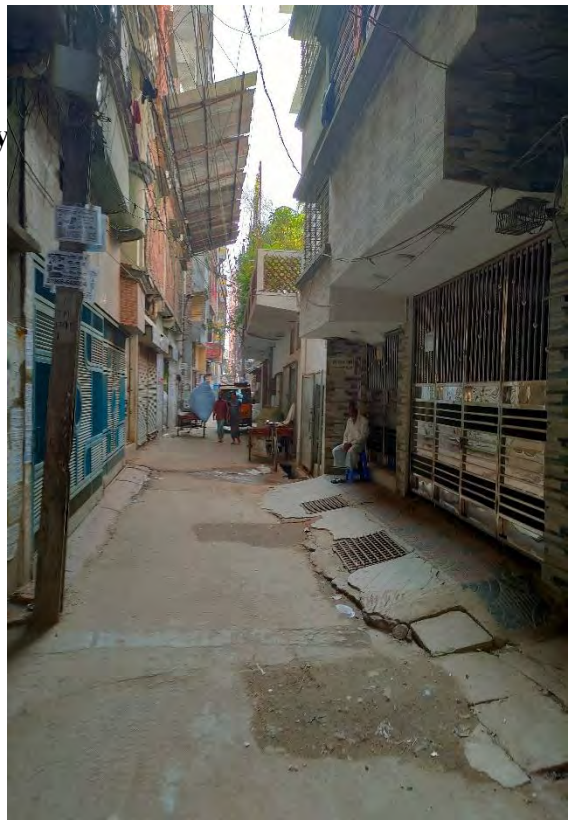


Figure 21 Islambagh

Figure 22 Highrise building in Kellar mor.

Figure 23 Islambagh kacha bazar area

At Ward 29, prominent roads and areas include East-West Islambagh, Shayestha Khan Road, Posta, Haji Rahim Box Lane, and Water Works Road. It is worth noting that the buildings near Buriganga are primarily commercial and mixed-use structures. Other types of structures include residential areas, businesses, institutions, and grocery stores.

There are numerous factories in the area involved in the production of chemicals, plastics, and electrical products, which pose a significant fire hazard risk. Despite most structures being of modest height, it has been identified that the presence of combustible materials makes the location vulnerable to fire incidents following an earthquake.

Survey results indicate that the middle zone of Ward 29 experiences high population density. People commute to this area for work but do not permanently reside here (highlighted in yellow), as it primarily houses factories. However, due to the abundance of chemical factories in the vicinity, the populated area nearby is also at risk of fire outbreaks. Most of the narrow roadways in the area are numbered, exacerbating the potential dangers. In the event of a fire or earthquake, rescue efforts may be delayed due to congested routes.

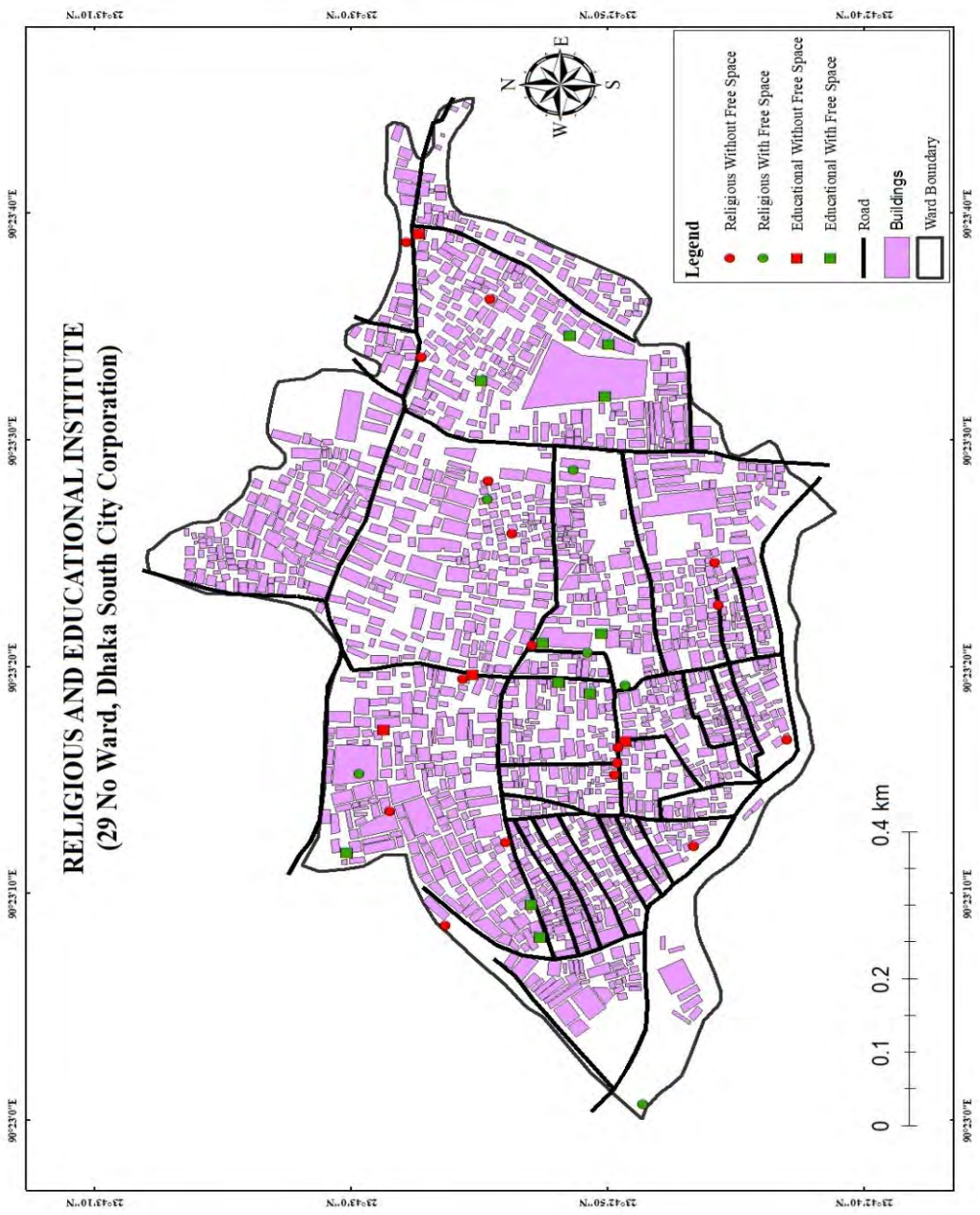


Figure 24 Space identification of school and religious place at ward 29.

Figure 24 presents a map showcasing the current religious and educational institutions in Ward 29. The circular markers indicate the locations of religious institutions within the ward. The map reveals that there are approximately 24 religious' institutions, with the green markers representing those with open spaces and the red markers representing those without. Out of the total religious institutions, only six in Ward 29 have open spaces that can potentially be utilized as shelters during calamities.

Similarly, the square markers indicate the locations of the 17 existing educational institutions, of which 11 have open spaces. However, these open spaces are often too small to accommodate many people at once. This analysis highlights the insufficient availability of open areas that can serve as shelter spaces during emergencies such as fire hazards and earthquakes.

According to the study and data from Lalbagh Fire Station, there are currently three high-rise structures in Ward 29, each consisting of 6 to 9 stories. Out of these, two are residential buildings, while one poses a mild hazard. The total population residing in these structures exceeds 157 individuals. The nearby roads have widths of 20 feet and 16 feet. Table 10 shows the details of these three buildings. It includes the address of these buildings, number of stories, and the hazard type. The table also describes the safety plan, emergency exit, road details, and underground reserve capacity as well. This information might help the authority to take immediate steps to work on these buildings and minimize the loss during any disaster.

These structures lack emergency escape routes, which increases the risk in case of a disaster. Additionally, they do not have a safety plan for fire hydrants, nor do they possess building clearance from the fire station, as stated in the report. However, the data reveals that these buildings have underground reserves with a capacity of nearly 15,000–20,000 liters, which can serve as a valuable resource for rescue teams during fire or earthquake emergencies.

Owner	Address	Floor	Hazards Type	Residing Population	Width of the in-front Road (In feet)	Emergency exits, lifts, or stairways	Fire Pump/Safety Plan	Roof	Building Clearance from Fire Service	Underground Reserve capacity (Litter)
Hazi Md. Zakir H	115/2 West	7	Residential	72	20	No	No	Open	No	15000
Hazi Yousub	63, Water Works	9	Residential	60	20	1	No	Open	No	20,000
Aftaf Khan	141, Water Works	8	Light Hazard	25	16	1	No	Open	No	20000

Table 10 Three high-rise buildings with details (Source: Lalbagh Fire Station).

