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# Risk of Fire Disaster: Consequences on Industry Sectors in Bangladesh

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### **Abstract**

Fire disasters have a devastating impact on both lives and properties. The purpose of this study was to explore the causes and consequences of fire disasters and find out the probable measure to reduce the effect of it. A cross-sectional descriptive study was conducted on 20 industries at Gazipur in Dhaka. Multi-stage probability proportionate to size sampling technique was applied to select the industry. A total of 200 workers were selected for data collection. A semi-structured questionnaire was applied for collecting primary information through face to face interview, focus group discussion (FGD), and key informants interview (KII). Secondary data was collected from various secondary sources. Results revealed that the majority (70.5%) of the workers was female and the mean age of them was 29 years. Besides this, most of the workers (52.2%) had formal education and average monthly income of them was 13329 Tk. only. The study also discovered that the electric short circuit (28.5%) and boiler explosions (26%) were the major cause of fire disaster. During the fire outbreak the lack of emergency exit route (83.6%), lack of signage (79.7%), inadequate staircases (82.8%), suffocation (77.3%), and the shortage of emergency light (63.3%) was significantly increased the human causality. Results indicated that 91% of the industry had no fire control system, about 70% of the industry had no emergency exit route, 75% of the industry had no underwater reservoir, and only 5% of the industry had enough level of fire extinguishers. More than 90% of the industry has no fire control training system, only 5% of the workers had got first aid training, more than 50% of the workers had no knowledge how to get rid of fire disaster. After the fire disasters, about 90% of the affected personnel felt inhalation problem, 91% of international trade order was canceled and unemployment problem had increased considerably. Therefore, institutional reform, strengthening of capacity at the individual and institutional level is needed in order to reduce fire hazard risks in the industry.

#### **Keywords**

Disaster, Fire, Industry, Risk, Bangladesh

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### 1. Introduction

Much of the research in recent years has been exposed that Bangladesh is a disaster-prone country [31, 53, 61] where natural disasters [39] is affected every year with high intensity, at the same time, the frequency of anthropogenic disasters [40, 64], have been increased significantly. The major anthropogenic disasters in Bangladesh are fire, building collapse, industrial accidents etc. [30]. Fire disaster in buildings is among the known man-made disasters with

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the most devastating events [41, 65]. Many recurring fire incidences have been reported globally [28]. Apart from loss of property and life, fire disasters have been associated with prevalence of diseases that have been reported to contribute about 1% of the global diseases burden [36]. The most devastating effects of fire disaster in buildings, as recorded in literature, include the collapse of the World Trade Centre [18], the fire disaster in Sweden that occurred in 1998 killing 63 people [17], and the Mumbai and Sharjah high-rise buildings fire incidences to mention a few.

In Bangladesh, the industry sector plays a vital role in the socio-economic development. The industrial segment like readymade garment sectors, pharmaceutical, polymer and plastic industries have been boomed in recent years. The rapid expansion of the industry has not followed the proper guideline for construction; as a result, widespread safety problems have increased. Most of the building has faulty electrical circuits, inadequate escape routes, and unsafe equipment [63]. Every year fire accidents occur in the several industries which creates a devastating disaster for human lives in Bangladesh. Therefore, the industry sector is the main earning sector in this country. Only the textile sectors every year earns 75% of our foreign currency [4] and more than 4 million workers have engaged in these sectors [23, 38, 43, 49]. Fire hazards have been a persistent problem in the country's readymade garment (RMG) industry for over a decade. Bangladesh has over 4,500 RMG factories, which employ more than four million workers and account for US\$19 billion in export [12, 66]. In Bangladesh, fire accidents in export-oriented garment factories continue to kill workers; most of them are women and children. Despite a number of initiatives to curb fire accidents in the garment industry, there are still a significant number of fire occurrences in this industry [1]. With the rapid growth of RMG sector (21.5 billion in the last year), it has become a regular newspaper heading for the last few years that workers have died of some sort of accident at their garment factories. Some historic accidents in ready-made garments sector have already occurred. According to the Sammilita Garments Saramik Federation, more than 530 workers died in 30 fire incidents in several RMG factories between 1990 and 2013. At least 1,383 workers also died in several incidents including building collapse. A fire in the Tazreen Fashions factory in Bangladesh killed at least 112 workers. Probably caused by a short circuit on the ground floor of the building, the fire rapidly spread up the nine floors where garment workers were trapped due to narrow or blocked fire escapes. Many died inside the building or while seeking an escape through the windows [20]. Beside this, one of the major reasons behind the workers death was narrow exits and absence of any escape route or emergency exits. The factory

