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Evaluation of Causes and Effects of Fire and Other Safety Incidents in Readymade Garment Industry of Bangladesh

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Abstract: The readymade garment industry in Bangladesh is one of the foremost significant export-oriented industries, but it faces issues in ensuring worker safety. Industrial accidents threaten workplace safety, which is additionally amongst the foremost critical challenges in the world's industries. The objectives of this paper are to explore the numerous lethal incidents in the industry in Bangladesh and also explore the causes for these lethal incidents with the effect of those incidents. This paper aims to present a case study of the working conditions of readymade garment industries in Bangladesh and the case study presented past and running unsafe working conditions in the industry of violations of human rights and the high prevalence of injuries on duty by the workers. Differing kinds of causation in the recent decade have made the Bangladeshi garment industry ambiguous. Among 4,560 garment industries, 237 lethal incidents happened and that ratio was 5.2% during the last 31 years (1990-2020). Almost 237 lethal incidents, 94.09% incidents occurred by fire and only 1.27% incidents were caused by building collapse and 3.38% incidents were caused by boiler burst and another 1.27% by other different incidents. The total number of harmed people was 6,870 of which 1,689 people were injured and 5,181 people died, also the highest incident happened from 2011 to 2015 when 3,800 people were injured and 1,287 people died. This paper will investigate around for the causes of the various incidents and can expose the precautionary measure for those problems in the fashion industry which affected their sustainability and profitability.

Keywords: Readymade Garment Industry of Bangladesh, Fire and Safety, Causes and Effects, Fire Risk Index (FRI), Building Collapse and Fire Hazards, Occupational Health and Safety (OHS), Risk and Safety Assessment

1. Introduction

The readymade garment sector has been playing a very important role in the entire economic development of Bangladesh. In the workplace, differing types of commercial disasters have resulted in several initiatives worldwide to save human life and reduce material damage, both nationally and internationally [1]. The Rana Plaza collapse was the worst industrial accident in the history of the garment industry in Bangladesh. In the wake of the tragedy, two significant transnational governance initiatives emerged “the Accord afire and Building Safety in Bangladesh” (Accord) and “the Alliance for Bangladesh Workers Safety” (Alliance) [2]. After the tragedy occurred, the policy response included a change in Bangladeshi labor law, international buyer-coordinated building inspections, tariff penalties, and attempts at improved social dialogue coordinated by international buyers, unions, the Bangladeshi government, and therefore the ILO [3].

Bangladesh is a South Asian country bordering India and Burma, and within the south of the country, there is the Bay of Bengal. The country contains territory of 143,998 sq km, a total inhabitant of 16, 36, 54, 860 (July 2013). The amount of total GDP is US$302.8 billion and therefore the GDP growth rate is 6.1% (2012). The GDP contributions by sectors are agriculture 17.7%, Industry 28.5% and private or govt. Service 53.9%. The main exporting partners of Bangladesh are USA, Germany, UK and France (World factbook 2014) [4]. The Ready-Made Garments sector is the largest exporting industry

of Bangladesh which experienced phenomenal growth during the last 25 years. This sector contributes 75% of foreign currency earnings and 13% of the GDP growth in Bangladesh [5]. The garment industry is Bangladesh's biggest export earner with a price value of over US$27.9 billion of exports within the 2019-20 FY (BGMEA, 2022).

Bangladesh continues to be the second-largest exporter of ready-made garments in the world after China. After that, it became the sixth-largest exporter of apparel in the world after China, the EU, Turkey, Hong Kong and India 2006. In the year of 2006, Bangladesh's share in the world apparel exports was 2.8%. The US was the biggest single market with US$3.23 billion in exports, a 30% share in 2007. Nowadays, the US remains the biggest marketplace for Bangladesh's knitted garments taking US$2.42 billion, a 47% share of Bangladesh's total knitted exports. The European Union remains the largest regional destination Bangladesh exported US$5.36 billion in apparel; 50% of their entire apparel exports. The EU took a 61 % share of Bangladeshi knitwear with US$3.36 billion in exports. In 2017, the whole export of apparel items in EU countries was 18,695 million US dollars, where the EU imports 64% of total apparel items from Bangladesh & growth is 4.17%. However, the USA is the single largest market in Bangladesh, where Bangladesh exports 5,246.91 million US dollars of apparel items in 2017, but there is a growth of about 2.27% [6].

Safety has become a problem of major concern with the rise in population and rapid industrialization. Occupational accidents result in 317 million accidents and exceed 2.3 million fatalities in workplaces globally annually, in keeping with the International Labor Organization. Substandard workplace safety standards are estimated to cost the world economy 4% of GDP annually [7]. Safety measures have already been acknowledged as important for ensuring workplace safety and lowering accident rates [8-10]. Up to April 2017, a minimum of 142 RMG workplace fire incidents had occurred since the Tazreen Fashions Factory fire and Rana Plaza Building collapse, resulting in the deaths of 1,148 employees [11]. As a result of this deadly collapse, Bangladesh's government upgraded the Chief Inspector of Factories and Establishments office to the Department of Inspection for Factories and Establishments on January 15, 2014, with enhanced manpower, stronger leadership, and high infrastructure [12].

A fire in the Tazreen Fashion Ltd. Garment factory in the Ashulia district of Dhaka, Bangladesh, killed 112 persons on November 22, 2012. In March 2013, in response to the catastrophic fire, the government, employers, and workers agreed on a National Tripartite Plan of Action to extend fire safety in Bangladesh's Ready-Made Garment sector [13]. Overall, 4,127 factories were examined, with 1,819 being inspected by the Accord, 759 being inspected by the Alliance [14], and 1,549 being inspected under the NI [7].

Safety is a very vital component of the manufacturing process. Fire is one of the foremost common humans caused risks, and it occurs as a result of insufficient or no preventative measures. According to official figures from the Bangladesh Fire Service and Civil Defense, there were a total of 19,672 fire incidents across the nation in 2018, with 6,208 of them occurring in Dhaka. The cost of the damage and loss is enormous. In the year 2018, fires killed a minimum of 130 people and injured 664 others across the country [15]. High population density, unplanned urbanization and industrialization, and non-compliance with the codification of buildings are all high-risk factors [16].

In Bangladesh, the total number of fires is steadily growing. There have been 9,310 fire incidents across the country in 2008, compared to 19,642 fire incidents in 2018. As a result, fire occurrences climbed by 111% in ten years [17]. Between 2004 and 2018, at least 1,970 persons were killed in over 200,000 fires across the country. However, 2011 saw the maximum number of casualties (365 dead and 1,385 wounded). 2015 was the bloodiest year in terms of financial losses, with the country losing an estimated 8500 million BDT (more than USD 100 million) on account of 17,488 fires [18]. The studies were focused on finding scientific reasons for the fire, building collapse, boiler burst and other safety incidents. The major findings of the studies show that the incidents because of its high level of population, the dense concentration of population, narrow roads, the existence of flammable building materials, old electric and water supply systems, unplanned construction of buildings, and chemical and hazardous material in Readymade Garments etc. Also, the studies found precautionary measures for those problems to manage fire hazards, building collapse incidents, boiler burst incidents and other safety incidents [19].

2. Objectives

Some objects are shoving the apparel industry negatively forward to unsafe working places but why these causes are making the ready-made garment sector so risky is a burning question. This research will help to explore the effect and causes of why the Bangladeshi apparel industry is forwarding negatively. The specified objectives of this paper are listed below;

i. To identify the lethal incidents in the history of the RMG industries in Bangladesh.
ii. To evaluate the causes and effects of identified lethal incidents.
iii. To specify the preventive actions for the stated causes of the identified lethal incidents.

3. Methodologies

3.1. Identification of the Lethal Incidents in the History of the RMG Industries in Bangladesh

Among 4,560 garments factories (BGMEA, 2020), 237 garments factories were treated as the sample. The samples are selected by the incidents that occurred in the history of Bangladeshi RMG industries during the last 31 years from 1990 to 2020.

3.2. Evaluation of the Causes and Effects of Identified Lethal Incidents

The data has been collected from secondary sources and followed different tools and equations to calculate the causes and effects of different types of incidents. There are some equations (BCI, FI, BBI, DBC, DF, DBB) for the calculation procedure. These equations are briefly stated below;

$$\text{Building Collapse Incident (BCI)} = \frac{\text{Incident Occurred by Building Collaps}}{\text{Total Incident}} \times 100 \quad (1)$$

$$\text{Fire Incident (FI)} = \frac{\text{Incident Occurred Fire}}{\text{Total Incident}} \times 100 \quad (2)$$

$$\text{Boiler Burst Incident (BBI)} = \frac{\text{Incident Occurred by Boiler Burst}}{\text{Total Incident}} \times 100 \quad (3)$$

$$\text{Other Incident (OI)} = \frac{\text{Incident Occurred by Other Causes}}{\text{Total Incident}} \times 100 \quad (4)$$

$$\text{Death by Building Collapse(DBC)} = \frac{\text{Number of Death by Building Collapse}}{\text{Total Number Of Death}} \times 100 \quad (5)$$

$$\text{Death by Fire(DF)} = \frac{\text{Number of Death by Fire}}{\text{Total Number of Death}} \times 100 \quad (6)$$

$$\text{Death by Boiler Burst (DBB)} = \frac{\text{Number of Death by Boiler Burst}}{\text{Total Number Of Death}} \times 100 \quad (7)$$

$$\text{Death by Other Incident (DOI)} = \frac{\text{Number of Death by Other Incident}}{\text{Total Number Of Death}} \times 100 \quad (8)$$

3.3. Specifying the Preventive Actions for the Stated Causes of the Identified Lethal Incidents

These deadly Incidents have been brought to its court following the guidelines of the Bangladesh National Building Code (BNBC) and Bangladesh Fire Service & Civil Defense (BFSCD) to resist these very cautious fundamentals.

