Fire Hazard Assessment of Existing Buildings in Reazuddin Bazar in Chattogram City

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ABSTRACT

Bangladesh has observed numerous deadly fire events that caused number of death, injuries and economic losses. The main reason is the lack of proper facility management system in post construction phase in Bangladesh. Moreover, it has been observed that lack of knowledge and proper management system of facilities causes more difficulties to respond to fire hazards, which is very unfortunate for the nation. The purposes of this research are to find out the most prone reasons of fire disaster in Chattogram which leads to casualties and economic damages, that has been evaluated by studying different fire-accident related case studies which occurred in Chattogram during different intervals of time. After getting data, comparing different case studies and analysis for the results, lately a qualitative questionnaire survey has been conducted to achieve the real picture of Facility Management practices in Chattogram and opinion of different people. Later, it was discussed how fire safety system can be improved. Comparing the data through different case studies and questionnaire survey, suggestion and recommendations round the research which show the complete workflow and program to improve fire safety.

Keywords: Fire safety, Fire hazard, Readymade garments fire hazards, Random sampling.

INTRODUCTION

Bangladesh is one of the most disaster-prone countries in the world. The country is vulnerable to massive natural and human-induced disasters owing to its geographical location and faced them in the past. Overpopulation and unplanned and illegal structures besides poor utility management and apathy often cause these disasters. Fire related disaster is one of the most fatal one. Fire mainly affects residential and industrial buildings doing many casualties and significant property damage. Dry weather, short-circuit, random disposal of burning matchstick or cigarette, etc., cause fire in Bangladesh. Proper household practices, well-handled combustible material, post-fire action, and use of fire extinguishers can check fire. Fire often causes massive disaster in life and resources in urban areas of Bangladesh. The urban sprawl in a developing country like Bangladesh makes people to lead lives in unsafe living and working environment. Most of residential buildings have been used for industrial purposes not being modified. Besides, the same building has been used for both industrial and residential purposes not following Fire Act 2003 and BNBC

2006 and without taking precautionary safety measures in rambling urban area. 80% of residential houses in Old Dhaka contain unauthorized factories or warehouses of either poisonous and combustible chemicals or plastic materials (Daily Star, 2010). They risk both lives and goods of occupants. The purpose of this thesis is to survey each building in Chattogram to sort out buildings that lack fire safety.

In Bangladesh, approximately 78% of the total foreign currency is generated from readymade garment sector. Bangladesh is also the second largest apparel exporter in the world with a total export of USD $17.91 billion in the fiscal year of 2010-11 (BGMEA, 2016Given the importance of fire safety in the garment sector, there have been concerted efforts from the government, the industry lobby (BGMEA), and the international buyers of the apparel products, to improve the fire safety culture and this has indeed reduced the fire incidents and losses significantly (Alam, 2006; Ahmed and Hossain, 2009). Despite the various measures, rules, and regulations implemented in the past decades, there are still several instances of fire outbreak in the garment factories every year, resulting in significant losses of lives, livelihoods (through injuries), equipments, and materials (Ahmed and Hossain, 2009). Like any developing country, there is a lack of data on fire safety in Bangladesh, and, although there is a few studies on fire safety status in general no comprehensive fire safety assessment of the garment factories were undertaken before. In the wake of a recent fire disaster at a garment factory that killed more than 100 factory workers, fire safety evaluation of the industry became even more important (Firoz, 2011). The recent fire at the Tazreen Fashions garment factory has brought the perennial challenge of worker safety into the spotlight once again. Given the constant pressure to lower costs and the dearth of meaningful government oversight, businesses are continually tempted to reduce costs at the price of worker safety. The country's comparative advantage is low costs; the minimum wage for workers is a mere Tk. 3,000 ($37) per month (Huda and Ahmed, 2011). As keeping costs low has been one of the keys to the sector's success in Bangladesh, there are strong disincentives to make necessary investments in worker safety. While improvements were made over the years, the safety record of RMG industry in Chattogram remains poor (Tazreen and Sabet, 2013). There is some disagreement about the number of worker deaths in the industry. According to the Bangladesh Institute of Labor Studies, 431 workers died in 14 major fire incidents between 1990 and 2012 (Prothom Alo, 2013). However, according to Bangladesh Fire Department, 414 garment workers were killed in 213 factory fires between 2006 and 2009 alone (Prothom Alo, 2013). Especially, enforcement of the rules and regulations and day to day health and safety management practices on factory floor is a major issue. In order to improve the fire safety in the readymade garment industries, it is important to understand and quantify the current state of affair in fire safety of the garments factories. Therefore, the aim of this study is to examine the fire hazard and intensity of fire hazard, existing conditions, and remedial measures to reduce the problems in Chattogram.