had only three narrow staircases for the workers. Many workers could not able to escape through the narrow exits. Additionally, a total of 158 people were killed and the property worth about Tk. 3832.69 million was burned in 6,454 fire incidences within Dhaka City during the period of 2001 to 2007 [11]. Then on April 24, 2013, the collapse of another building, housing RMG factories, the Rana Plaza commercial building in the greater Dhaka area, caused a death to of 1,129 [8, 60]. On the other hand, in the year of 2013 to 2015, a total 908 had injured and 31 death due to fire explosion [22]. It has been found that the causes of these incidents are almost 94% by fire, 3.03% by building collapse and another 3.03% by others different incidents [24].

Bangladesh already has a strong foothold in the world's apparel market. But, rapid and unplanned clustered growth of industries leads to adverse health hazard & environmental consequence in an alarming way. Because, less attention is paid to health & environmental protection; safety regulations are not effectively implemented and fully developed [6, 48, 55]. Workers are less secure as monetary remunerations are never beyond just enough, sometimes even less. They are less safe as anytime accidents can cause them disability or even loss of lives. In most cases their lives are endangered by risk of fire. They lack the safety, especially, safety from fire. Low salary and fewer benefits will affect these workers' daily life but fire incidents threaten their lives [5, 42]. Previous studies [2-3, 37, 45-46, 52, 59] showed that worker in the garment, shoe manufacturing, textile, and weaving factories have highlighted adverse working conditions to include crowded workspaces, poor lighting and air quality, and a variety of ergonomic hazards, such as repetitive movements, awkward postures, and piecemeal work which is responsible for fatal fire hazard. Among the adverse health effects associated with garment factory employment, vision disorders musculoskeletal disorders and respiratory abnormalities.

Regretfully, almost all the accidents that have happened over the years or at least the loss of lives could have been avoided if only a few cautionary measures were taken by the concerned and relevant authority [55]. Most garment factories as well as other industries do not have adequate fire prevention measures [26]. In the earlier studies suggest that provision of adequate escape paths, fire drills, emergency plans and training, first aid, fire and smoke alarm systems, safety and exit signage, and announcement systems which will help to reduce the casualties. In addition to, promote higher level policy changes involving safety, skill development, upward mobility, improved health care, and wage enhancement. The purpose of this study was to explore the causes and consequences of fire disasters and find out probable measure to reduce the effect on it.

### 2. Methodology

### 2.1. Study Area

Dhaka is one of the major industrials areas in Bangladesh and the Gazipur district has got the third position. Gazipur district was previously a sub-district of Dhaka district. It was upgraded to a district in 1984 under Dhaka Division. It is bounded on the north by Mymensingh and Kishoreganj Districts, on the east by Narsingdi District, on the south by Naranyanganj and Dhaka Districts and on the west by the Tangail District. The Geo-position of Gazipur District is between 23°53' to 24°20' North latitudes and between 90°09' to 90°42' east longitude (Figure 1). The total areas of the district are 1806.36 sq.km of which 17.53 sq.km was riverine and 273.42 sq.km forest area [9].

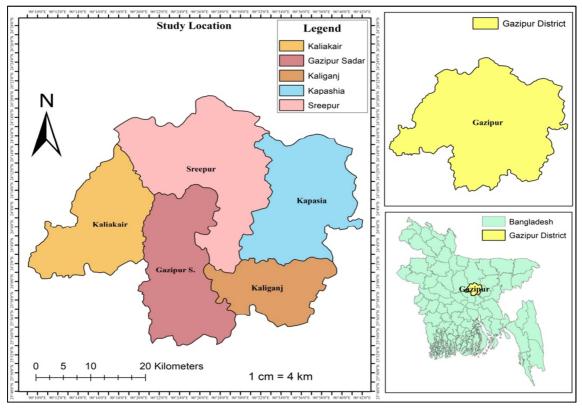


Figure 1. Study Area of Gazipur District.