4. Safety Issues in Bangladesh

In Bangladesh, around 30 million people are directly or indirectly involved in the RMG business. This industry contributes to the creation of jobs, the reduction of poverty, and also the empowerment of rural women [20]. At the beginning of the RMG business, industrial buildings were occasionally discovered in an unanticipated way, leading to the conversion of ordinary structures to factory functions. As a result, multiple catastrophic collapses occurred, including the Rana Plaza and Tazrin tragedies, which claimed many lives and wounded thousands more. As a result, the matter of safety has become a top focus [21].

4.1. Fire Risk Assessment Method

In our research, according to BNBC-93, we have divided the 'hard' characteristics into three categories: preventive requirements, means of escape, and in-built firefighting capabilities, each of which comprises multiple distinct parameters. BNBC-93 parameters form up all of those 'hard' parameters. The 'soft' parameters are treated as a one-unit [22]. The Fire Risk Index (FRI) for the 'hard' and 'soft' parameters was generated using the subsequent linear additive model:

$$\text{Fire Risk Index (FRI)} = \frac{\sum_{i=1}^{1} \text{wi xi}}{\sum_{i=1}^{n} \text{wi}} \quad (9)$$

Where wi is the weighted amount to examine how the relevance of certain characteristics varies concerning each other, the mark (a dimensionless score) for the parameter i is given by xi, and also the overall set of parameters is given by n.

Figure 1. *Soft factors: The clear width of an exit corridor reduced by piled-up boxes [23].*

Figure 2. *Soft factors: The empty overhead storage tank for firefighting [23].*

Figure 3. *Hard factors: The stairway does not meet regulations [24].*

Figure 4. *Hard factors: The entrance does not meet regulations [24].*

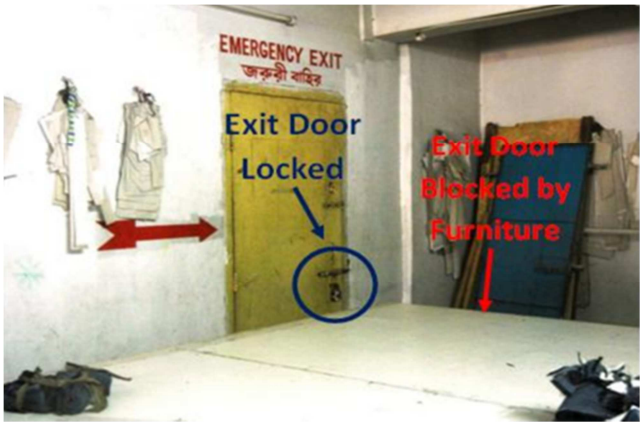

Figure 5. *Soft factors: The exit door is blocked by furniture and also it is locked [23].*

Figure 6. *Soft factors: The exit gate meets as per regulation but is blocked [24].*

Figure 7. *Soft factors: The exit corridor width meets regulation but is reduced in practice [24].*

Figure 8. *Soft factors: The stairway width meets regulation but is reduced in practice [24].*

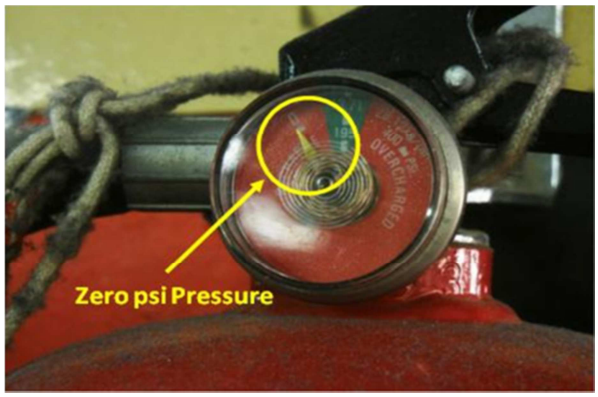

Figure 9. *Soft factors: Fire extinguisher with zero operating pressure [23].*

Figure 10. *Soft factors: Fire extinguisher with no nozzle [23].*

4.2. Major Lethal Incidents in Readymade Garment Industry of Bangladesh

In this research, the goal is to point out the most serious occurrences that occurred in the Bangladeshi textile industry. Between 1990 and 2020, 1,689 individuals died and 5,181 persons or employees were badly hurt in Bangladesh's textile industry's 237 dangerous accidents. All of those events have an immediate and indirect impact on the ready-made clothing sector's profitability, productivity and growth. The downfall of the Rana Plaza was the biggest disaster occurrence in the history of the country. The fire at Tazreen Fashions Ltd. was another unfortunate disaster. Aside from these two, there have been a few deadly instances in Bangladesh's RMG sector's history. Those are all listed in the below short:

4.2.1. Case One: Chowdhury Knitwear and Garment Factory

At the Chowdhury Knitwear and Garment factory in Shibpur, near Dhaka, on the night of November 25, 2000, a minimum of 48 people lost their lives and more than 150 were injured, some were in serious condition. That fire incidents were Bangladesh's worst in history. The one escape gate was shut, according to survivors, neighbors, and firemen, preventing workers from fleeing death. When the fire broke out at 7:00 p.m., it is estimated that up to 800 individuals were working overtime. The factory was a four-story structure and panicked employees on the second and third floors ran to the exits, but the first-floor gate on the only stairway was shut. The worker who could not escape were burned alive and it took four hours to put out the fire and rescue the surviving people.

4.2.2. Case Two: The Spectrum Sweater Ltd.

On April 11, 2005, the 9 storied factory building of Spectrum Garments in Palash bari of Savar crashed, killing around 70 people and injuring a minimum of 100 people. The location was also visited by political leaders, members of IEB, RAJUK, BGMEA, BUET, BACE and other concerned organizations within a short time after the incident and several times later [25].

4.2.3. Case Three: KTS Composite Fabrics Mill

On February 23, 2006, the biggest disaster in the history of Bangladesh, a catastrophic fire raged through KTS Fabrics Industries in Chittagong, Bangladesh. The victims were unable to flee since the emergency gate was closed, according to the rescued workers. At the KTS Composite Fabrics Mill in Chittagong, this tragedy killed an estimated 54 people and wounded about 150 others, that of them were women. Workers believe that up to 1,200 people were working inside and outside the structure at the time of the incident (The Daily Star, 25 February 2006). Exits were locked to prevent workers from fleeing the site, the gate being sealed purposely after the fireplace was discovered. This is the long line of disasters showing Bangladesh's clothing industries for garment workers and occupational safety.

4.2.4. Case Four: Garib & Garib Sweater Factory

On 25th February 2010, almost 21 workers died when the factory caught fire for the second time within six months. The smoke could not get out of the ventilation systems.

4.2.5. Case Five: Tazreen Fashions Ltd.

On 24 November 2012, at approximately 7.00 p.m. a fireplace broke out in Tazreen Fashions Ltd. It was Bangladesh's largest fire incident where 112 persons were died and 200 workers were injured. The fire started on the bottom level of the nine-story building, apparently triggered by a short circuit, trapping the workers on the upper floors. The fireplace blazed for more than seventeen hours before firemen were able to put it out.

4.2.6. Case Six: Rana Plaza

On April 24th, 2013, the eight-story commercial skyscraper on the outskirts of Dhaka, Bangladesh, known as the Rana Plaza Tower, fell [26, 27]. A municipal engineer had been to inspect the structure the day before after receiving concerns about cracks. He judged the structure dangerous and advised that everyone leave [28]. Several garment companies with a total workforce of around 5,000 people were housed in the structure. Recovery attempts took many days due to the nature of the catastrophe site and the need to avoid further injuring survivors; the final survivor was recovered on May 10, 16 days after the building collapsed [29]. It is Bangladesh's worst fire disaster, with 1,134 persons died. Approximately 2,500 people were injured, and about 100 were reported missing among the 5,000 workers in the Rana Plaza factories on that day [30].

4.2.7. Case Seven: Aswad Composite Mills

On October 8, 2013, in an extreme fire at the Aswad Composite Mills clothing factory in the Gazipur district, ten persons died and 50 others were injured. The fire started at 6.00 p.m. in the factory's dyeing area, which is owned by Palma Group. The cause of the fire remained unknown at the time. At approximately 12:45 a.m. firefighters had the flames under control, according to fire authorities. The fire moved to a nearby chemical shop, engulfing two levels, before a boiler on the lowest floor blew, fueling the flames even more.

4.2.8. Case Eight: Tampaco Foils Ltd.

On Saturday morning, September 10, 2016, When the

explosion occurred at 6:15 a.m., around 100 workers were on the morning shift. When a boiler explodes, at least 24 people are died and more than 50 are injured. The explosion sparked a massive fire and caused the three-story manufacturing building to partially collapse.