METHODOLOGY

Study Area
The study area is Reazuddin Bazar, Kotwali Thana (Chittagong Metropolitan) area 7.68 sq km, located in between 22°19' and 22°22' north latitudes and in between 91°50' and 91°53' east longitudes. It has a Population 282975; Water bodies Karnafuli river and Chaktai Canal are notable.(Bangladesh Population Census 2001).
The study area Reazuddin Bazar intrinsic in Kotwali Thana, and the Biggest Bazar in Chattogram. It has a population of 31910 for its economic activity (Home City, April 08, 2019). Moreover, it is 22 no. wards, Area 0.80 sq. km (Home City, April 08, 2019).

[Fig. 1].Map of the Reazuddin Bazar Area in Chattogram City

Sampling

A purposive judgment sampling method has been used for the study. In Reazuddin Bazar area, there about between to nearby 11601 shop. Due to authority restriction and other jurisdictional limitations, only 313 Existing building in Reazuddin Bazar have taken as a sample for the study. Therefore, for a balance of comparison at Reazuudin Bazar hub and each building and shop survey also taken 313 building as a sample for the survey.

Mapping

The Reazuddin Bazar for the purposes of mapping and analysis of the risk and vulnerability assessment at the Reazuddin Bazar area. For the base of accuracy, source maps have collected from the Location in Reazuddin Bazar, Chittagong Development Authority (CDA), Chittagong City Corporation (CCC) and Google Satellite.

Checklist Survey

A checklist has developed and surveyed on the basis of Bangladesh Fire Service and Civil Defense Authority (BFSCDA) for Reazuddin Bazar existing fire safety system and capacity.

In Depth Interviews

Some detail In-depth Interviews have conducted with shop workers, fire safety officers and fire safety workers who are experienced and available knowledge about fire and fire safety systems in his working place.

Data Presentation and Analysis

Collected primary surveyed and secondary sources data have analyzed and represented through MS Excel, MS Access and Arc GIS etc. Following two type of assessment methods have been applied for risk and vulnerability identification:

Qualitative Method for Fire Risk Assessment

In this study, a qualitative method by checklists and narratives approach has been applied on the basis of Hultquist and Karlsson (2000) (Table 1) [14]. The checklist approach mainly was checked the performance

of the building (or, in present case, Reazuddin Bazar), generally in a yes/no format, with respect to a set list of standards or codes relevant to fire safety according to following parameters with their weights.

Quantitative Method for Fire Risk Index (FRI) of Assessment: In quantitative method, risk indexing has been used as evaluating multiple attributes into a single value and various risk indexes by primarily in the number. Types of parameters (attributes) considered and the arithmetic functions used to summarize these parameters. Among various types of fire risk rating, the most popular ones are Gretener's index, FRAME index, Dow's Fire and Explosion Index, Fire System Evaluation System (FSES) Index and Hierarchical Approach (Hultquist and Karlsson, 2000). The study mainly carried out through Dow's Fire and Explosion Index by following equation:

$$\text{FRI} = \frac{\sum_{i=1}^{n} X_i}{\sum_{i=1}^{n} W_i} \times 100 \quad \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \dots \text{(1)}$$

where, x_i is a dimensionless score or grade points for parameter i, w_i is the importance of parameter i and n is the number of total parameters. The weight w_i is used to incorporate the variations in importance of the parameters relative to each other and is generally determined by expert opinion and/or from past data, if available. The grade points or scores x_i reflect the 'measure' of the danger, consequence or safety offered by a particular parameter i. Since the units of measurement for different parameters are different, x_i is expressed as a normalized dimensionless number so that they can be added together [17].

Development of the Parameters and Weights

Generally, the existing building are required to follow the regulation of fire safety set by BNBC-93 as well as the BFSCDA regulations for the 'hard' parameters. Although the BFSCDA checklist contains some soft parameters, they are not comprehensive. There is also no other standard set by any regulating authority to ensure the operational safety and fire management practices in the existing building. The soft parameters were initially selected using BFSCDA's checklist, literature review and discussion with two fire safety experts. A survey was then carried out at existing building in Reazuddin bazar to ensure that the identified parameters are 'measurable' during inspections and the parameters are then fine tuned to produce the final list of 65 (i.e. n = 65) soft parameters.

The list of soft parameters and the weighting scheme are then presented to ten experts. These experts are chosen from the academics and the professionals who are directly involved with fire safety or disaster management. They include four academics involved in disaster management and fire safety design of buildings, three officials from BFSCDA, one official from Bangladesh Army in charge of fire protection, an engineer from National Housing Authority, and an urban risk reduction specialist from the Comprehensive Disaster Management Program. The experts provided their grades for the selected soft parameters as per Table-3(i) using their own judgment about the parameters and their importance.

Advanced techniques, such as analytical hierarchy process, fuzzy theory, reliability interval method, grey relational model or simulation approach have been applied in the literature in order to generate reliable weights for the parameters

Table 1:Definition of Weights for Each Parameter

Weight	Description of consequences
5	Most important—if not present, very high damage of both life and properties may occur
4	Important—if not present, considerable damage of both life and properties may occur
3	Essential—loss of life may not occur but other losses and injuries are high
2	Essential—loss of properties and injuries are considerable
1	Not essential but preferable

from expert judgments. However, given the lack of resources to generate such measures and noting Watt's [18] third axiom of fire risk—a totally objective or scientific way to measure fire risk does not exist—we follow the simple process of averaging the weights for each parameter. In order to ensure that the weights are not significantly influenced by the extreme values offered by one or two experts, we remove the maximum and minimum weights for each parameter and then average the weights by the remaining eight experts. Table-4(i) presents the list of the soft parameters and their associated weights from the expert opinions. Figure 4.2(iii) presents the summary of the experts' opinions through a column chart.

Performance Grading for the Parameters
During the field inspection of the existing building in reazuddin bazar, each of the parameters is given a grade point, xi in Equation 1, for each building, ranging from 1 to 5, depending on the building's performance in that parameter. Since the performance of the soft parameters are sometimes difficult to measure quantitatively, for many of the parameters the grade points were awarded based on qualitative observations (e.g. accessibility to fire hydrant, or workability of announcement system). The scale of grading has been formulated by consultation with the experts, management and workers of the existing buildings, and BFSCDA. Table-4(ii) presents the grade point used. For a few parameters, where quantification was possible, the grading strategy is based on the measured quantity. For example, if the dedicated water tank for fire-fighting is full, then the grade point is 5, but if the tank is 45% full, then it has a 55% deviation from the 'ideal' case, and thus assigned a 4 as per Table-4(ii). Detail description of the definition of grade points for each parameter in Table-4(ii) is available in Huda and Ahmed [12].