According to Gazipur district bureau of Statistics 2011, Gazipur district has 5 Upazila. Total industry 1773, garment industry 897, textile industry 127, rice mills 390 and others 358. Total fire brigade station 3 and Police station 13. This study area selected depends on the study objectives to fulfill the study. Though Gazipur is one of the major industrial zones in Bangladesh, it has not adequate fire brigade station which is one of the main reasons of highest consequence during fire disaster. In Gazipur Sadar Upazila has only 2 fire stations but this area at least 1363 industry situated. On the other hand, Kaliakoir has 153, Kaligonj has 76, Kapasia has 17 and Sreepur Upazila has 173 industries but for these upazila have only two fire brigade stations and these stations situated in Kaliakoir, Sreepur Upazila respectively. It was found from the baseline study that only four fire stations in Gazipur district against 1773 industries [9] (Table 1). It's a very alarming condition for Gazipur district industrial sector

Table 1. Number of Industry and fire Brigade Station in Gazipur.

Upazila	Fire Brigade Station	Industry
Gazipur Sadar	2	1363
Kaliakair	1	153
Kaliganj	0	67
Kapashia	0	17
Sreepur	1	173
Total	4	1773

### 2.2. Research Design and Data Collection Procedure

A cross-sectional descriptive study design [29, 54] was applied. On the other hand, quantitative and qualitative method [34-35] was used to complete the study. The study was conducted from 1<sup>st</sup> July 2017 to 30<sup>th</sup> January 2018 at Gazipur district where most of industry is situated. Multistage probability proportionate to size (PPS) sampling [51] was applied to select the industry. For selecting sample size, purposive sampling technique has been used [35]. A total of

200 samples were selected from the 20 industries in order to fulfill the research purpose. Among the sample garments workers were 160, Pharmaceuticals workers were 20, and Polymer and plastic workers were 20. Quantitative information was collected by face to face interview of industry workers. Besides this, 30 Key Informants Interview (KII) and 5 Focus Group Discussion (FGD) (Every discussion include 8-10 fire affected personnel) was conducted to gather qualitative information. Secondary data was collected from online journals, literature review, BFSCD, BBS, and Newspaper etc.

### 2.3. Data Analysis Method

Data analysis is an on-going part of the data collection [15]. Upon completion of the data collection, data has been entered and cross-checked and were transferred into the computer for statistical analysis. Statistical analyses were performed using sophisticated Microsoft Excel program and SPSS version 22.0. Statistical analysis included calculation of the proportions, mean, median, range, and standard deviation for descriptive analysis.

### 3. Results

Among the 200 respondents, maximum (48%) were in age group 30-39 years followed by 44% in the age group 20-29 years. The mean age was 29.7 years (SD-6.48 years) and the age varied from 20 to 50 years. Majority (70.5%) of the respondents was female and 29.5% was male. Most of the respondents (52.5%) had formal education and a few (9%) had education up higher level (Table 1). More than 90% respondents were general worker in their industry and only 9.5% of them were supervisory work. Among the total respondents, 41.5% had work experience between 5-10 years and 31.5% had working experience less than 5 years in the industry. The average work experience of the respondents was 7.98 years (SD-5.14 years). The average monthly income of the respondents was 13329 taka and the minimum income was 1200 taka and maximum was 50000 taka. Regarding fire hazards, the majority (64%) of the respondents were found to experience from the fire disasters (Table 2).

Table 2. Demographic and Socio-economic characteristics.