4.2.9. Case Nine: Multifabs Limited

On Tuesday, July 03, 2017, the numerous boiler explosions, which took so many lives across the country, were blamed by labor rights organizations on a lack of effective inspection by the concerned authorities in charge and plant owner's incompetence. According to the official, they claimed that the latest boiler explosion on Monday at Multi fabs Ltd., a garment manufacturing firm in Gazipur, died at least 13 workers and injured at least 50 others, who added that all of the injured were taken to nearby hospitals. Proved that the RMG sector's security measures were insufficient.

4.2.10. Case Ten: Ideal Textile Mill

On September 20, 2017, a fire at the Ideal mill in Munshiganj claimed the lives of six individuals. The deaths of five men and a woman were discovered inside the manufacturing building, and the factory's 50-year-old chef was among the fatalities. The fire started at 10:00 a.m. on Wednesday on the fourth floor of the six-story building in Muktarpur and was put out at 2:30 p.m. following three hours of work by three fire departments. Families who have lost relatives will be compensated with Tk 20,000 apiece.

4.2.11. Case Eleven: Unimax Textile Limited

On September 28, 2018, according to the senior station officer of Rescue Service and Civil Defense Jadavpur, the fire started due to a technical error while installing the boiler machine in the plant of Unimax Textile Limited. Around 12:15 p.m., the accident occurred. According to the official, three fire-fighting units arrived at the scene and contained the incident at about 1:15 p.m. According to him, no one was hurt in the fire, but the boiler machine and a few other pieces of equipment were destroyed. The extent of the fire's damage has yet to be established.

4.2.12. Case Twelve: Islam Garments Ltd.

On Friday, January 10, 2020, a fire broke out at an RMG plant in the Kona Bari region of Gazipur city, at a clothes factory owned by Islam Group. Eight hearth Service units worked constantly for four hours to put out the fire and get it under control. The fire injured four persons, including two female workers, which is common among factory workers. According to factory workers, representatives of the Fire Department, and locals, a fire broke out on the fifth level of Islam Garments Limited.

Table 1. *List of the lethal incidents in RMG industries (1990-2020).*

Name of The Factory	Location	Time	Cause	Injury	Death
Saraka Industries Ltd.	Dhaka	1990	Fire	45	23
Prostal Industrial Company Ltd.	Dhaka	1995	Fire	12	05
Lusaka Fashion Ltd.	Dhaka	1995	Fire	09	06
Faa Garments Ltd.	Dhaka	1995	Fire	06	03
Suntex Fashion (BD) Ltd.	Narayanganj	1996	Fire	16	12
Nouvelle, Florence Fabrics, Modern Garments	Dhaka	1997	Fire	50	05
Rohman and Rohman Apparels Ltd.	Dhaka	1997	Fire	14	07
Maxbon (BD) Ltd.	Dhaka	1997	Fire	04	02
Jahanara Fashion Ltd.	Dhaka	1997	Fire	32	20
Shanghai Fashion Ltd.	Dhaka	1997	Fire	14	05
Novelli Garments Ltd.	Dhaka	1997	Fire	08	05
Doreen Garments Ltd.	Gazipur	1997	Fire	03	02
B. P. Garments Ltd.	Gazipur	1998	Fire	01	--
S. K. S. Garments Ltd.	Dhaka	1998	Fire	--	--
Capital Garments Ltd.	Gazipur	1998	Fire	--	--
Sanjeri Toys (BD) Ltd.	Dhaka	1999	Fire	--	--
Latest Garments Ltd.	Gazipur	1999	Fire	--	--
Ajax Sweater Ltd.	Dhaka	1999	Fire	02	--
Rose Fashion Ltd.	Gazipur	1999	Fire	20	02
Actor Sporting Ltd.	Dhaka	1999	Fire	05	--
Crony Fashions Ltd.	Narayanganj	1999	Fire	04	--
King Sweater Industries Ltd.	Dhaka	2000	Fire	--	--
Sweater Fashion Ltd.	Dhaka	2000	Fire	--	--
Globe Knitting (BD) Ltd	Dhaka	2000	Fire	08	12
Lusaka Fashion Ltd.	Dhaka	2000	Fire	01	--
Dream Wears Ltd.	Dhaka	2000	Fire	--	--
Chowdhury Knitwear and Garments Ltd.	Dhaka	2000	Fire	100	--
Europe Sweaters Ltd., AJAX Sweaters Ltd., Macro Sweater Ltd. And Four Wings Ltd.	Dhaka	2001	Fire	45	21
Sydney Fashions Ltd.	Dhaka	2001	Fire	--	--
Anorway Textiles and Apparels Ltd.	Dhaka	2001	Fire	01	--
Polar Sweaters Ltd.	Dhaka	2001	Fire	02	--
Faa Design Ltd.	Gazipur	2002	Fire	03	--
Hamid Textile Mills Ltd.	Dhaka	2003	Fire	04	--

Name of The Factory	Location	Time	Cause	Injury	Death
Haesong Corporation Limited	Dhaka	2003	Boiler Burst	05	--
Blockwaize Garments Ltd.	Dhaka	2003	Boiler Burst	04	--
The Best Denim Apparels Ltd.	Dhaka	2004	Fire	--	--
Shifa Apparels Ltd. And Omega Sweaters Ltd.	Dhaka	2004	Fire	50	07
Shan Knitting and Processing Ltd.	Narayanganj	2005	Fire	20	22
The Spectrum Sweater Ltd.	Dhaka	2005	Building Collapse	74	64
N. A. Z. Bangladesh Ltd.	Dhaka	2005	Fire	04	--
Continental Apparels Ltd.	Dhaka	2005	Fire	30	
Chery (Pvt.) Ltd.	Dhaka	2005	Fire	22	--
KTS Textile Industries Ltd.	Chittagong	2006	Fire	150	63
Multiple factories	Chittagong	2006	Fire	100	--
Saiem Fashion Ltd.	Gazipur	2006	Fire	45	06
News Style Garments Ltd.	Dhaka	2006	Fire	05	--
Mega Text Ltd.	Gazipur	2006	Fire	32	--
Envoy Garments Ltd.	Dhaka	2007	Fire	02	--
Max Reliance Apparels Ltd.	Dhaka	2007	Fire	--	--
Starlight Sweaters Ltd	Dhaka	2008	Fire	--	--
J. K. Fabrics Ltd.	Dhaka	2008	Fire	--	--
A To Z Knitwear Ltd.	Dhaka	2009	Fire	--	--
Mohammadi Fashion 2000 Ltd.	Dhaka	2009	Fire	--	--
Knit Concern Ltd.	Narayanganj	2010	Fire	15	--
Garib & Garib Company Ltd.	Gazipur	2010	Fire	50	21
Matrix Sweaters Limited	Gazipur	2010	Fire	22	01
That's It Sportswear Ltd.	Dhaka	2010	Fire	100	29
Euro Tex Ltd.	Dhaka	2011	Fire	62	02
Common Threads Ltd.	Dhaka	2011	Fire	01	--
Tazreen Fashions Ltd.	Dhaka	2012	Fire	200	112
Swan Garments Ltd.	Dhaka	2012	Fire	--	01
Al-Shahriar Fabric Ltd.	Dhaka	2012	Fire	--	--
Section Seven Apparels Ltd.	Chittagong	2012	Fire	50	--
Concord Garments Ltd.	Dhaka	2012	Fire	--	--
East Light Knitwear Ltd.	Dhaka	2012	Boiler Burst	10	--
Siams Superior Ltd.	Chittagong	2012	Building Collapse	05	--
Vision Apparels Ltd.	Dhaka	2012	Fire	100	--
Crescent Leather Ltd.	Dhaka	2012	Fire	16	--
Pacific Blue Jeans	Dhaka	2012	Fire	24	--
Makka Garment and Hosiery Industry	Pabna	2012	Fire	--	--
BD Hechong Ltd.	Gazipur	2012	Fire	15	--
AKH Stretch Garment Ltd.	Dhaka	2012	Fire	50	01
NRR Fashion Ltd.	Narayanganj	2012	Boiler Burst	05	--
Active Composite Ltd.	Dhaka	2012	Fire	50	--
Liss Apparels Washing and Sand Blasting Industries Ltd.	Chittagong	2012	Fire	--	--
Nasa Basic Limited (RMG factory)	Dhaka	2012	Fire	20	--
Cotton Club Limited	Gazipur	2012	Fire	06	--
Bonded Fashion Ltd.	Gazipur	2012	Fire	30	--
Sagar Garments Ltd.	Dhaka	2012	Fire	05	--
New Age Apparels Ltd.	Dhaka	2012	Fire	05	--
Ananta Knitwear Ltd.	Dhaka	2012	Fire	10	--
Ither Tex Ltd.	Dhaka	2012	Fire	40	--
Epic Garments Ltd	Narayanganj	2012	Fire	15	--
Rupa Knitwear Ltd.	Gazipur	2012	Fire	--	--
Olympic Accessories Limited	Gazipur	2012	Fire	--	--
Pacific Jeans 2000	Chittagong	2013	Fire	35	--
Abonti Colour Text Ltd. (Unit-2)	Narayanganj	2013	Fire	50	--
Polycon Fashion	Gazipur	2013	Fire	--	--
Smart Export Garment	Dhaka	2013	Fire	50	08
Knit Asia Limited	Dhaka	2013	Fire	--	--
Abdullah Spinning Mill	Narayanganj	2013	Fire	--	--
Envoy Garments Ltd.	Dhaka	2013	Fire	100	--
Thread factory of the Opex & Sinha Group	Dhaka	2013	Fire	--	--
Manami Fashions Ltd.	Dhaka	2013	Fire	--	--
A factory of Nisa Group	Cumilla	2013	Boiler Burst	02	01
Mesbah Textile Mill	Gazipur	2013	Fire	--	--
Palmall Knitwear Limited	Gazipur	2013	Fire	--	--
Biswas Textile Mill	Dhaka	2013	Fire	--	--
A warehouse of denim factory in Beximco Industrial Park	Gazipur	2013	Fire	--	--
Smart Export Garment Ltd.	Dhaka	2013	Fire	15	07