Data Collection
The FRI developed above is applied on real data collected from the existing building in Reazuddin Bazar in Chattogram. One of the most difficult aspects of this research was to obtain credible data while ensuring the 'surprise' element during the data collection inspections. Since the existing building are resistant to visits by external visitors, especially to outsiders wanting to investigate their fire safety performances, it was necessary to obtain assistance from the BFSCDA. The researchers were introduced to fire safety inspectors, who were instructed by the higher authority within BFSCDA to accompany the researchers during site visits. Although the inspector of a particular region was informed about the impending visits a day before, the names of the building to be visited were not revealed. Given that there are a large number of building within the jurisdiction of each inspector, it was assumed that it would not be possible to leak the information ahead of time to all of the building, or even if leaked, all of the buildings will not take actions given the lack of precision about the inspections. The inspectors were also informed that the results were for academic purpose only and the names of the building would remain confidential. This way any potential announcement bias was avoided.
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Table 2: Grade Point of Soft Parameter

Grade point	Not quantifiable parameters subjective observations	Quantifiable parameters % deviation from ideal case
5	Excellent	Less than 10%
4	Good	From 10% to 30%
3	Average	From 31% to 60%
2	Poor	From 61% to 80%
1	Very poor	More than 80%

In the absence of strict land use plans, the existing building are spread throughout the reazuddin bazar in chattogram city although there area few clusters where the concentration is much higher. The regions were chosen for inspection and almost of 9865 shop and building were inspected, which represent around 57% of all the existing building in reazuddin bazar in chattogram. Within each region, all the existing building

were listed alphabetically by name, and then chosen randomly using Microsoft Excel's random number generator. The sample can thus be described as stratified (by region) random. A purely random sample from all chattogram regions was not possible due to management and resource limitations. Given the largest concentration of existing building in these reazuddin bazar regions in chattogram, there are reasons to be optimistic that this sample would adequately represent the current status of the industry although further efforts to increase the spatial coverage and sample size in future will be beneficial. A further existing building did not allow immediate entry of the researchers despite the presence of the fire inspectors. Although some of these building asked the researchers to return another day, they were not inspected further because of the potential for announcement bias. Also, the significant number of refusals to enter the building gives confidence that the inspections were not leaked ahead in time. The number of employees in each building was either directly collected or calculated.

Results and Discussions
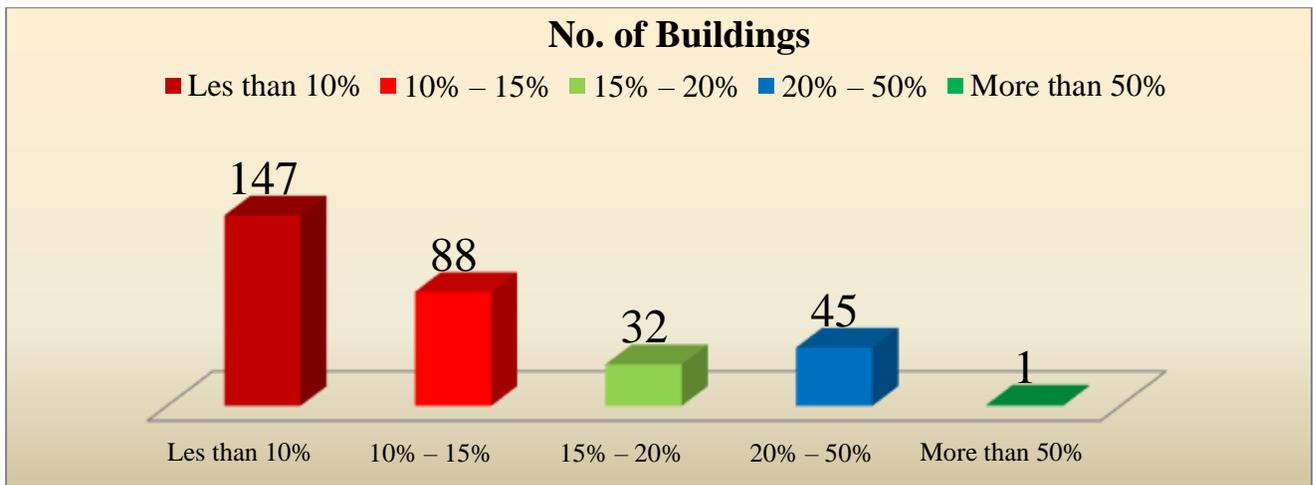
[Fig. 2]. Column chart for percentage of parameters for well and critical Existing Buildings. (Color figure Illustration).