Characteristics	Frequency	Percentage	
Gender			
Male	59	29.5	
Female	141	70.5	
Age Group			
20-29 Years	88	44.0	
30-39 Years	96	48.0	
40-49 Years	13	6.5	
>50 Years	3	1.5	
M-29.7, SD-6.48, Minimum-20 and Maximum-50 Years			
Educational Status			

Characteristics	Frequency	Percentage
Illiterate	23	11.5
Primary level	105	52.5
Secondary level	37	18.5
SSC or Equivalent	9	4.5
HSC or Equivalent	8	4.0
Honours or Equivalent	12	6.0
Masters or Equivalent	6	3.0
Position of work		
General worker	181	90.5
Supervisor	19	9.5
Experience of the work in Years		
<5 Years	63	31.5
5-10 Years	83	41.5
11-15 Years	37	18.5
16-20 Years	7	3.5
21-25 Years	10	5.0
M-7.98, SD-5.14, Minimum-1 and Ma	ximum-23 Years	
Income per month in TK		
6000-10000 Tk.	70	35.0
10001-15000 Tk.	86	43.0
15001-20000 Tk.	29	14.5
20001-25000 Tk.	11	5.5
>25001 Tk.	4	2.0
M-13329.50, SD-8305.10, Minimum-	200.00 and Maxim	um-50000.00 Tk.
Experience of fire hazards		
Yes	128	64.0
No	72	36.0

Concerning the causes of fire disasters, over 28.5% of the respondents reported that the electric short circuit was one of the major cause of fire disaster followed by 26% of the respondents stated that the electric boiler explosion was another cause of the accidents. On the other hand, 21.5% of the respondents were reported that storage of flammable materials also responsible for fire disaster which has been displayed in Table 3.

Table 3. Causes of fire hazards in Industry Area.

Causes of fire hazards	Frequency	Percentage
Electric short circuit	57	28.5
Boiler explosion	52	26.0
Storage of flammable materials	43	21.5
Transformer explosion	14	7.0
Canteen/kitchen	9	4.5
Overheating	7	3.5
Lack of awareness	18	9.0
Total	200	100.0

Causality factors of fire hazards were comparing by the affected respondents' experience of fire hazards as detailed in Table 4. From the study, it was found that 86% of the workers had been affected significantly ( $\chi^2$  7.65; P=0.006<0.05) because blocked emergency exit route. On the other hand, a higher portion (79.7%) of the workers significantly ( $\chi^2$  3.75; P=0.053<0.05) suffered during the fire accident due to lack of signage for the escape route. Likewise, it was also found that 73.4% of the workers got jam-packed due to the staggered layout of the machine. Similarly, 63.3% of the workers couldn't find an emergency exit route because of the shortage of light ( $\chi^2$  4.86; P=0.027<0.05). Additionally, more than 75% of the workers had affected during the accident due to the

doors of escape route wasn't fire resistant and not self-opening as well as didn't open along the direction of escape. Besides this, 83.6% of the workers mentioned that due to the lack of exit route workers suffer from suffocation and be stampede

during the fiery explosions and the difference is statistically significant. From the study, it was found that workers and owners lack of awareness was not statistically significant ( $\chi^2$ .32; P=0.569>0.05).

Table 4. Causality factors of Fire hazards.