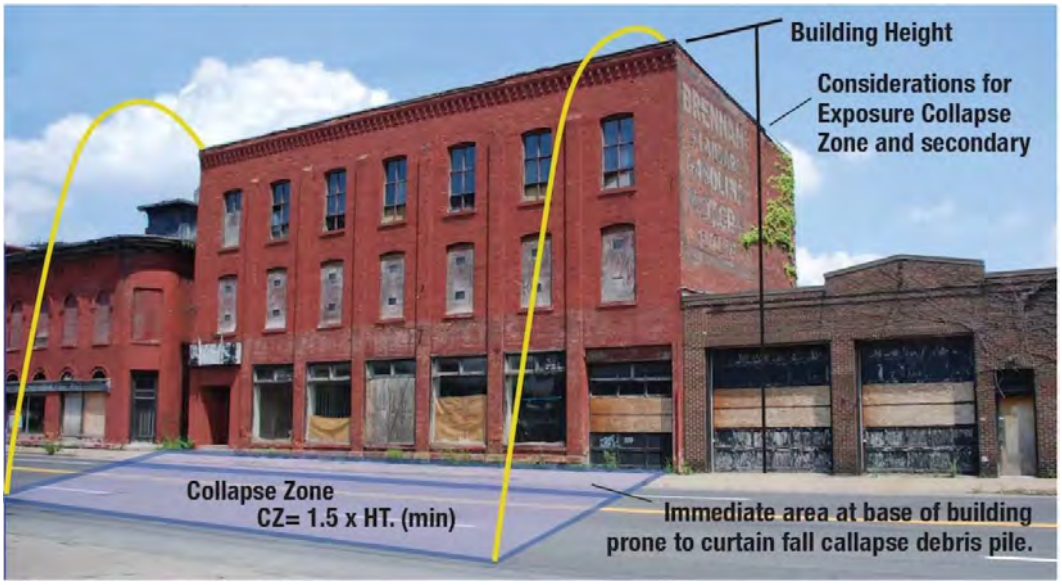


Figure 25 Building height and collapse distance ratio. (Source: Khan, 2004)

Figure 25 illustrates that the collapse of a building would require nearly 1.5 times the height of the building as the surrounding space. Therefore, in the event of a fire or earthquake disaster in this area, it is evident that it would have a significant impact, affecting a large area.

The Lalbagh fire station claims to have compiled all the necessary information regarding the location of water sources in the area. They have listed the structures that have water storage, which can be used as a supply of water in case of an emergency. This information includes details such as the building owner, the distance of the building from Lalbagh Station, specifics of the building, and the volume of water in the reservoir. The identified buildings range in distance from 0.3 km to 3 km.

Table 11 presents a list of buildings that have water reservoirs, along with detailed information on the water volume. This facilitates prompt action by the fire station when required.

SL	Name	Address	Distance from Station	Reservoir Type		Reservoir and volume holding
				Natural	Artificial	
1.	144/1 Water Workers	144/1 Waterworks Road, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	50,000 Liter
2.	Agrani Bank	Water Workers Road, Dhaka	1.5km		Underground Reservoir	25,000 Liter
3.	Janata Bank	Water Workers Road, Dhaka	1.5km		Underground Reservoir	15,000 Liter
4.	Meghna Bank	Water Workers Road, Dhaka	1.5 km		Underground Reservoir	20,000 Liter
5.	Chawk Bazar WASA	198 Water Workers Road, Chawkbazar, Dhaka	2 km	Natural	Underground Reservoir	
6.	Dhakeshwari temple	Dhakeshwari Temple, Dhaka	150 gauge	Natural	Underground Reservoir	Pond
7.	13&14 Bakshi bazar	13-14 Nayangar road, Bakshi, Bazar, Dhaka	300m		Underground Reservoir	100000 Liter
8.	2 orphanages	2 Orphanage Road, Bakshi Bazar	400m		Underground Reservoir	10000 Liter
9.	Badrunnesa govt. women college	7 no Bakshi Bazar Road, Dhaka	.01 km		Underground Reservoir	15000 Liter

10.	Bakshi bazar	19/1 Bakshi Bazar, Dhaka	2.5 km		Underground Reservoir	10000 Liter
11.	Jail area	Jail Area, Bakshi Bazar Dhaka	900m	Natural	Underground Reservoir	Pond
12.	Hossain Dalan	66 no Hossain Dalan Road, Chawkbazar, Dhaka	3 km	Natural	Underground Reservoir	Pond
13.	16 Bakshi Bazar	16 Umesh Datta Road, Bakshi Bazar, Dhaka	1.5km		Underground Reservoir	10000 Liter
14.	Shahi Mosque	Chawkbazar, Dhaka	1.2 km		Underground Reservoir	15000 Liter
15.	Begum Bazar	Ward Counselor Office, Chawkbazar, Dhaka	1.2 km		Underground Reservoir	10000 Liter
16.	Moulavi mosque	Moulavi Bazar, Dhaka	2 km		Underground Reservoir	10000 Liter
17.	Sowari ghat	30 Soari Ghat, Chawkbazar, Dhaka	2.5 km		Buriganga river	8000 Liter
18.	1/1/1 jail road	1/1/1 Jailroad, Chawkbazar, Dhaka	2 km		Underground Reservoir	15000 Liter
19.	146-148 Midford	146-148 Midford Road, Chawkbazar, Dhaka	2.5 km		Underground Reservoir	10000 Liter
20.	Rahmatganj Market	34/3 Rahmatganj, Chawkbazar, Dhaka	2 km		Underground Reservoir	20000 Liter

21.	Chawkbazar telephone Bhaban	Chawkbazar telephone Bhaban, Dhaka	3 km		Underground Reservoir	25000 Liter
22.	Chawkbazar	Chawkbazar, Dhaka	3 km		Underground Reservoir	20000 Liter
23.	Ibn Sina Diagnostic Center	Ibn Sina Diagnostic Center, Dhaka	150 gauge		Underground Reservoir	90000 Liter
24.	Dr. Nijam Medical Hall	19 Dhakeshwari Road, Lalbagh, Dhaka	250 gauzes		Underground Reservoir	50000 Liter
25.	Standard Chartered Bank	Waterworks Road, Dhaka	1.5 km		Underground Reservoir	8000 Liter
26.	Sonali Bank Limited	1 Urdu Road, Dhaka	1.2 km		Underground Reservoir	40000 Liter
27.	Hazi Ahmed Aslam Mansion	4 Harnath Gosh Road, Chawkbazar, Dhaka	2 km		Underground Reservoir	2400cubic foot
28.	Jakaria Mansion	Urdu Road, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	2400cubic foot
29.	Josna Bhaban	48 Urdu Road, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	1440 cubic foot
30.	SakibAnwar tower	46 Urdu Road, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	80000 Liter
31.	Halima Market	4 ajgar lane, Urdu Road, Chakbazar, Dhaka	1.5 km		Underground Reservoir	18000 Liter

32.	Sultan Mansion	71 Circular Road, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	50000 Liter
33.	Hazi Bhaban	2 Urdu Road, Dhaka	1.5 km		Underground Reservoir	640 cubic foot
34.	Abeda Mansion	25/1 Chawkbazar, Dhaka	2 km		Underground Reservoir	1440 cubic foot
35.	Abeda Mansion	25/1 Chawkbazar, Dhaka	2 km		Underground Reservoir	1440 cubic foot
36.	Mostafa Tower	24 Maolana Mufto Road, Chawkbazar, Dhaka	2 km		Underground Reservoir	1440 cubic foot
37.	Sahidullah Market	41/1 Ajgar Lane, Dhaka	1.5 km		Underground Reservoir	1680 cubic foot
38.	Al Amin Market	5 Urdu Road, Chawkbazard, Dhaka	1.5 km		Underground Reservoir	1680 cubic foot
39.	Malek Mansion	26 urdu Road, Chawkbazar, DHaka	1.5 km		Underground Reservoir	1200 cubic foot
40.	Amin Market	47/1 Ajgar Lane, Chawkbazar, Dhaka	1.5 km		Underground Reservoir	1000 cubic foot
41.	Chawk Shahi Mosque	9 Kamaldah Urdu Road, Chawkbazar, Dhaka	2 km		Underground Reservoir	65000 gallon
42.	Basar Mansion	Nandakumar Datta Road,	2 km		Underground Reservoir	30000 Liter

