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FIRE RISK SITUATION ANALYSIS IN THE NIMTOLI AREA OF OLD DHAKA

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Abstract

Assessment of the fire risk situation of Nimtali area by using eight indicators related to the fire source, fire spreading and evacuation during fire incidents was conducted. The results revealed that none of the buildings has emergency exits, fire protection measures, fire hydrant and provision of a fire drill. The area is densely populated. Most of the buildings are mixed-used and have no space in between. Electrical cables are haphazardly hanging from poles. Access roads are incredibly narrow. By analyzing eight indicators, it is found that the entire Nimtoli area is still at risk of fire hazard. Within Nimtoli, 32% area is at high risk, and 45% is at moderate risk of fire hazard. Proper fire safety measures and safety inspection, regular maintenance of utility lines, awareness about fire hazards among the dwellers, proper implementation of Bangladesh national building code (BNBC) and regulation of mixed-use of buildings can drastically reduce the fire risk in the urban area of Bangladesh.

Key words: Fire hazard risk, Risk mapping, Nimtoli, Old Dhaka

Introduction

Fire incidents are one of the significant hazards in Bangladesh, particularly in the urban and industrial area. In 2019, the number of reported fire incidents was 24,078, and estimated damages were 330.04 million (in BDT), which caused 184 death and 560 injuries in Bangladesh (BFSCD 2020). Fire incidents in Bangladesh are increasing day by day (Fig. 1). High density of population, concentration of wealth and human activities (production, transport and service) are responsible for high risk of fire in the urban settlements compared to the rural settlement (Maniruzzaman and Haque 2007). The highest numbers of incidents occur in Dhaka city and its surrounding area. Electrical short circuits and fire from the burner are two leading causes of a fire incident in Dhaka as well as in Bangladesh (Islam and Adri 2008). Alam and Baroi (2004) found from their study that over 60% fire incident in Dhaka occur between noon to midnight and the dry season (December to March) is the riskiest period of the year (Nearly twice fire

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incident occur compared to the wet season). Commercial and mixed landuse areas are more vulnerable to a fire incident in Dhaka (Rahman and Islam 2019). Based on a study on 31 slums in 2019, BFSCD (2020) reported that fire incidents cause a colossal amount of economic loss and claimed many lives; many people become homeless and lost their all belongings within a few hours, particularly those who are living in the slum areas.

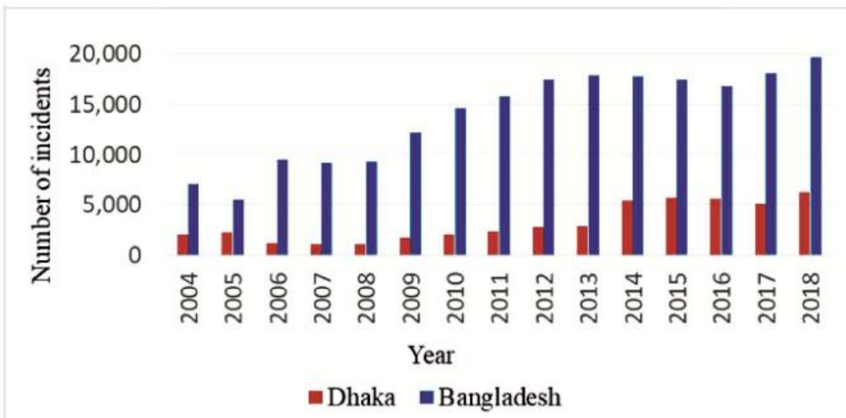

Fig. 1. Year-wise number of fire incidents in Dhaka and Bangladesh.
Source: BFSCD 2020, Tishi 2015.

Old Dhaka is prone to fire incidents due to mixed use of land, very high population density, unplanned and haphazard urban development, depots of chemicals in the residential area and lack of awareness of residents. A makeshift chemical warehouse in a residential building fuelled the fire of tragic Nimtoli incident on June 3, 2010, which claimed 124 lives (Molla 2019). Another tragic fire incident occurred in old Dhaka (Chawkbazar area) from a depot of chemicals on the night of February 20, 2019, which claimed 67, lives (Molla 2019). Awareness of city dwellers and activities of different authorities have increased to prevent fire immediately after a significant incident. With time, these activities are slowed down. As a result, another incident occurs. We face many fire incidents every year (Fig. 1), but the number of researches are very small in number on this issue. In this study, several physical indicators are analyzed to assess the present fire risk situation of the Nimtali area. This study also tries to find out what changes occurred since the devastating fire of 2010.