Less than 10% according to BNBC code, these are among the most high risk building.10% - 15%, These are among the high risk building.15% - 20%; There are among the moderate risk building. 20% - 50%; Even if there are among the moderate risk building, the risk can be avoided by taking precautions.More than 50% are only one building has followed the BNBC code, which we consider to be a safe building, but this buildings may also be risk for surrounding buildings.
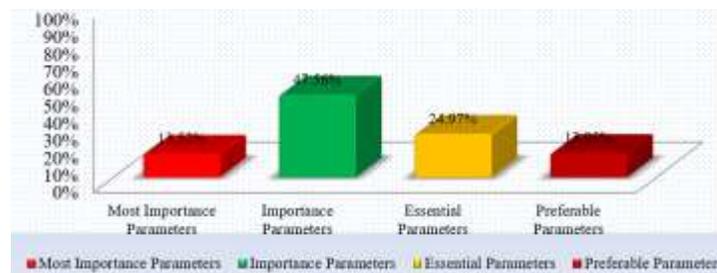
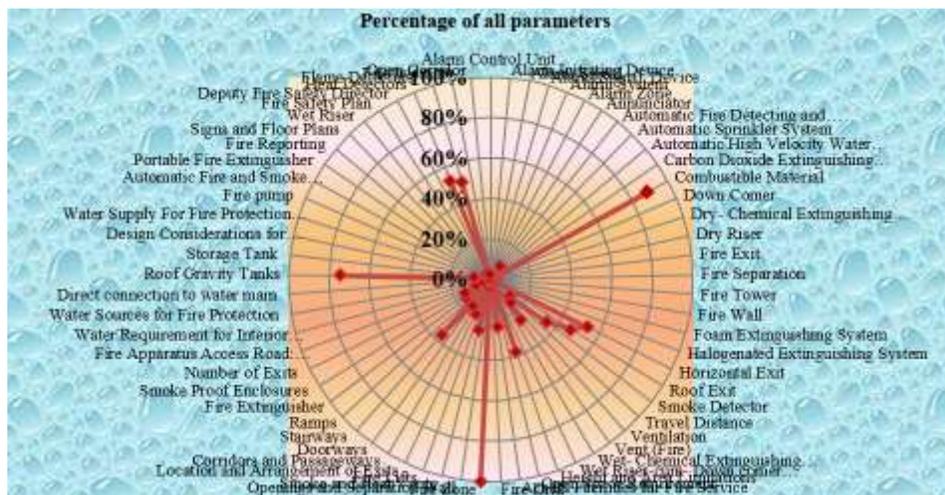**Fire Hazard Risk Indexing by Different Parameters**
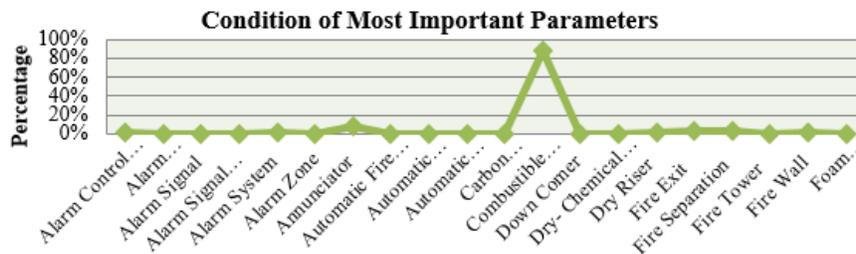
[Fig. 3]. Comparative scenario of the condition of Most Important Parameters
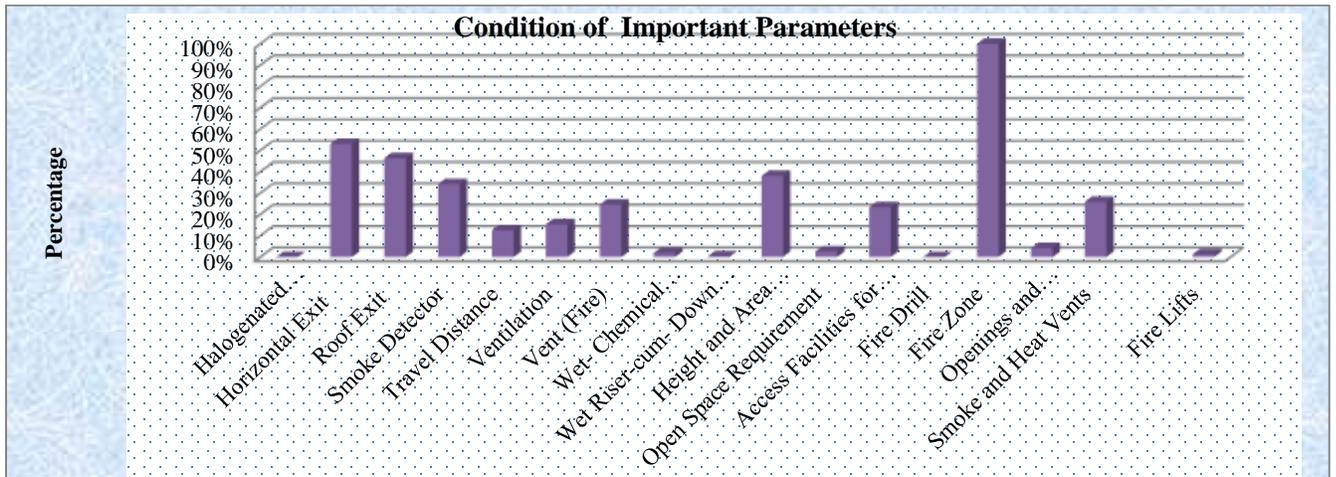
[Fig. 4]. Comparative scenario of the condition of Important Parameters