Name of The Factory	Location	Time	Cause	Injury	Death
Kang Book BD Limited	Chittagong	2013	Fire	05	--
Rana Plaza	Dhaka	2013	Building Collapse	2,500	1,134
Uni Garment Ltd.	Chittagong	2013	Fire	14	--
GM Garments Factory	Gazipur	2013	Fire	03	--
Tung Hai Sweater Limited	Dhaka	2013	Fire	--	07
Bandu Design Ltd.	Dhaka	2013	Fire	20	--
Arba Textile Ltd.	Dhaka	2013	Fire	10	--
Starlight Sweaters Ltd.	Gazipur	2013	Drinking Contaminated Water	40	--
Binni Garment Factory	Dhaka	2013	Fire	--	--
Papella Shoes Ltd.	Chittagong	2013	Fire	--	--
Nakano International Co. Ltd.	Pabna	2013	Fire	07	--
M.M. Garment Ltd.	Gazipur	2013	Fire	--	--
Nipa Fashion Wear Industry Ltd.	Dhaka	2013	Fire	--	--
JK Group factory	Dhaka	2013	Fire	10	--
Nipun Garment (PTE) Ltd.	Dhaka	2013	Fire	--	--
Sicily Garments	Dhaka	2013	Fire	03	--
Aswad Composite Mills	Gazipur	2013	Fire	50	10
Riyad Dying	Gazipur	2013	Fire	15	--
Aman Spinning Mills Ltd.	Dhaka	2013	Fire	25	--
Mondol Group's garment factory	Dhaka	2013	Fire	15	--
Standard Garment Factory	Gazipur	2013	Fire	--	--
Japan-Bangla Garments	Dhaka	2013	Fire	--	--
Swadhin Dyeing Factory	Gazipur	2014	Fire	--	--
Al Muslim Garment Factory	Dhaka	2014	Fire	--	--
Al-Lima Textile Limited	Dhaka	2014	Fire	--	--
Jeans Treat Ltd.	Dhaka	2014	Fire	--	--
Jaba Textile Mill	Narsingdi	2014	Fire	--	--
Green Leaf Apparel	Dhaka	2014	Fire	01	--
Rangdhanu Spinning Mills Ltd.	Dhaka	2014	Fire	--	--
Karnaphuli Knitting, Siddique Knitting Fashion Park International Ltd.	Chittagong	2014	Fire	--	02
Fashion Park Int'l Ltd.	Chittagong	2014	Fire	--	--
Chowdhury Leather Factory	Dhaka	2014	Boiler Burst	--	--
ZA Sweaters Ltd.	Dhaka	2014	Fire	04	--
Syntax Industries Ltd.	Dhaka	2014	Dyeing Machine Explosion	02	--
S. S. Sweater Ltd.	Gazipur	2014	Fire	10	--
Mayer Doha Fashion Ltd.	Dhaka	2014	Fire	03	01
Amina Exports Wear Ltd	Dhaka	2014	Fire	10	--
Precious Apparels Ltd.	Chittagong	2014	Fire	--	--
Cordial Design Ltd.	Dhaka	2014	Fire	--	--
Northern Fashion Ltd.	Gazipur	2014	Fire	--	--
Mega Yarn Dyeing Mills Limited	Gazipur	2014	Boiler Burst	04	01
Ishraque Spinning Mill	Gazipur	2014	Fire	03	--
Kajal Woolen Mills Limited	Dhaka	2014	Fire	--	--
Fuji Garments Ltd.	Dhaka	2014	Fire	--	--
Legos Apparels Ltd.	Gazipur	2014	Fire	--	--
Kader Synthetic and Compact Spinning Mill	Gazipur	2015	Fire	04	--
Supreme Jute and Knitex Ltd.	Dhaka	2015	Fire	04	--
Nawab spinning mill	Narayanganj	2015	Fire	08	--
Siho Fibre Limited	Chittagong	2015	Fire	--	--
Next Collections Ltd.	Dhaka	2015	Fire	30	--
Bilash Garments Ltd.	Dhaka	2015	Fire	--	--
Agami Washing	Gazipur	2015	Fire	06	--
Dignity Textiles Mills Ltd.	Gazipur	2015	Fire	--	--
Habitus Fashion Ltd.	Munshiganj	2015	Fire	--	--
NAZ Bangladesh Ltd.	Gazipur	2015	Fire	--	--
Comfort Apparels (Pvt.) Ltd.	Dhaka	2015	Fire	03	--
Ciho Fiber Ltd.	Chittagong	2015	Fire	--	--
Al-Muslim Group	Dhaka	2015	Fire	20	--
Amin Dyeing	Narayanganj	2016	Fire	05	--
Matrix Sweaters Ltd.	Gazipur	2016	Fire	--	--
Style Garments Ltd.	Dhaka	2016	Fire	--	--
Tampako Ltd.	Gazipur	2016	Boiler Burst	70	34
Pretty Sweaters Ltd.	Gazipur	2016	Fire	--	--
Vibjiur Knit Composite	Narayanganj	2016	Fire	--	--
Sinha Designers Ltd.	Narayanganj	2016	Fire	--	--
Haves Garments	Chittagong	2016	Fire	--	--
Ibrahim Kint Garments (Pvt.) Ltd.	Narayanganj	2016	Fire	--	--

Name of The Factory	Location	Time	Cause	Injury	Death
Tanaz Fashions Ltd.	Gazipur	2016	Fire	10	--
Alema Textiles Ltd.	Gazipur	2016	Fire	--	--
Momo Tex Ltd.	Narsingdi	2016	Fire	15	03
Target Sweater Ltd.	Gazipur	2016	Fire	--	--
Raiyan Knit Composite Ltd.	Gazipur	2016	Fire	--	--
Nur Group	Gazipur	2016	Fire	--	--
Brishti Fashion	Dhaka	2016	Fire	06	--
Tropical Knitwear	Gazipur	2016	Fire	10	--
Confidence Knitwear Ltd.	Gazipur	2016	Fire	02	--
Saad Fashion Ltd.	Gazipur	2016	Fire	--	--
Jamuna Spinning Mills Ltd.	Gazipur	2016	Fire	--	--
Continental Group	Dhaka	2016	Fire	25	--
Mamun Knitwear Ltd.	Gazipur	2016	Fire	--	--
Beacon Knitwear Limited	Gazipur	2016	Fire	50	--
Centex Textile and Apparels Ltd.	Dhaka	2016	Fire	--	--
Crystal Composite Ltd.	Dhaka	2016	Fire	--	--
Softex Sweater Industries (Pvt) Ltd.	Dhaka	2016	Fire	--	--
J.M. Fabrics Ltd.	Dhaka	2016	Fire	--	--
M.M. Knitwear Ltd.	Gazipur	2016	Fire	--	--
Medlar Apparels Ltd.	Dhaka	2016	Fire	--	--
Cotton Factory	Gazipur	2017	Fire	--	--
Anlima Textile	Dhaka	2017	Fire	15	--
Eco Cotton Mill	Gazipur	2017	Fire	--	--
Bintax Factory	Chittagong	2017	Fire	--	--
Opex Sinha Group	Narayanganj	2017	Fire	--	--
Denim Factory	Narayanganj	2017	Fire	--	--
Combined Apparels Ltd.	Chittagong	2017	Fire	--	--
Z R Sweater Ltd.	Gazipur	2017	Fire	--	--
Fareast Knitting and Dyeing	Gazipur	2017	Fire	--	--
Tamizuddin Textiles Mills Ltd.	Gazipur	2017	Fire	--	--
Multifabs Limited	Gazipur	2017	Boiler Burst	20	13
Ideal Textile Mill	Munshiganj	2017	Fire	--	06
Plummy Fashions Ltd.	Narayanganj	2017	Fire	--	01
Lucky Textile Mill	Dhaka	2017	Fire	--	--
S2L Fashions Pvt. Ltd.	Gazipur	2017	Fire	--	--
Sinha Denim Wear Ltd.	Dhaka	2017	Fire	--	--
Z K Fashion Ltd.	Dhaka	2017	Fire	--	--
Far East Knitting & Dyeing Industries Ltd.	Dhaka	2017	Fire	--	--
Medlar Apparels Ltd.	Dhaka	2017	Fire	--	--
Priyanka Garments Ltd.	Dhaka	2017	Fire	--	--
Ibrahim Composite Textile Mills Ltd.	Narayanganj	2018	Fire	--	--
TKM Garment Factory	Chittagong	2018	Fire	--	--
Greenland Garments Limited	Gazipur	2018	Fire	--	--
Mosharaf Composite Limited	Gazipur	2018	Fire	--	--
Three Factories (A Plus, Today and SD)	Dhaka	2018	Fire	--	--
Ashiana Garments Ind. Ltd.	Dhaka	2018	Fire	--	--
Kamal Textile Ltd.	Dhaka	2018	Fire	--	--
Mirpur Embroidery Factory	Dhaka	2018	Fire	03	--
Sadid Sourcing	Dhaka	2018	Fire	02	01
Unimax Textile Limited	Gazipur	2018	Fire	--	--
Doreen Garments Ltd.	Gazipur	2018	Fire	--	--
Anon Tex	Gazipur	2019	Fire	--	--
Masuma Textile Composite Mill	Gazipur	2019	Fire	--	--
Garib and Garib Limited	Gazipur	2019	Fire	--	--
RN Spinning Mill	Cumilla	2019	Fire	--	--
Keya Spinning Mill Ltd.	Gazipur	2019	Fire	--	--
Unity Accessories Limited	Chittagong	2019	Fire	--	--
Otto Spinning Limited	Gazipur	2019	Fire	--	--
Zarba Textile Mills Ltd.	Gazipur	2019	Fire	--	--
Mother Textile Ltd.	Gazipur	2019	Fire	--	--
Keya Spinning Mill Ltd.	Gazipur	2019	Fire	--	--
NR Textile Mill Ltd.	Gazipur	2019	Fire	--	--
Natural Sweaters Village Ltd.	Dhaka	2019	Gas Heater Exploded	05	01
Centex Textile and Apparels Ltd.	Dhaka	2019	Fire	--	--
Aboni Knitwear Limited	Dhaka	2019	Fire	--	--
Amanah Fashion Ltd.	Dhaka	2019	Fire	--	--
Islam Garments Ltd. (Unit-2)	Gazipur	2020	Fire	04	--