Study area: The study area is situated in ward number 33 (formerly 69; total area is 0.36 km^2) under the 4th zonal office of Dhaka South city corporation area (Fig. 2a). This ward lies under Bangshal Thana, which was a part of Kotwali Thana. The population density in ward number 33 is 181,359 people per km^2. The number of households is 12,891 (Banglapedia 2015, BBS 2015). There are almost four hundred buildings in Nimtoli area. Many restaurants, tea stalls and Bakarkhani (a kind of backer shop) stores are situated in this area.

Methods: Both primary and secondary data are used for this study. Primary data collection methods include field observation, building inventory, landuse survey and interviews. A field survey has been conducted in 2018 for this study. Secondary data are collected from different published and unpublished sources, government and non-government organizations. In this study, non-participation observation method is used. It involves observing and recording events (photographic devices and field notes are used) on the spot, without any interaction with the community. During primary data collection, this study identifies risk factors/indicators for fire hazard analysis through field observation (Table 1). These factors are identified based on their ability to generate fire, the spread of fire quickly, constrain of quick evacuation and rescue. In-depth interviews have been conducted with urban planners of Bangladesh University of Engineering and Technology (BUET) and the University of Dhaka, experts from Bangladesh fire services and civil defence and residents of Nimtolia area. Fire safety measures, firefighting capabilities, and how fire risk can be reduced in the study area have been discussed with the interviewees. Based on experts' opinion, and the previous study of Rahman et al. (2017), weightage has been given to those indicators (Table 1). A scale of 8 to 1 has been assigned, eight equals to high susceptibility, and one equals to low susceptibility. Each risk factor is divided into several sub-indicators. Rank values from 0 to 4 have been assigned to those indicators to understand the risk index of each structure. Shapefiles of buildings, roads are exported from the open street map (OSM). The shapefiles contain some information about the structure type, material, level, quality. This information is validated during the primary data collection. Landuse survey has been carried out to collect data about landuse pattern, type of buildings, use of buildings, level (storey) of the building, interior information like the width of the staircase, collapsible gates etc. Width of the staircase has been measured manually using tape. Location of hazardous structures and utility facilities (transformers, electric poles) has been recorded through GPS. In the inventory; building material, building type, quality, use purpose, building level, the width of the staircase, access road next to structures, have been recorded. The study has used ArcGIS, Microsoft office packages to analyze the collected data. Finally, an individual risk map and aggregated risk map of the study area have been generated.

Table 1. Weightage and score of fire risk factors for structures.

Factors	Weightage*	Sub-factors	Score
Distance to hazardous structures	8	Hazardous structure	3
		Structures within 10 m of hazardous structure	2
		Structures within 15 m of hazardous structure	1
		Structures more than 15 m distant of hazardous structure	0
Space between adjacent structures	7	No space	2
		Space 0.5 -1.0 m	1
		Open space/unused space	0
Collapsible gate within structures	6	Structure without collapsible gate	1
		Structure with collapsible gate	2
Width of stair case of structures	5	< 2ft	4
		2 ft - 2.4 ft	3
		2.5 ft - 2.9 ft	2
		3 ft - 3.5 ft	1
		No stair case/>3.5 ft	0
Proximity to transformers	4	Structures within 3 m distance	3
		Structures within 5 m distance	2
		Structures within 10 m distance	1
		Structures more than 10 m distance	0
Distance from electric pole	3	Structures within 1 m distance	4
		Structures within 2 m distance	3
		Structures within 3m distance	2
		Structures within 4 m distance	1
		Structures more than 4 m distance	0
Proximity to roads	2	Roads within 10 m of structures	1
		Roads within 15 m of structures	2
		Roads within 20 m of structures	3
		Roads more than 20 m of structures	4
Accessibility to roads	1	Accessible	1
		Not accessible	2

*Weightages have been given based on experts' opinion, field observation and previous study of Rahman *et al.* 2017.

Results and Discussion

Landuse and building inventory: There are around 411 buildings (Table 2) in Nimtoli. Majority of the buildings are in dilapidated condition and have not built by following construction rules. About 66.4% of buildings are non-engineered buildings. Only ten buildings in Nimtoli are over six storeys (Table 2). The analysis shows that 48% of structures are residential, 33% mixed, and the other 19% are used as commercial, industrial, public facilities.