		Chawkbazar, Dhaka				
43.	Madina Ashik Tower	21-27 Chawk Circular Road, Chawkbazar, Dhaka	2 km		Underground Reservoir	50000 (2) Liter
44.	Hossain Mansion	31 Chawk Circular Road, Dhaka	2 km		Underground Reservoir	12000 Liter
45.	Hossain Plaza	Biren Bose street, Chawkbazar, Dhaka	2 km		Underground Reservoir	12000 Liter
46.	AC Mosque Market	63 Chawk Mogoltuli, Chawkbazar, Dhaka	2 km		Underground Reservoir	10000 Liter
47.	Samsul Haque Tower	88/890 Chawk Mogoltuli, Chawkbazar, Dhaka	2 km		Underground Reservoir	20000 Liter
48.	Makka Madina tower	86/A chawk, Mogoltuli, Chawkbazar, Dhaka	2 km		Underground Reservoir	50000 Liter
49.	Sadek mansion	85 chawk, Mogoltuli, Chawkbazar, Dhaka	2 km		Underground Reservoir	10000 Liter
50.	Siraj tower	86 chawk, Mogoltuli, Chawkbazar, Dhaka	2 km		Underground Reservoir	80000 Liter

51.	Lalbagh view	27/4 Dhakeshwari Road, Lalbagh Dhaka.	200 gauges		Underground Reservoir	80000 Liter
52.	Manas	27/4 Dhakeshwari Road, Lalbagh Dhaka.	200 gauges		Underground Reservoir	80000 Liter
53.	Lalbagh Classic	27/4 Dhakeshwari Road, Lalbagh Dhaka.	200 gauges		Underground Reservoir	40000 Liter
54.	Mamtaz Begum Bhaban	19 Dhakeshwari Road, Lalbagh Dhaka.	100 gauges		Underground Reservoir	32000 Liter
55.	Bahdul Aman Bhaban	19/2 Dhakeshwari Road, Lalbagh Dhaka.	100 gauges		Underground Reservoir	28800 Liter
56.	Hanif Bhaban	19/1 Dhakeshwari Road, Lalbagh Dhaka.	100 gauges		Underground Reservoir	21600 Liter
57.	Asiana tower	92/1/3 Dhakeshwari Road, Lalbagh Dhaka.	50 gauges		Underground Reservoir	29400 Liter
58.	Salma villa	21/2 Nur Fateh Lane Dhaka	50 gauges		Underground Reservoir	30000 Liter
59.	Shagun Community Center	21/2 Nur Fateh Lane Dhaka	20 gauges		Underground Reservoir	30000 Liter
60.	Anhab Bhaban	21/2 Nur Fateh Lane Dhaka	15 gauges		Underground Reservoir	30000 Liter

61.	Ashram Alam	6/3/2 orphanage	50 gauges		Underground Reservoir	21600 Liter
62.	Karim Arked	6/2 Orphanage Road, Dhaka	50 gauges		Underground Reservoir	30000 Liter
63.	Jumman Villa	Jumman Bepari Villa, Dhaka	50 gauges		Underground Reservoir	24000 Liter
64.	Moulavi bazar tower	Moulavi Bazar	1.5 km		Underground Reservoir	50000 Liter
65.	Moulavi bazar trade center	Moulavi Bazar	1.5 km		Underground Reservoir	50000 Liter
66.	Gulbadan Mosque Complex	Moulavi Bazar	1.5 km		Underground Reservoir	50000 Liter
67.	Bismillah tower	Midford sarak	2 km		Underground Reservoir	50000 Liter
68.	M.K tower	Midford sarak	2 km		Underground Reservoir	50000 Liter

Table 11 Old Dhaka building details with a water reservoir.

4.3 Adjacent Roads and Surrounded Fire Stations

Few roads are wide enough to allow a fire department to reach the scene quickly, according to surveys. Few roads exist between 3 and 9 meters, with the majority being less than 3 meters. Figure 26 shows the road width with a pie chart that defines the condition of the road of Ward 29. The pie chart shows almost 25% of buildings are between 3-9 m, and 75% of buildings are less than 3m. A 7-story structure requires a minimum of 30 feet of road for a fire department with a car, however, these are scarcely available in this area. The only vehicle that can access this route during a fire hazard can carry 40 liters of water and 100 feet of pipe, which is a bike.

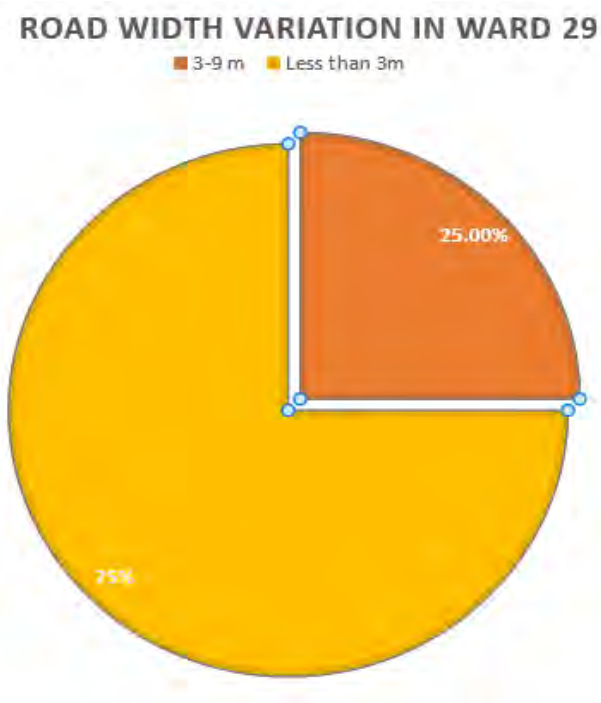


Figure 26 Road details with pie chart- ward 29.

In Figure 27, the red mark shows the fire station at old Dhaka and the blue one is the water body. That defines the catchment area of the water body near the fire station. The study states in Figure 27, that there isn't a fire station within two kilometers of this location. These 2 kilometers take a long time to complete due to the tight roads, which could result in more dangerous circumstances due to time limitations.

According to Kajal Miah, senior station officer at Lalbagh Fire Station, they have numerous challenges when doing any rescue mission. Because of the numerous banners in the area, it is dangerous for both the rescue crew and them to drive during an emergency. Nearly all the fire station's fire brigade vehicles can transport 21,000 liters of water at once. However, they hardly ever can operate those vehicles because they cannot fit within the minimal road width.

They may transport a vehicle with a maximum capacity of 1800 liters, and the water gets finished in 5-7 minutes after utilizing 4-5 pipes. Then, to address the situation, they must once more determine the closest water source. They must use motorcycles if the route is narrow since they can only transport 40 liters of water at a time, which is only enough to cover one or two stories of buildings. According to the station manager, the adjacent fire stations attempt to hold some training sessions each week but infrequently receive cooperation from the local populace and the government.