Name of The Factory	Location	Time	Cause	Injury	Death
Shamsher Apparels	Dhaka	2020	Fire	--	--
Gemini Fashion	Chittagong	2020	Fire	--	--
Chaity Composite Ltd.	Narayanganj	2020	Fire	--	--
Total (Person)				5,181	1,689

4.3. Identification of the Lethal Incidents in the History of the RMG Industry in Bangladesh (1990-2020)

Fire incidence is the most common occurrence in Bangladesh's RMG industry. The fire caused 94.09% of the occurrences in the previous 31 years, with just 1.27% of incidents caused by building collapse, 3.38% of incidents caused by boiler burst, and another 1.27% by other accidents "Figure 11". The chances of a deadly event are higher than the chances of a structure collapsing. In Bangladesh, an electrical short caused the majority of the fire mishaps in the RMG industry. Furthermore, the fire was caused by a variety of factors, including a boiler blast, an electrical short, manual activity, and so on. Building collapse, on the other side, occurs far less frequently than fires. Poorly constructed structures and unlawful construction are the most common causes of building collapse. Fires accounted for nearly 223 of the 237 events, with only three resulting from building collapses. Tazreen Fashion, Standard Group, Garib & Garib, Erotex, and other big fires occurred, and the two most influential building collapses were Rana Plaza and Spectrum garments limited. The other concern was that a worker set fire to Standard Group, a ten-story structure in Kona Bari, Gazipur, and subsequently the most essential clothes in Gazipur were ruined in an excessively short time. Unrest in the workplace was the cause of this occurrence.

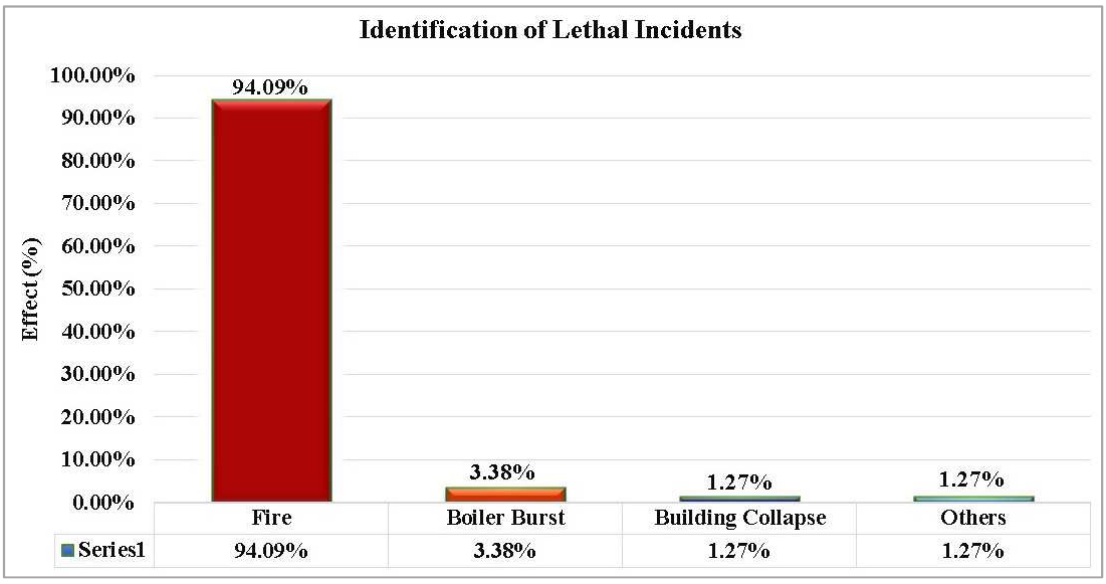

Figure 11. *The lethal incidents in RMG industries (1990-2020).*

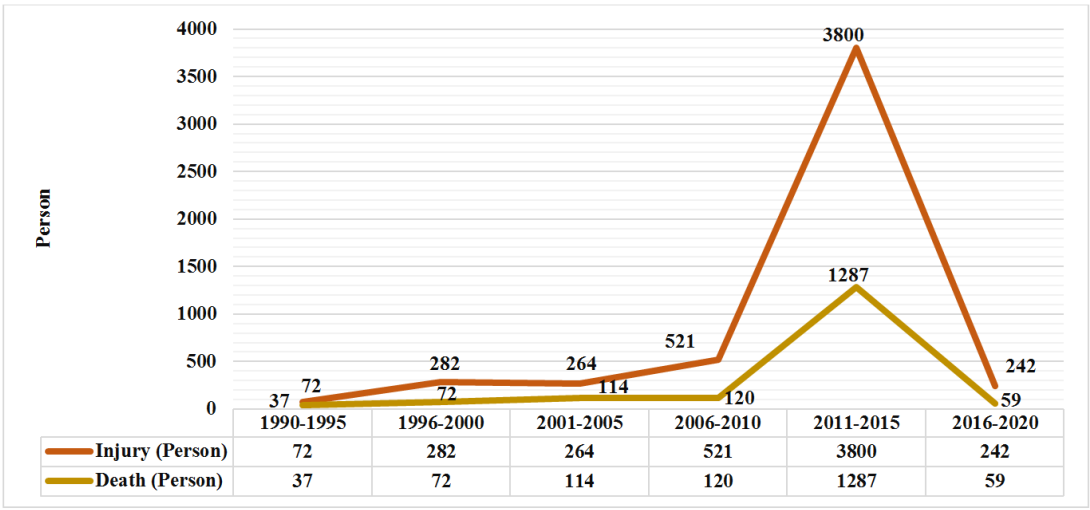

Figure 12*. The number of injured and dead persons in different years (1990-2020).*

Table 2. Injured and dead persons in different years (1990-2020).

Year	Injury (person)	Death (person)
1990-1995	72	37
1996-2000	282	72
2001-2005	264	114
2006-2010	521	120
2011-2015	3,800	1,287
2016-2020	242	59
Total (Person)	5,181	1,689

Deadly incidents are a typical scenario in Bangladeshi garment factories. The industry has been suffering from building collapses, frequent fires, and other avoidable industrial incidents. In the last five years, almost 242 people have been injured and 59 people have died. The very worst incident happened from 2011 to 2015 where 3,800 people were injured and 1,287 people died "Figure 12".

Almost all of those industries are in major cities of the country, including Dhaka, Narayanganj, Chattogram, Gazipur, Cumilla and Narsingdi. "Figure 6" showed the quantity of injured and dead persons in different places from 1990 to 2020. Among the 237 fire incidents from the entire number of dead is 1,689 and also the injured are 5,181 people. Where in Dhaka, the injured are 4,132 and also the death is 1,489 which is the highest "Figure 13". Then Gazipur, were injured are 528 and died are 90 people. After that Chittagong where the injured are 359 and died are 65 and in Narayanganj were injured are 138 and died are 35. Pabna has the lowest injured and no death "Figure 13".

Table 3. Injured and dead persons in different places (1990-2020).