Mixed-use (same structure/building used for a different purpose for example residential, commercial and restaurants are co-located in one building) of building escalates the risk of fire. The ground floor of mixed-use buildings are used as a storehouse of waste paper, old containers of plastic and tin, wasted electronic parts, plastic bags. These materials are

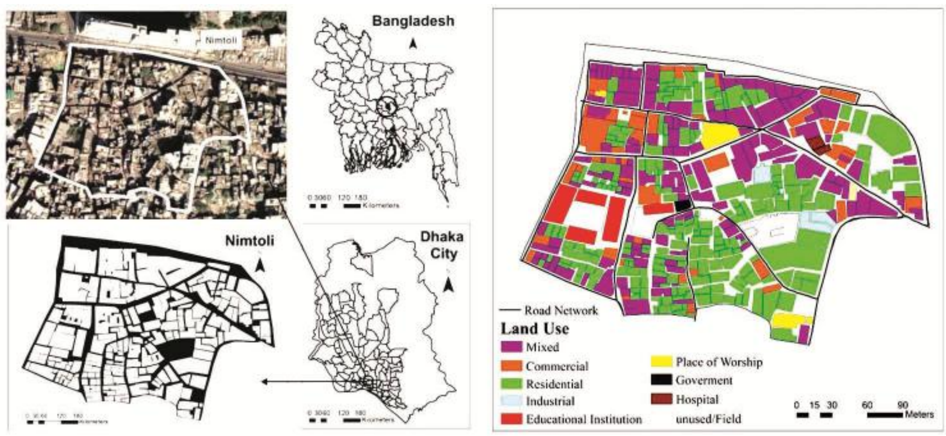

Fig. 2. a. Location and b. landuse pattern of structures in Nimtoli in old Dhaka.
Source: Open street map and field survey 2018.

Table 2. Story information of structures in Nimtoli.

Building level	No. of structure	Percentage
1 storey	114	27.74
2 storey	80	19.46
3-4 storey	105	25.55
5-6 storey	102	24.82
More than six storey	10	2.43
Total	411	100

Source: Field survey, open street map 2018.

highly sensitive to fire. Buildings used for commercial purpose are not equipped with fire protection measures. Many commercial buildings are used as shops, hotels, restaurants and a baker shop. The field survey observed that number of open spaces is minimal in Nimtoli area (Fig. 2b). It is important to note that there are no water bodies and fire hydrants in Nimtoli area. Some roads are incredibly narrow. No emergency exit fund in the buildings of Nimtoli during the survey. Fire protection measure and equipment are not found inside any of these buildings. There are no provisions of a fire drill in this area. Previously, many buildings were used as the depot of combustible materials. During the field survey, no chemical depot could be identified in this area. Local residents claimed that all chemical storehouses had been shifted from Nimtali since 2010 incident.

Fire source and spreading of fire: The hazardous structures are termed to those which have the potential to ignite and spread fire to other structures. From the field observation, the structure used as a hotel, *bakarkhani* shop (backer shop), and tea stall has been marked as hazardous structures. These hazardous structures can ignite a fire in this area. Structures within 10 m, 15 m, over 15 m distance of hazardous structures have been demarcated and termed them as high, moderate, low risk structures. A score of 3-0 have been assigned to these sub-factors according to risk (Table 1.). Score 3 has been given to the hazardous structures itself, and 2 - 0 score has been applied to the other structures (Table 1) and a risk map (Fig. 3a) is produced. There are 5.3% structures used as a hotel, tea stall, *bakarkhani* shop in Nimtoli area. The risk map reveals the fact that 30.36% of structures are at high risk, 8.7% at moderate risk and 55.6% at low risk.