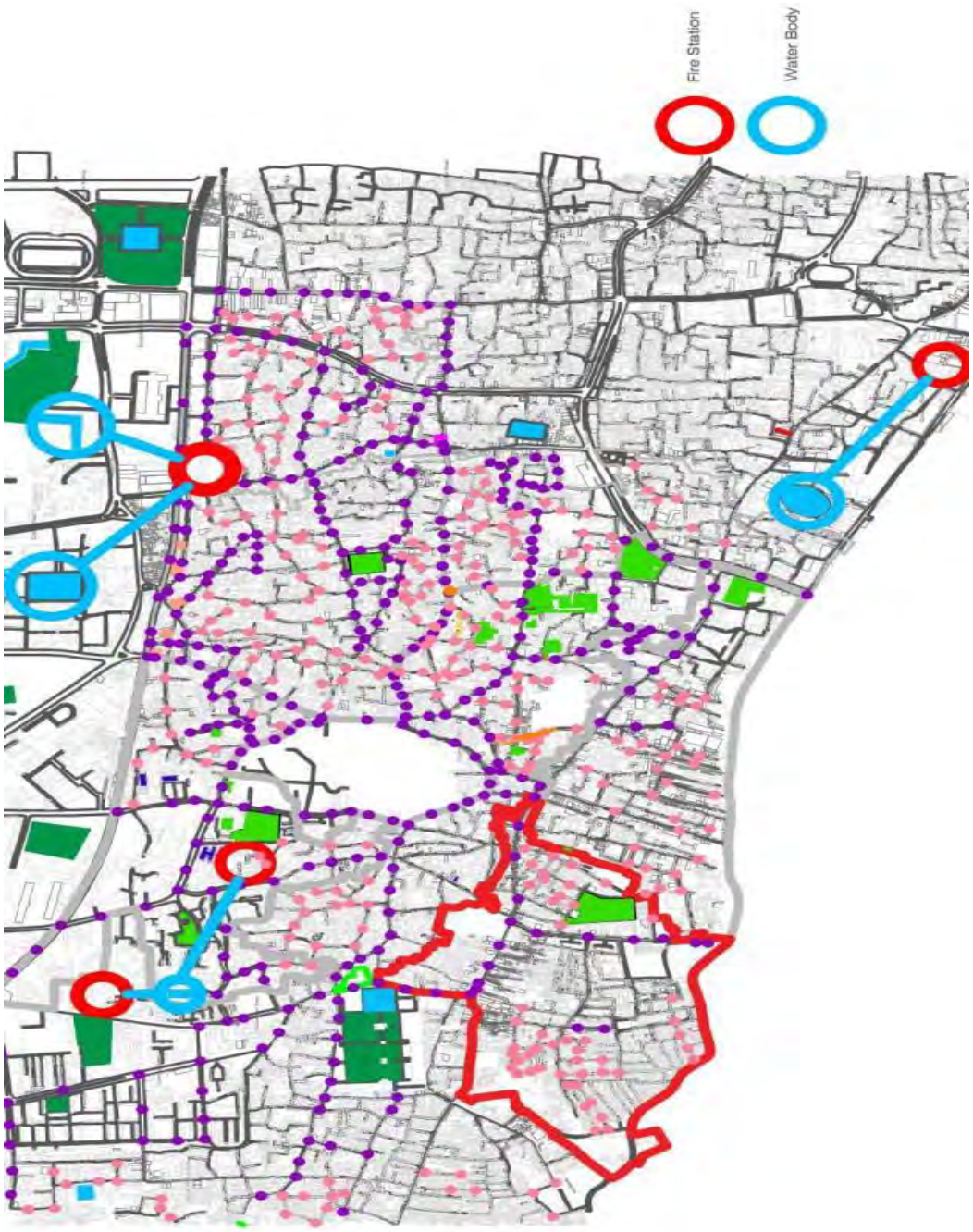


Figure 27 Fire Stations and water bodies in nearby catchment areas.

4.4 Building analysis

The author employed a simple random sampling procedure considering the account of the waterworks road and Zone 1 for building survey analysis. The author selected 20 buildings for further investigation. The author has assigned numbers to such structures and has chosen his necessary samples using an arithmetic progression with a common difference of 10. The author used those building surveys to try to determine certain structural outcomes and came to some similar findings.

Table 12 shows the number of floors of the buildings, and their type with some other information.

Sample	Floor	Building type	Stair width	Setback/side Road width
Sample 1	3	Mixed-use	1m	1.5 m (Road)
Sample 2	4	Mixed-use	1m	Shared wall
Sample 3	4	Residential	0.8m	Shared wall
Sample 4	2	Mixed-use	0.8m	Shared wall
Sample 5	4	Mixed-use	1m	Shared wall
Sample 6	2	Mixed-use	0.5m	0.8m
Sample 7	2	Mixed-use	1m	Shared wall
Sample 8	2	Mixed-use	0.8m	1.5m
Sample 9	4	Commercial	0.8m	1.5m
Sample 10	2	Residential	0.5m	Shared wall
Sample 11	5	Mixed-use	1m	Shared wall
Sample 12	2	Mixed-use	0.5 m	1m
Sample 13	4	commercial	1m	Shared wall
Sample 14	5	Mixed-use	0.8m	Shared wall
Sample 15	2	Mixed-use	0.8m	Shared wall
Sample 16	2	Residential	1m	Shared wall
Sample 17	4	Mixed-use	0.8m	1.5m
Sample 18	2	Mixed-use	0.6m	0.8m
Sample 19	2	Mixed-use	0.6m	0.8m
Sample 20	3	Mixed-use	0.5m	1.5m

Table 12: Location and basic features of 20 surveyed buildings.

Figures 28 and 29 show the GIS map location of these surveyed buildings. Here through Figure 28, the author has selected buildings from Zone 1 and Figure 29 shows the building near specific Waterworks Road. The yellow marked blocks, show the buildings that were chosen for further survey. The red mark shows specific locations identified through GIS and the purple mark shows existing buildings. The map also shows existing road connections and the ward boundary as well.

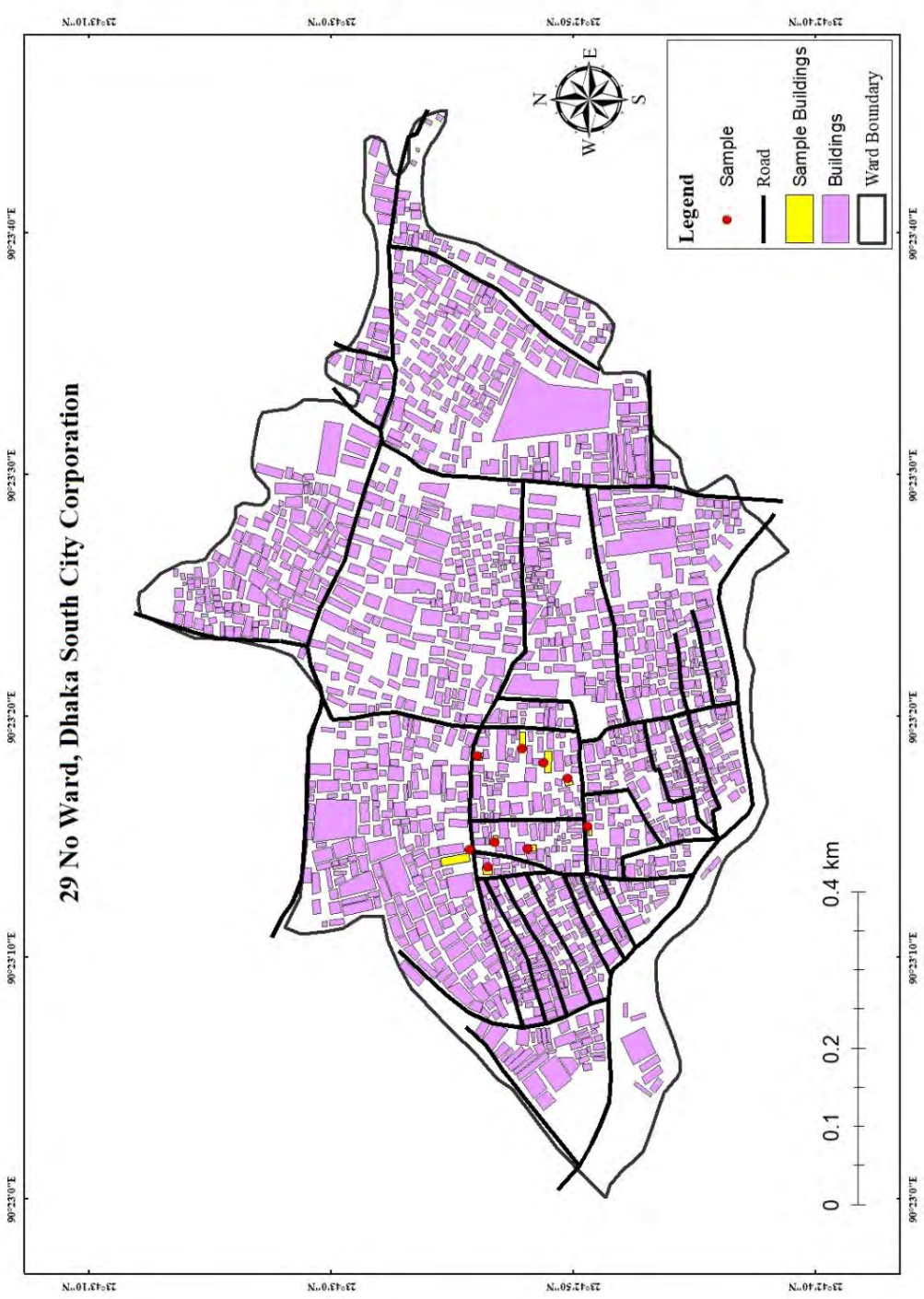


Figure 28: GIS overview of 9 buildings surveyed buildings from Zone 1.