Causality of fire hazards		Experience of fire hazards		T. ( )	C: te T	D 14
		Yes No		— Total	Significance Test	Result
Displied amarganay avit route	Yes	86 (67.2%)	34 (47.2%)	120	.2765: D=0.006<0.05	S
Blocked emergency exit route	No	42 (32.8%)	38 (52.8%)	80	$\chi^2$ 7.65; $P$ =0.006<0.05	3
I l f - i f	Yes	102 (79.7%)	65 (90.3%)	167	<sup>2</sup> 2 75 P 0 052 50 05	C
Lack of signage for escape route	No	26 (20.3%)	7 (9.7%)	33	$\chi^2$ 3.75; $P$ =0.053<0.05	S
C4	Yes	94 (73.4%)	26 (36.1%)	120	.2 26 75. P=0.000 <0.001	S
Staggered machine layout	No	34 (26.6%)	46 (63.9%)	80	$\chi^2$ 26.75; $P$ =0.000<0.001	5
Chartage of Emarganay light	Yes	81 (63.3%)	34 (47.2%)	115	·2 4 86: P=0 027<0.05	S
Shortage of Emergency light	No	47 (36.7%)	38 (52.8%)	85	$\chi^2$ 4.86; $P$ =0.027<0.05	5
Doors, opening along escape routes, are not fire	Yes	101 (78.9%)	27 (21.1%)	132	$\chi^2$ 26.39; $P$ =0.000<0.001	C
resistant	No	31 (43.1%)	41 (56.9%)	68		S
Doors are not self-closing and often do not open	Yes	97 (75.8%)	35 (48.6%)	132	2 15 15 D 0 000 <0 001	S
along the direction of escape	No	31 (24.2%)	37 (51.4%)	68	$\chi^2$ 15.15; $P$ =0.000<0.001	
Adequate doors as well as adequate staircases are	Yes	106 (82.8%)	40 (55.6%)	146	·2 17 26. P=0 000 <0 001	C
not provided to aid quick exit	No	22 (17.2%)	32 (44.4%)	54	$\chi^2$ 17.36; $P$ =0.000<0.001	S
	Yes	70 (54.7%)	27 (37.5%)	97	2 5 45 B 0 020 50 05	C
Fire exit or emergency staircase lacks maintenance	No	58 (45.3%)	45 (62.5%)	103	$\chi^2$ 5.45; $P=0.020<0.05$	S
T. I. C. iv.	Yes	107 (83.6%)	44 (61.1%)	151	2 12 50 P 0 000 50 001	C
Lack of exit route	No	21 (16.4%)	28 (38.9%)	49	$\chi^2$ 12.59; $P$ =0.000<0.001	S
0.00 (	Yes	99 (77.3%)	37 (51.4%)	136	21426 P. 0.000 -0.001	C
Suffocation, stampede	No	29 (22.7%)	35 (48.6%)	64	$\chi^2$ 14.26; $P$ =0.000<0.001	S
Y 1 C	Yes	82 (64.1%)	49 (68.1%)	131	2	NG
Lack of awareness	No	46 (35.9%)	23 (31.9%)	69	$\chi^2.32$ ; $P=0.569>0.05$	NS

Majority respondents reported that the electricity and gas lines are mainly responsible for the fire disaster. Based on the respondents' opinion, only 24% of the respondents' stated that their industry authority regularly checks the gas and electricity line. On the other hand, about 45% of the respondents reported that they didn't check it's without any problem basis as illustrated in Table 4. Bangladesh fire service and civil defense department provide fire safety certificate for every industry. So they have a key responsibility to regularly contact those industries. But all of

the respondents' reported that the BFSCD department couldn't visit the industry in normal time while 89% of them reported that they had only come when the fire accident occurred. In recent time fire alarm and smoke detector give the special benefit to reduce the fire accident in the industry sector. From the survey, it was found that most of the industries have a fire alarm system, but the majority of them have no smoke detector system, more than 90% of the respondents' mentioned it (Table 5).

Table 5. Status of Preventive measures.

Variables	Category	Frequency	Percentage (%)
	Regular checking	48	24
	Problem basis	90	45
Factory check ups	No check at all	42	21
	Don't now	16	8
	Yes- In normal time	0	0
Vigit by DECCD department	No-In normal time	200	100
Visit by BFSCD department	Yes- Only accident time	178	89
	No- only accident time	22	11
Existence of fire alarm	Yes	190	95
	No	10	5
Enistance of annulus detector	Yes	20	10
Existence of smoke detector	No	180	90

Based on the workers' opinion, it was found that most of the industry has no own fire control system. About 70% of the respondents stated that the industry had no fire emergency exit plan. On the other hand, only 28% of the respondents mentioned that they had known the nearby fire station number

while 6% of them have got training on the fire control system. Moreover, 75% of the respondents mention that the industry has no underwater reservoir. In addition to, about 42% of the respondents reported that their industry had the fire extinguisher but it wasn't working as well as 29% of them

stated that maximum extinguisher was date expired evidence for this is in Table 6.

Table 6. Existence of Fire Fighting Equipment.