District	Injured (person)	Death (person)
Dhaka	4,132	1,489
Gazipur	528	90
Chittagong	359	65
Narayanganj	138	35
Cumilla	02	01
Munshiganj	--	06
Narsingdi	15	03
Pabna	07	--
Total (Person)	5,181	1,689

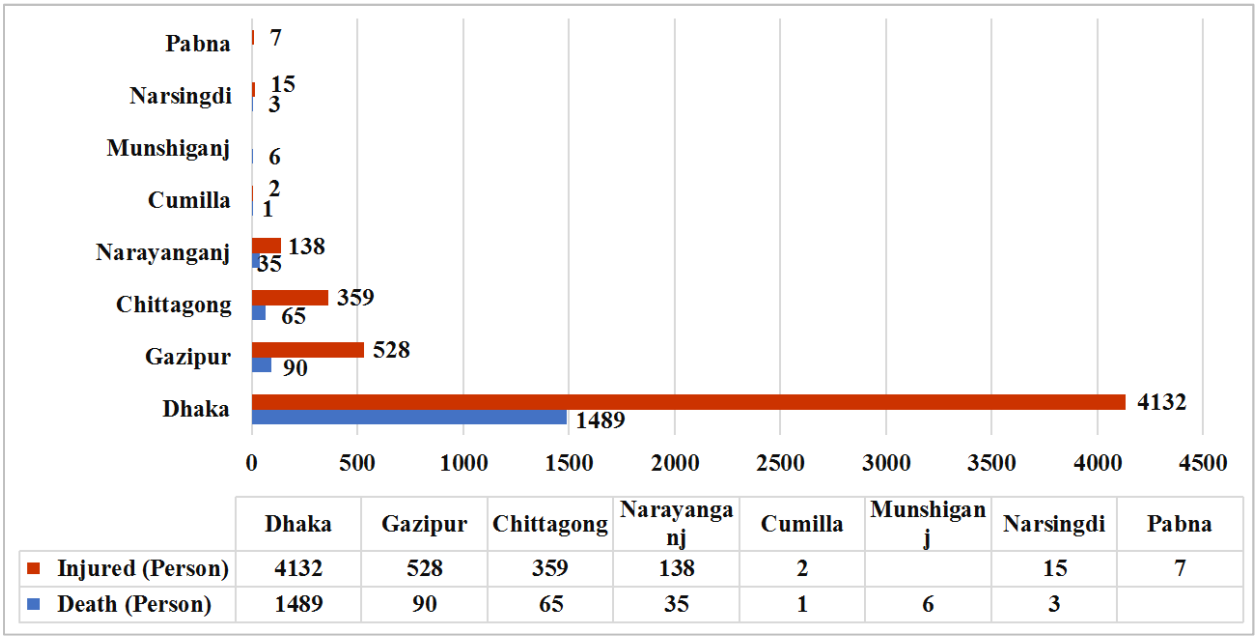

Figure 13. The number of injured and dead persons in different places (1990-2020).

4.4. Evaluation of the Causes and Effects of Identified Lethal Incidents

Table 4. Comparison between death and injury (1990-2020).

Effect	Incidents	Death/Injured	% in Actual	% in Total	Number of Death/Injured	Total Death and Injured
Death	Building Collapse	1,198	70.92%	17.43%	1,689	6,870
	Fire	441	26.11%	6.42%		
	Boiler Burst	49	2.90%	0.71%		
	Others	1	0.06%	0.02%		
Injured	Building Collapse	2,579	49.78%	37.54%	5,181	
	Fire	2,445	47.19%	35.59%		
	Boiler Burst	110	2.12%	1.60%		
	Others	47	0.90%	0.68%		

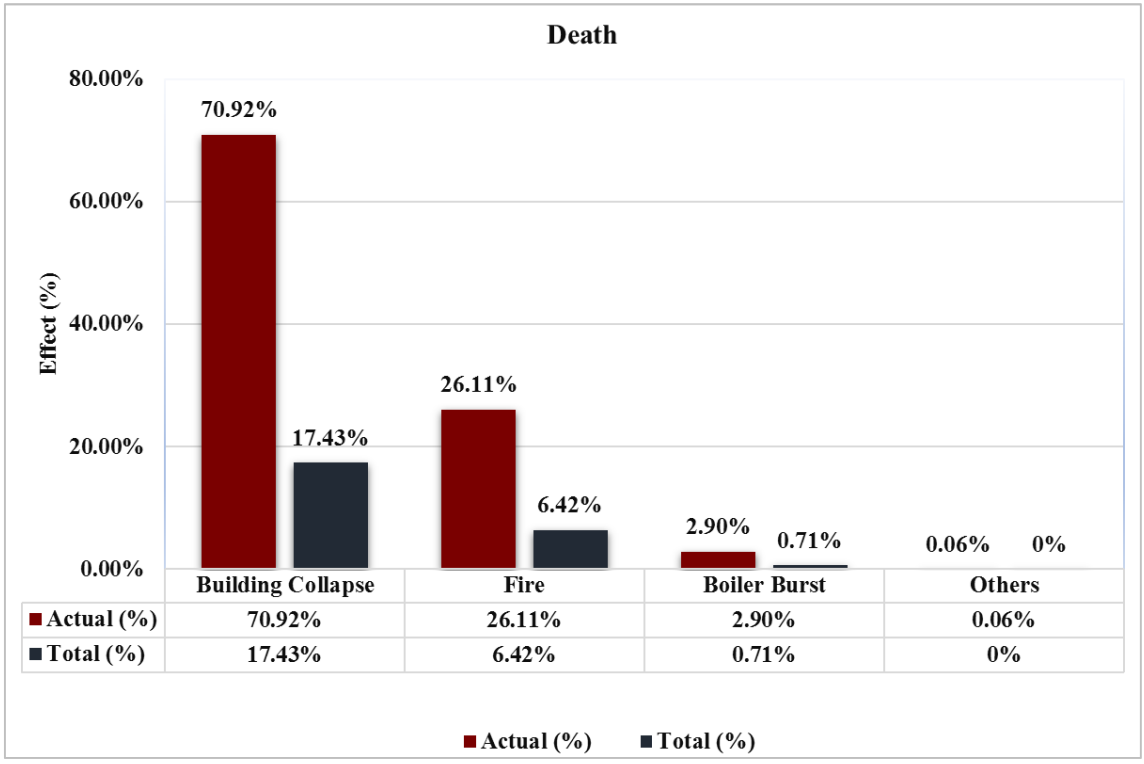

Figure 14. *Causes and effects of the lethal incidents from 1990 to 2020 (Death).*

In the above "Figure 11", it will be seen that the likelihood of building collapse is just 3.38% and also the possibility of a fireplace incident is 94.09%. In our country, death by building collapses is more than death by fire incidents but the number of fire incidents is more than the number of building collapses. Here the proportion of death by building collapse is nearly 70.92% whereas the death by fire incidents is nearly 26.11% "Figure 14" and "Table 2".

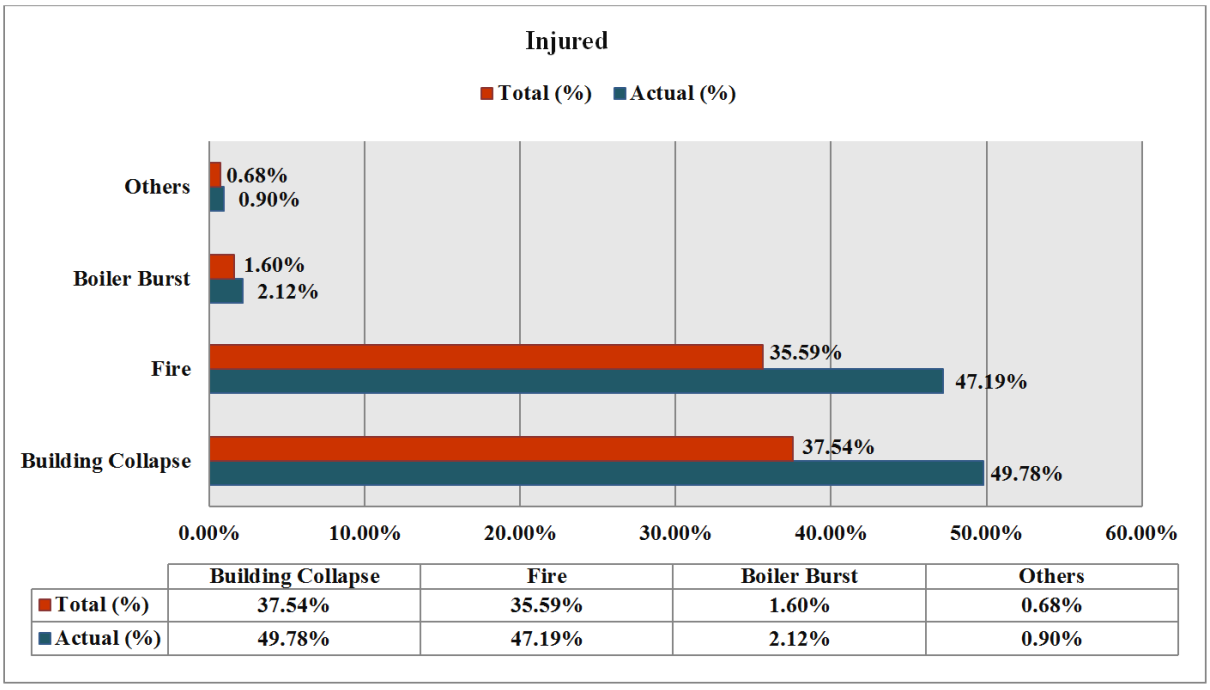

Figure 15. *Causes and effects of the lethal incidents from 1990 to 2020 (Injured).*

Without this comparison, the number of injured workers by building collapse is additionally quite the number of injured by fire. Almost 49.78% of injured workers were from building collapse whereas 47.19% from fire is nearly the identical other "Figure 15" and the percentage of injured workers from boiler burst is 2.12% and by others is 0.90%.