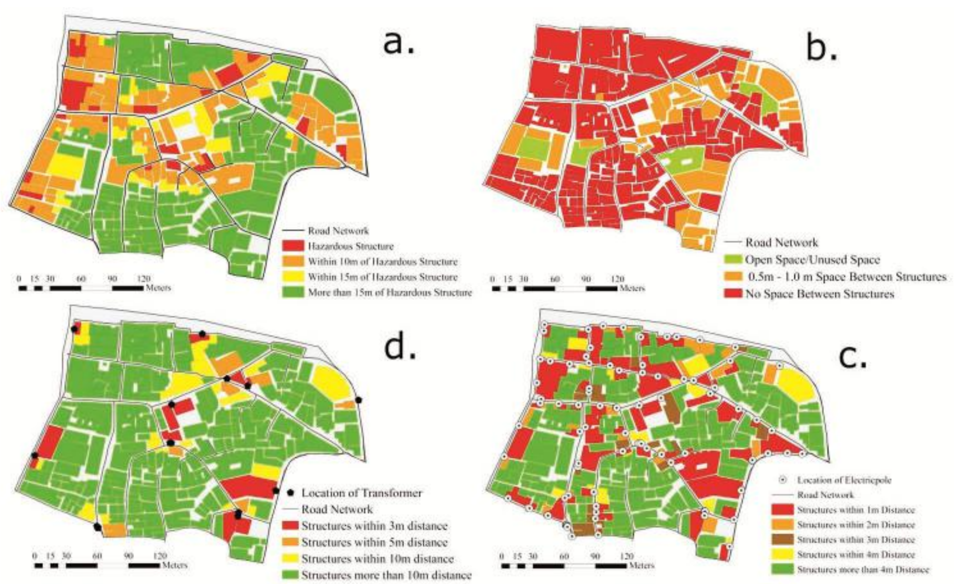

Fig. 3. Showing a. hazardous structures, b. space between structures c. location of electric poles and d. location of transformers in Nimtoli area.

Proper space between structures is essential to keep building safe from spreading of fire from other structure. The nearest buildings always have a higher probability of catching fire from the affected buildings than the distant one. Construction rules amended by the government of Bangladesh in 1996 imposes conditions on setbacks, site coverage, plot usage, which ensures building safety during different hazards (Rahman *et al.* 2017). Setback defines the optimum distance that a structure should maintain from the adjacent road and other structures. For Dhaka city, a minimum 1.5 m space in front, 1 m space in backside and 0.8 m space in both sides must be kept for a plot size of two *katha* (1440 ft^2) or less amount of land (GOB 2008). The study found that 90% of structures do not have any space between each other (Fig. 3b and Fig. 4). Only 10% have space 0.5 to 1 m (Fig. 3b) which has not followed the rules for all side of the plot. The structures with no space are scored as 2, and space with 0.5 - 1.0 m has been given score one (Table 1).

Fig. 4. Image of buildings without any space between each other (left image) and placement of transformer near residential building (right image) in Nimtoli area.

The electric poles have been marked in the study area during primary data collection (Fig. 3c and Fig. 4). Electric poles and cable can ignite the fire from a short circuit. Even if a fire occurs from other sources, electrical poles and cables can pose a risk for life and property. Electric cables are connected with individuals structures from the pole for electricity supply. A safe distance must be kept from an electric pole to avoid a fire incident. The buffer zones of 1, 2, 3 and 4 m from the electric pole are created to identify structures at risk for electric pole. The structure within 1, 2, 3, 4 and over 4 m are termed as very high, high, moderate, low, very low risk structures, and a score of 4 to 0 have been assigned (Table 1). Based on weights and score a risk map is produced (Fig. 3c). Underground electricity lines can increase fire safety and aesthetics of the area. Underground lines also can reduce damages of the electric supply system during the storm season.

Eleven transformers have been marked in the study area (Fig. 3d). The electric transformer is a dangerous source for a fire. A burst of a transformer can affect the nearest structures. The 2010 Nimtoli fire had started because of a transformer burst as claimed by some residents. To know the risk situation of the structures, several buffer zones are created from the transformer. During field observation, the study found that the location of transformers is very close to the buildings. So 3, 5, 10 m and more than 10 m buffer zone are created. Structures within 3 m, 5 m, 10 m and over 10 m have been marked as very high, high, moderate and low risk structures. Here rank value has been given from 3 (high risk) to 0 (low risk) (Table 1). All these information are used for producing a risk map for transformers (Fig. 3d). The study found that only 5.5% of structures are at high risk, 6% at moderate risk and 88.5% have a low risk because of the transformer.