Variables	Category	Frequency	Percentage (%)
E	Yes	18	9
Factory have own fire control system	No	182	91
Ft	Yes	60	30
Factory have fire exit plan	No	140	70
W 1 V 1 1	Know the nearby fire station number (yes)	56	28
Worker Knowledge	Have training on fire control (yes)	12	6
	Yes	26	13
Existence of under water reservoir	Yes but not enough	24	12
	No	150	75
	Not seen	28	14
	Exists but not working	84	42
Fire extinguisher	Exists but date expired	58	29
	Not enough but can be reached	20	10
	Satisfactory	10	5

Table 7 demonstrates the present status of safety measure in industries. From the study, it was found that most of the industry (91%) has no fire training system while 7% of the industry has arranged training for 1-2 days. On the other hand, only 2% of the industry has arranged training for maximum 7 days. First aid training is important for all level of people. It was found from the survey, that only 52% of the respondents had known to first aid but they had not got any training while 12% of the workers have no knowledge about first aid. On the contrary, only 31% of people had got a minimum level of training. According to

results, about 54% of the respondents' had no knowledge about how to get rid of fire where 54% of the respondents had a medium knowledge and only 12% of them had general knowledge to get rid of fire hazards. Most of the industry hasn't arranged fire control drill system within 3 months. More than 95% of the respondents mention that their industry hasn't arranged fire control drill system within 6 months. In addition, 90% of them mentioned that their industry hasn't arranged any fire control drill.

Table 7. Present status of safety measure in Industries.

Present Status of Safety Measures	Frequency	Percentage (%)		
Fire Control Training Status				
No Training system	182	91		
Minimum level training system	14	7		
Moderate level training system	4	2		
Maximum level training system	0	0		
First Aid Training Status				
Not know	24	12		
Only Know what is first aid	104	52		
Minimum level training	62	31		
Trained person	10	5		
Knowledge about how to get rid of fire accident				
No Knowledge	108	54		
Medium Knowledge	56	28		
General knowledge	24	12		
High knowledge	12	6		
Fire control Drill system				
Every 3 months Yes	0	0		

Present Status of Safety Measures		Frequency	Percentage (%)
	No	200	100
F	Yes	10	5
Every 6 months	No	190	95
E 1	Yes	20	10
Every 1 year	No	180	90

## 4. Consequences of Fire Disaster

Based on the opinion of the workers' and the industrial authority, it was found from the study that, there was mainly three types of effect is resultant due to fire hazards. Majority of the respondents reported that economic and health-related consequences were mainly noticed during and after the accident. Besides this, they also mentioned the social consequences. As can be seen in Figure 2, after the fire accident due to the shutdown of the industry a great economic impact had felt on the owner as well as the workers. Moreover, about 91% of the authority reported that the international traders cancel their agreements, as a result, the dignity of the industry decreased. According to the Figure 3, it was found that about 80% of the affected workers reported that during and after of the fire incident the inhalation problem is mainly observed. Besides this, about 80% of the workers mentioned that when they affected by fire hazards had faced shocked and anxiety problem. About 60% of the workers reported that during the fire accident, most of them had injured because of no exit route, suffocation etc. Figure 4 represents the social consequences due to fire disaster. About 95% of the workers' reported that after the fire disaster they lost their job as a results unemployment problem was observed. On the other hand, more than 60% of the workers mentioned that after the incident their social security and dignity was attenuated. Besides this, about 35% of them stated that the criminal activity was increased due to no options for income after the incidents as well as they involved in illegal business.

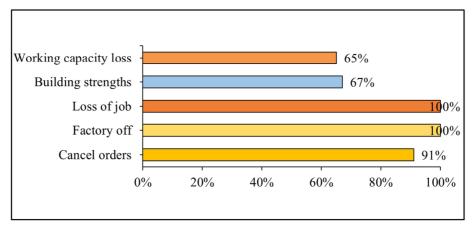


Figure 2. Economic effects due to Fire Disaster in Industry.

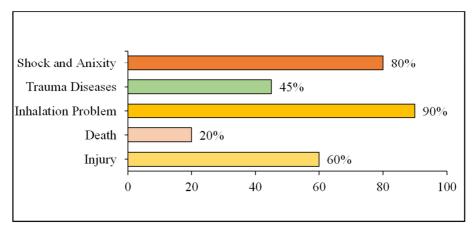


Figure 3. Health Impact due to Fire Disaster in Industry.

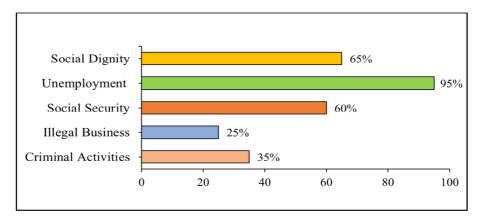


Figure 4. Social Consequences due to Fire Disaster in Industry.