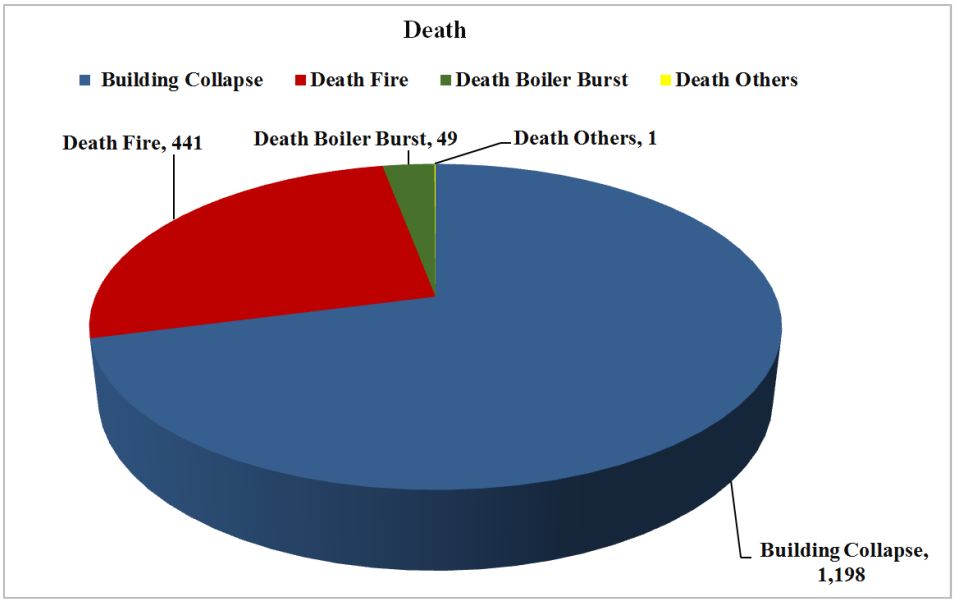

Figure 16. *The number of dead persons in different incidents (1990-2020).*

Fire is the frequent accident within the readymade garment industries and there are lot of fire incidents where there was no death but building collapse is not common but more serious than fire. Of the 223 fire incidents from the overall number of deaths is barely 441 where only two building collapse incidents were the causes of virtually 1,198 workers death "Figure 16" and the number death by boiler burst are 49 and the number death by others is 1.

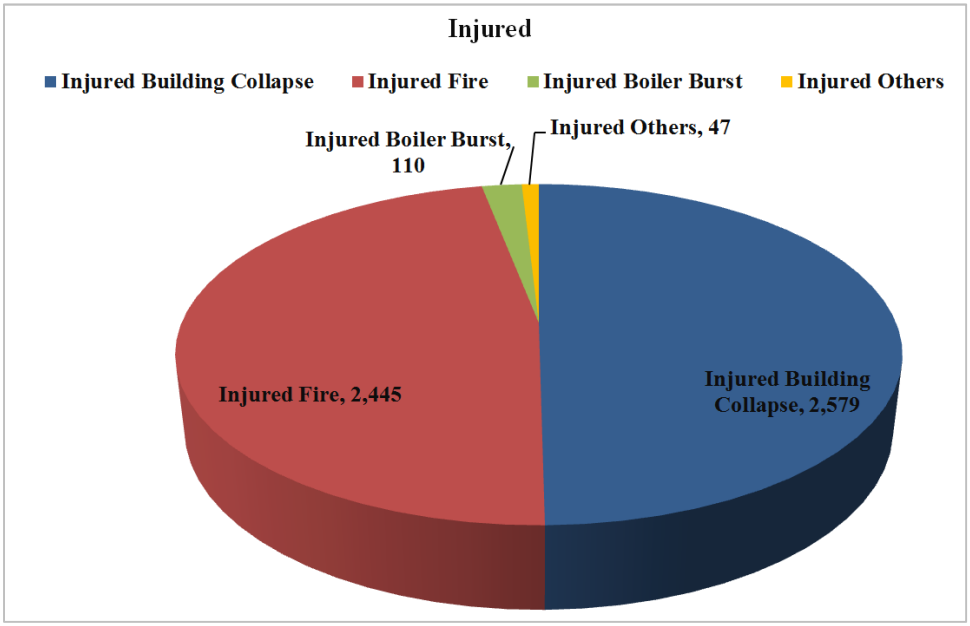

Figure 17. *The number of injured persons in different incidents (1990-2020).*

"Figure 17" shows, amongst 31 years database on the basis of injured persons in different accidents that within the 223 fire incidents from the whole number of injured is merely 2,445 whereas only two building collapse incidents were the causes of just about 2,579 workers injured and the number injured by boiler burst are 110 and by others are 47. Also, fire is the commonest incident were plenty of injuries and death occurs whether a building collapse is more serious than fire.

4.5. Preventive Measures for Building Collapse, Fire Incidents, Boiler Burst and Other Incidents

The studies found that lack of preparedness and coping capacity to manage fire hazards, limited or no knowledge about fire-fighting techniques and lack of resources are some of the reasons which increase the level of vulnerability of the people [19]. It is crucial to require the required actions to ensure the protection of the RMG sector in Bangladesh. All the

responsible parties like the govt., owners, stakeholders even Employees also should take these measures in numerous ways.

Table 5. *Preventive actions for the Incidents.*

Building Collapse	Fire Incidents
Have to ensure National Building Code. Have to assure the building approval plan from RAJUK. Have to take the measurements of the wind speed before constructing the building. Collect occupancy certificates before starting the structure. Have to focus on building safety by audit and ISO 45001.	Have to ensure the Factory Act. Have to confirm the Electricity Safety Act. Have to ensure the Fire Safety Act. and National Have to follow the Fire Code by NFPA. Have to ensure proper training for management and employees. Have to confirm special audits in electric sections.

Boiler Burst	Others Incidents
To prevent boiler explosions is must keep regular and proper maintenance. Check whether the gas pressure level and also the main electrical power supply lines are working properly or not daily and also the flame of fireside should be monitored regularly whether it's appropriate or not. Make sure to test the acceptable amount of steam in the boiler and therefore the water level controller should be cleaned every 30 days. Every six months Boiler Fire Tube, Fire Chamber and Compressor must be cleaned and checked all safety valves of the boiler once a month.	To prevent gas heater explosions, install gas detectors within the workplace, where people are going to be able to hear the alarm. Maintain and monitor gas detection equipment on an everyday basis. Ensure the batteries are working. It's also wise to have your gas detectors periodically checked by professionals. To reduce the prospect of fire, keep all combustible materials far away from water heaters, furnaces or other gas appliances. To remove undesirable chemicals, biological contaminants, suspended solids, and gases from water use an advanced and complicated water purification system for workers' good health.

4.6. Developments and Activities by Concerned Authorities

The government and the BGMEA have taken many steps to address security concerns in the RMG sector. On June 11, 2005, a high-level Social Compliance Forum was established, chaired by the commerce minister and co-chaired by the labor ministry. The government has established two Task Forces and one Compliance Monitoring Cell to meet several assertions on social compliance, including occupational safety and security, labor welfare, and the prosperity of working circumstances inside Bangladesh's export-oriented RMG business. RMG has two Task Forces, one on Labor Welfare and the other on Occupational Indemnity. The Compliance Monitoring Cell was established under the Export Promotion Bureau's office to monitor operations related to social compliance, such as safety and security, labor welfare, and the improvement of working conditions in Bangladesh's RMG industry. As the leader of the Compliance Monitoring Cell, the Director-General (Textiles) of the Export Promotion Bureau is acting. The Bangladesh government's competent agencies must build similarly strong organizations with equally robust processes. Under the ILO's RMGP initiative [31], activities are undertaken to build this capability, although there are significant obstacles to overcome [12]. Recent government initiatives, such as these Forums, Task Forces, and cells, allow for comprehensive security regulation in RMG. However, to ensure that the RMG factories in Bangladesh are secure, a well-designed institutional framework is required. The BGMEA has played a critical role in enforcing security concerns in the workplaces of its members. The initial goal of the BGMEA's security section is to improve safety measures in BGMEA Member Units and raise awareness among garment factory employees about fires and other incidents. All efforts involving Fire Safety in RMG Units are being monitored by a BGMEA committee on Safety Measures [32].

The BGMEA has implemented initiatives in two ways:

Operational:

a) The Security Section Monitors are conducting fire evacuation drills in RMG Units to raise awareness among factory employees and to provide recommendations to the factory authorities to improve safety measures in the plant.
b) Safety Monitors visit garment manufacturers and fill out a Checklist of Fireplace Safety. Following the observation of the manufacturers' flaws, the BGMEA sends a letter to the affected factories, requesting that they take the appropriate measures.

Training:

a) The BGMEA's security cell conducts fire prevention, extinguishment, rescue, and tending training for garment factory employees and personnel.
b) The factory's workers are also given fire prevention and safety training by the BGMEA's Fire Service and Civil Defense Department.

From July 1, 2006, BGMEA began a follow-up (2nd stage) program. This involves BGMEA surveillance teams inspecting clothing factories and conducting fire drills.

The majority of textile companies lack appropriate fire protection. In addition to other code infractions, the majority of garment factories lack fire escapes and fire alarms, according to a 1997 survey. According to the Bangladesh Fire Brigade, 58 fire incidents occurred in the garment sector between November 1997 and November 1998, killing 118 employees, 90% of whom were women [33].