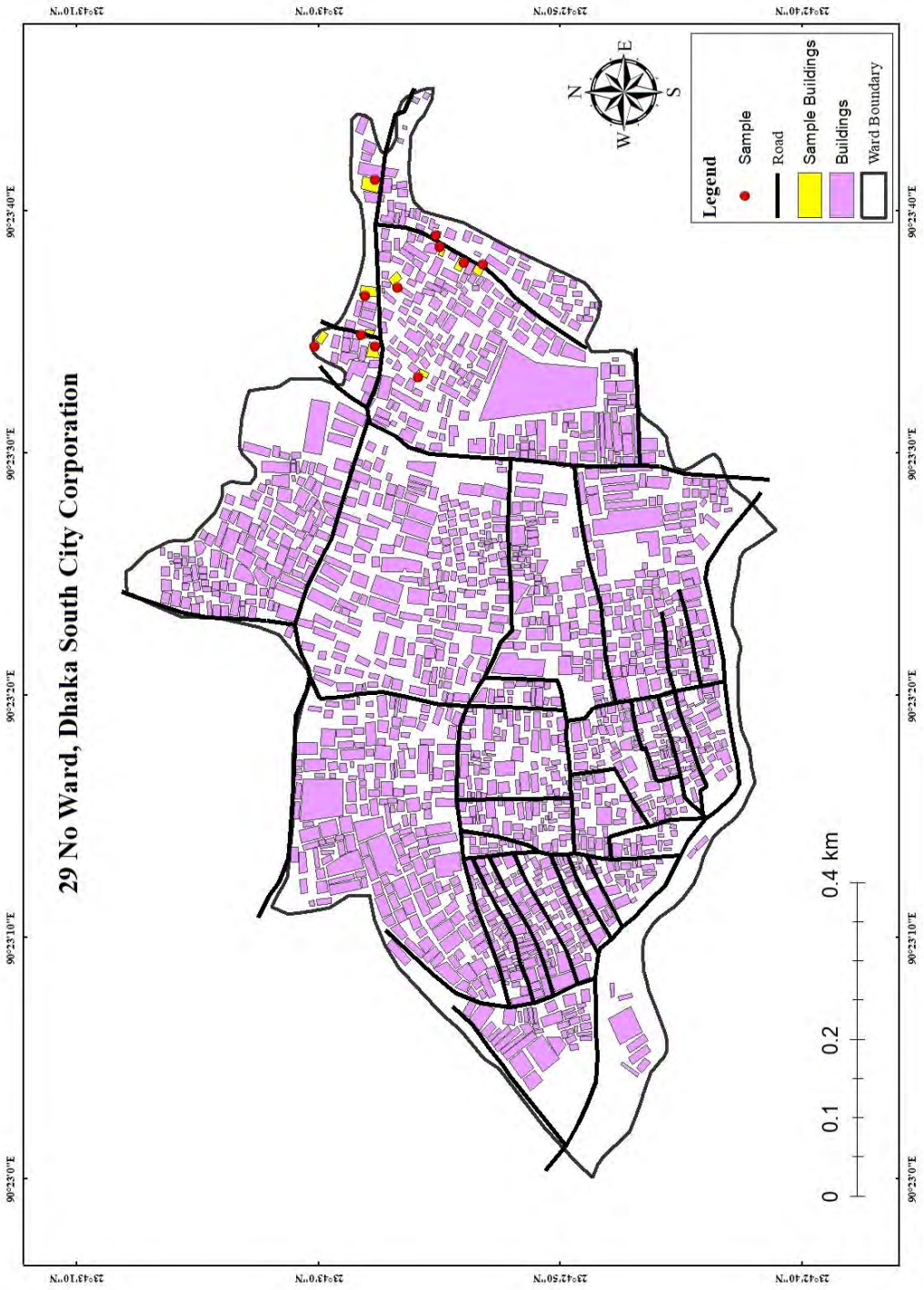


Figure 29: GIS overview of 11 surveyed buildings from Zone 1.

According to the study, 75% of buildings are mixed-use buildings, while the other 25% are made up of both commercial and residential structures (Figure 34). We may infer from this ratio that most of the structures in this area are mixed-use structures. Most mixed-use structures feature factories on the bottom level or both the ground and first floors. Most mixed-use buildings—nearly 60%—contain printing or plastic factories in addition to restaurants and grocery stores. The employees of certain industries reside on some higher levels or mezzanine floors in some buildings. They also consider that to be hazardous. Some mixed-use structures also include restaurants or supermarkets. Like mixed-use buildings, commercial buildings often include manufacturers on all levels, and in certain situations, employees reside on the higher floors.

Figure 30: Sample 09

Figure 31: Sample 11

Figure 32: Sample 13

For Sample 9 in Figure 30, the whole building is used for commercial purposes and workers live here as well. For sample 11 in figure 31, 4 families live there and there is a shop on the ground floor. From figure 32 sample 13, the warehouse is on the ground floor, and on the upper floors, 6 families live there. Here we can see that most of the buildings are mixed-use buildings.

It seems that 50% of the structures are two stories tall, while 30% are four stories. The remaining ones are structures of 3 and 5 stories. However, since there is extremely limited space for roads in buildings with four and five stories, they may block them during an earthquake and hinder emergency escape.

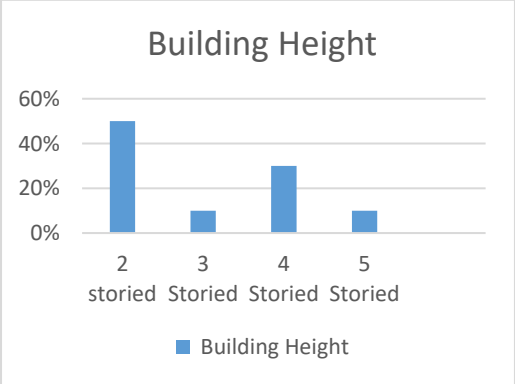


Figure 33: Percentage of Building height.

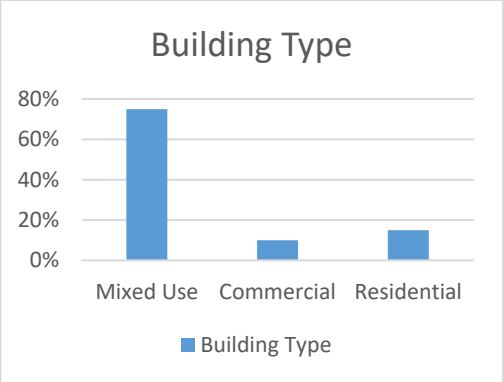


Figure 34: Percentage of Building type.

Regarding stairs in Figure 38, a study reveals that 35% have a 1 m width and 35% have a 0.8 m width. However, only 30% of the stairs are higher than 0.5 meters. In other instances, the stair was not in the design, therefore they created an external stair from the exterior of the structure and expanded their level Some staircases are in a dark space that is hard to reach in a hazardous circumstance. Some of the stairs have weak structures and are broken. During the assessment, it was also discovered that the stairs are partially obstructed by industrial equipment or by other materials, which explains why they are not even accessible in an emergency.

Figures 35-37 and 40-42 show some stairs that looked vulnerable in ward 29. Some of them have very weak structures and some are not having enough width. In Figure 42, the stair of sample 4 is externally added which was not a part of the existing plan. These are some stair issues that are making the structure vulnerable.

Figure 35 Sample 6

Figure 36 Sample 19 (a)

Figure 37 Sample 19 (b)

Most of the buildings do not adhere to adequate setback regulations. 20% of buildings have a setback between 0.8 and 1 meter, while 55% of structures share a wall (Figure 39). The shared wall separates two different units together. It can be a strong structure, but those buildings don't have fire exit and they have weak structure as well, that make the buildings vulnerable. The shared wall hampers the ventilation as well which can be an issue during any fire hazard. Some of the buildings included in the study have tertiary roadways that are 2-2.5 m wide. The structural expert claims that some of these structures have too weak of a foundation, inadequate stair widths, and unintentionally added stairs that might be earthquake- prone. There are numerous wire connections, including transformers, all around almost every structure that an earthquake might convert into fire hazards.