[Fig. 5]. Overall condition of the grouping parameters Existing building in Reazuddin bazar hub in Chattogram city.

[Fig. 6]. Spider diagram for overall level of good condition in all parameters existing building at Reazuddin bazar area.

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CONCLUSIONS

No building completely follow BNBC code.N.N Tower building follow 60 percent of BNBC code.In percentage parameter for building less than 10% are 147, 10 – 15% are 88, 15 – 20% are 32, 20 – 50% are 45 and more than 50% is The maximum building weight of each parameter – combustible materials, fire zone and roof gravity tanks were found to be the highest. Combustible materials and fire zone will have the most detrimental effect. Most important parameters are 13.52%, important parameters are 47.56%, Essential parameters are 24.97%, and preferable parameters are 13.95%.Here we have found that important parameters in buildings that are moderate risk building and those that are in the most important parameters are high risk building

RECOMMENDATIONS

In the existing scenario, the building should be constructed maintaining the standard. Ensuring the building of fire incident. We can request CDA to rearrange or reconstructed all the structure which are not following the Fire Service Civil Defense Rule to avoid the fire hazard. Increasing people community to awareness about the fire safety. We have to ensure by the respective Government Authority. The study we have found that there buildings would be constructed with fire alarm, smoke detector, fire extinguisher etc. should be required detailed evaluation form. High rise building should be constructed instead of kucha bazar, fish bazar, and slum. Road side should be increased instead of beside existing shop of road.

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