This concern is highlighted in five (i, ii, vi, xi, and xii) [34] "recommendations" from the perspective of female workers:

a) For industrial buildings, sufficient broad fire exit doors and enough ventilation with regular maintenance for air circulation should be constructed. Fire drills should be done regularly, at least twice a year.
b) More restrooms for female employees.
c) Clean drinking and washing water for female employees.

d) Full-time medical assistance and care for female employees, provided by female physicians and highly trained nurses.
e) Safety management training for all types of employees.
f) Maternity leave and weekly vacation with purchase for female employees.
g) Wages should be equal and rationale for both male and female workers to maintain a decent level of living.
h) Because of the security of their jobs, management should give appointment letters to all sorts of employees.
i) Management should allow for a low-level reorganization of the union.
j) In relevant parts of the industry, proper exit and safety signs should be used.
k) All garment industry buildings should have an accurate announcement system on how to exit the premises.
l) To ensure a healthy industry, management must supply minimum legal criteria.

5. Results and Discussions

Without any doubt, Bangladeshi textile industries are known as one of the unsafe working environments in the apparel-producing country. Nowadays, Bangladesh is trying to follow developing country's fire and other safety precaution standards. As a result, the accident and incident rate of last five years has been decreasing a lot. Fire incidents, building collapses and other industrial incidents have been plaguing the readymade garments sector. Almost 242 individuals have been injured and 59 people have died in the previous five years. The worst event occurred between 2011 and 2015 when 3,800 individuals were injured and 1,287 died. The fire was responsible for 94.09% of the 237 events during the previous 31 years, with just 1.27% of incidents caused by building collapse, 3.38% by boiler burst, and 1.27% other accidents. The building collapse incidents are lower than the fire incidents rate. The fire incident is the most common occurrence in Bangladesh's RMG industry. In Bangladesh, the majority of the fire accidents in the RMG industry were caused by electrical contact. Furthermore, the fire was caused by a variety of factors, including a boiler blast, an electrical short-circuit, and manual activity, among others. On the other side, building collapse occurs far less frequently than fires. Unplanned constructed structures and unlawful construction are the most common causes of building collapse. Fires accounted for nearly 223 of the 237 events, with only three resulting from building collapses. Tazreen Fashion, Standard Group, Garib & Garib, Erotex, and others had the greatest fires, therefore Rana Plaza and Spectrum garments limited were the two most impactful buildings collapses.

Almost those industries are in major cities of the country, including Dhaka, Narayanganj, Chattogram, Gazipur, Cumilla and Narsingdi. The amount of injured and dead persons in different places from 1990 to 2020. Of the 237 fire incidents, the overall number of deaths is 1,689 and also the injuries are 5,181 people in Dhaka, the injuries are 4,132 and also the death is 1,489 which is the highest. Then Gazipur, where injuries are 528 and death is 90 people. In Chittagong, injuries are 359 and deaths are 65 and in Narayanganj where injuries are 138 and deaths are 35 people. Pabna has the lowest injuries and no death. The chance of a structure collapsing is just 3.38%, therefore that the possibility of a fireside event is roughly 94.09%. The risk of a building collapsing is greater than the risk of a fire, but in terms of death and injury, the number of fatalities is compared to the number of deaths caused by fire. Here, the fatality rate due to building collapse is around 70.92%, whereas the death rate due to fire events is around 26.11%. Without this comparison, the number of employees injured by building collapse exceeds the number of workers injured by fire. Practically 49.78% of wounded employees were caused by building collapse, while 47.19% were caused by fire, which is nearly identical to one another.

Fire is a common incident within the garment industry and there are many fire incidents and accidents where there was no death, but building collapse is not common but more serious than fire. Only two building collapse accidents resulted in the lives of about 1,198 workers, out of the 223 fire incidents that resulted in a total of 441 deaths. In the 223 fire accidents, almost 2,445 people were injured and two building collapse occurrences resulted in the injured of roughly 2,579 employees.

It has been found in this paper that there are many risk factors in RMG industries that should be controlled permanently. Building collapse kills more people than any other cause of death, and fire is the most prevalent cause of death in Bangladesh's textile sector [32]. In this case, the owner, management, concerned authorities and employees are responsible for controlling building collapse risks by 71.43%, 0%, 35.71%, 0% respectively, and in case of a fire incident, the owner, management, concerned authorities and employees are responsible for controlling fire incident by 0%, 92.85%, 0% and 7.14% respectively [35]. As a result, the owner, management, concerned authorities and employees should be aware of the possibility of reducing the risk by following the above-mentioned risk-controlling activities.

6. Major Findings

a) Among 4,560 garment industries 237 lethal incidents happened and that ratio was 5.2% during the last 31 years (1990-2020).
b) Within 237 lethal incidents, 94.09% incidents occurred by fire and only 1.27% incidents were caused by building collapse and 3.38% incidents were caused by boiler bursts and another 1.27% by other different incidents.
c) The number of total harmed people was 6,870 of which 1,689 people were injured and 5,181 were dead, also the highest incident happened from 2011 to 2015 when 3,800 people were injured and 1,287 people died.

d) Recently the number of affected people increased due to the coronavirus (COVID-19) pandemic, which is a breakneck matter for the RMG industry. In Dhaka city, the number of injured people was 4,133 and the number of dead people was 1489 which was the highest number among the cities. Also, the second-highest number of injured is 528 people and deaths are 90 people. Whether the lowest injured and death number was in Cumilla and these were 2 and 1.
e) Almost 49.78% were injured by the building collapse, 47.19% were injured by the fire, 2.12% were injured by the boiler bust, 0.90% were injured by other incidents and 70.92% died by the building collapse, 26.11% died in the fire, 2.90% died by the Boiler bust, 0.06% died other incidents (actual rate).
f) Almost 37.54% were injured by the building collapse, 35.59% were injured by the fire, 1.60% were injured by the boiler bust, 0.68% were injured by other incidents and 17.43% died in the building collapse, 6.42% died by the fire, 0.71% died by the Boiler bust, 0% died other incidents (total rate).

7. Conclusions

A safe and secure working environment has to ensure for the workers and is a basic fundamental right. At the same time, proper implementation of general and international standards should be made mandatory; otherwise, death traps for workers will still continue. Among 4,560 garment industries, 237 lethal incidents happened which was 5.2% during the last 31 years (1990-2020). Almost 237 lethal incidents, 94.09% incidents occurred by fire incidents and just 1.27% incidents were caused by building collapse and 3.38% incidents were caused by boiler bursts and another 1.27% by other different incidents. The number of totals harmed people was 6,870 of which 1,689 people were injured and 5,181 were dead, also the very worst incident happened from 2011 to 2015 when 3,800 people were injured and 1,287 people are dead. Almost 49.78% were injured by the building collapse, 47.19% were injured by the fireplace, 2.12% were injured by the boiler bust, 0.90% were injured by other incidents and 70.92% died by the building collapse, 26.11% died by the fireplace, 2.90% died by the boiler bust, 0.06% died others incidents (actual rate). Almost 37.54% were injured by the building collapse, 35.59% were injured by the hearth, 1.60% were injured by the boiler bust, 0.68% were injured by other incidents and 17.43% died by the building collapse, 6.42% died by the hearth, 0.71% died by the boiler bust, 0% died others incidents (total rate). The government's and the BGMEA's recent actions showed much more improvement progress in implementing industry safety standards. The owners of garments should be more concerned about industrial safety-related laws and regulations, which may help them to save even more money due to the high costs of accidents. Inspection, reporting, and compliance to existing national and international rules and regulations must all be appropriately enforced to prevent additional tragedies caused by a lack of workplace safety. As a result, a solution for the permanent improvement of working conditions for Bangladeshi garment workers is to incorporate the occurrence of a more complete corporate social responsibility concept related to global outsourcing issues. To avoid future tragedies, all stakeholders, including the Bangladeshi government, brands and retailers, the Bangladesh Garment Manufacturers and Exporters Association, Bangladesh Knitwear Manufacturers and Exporters Association and factory owners must shoulder the appropriate obligations. So, they must plan to handle all of the operations that must be controlled inside the clothing sectors. Although the fire risk index reveals that the fire safety level is below the industry requirement, there are several chances and opportunities to improve fire safety in Bangladesh's RMG industry. The government should strictly maintain infrastructure standards for all industrial structures. Undoubtedly, the Bangladeshi RMG sector is one of the risky workplaces in the apparel-producing country. Building collapse is deadlier than the other lethal incident, but fire incident is the presumably incident within the Bangladeshi garment industry. So, the garment owners, management, employees and concerned authorities should be aware to reduce the deadly incidents by following the risk-controlling techniques.

Nomenclature

Abbreviation/Symbol	Meaning
RMG	Ready Made Garment
BCI	Building Collapse Incident
FI	Fire Incident
BBI	Boiler Burst Incident
DBC	Death by Building Collapse
DF	Death by Fire
DBB	Death by Boiler Burst
n	Total number of parameters
m	Meter
xi	Mark (a dimensionless score) for parameter i
sq km	Square kilometer
FRI	Fire Risk Index

ILO	International Labor Organization
$	Dollar
%	Percent
∑	Summation
FY	Financial Year
EU	European Union
GDP	Gross Domestic Product
NI	National Initiative
wi	Weight value for the importance of varied parameter
BNBC	Bangladesh National Building Code
NFPA	National Fire Protection Association
ISO	International Organization for Standardization

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