Based on the FGD and KII, some precautionary measure was identified which summarized in Table 7. It was found from the expert consultations and the opinion of affected workers that most of the fire disaster was occurred due to the electric short circuit, so most of them (91.7%) recommend that the electrical wiring must be properly designed, installed and maintained which will reduce the accident significantly. From the study, it was found that most of the workers couldn't get first aid training, as a result during the fire

disaster they couldn't save himself, so they suggest (90.0%) all workers' first aid training should be compulsory. Besides this, it was found that most of the industry had no smoke and fire alarm system, so 88.3% of the participants suggest installing a smoke/fire alarm system as soon as possible. On the other hand, it was found that most of the industry had no fire drill system which increased the causality during the fire incident, so 80.0% of the experts recommend every industry should provision of the mock drill on the regular basis as

well as adequate number of extinguishers and teach the workers how it used to reduce fire detonation. Moreover, 75% of the expert and affected persons suggest that the authority should construct the building materials with fire resisting materials which will help to reduce the fire outburst. Additionally, more than 70% of them suggest that the authority should install adequate exit and a proper escape route and should always open emergency exit route. In

addition to, the emergency exit route should not be blocked with machine layout as well as escape routes should be lighted at all times which recommend 61.7% and 53.3% of the participants respectively. Also, they suggest that the exit doors should be protected and should open along the direction of escape (41.7%) as well as emergency fire hose should be established (38.3%).

**Table 8.** Precautionary Measure to mitigate the risk of fire hazard (N=60).

Precautionary Measures	Frequency	Percent	Rank	
Building should be constructed with fire resisting materials	45	75.0	6	
Adequate exits and proper escape routes should be designed	42	70.0	8	
Electrical wiring must be properly designed, installed and maintained	55	91.7	1	
Escape routes should be lighted at all times be indicated by signs	32	53.3	10	
Regular fire drills should be held	48	80.0	4	
Doors should be protected and should open along the direction of escape	25	41.7	11	
Smoke detector/Fire alarm systems must be installed	53	88.3	3	
Adequate number of extinguishers should be provided	46	76.7	5	
Emergency fire hose should be established	23	38.3	12	
First aid training should be compulsory	54	90.0	2	
Emergency exit route should be always opened	44	73.3	7	
Exit way should not be blocked	37	61.7	9	

(Source: KII and FGD)

### 5. Discussions

It is crucial and mandatory for every industry to ensure workers safety. Safety lapses are serious matters and the authorities concerned are harshly punished by the safety regulatory authorities for any acts of omission and commission. Unfortunately in Bangladesh, state safety regulation and intervention are extremely poor. Like everything else, it is also relegated more to a routine than any prevention or inspection function based only on the whims and desires of the industry owner. Over decades no worthwhile safety audit has been seen, not even any kind of investigation or positive measures from the industry owners or inspection authorities who are primarily responsible for safety in the workplace. Findings from the study represent that most of the workers in the industry sector were female and the average age was 29 years, as well as they, had completed only formal education. These findings have corroborated with the findings from Begum, 2016 and Zohir, 2001 [10, 68] where the majority of workers was female and 60-75% of them 21-30 age group, as well as 72.8-73.8% only, had completed formal education. On the other hand, it was found from the study that an electric short circuit is the major cause of fire disaster in the industrial sector as well as the boiler explosions. Several studies have shown a similar cause [7, 14, 19]. A study from Ghana has observed that the major cause of fire accident due to electric short-circuits [62]. On the other hand, several studies in Bangladesh [1, 6; 64]have shown that the electric short-circuits; boiler and transformer explosions, storage of flammable materials,