Evacuations, rescue and firefighting: The proper width of the staircase is significant for smoother and rapid evacuation during a fire incident. Field inspection found that there is no emergency exit in any structure in Nimtoli. According to expert opinion, the width of the staircase must be at least 3.5 ft. Only 1.2% of structures have followed proper rules for the staircase. About 73.95% of structures have staircase width less than 3.5 ft; the rest of the structures (24.79%) are one-storied and do not have any staircase (Table 3). One storey building and the structures having staircase with width over 3.5 ft are termed as very low-risk structures, 3.0 - 3.5 ft staircase are termed as low risk, 2.5 - 2.9 ft as moderate risk, 2.0 - 2.4 ft are at high risk, less than 2 ft are grouped into a very high-risk structure. A score of 4 to 0 values have been assigned (Table 1) to the structures and a map is produced for this factor (Fig. 5a).

The structures having a collapsible gate act like an obstacle in the time of quick evacuation and rescue operation. During building inventory preparation, we observed that collapsible gates are kept under lock and key. In Nimtoli area gateman are not kept to maintain collapsible gates. The structures which have collapsible gate thus possess higher risk, and the structures without collapsible gate possess low risk. Based on expert opinion, score have been assign to 1 and 2 for structure with and without collapsible gates (Table 1). From the analysis, it is found that 42% of structures have a collapsible gate and 58% of structures do not have a collapsible gate (Fig. 5b).

Most of the access roads in Nimtoli area are narrow. According to the Dhaka metropolitan building construction rules 2008, every site has to be accessible to a minimum of 6 meter wide roads (GOB 2008). This minimum width ensures easy access to people and vehicle. At least 3.05 m (10 ft) road width is required for a small size fire control vehicle. If the fire control vehicles are unable reach incident sites, then fire control pipe or pumps are used for firefighting. During the 2010 incident, narrow roads created an obstacle for fire services to access their fire control vehicle and slower down

Table 3. Staircase widths of the structures in Nimtoli.

Stair case width	Percentage
No stair case (One story building)	24.79
less than 2 ft	1.68
2.0 - 2.4 ft	15.13
2.5 - 2.9 ft	33.61
3.0 - 3.5 ft	23.53
More than 3.5 ft	1.26

Source: Field survey 2018.

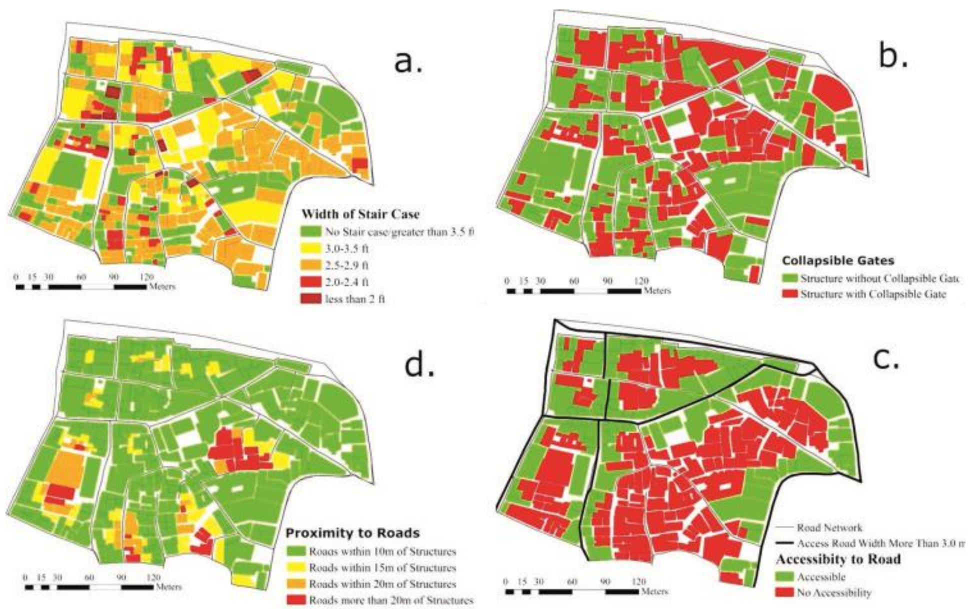

Fig. 5. Shows a. width of staircase, b. the collapsible gates, c. access roads width and d. the road proximity in Nimtoli area.

the firefighting process. The score has been assigned, and maps have been generated for this factor (Fig. 5c). Considering this, all structures accessible to the roads wider than 3.05 m have been identified. Analysis of this data shows that 67% of structures of the study area are not accessible to roads wider than 3.05 m.