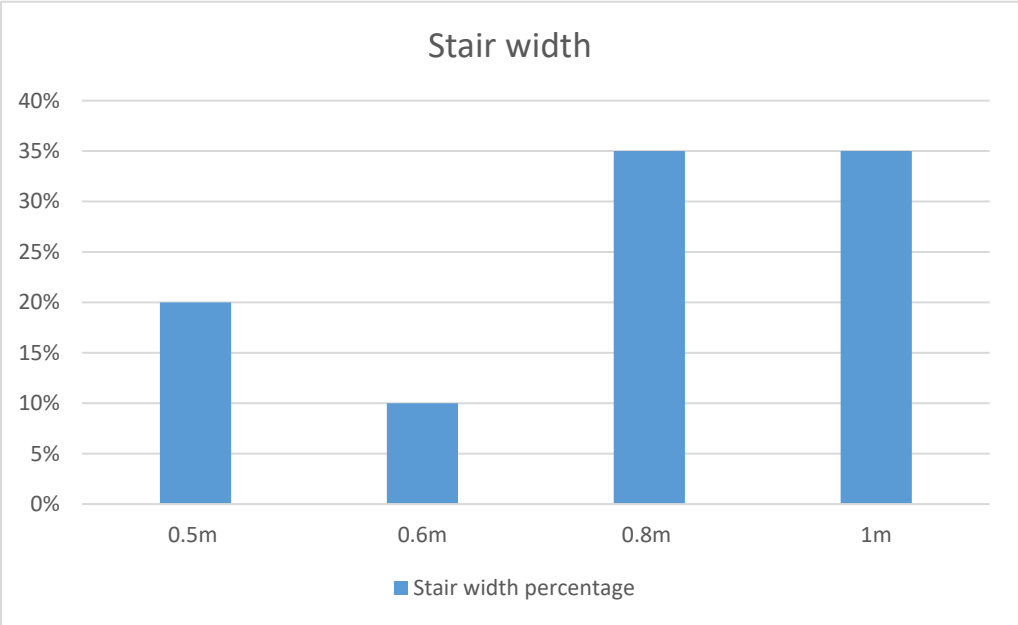


Figure 38: Percentage of different stair widths.

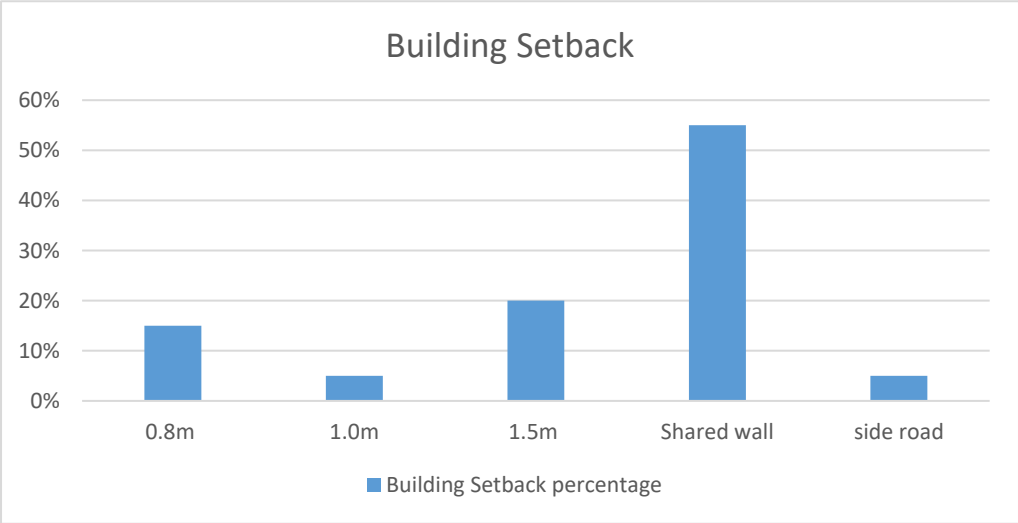


Figure 39: Percentage of different building setbacks.

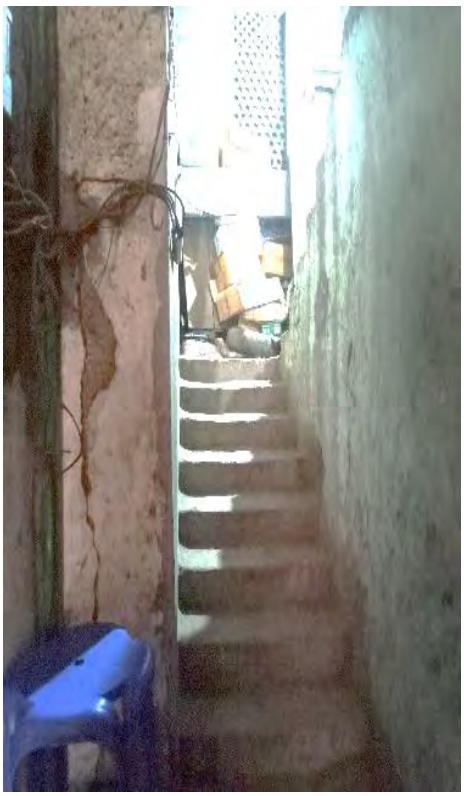


Figure 40: staircase of Sample 2.

Figure 41: staircase of Sample 3.

Figure 42: staircase of Sample 4.

CHAPTER-FIVE
SOCIAL VULNERABILITY ASSESSMENT

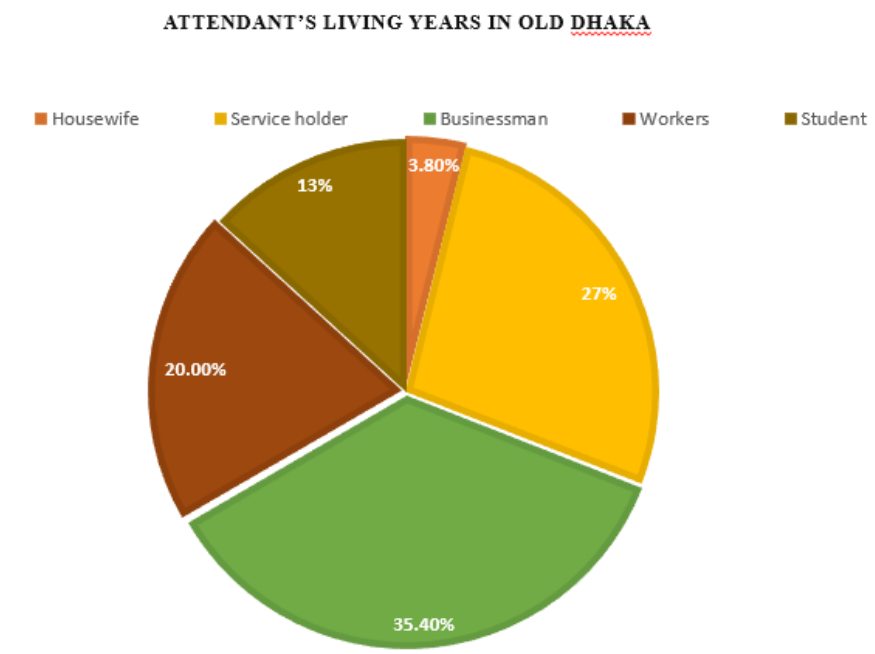
Here from Ward 29, Interviews are taken with 120 people to understand their views and perspectives regarding Fire Hazards and Earthquakes. The respondents were a mix of different professions and ages.

Here among 120 people, there are 26.9% were service holders, 35.4% were businessmen, 20% were students whose ages are between 18 and 30 years, 3.8% are housewives and workers are with 13.1%.

The people that work here every day are the main attendees. They have dealt with the issue and are concerned about these two great calamities as they do so in their daily lives. Nearly every day, students drive by the roadways and study the environment where businesspeople and service providers operate so they may assess any potential threats.

From Figure 43 we can see that, 30.8% of people have been living in this ward for 5-10 years, 26.9% have for more than 10 years, 23.1% have for 0-5 years, 12.5% have been living here by born and 6.6% people just come here to work. Given the range of living periods, it is now useful to comprehend how circumstances alter over time and how people's perspectives evolve.

This survey does not fully justify the Vulnerable situation of this ward but it helps to find out their perspectives and the ways to increase their awareness and knowledge regarding earthquake and fire hazards. Given that they deal with danger and hazards regularly and may make a significant difference, all the attendants here play a crucial part in this situation.