overheating etc. were the major cause of fire disaster in the industry sector. In recent time, Bangladesh Fire Service and Civil Defense Authority (BFSCDA) mandatory a rules for all industry, have to obtain certificate from them to operate industry as well as newly constructed industry should comply with Bangladesh National Building Code of 1993 (BNBC-93). Industries operating in old buildings have to also collect fitness certificate [63]. Besides this, they should inspect the safety status of the industry on regular basis. But from the study, it was found that the majority of the industry which was not constructed with comply the building code as well as fire-resistant materials. It was also found that, BFSCDA had visited the industry if the industry felt any problem. On the other hand, most of the industry had no smoke detector and fire alarm system, so before the fire detonation, anyone hadn't get any way to escape. Besides this, most of the buildings had no emergency exit route as well as escape doors were not suitable for the exit as a results during the fire outbreak most of the workers had suffered from stampede and due to the inhalation of smoke and toxic combustion gases. Various studies have corroborated about this findings [25, 6, 13, 21, 47, 64]. It was also found that most of the industry had no emergency exit route as well as the provision of emergency lighting as a result during the crisis whole industry falls into total darkness. These results related to previous studies [43]. Additionally, findings in the study denote that the majority of the industry had no standard firefighting equipment's. Similar findings have been revealed in the study of Ahmad & Kamruzzaman, 2015 [5]. From their study, it has been found that among the 25 selected industry in Dhaka city 32% of them had maintained fire extinguisher standard while 68% of them hadn't maintained their standard. On the other hand, only 40% of the industry had maintained fire drill standard while 60% of them hadn't maintained their standard, as well as 84%, hadn't their standard fire trained employee. Another finding from previous studies where showed that more or less every industry had firefighting equipment's but not maintained it properly [58]. The findings from the study reported that majority of the workers were not satisfied about the fire safety measure in their industry. Earlier studies in the same field also revealed similar results [42].

Findings revealed that the economic consequences from the fire disaster were drastically high. Due to the shutdown of the industry most of the traders had to cancel their agreements as results a great economic loss had resulted. Earlier studies have shown that due to the fire disaster during the year of 2000 to 2013 was monetary loss around Tk. 540 crores and about Tk. 18,264 crores worth of property [27]. It was found from the study that majority of the workers suffered from suffocation problem as well as shocks, anxiety, long term trauma diseases. Besides this, injury and death was common scenarios which also found from earlier research [19]. In addition to, the findings from the study showed that due to loss of job, unemployment situation was dramatically increased. In a consequence, most of the people involved at that moment illegal business activities. In the study, it was found from the consultations of expert members and affected personnel that the use of the smoke detector and fire alarm system will help to reduce the causality of fire outbreak. These findings have corroborated with earlier research [16, 32, 50, 67]. In addition to, emergency exit route sign will help to safely escape from the incident place which showed in previous studies [44]. The findings from this studies suggest that the emergency exist route should be free and open which will lessen the injury and death. These results related to the previous studies [33, 57]. Besides this, findings suggest that conducting fire evacuation drills before the fire hazard will help to save from the fire which also showed in earlier research [56].

### 6. Conclusion

The present status of fire safety in the industry sector in Bangladesh is highly vulnerable to formulate devastating disaster. From the observation and analysis of the results, it can be concluded that the safety measure of fire hazards in the industry is not sufficient. It was found that majority of the industry hadn't enough firefighting equipment's to tackle the fire disasters. Facilities like alarm, smoke detector, fire resistant door, a sufficient number of emergency fire exits

route, personal firefighters are only available in some industries but the amount inadequate. Besides this, most of the building hadn't enough lift and staircases. On the other hand, it was found that authority wasn't regularly checking the electricity line. The fire service authority shouldn't visit the industry without any reason. Majority of the workers had no idea how to get rid of fire disaster and they couldn't get any first aid training. Most of the industry had no provision of mock drill for the fire disaster. The study also revealed that after the disaster most of the affected personnel felt inhalation problem, as well as, due to shut down the industry the international trade relation was breakdown. Besides, the people were lost their income source as results unemployment problem was increased as well as criminal activities. So steps should be taken to solve these problems. People have to give primary knowledge on firefighting equipment's and also have to show them how to tackle the emergency situation. Regular fire drill should be conducted under the guidance of fire service and for this everyone's participation has to ensure. The evidence generated from this study needs to be further strengthened by conducting a more objective research on a large scale. This study recommends further detailed research on workers' health hazards risk due to fire hazard in the industry sector.

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