Fire hydrant facilities, open space and water body are not available in Nimtoli area. As a result, firefighting, evacuation and first aid activities are hard to conduct here. People can be trapped in their dwellings or workplace, and the fire control vehicle may not reach to them because of the improper approach road. Accessibility is important during any emergency response. The structures which have access to roads within 10 m, 15 m, 20 m are termed as low, moderate and high risk structures. The structures which do not have any access road within 20 m are marked as very high-risk structures. Based on a score of 4 to 1 (Table 1), a risk map has been produced (Fig. 5d). The analysis shows that almost 74.21% of structures have access road within 10 m and only 6.74% structures do not have access road within 20 m.

Aggregate risk mapping: All the identified risk factors have been integrated. Based on weightage and ranking value (Table 1) fire hazard risk of the structures of the study area have been calculated as fire hazard risk = (8* score of distance to hazardous structures) + (7* space between adjacent structures) + (6* collapsible gate within structures) + (5* width of staircase of structures) + (4* structures proximity to transformers) + (3* distance from to electric pole) + (2* proximity to roads) + (1* accessibility to roads).

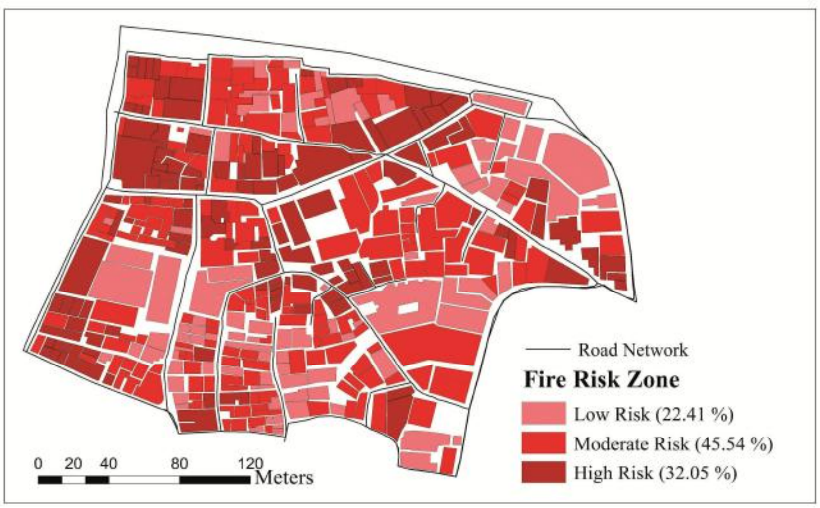

Fig. 6. Fire hazard risk map of Nimtoli.

All the structures have been categorized as severe, moderate and low risk in terms of eight risk factors (Table 4). The study found that 32% of structures are at high risk, 45.5% at moderate risk and rest of the structure at low risk (Fig. 6). The structure caught fire during the devastating 2010 Nimtoli tragedy still found as a high-risk structure for fire incidents from the analysis. The previous study in Bangshal area also found that the area is at high risk of fire because of mixed landuse, very high density of population, narrow roads, and non-engineered old buildings, lack of water bodies, open spaces and fire protection measures (Jahan *et al.* 2011). The possible lowest and the highest score is 17 and 81, respectively (Table 4). Using this score, a risk appraisal is developed (Table 4).

Table 4. Fire hazard risk appraisal scale.

Risk appraisal	Range
Low risk	17 - 35
Moderate risk	36 - 51
High risk	52 - 81

Conclusion

In terms of fire safety, firefighting facilities, evacuation, rescue and first aid facilities, the Nimtoli area is still at risk of fire incidents. Mixed-use of structure and the business of wastage material must be regulated to reduce the fire risk of the study area. Electricity lines must be taken to the underground. Building code should be implemented strictly by government authority. Building owner and residents should ensure fire safety measure and firefighting drill to reduce fire risk in Nimtoli area. Identification of risky structure and issuance of warning is crucial. The government should take immediate legal action against those who are not taking any important initiatives after warnings from Bangladesh fire service and civil defence (BFSCD). Proper fire safety measures, regular maintenance of utility lines, awareness about fire hazards within the residents, proper implementation of Bangladesh national building code (BNBC), a regular safety inspection by Bangladesh fire service and civil defence, regulation of mixed-use of buildings can drastically reduce the fire risk in Nimtoli and other urban areas of Bangladesh.

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