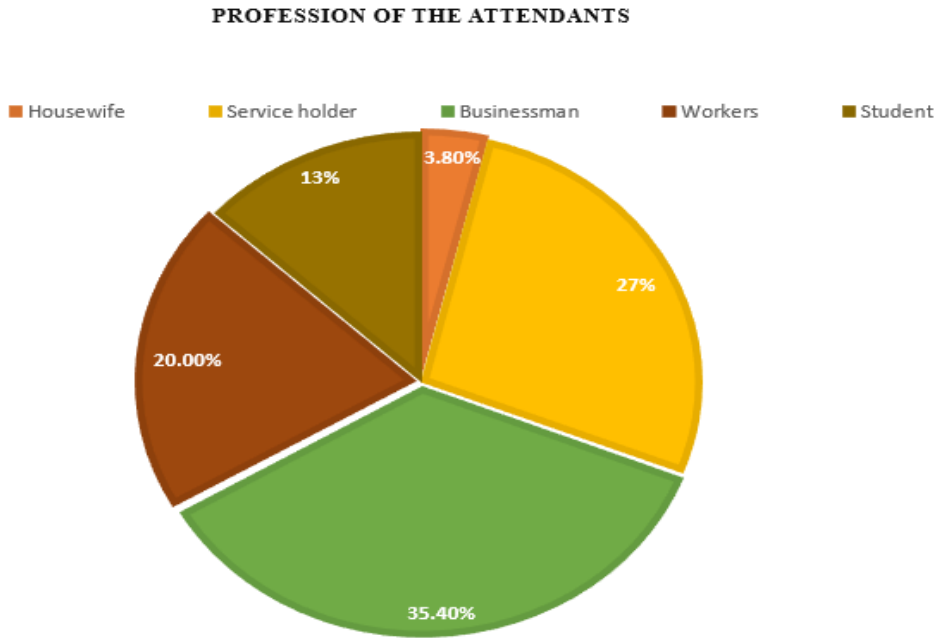


Figure 43 Profession and Living years of attendants.

5.1 Concern on Fire Incident According to Respondent

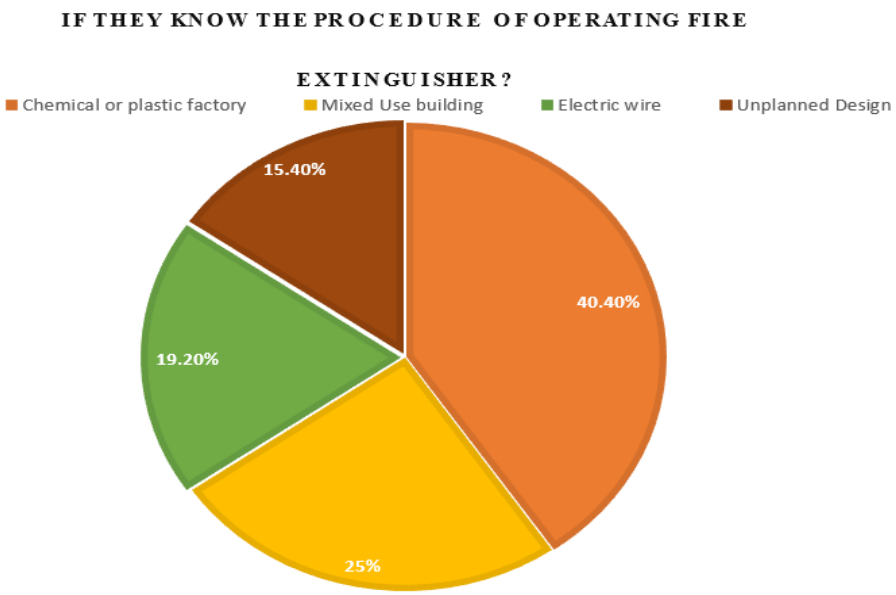
Here are some questions that have been asked regarding the fire occurrences, their reasons, and their knowledge to mitigate the risks. They have been asked about the main cause behind any fire incident. 40.4% of the total respondents said that it is because of chemical or plastic factories, 19.2% said the reason is electric wire and gas pipelines, 25% said the reason is mixed-use buildings and the rest of them said the reason is unplanned design.

Most mixed-use buildings, according to the respondents, include plastic, chemical, or printing accessory facilities on the ground level of each building. In Ward No. 29, the center zone primarily possesses these qualities, but other areas also exhibit them to a lesser extent.

The vulnerability to fuse hazards increases when buildings are near restaurants on the ground level that use cylinders. Such situations are frequent on the outskirts of roads in Ward 29. According to a survey, restaurants and polythene factories are often situated adjacent to each other on the ground floor, while residences are located on the upper floors. These factors contribute to the vulnerability of the area to fire hazards.

Figure 44 depicts the responses of attendees when asked about their knowledge of using fire extinguishers. The results indicate that 55.50% of attendees do not know the procedure, while 40% are familiar with it. Additionally, 4.50% of attendees mentioned that they might know about the procedure but haven't had the opportunity to try it yet. Among the 40% who know the procedure, it is observed that 19% are workers and 21% are students. However, no businessmen, service holders, or housewives reported knowledge of the procedure.

Furthermore, attendees were asked about their understanding of the root causes of fire events. The responses identified several causes, including mixed-use structures, narrow roads, ignorance, lack of fire extinguishers, unplanned land use, and water scarcity.



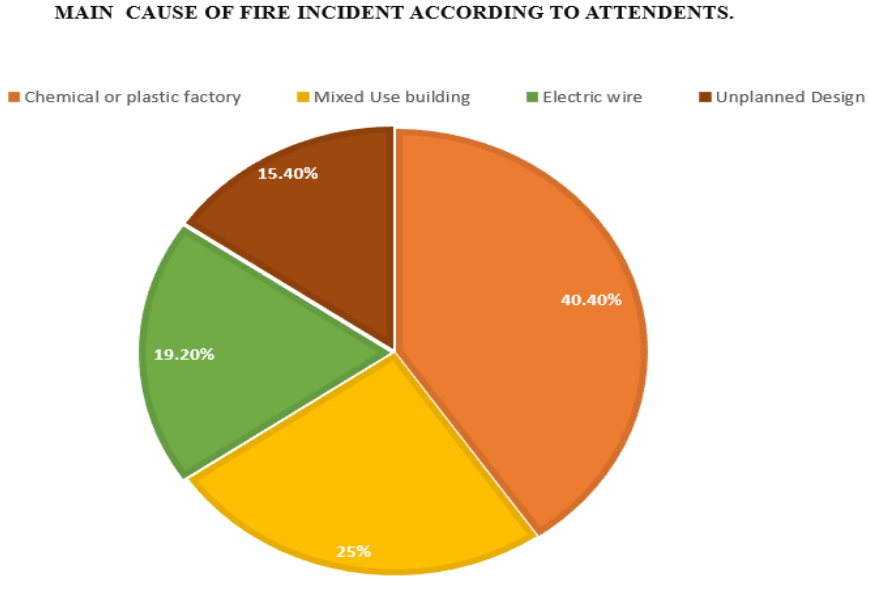


Figure 44 Pie chart of main causes of fire incidents according to attendants and people knowing the use of fire extinguishers.

Among the attendees in Figure 45, 42.30% believe that narrow roads are the primary cause. A closer look at the road map reveals that 85% of the roads in this ward are narrower than three meters. Although there are an adequate number of fire stations in the area, attendees noted that accessing them on time and at the right location is challenging due to congested and limited roadways.

26. 90% of individuals believe that mixed-use buildings are the main causes of significant loss in any fire threat. The problem is made worse by these adjoining mixed-use buildings that house plastic manufacturing and eateries. 3.80% of the attendees agree that there is a scarcity of water that aggravates the problem.

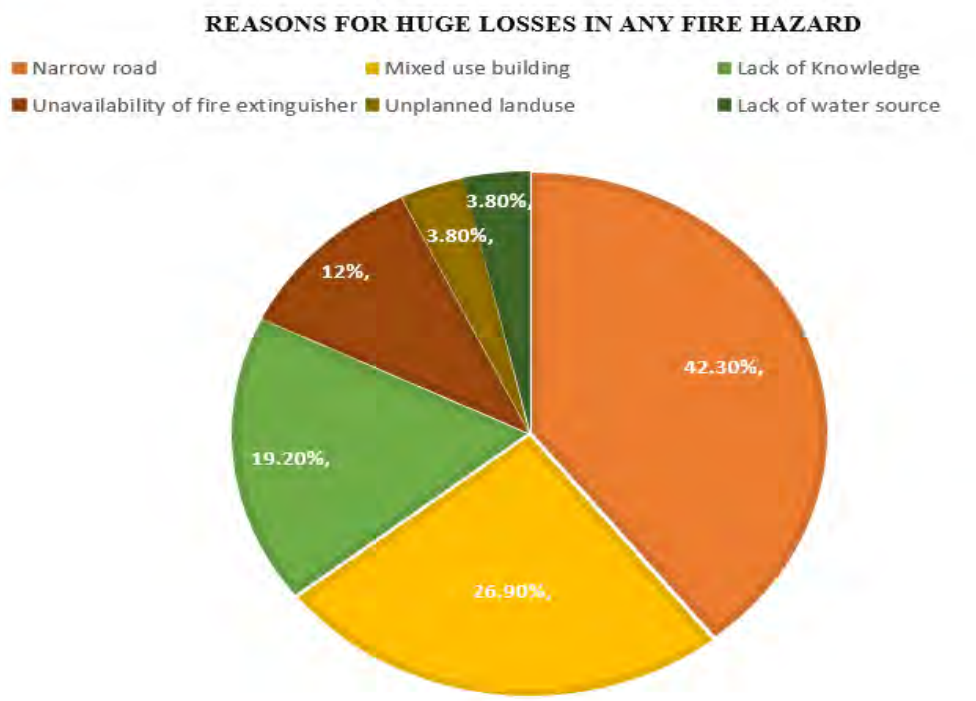


Figure 45 Pie chart of the percentage of reasons of fire hazard from the attendants.

5.2 Concern on Earthquake According to Respondent

Due to its unplanned design, the prevalence of illegal structures, and weakly constructed buildings, Old Dhaka is considered an earthquake-prone area. The study aims to shed light on how people perceive this calamity and assess their preparedness for similar risks in the future.

According to the poll shown in Figure 46, approximately 53% of the 120 participants believe that their region is highly susceptible to earthquakes due to the unplanned design of buildings. They express concerns about the lack of adequate shelter spaces in Ward No. 29 during any hazard. The unequal distribution of amenities further contributes to the area being unsuitable for residential purposes. In their opinion, zones with warehouses and factories in this ward mostly have narrow roads, resulting in overcrowding of people and vehicles, which poses a significant risk during an earthquake. The collapse of structures would lead to loss of life, and the affected individuals would have minimal time and face severe situations in finding shelters or escaping from the zone.

Additionally, 7.70% of respondents believe that congested buildings with shared walls increase the risk of earthquakes as they weaken the overall construction. The same percentage of people attribute the high population density in the area as a contributing factor. Moreover, 12% of respondents believe that poor emergency response capabilities are a reason behind the vulnerability, while 20% of participants believe that illegal structures are responsible for the heightened risk.

According to the poll in Figure 47, 73% of respondents to the poll stated that they have learned how to react to an earthquake from social media, television, or radio. 19% of respondents, the majority of whom are workers, said they had no information about this. Here 8% of total attendees said that they have no idea what to do during any earthquake.

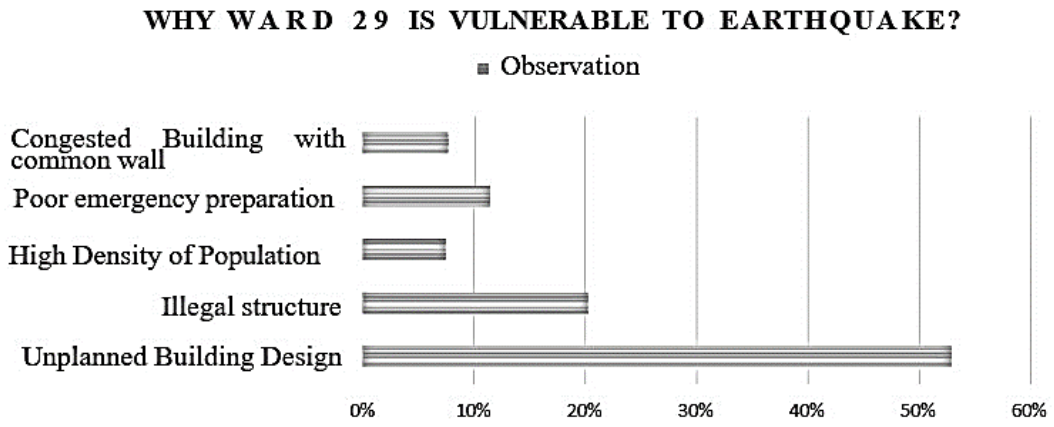


Figure 46 The reason for being vulnerable to earthquakes according to the attendants.

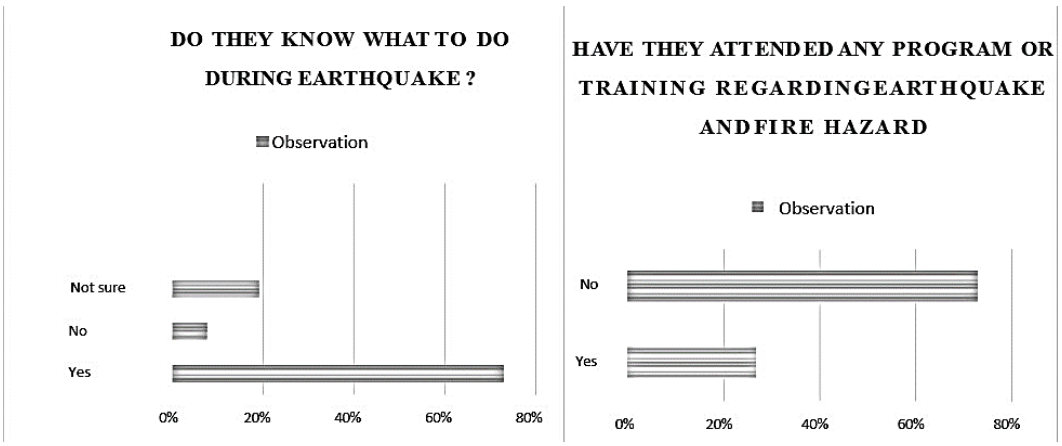


Figure 47 Knowledge and training attended by Attendants.

Again, in next chart, shows, that 73% of attendees reported not having gone to any programs or training sessions on fire hazards or earthquakes during this time, whereas 27% reported having gone to sessions led by trainers from the fire department and other NGOs.

CHAPTER-SIX
CONCLUSION AND RECOMMENDATION

The major asset of Old Dhaka is its high population density, compact layout, and mixed-use structure. Here, the strength of the local or indigenous economy acts as a potent magnet for numerous job prospects. However, several drawbacks in this area outweigh these advantages. Older structures congested local streets, vulnerable infrastructure, a lack of emergency exits, and unlawful vertical extensions are the main factors hindering further development in this area.

Some locations were identified as crucial and requiring immediate action following the survey and area assessment. The Islambagh neighborhood has numerous plastic and cosmetic factories, many of which are multi-use structures. Despite the proximity of the Buriganga River, the narrow roads and littered roadways with waste and industrial chemicals make it challenging for the Fire Brigade and Ambulance to help during fire hazards or earthquakes. It is important to assess the potential for additional disasters in this area. Here are some additional recommendations where immediate action can reduce the loss.

- Alir Ghat Road and Kellar Mor, there are several buildings with weak structures, shaky foundations, and cracked walls. Before the risk of future earthquakes arises, these structures should be torn down or rebuilt. The roadways are mostly covered with products or garbage from various factories, which should be immediately removed as they would hinder the passage of rescue vehicles during any hazard.

- The Chawkbazar neighborhood has many buildings with shared walls, requiring proper building inspections and maintenance. Another common situation in this area involves multi-use buildings with apartments and restaurants on higher floors. It is essential to thoroughly

examine the gas pipes supplied to the restaurants to mitigate potential fire hazards in the future.

- There are vacant and unused areas in the South-East area of Ward 29 that can be utilized as shelters during emergencies. The Eidgah fields can serve as both refuge and weekly training areas for the population, where the government can organize training sessions on fire and earthquake hazards.

- The river Buriganga and its numerous old buildings are the region's greatest assets. If the government intends to harness the population's strength, it is crucial to reorganize the neighborhood to ensure its safety and security.

- The locals should receive adequate training to handle unforeseen disasters and adopt necessary safety measures. Government and private organizations must educate the public about the dangers of chemical and plastic companies, as well as potential fire hazards and natural disasters.

- Buildings with weak structures should be designated as unsafe to protect the occupants from future disasters.

- Illegal buildings should be demolished promptly to prevent further incidents. Widening the existing road may be a solution to facilitate the passage of ambulances and fire brigades.

- Roads and stairs should be the main concern for Ward 29. This area doesn’t have as many historical structures as other areas. But many 5-6 storied structures are weak and vulnerable, which can be a cause of serious disaster as well.

- This area has many narrow roads and some of them are blocked with factory materials. The unplanned design, illegal floor extension, steel

stair connection, and mezzanine floor are some of the major features where the authority should take immediate action.

The only way to reduce the risk of fire and loss during an earthquake is to adhere to the laws and regulations of the competent authority. The locals or residents are often unaware of these special safety considerations, building restrictions, and laws. The area is highly susceptible to earthquakes and fires. Immediate action is necessary from the government and the people through proper land use planning and development management.

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