

Master's Thesis

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Master Thesis:

**Impact of Facility Management on Fire Safety Crisis in
Bangladesh's AEC Industry**

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CONCEPTUAL FORMULATION



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Conceptual Formulation

Master Thesis for Mr./Ms. Tanima Abdul Wahed

Student number s0552966

Topic: Impact of facility management on fire safety crisis in Bangladesh's architecture and construction industry

Summary:

Fire is frequently happening risk in Bangladesh's urban zones which is causing immense disaster in life and resources consistently. The rapid growing urbanization in the developing country like Bangladesh drives people to live in a very unhealthy way which lead to unsafe living and working environment. Without maintaining any rules and regulation in urban areas the industrial and residential building are blending in a same area which is causing a great high risk for the occupants. The purpose of this thesis is to develop an outline to minimize the hazard of facility management on fire and safety crisis in construction industry for risk reduction. This also offer a technical standard and a precise method of safety monitoring for the existing legal and regulatory framework in facility management which will effective for fire safety measure in Bangladesh.

Research questions:

- 1) What is the fire safety and rules regulation for the buildings in Bangladesh?
- 2) Why crisis arising regarding on safety issues?
- 3) Why it is overlooked in rules and regulation on fire safety factors in Bangladesh.
- 4) Which building are affecting more in regarding fire and safety measures?
- 5) What are the level of awareness about facility management in Bangladesh.
- 6) What are the main flaw in fire and safety issues in Bangladesh?
- 7) Major flaws in AEC in Bangladesh.

Prof. Eric Pollock

Signature of the Supervisor



ABSTRACT

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

Keywords: Fire safety, Fire hazard, RMG fire hazards, Industrial accident, Facility Management.

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LIST OF ABBREVIATION

AEC: Architecture Engineering and Construction

RMG: Ready-Made Garment

BGMEA: Bangladesh Garment Manufacturers and Exporters Association

BFCD: Bangladesh Fire Service and Civil Department

FRI: Fire Risk Index

FSCD: Fire Service Civil Defense

BBS: Bangladesh Sangbad Sangstha

BNBC: Bangladesh National Building Code

RAJUK: Rajdhani Unnayan Kartipaksha

TITAS: Titas Gas Transmission and Distribution Company

FM: Facility Management

BDT: Taka (currency of Bangladesh)

OSHE: Occupational Safety, Health and Environment

1. Introduction

1.1 Background:

Fire is frequently happening risk in Bangladesh's urban zones which is causing immense disaster in life and resources consistently. The rapid growing urbanization in the developing country like Bangladesh drives people to live in a very unhealthy way which lead to unsafe living and working environment. Most of residential building has continues to use as industrial purposes without any alteration their occupancy uses. Furthermore, the industrial and residential building were blended in a same area without maintaining proper regulations and precautionary safety measures in this urban development trend. It has been estimated that 80% of Old Dhaka's residential housing contains unauthorized factories or warehouses (Imam, 2010). Which is also causing a significant risk day by day in terms of physical, social and economic aspects for the occupants.

The purpose of this thesis is to develop an outline to minimize the fire hazard through facility management services in construction industry for the safety determination. This study offers to mitigate the fire hazard focusing on the core issues by safety monitoring, controlling and implementing existing legal regulatory framework through facility management consideration to upgrade the existing fire safety crisis in Bangladesh.

1.2 Statement of the problem:

Fire hazards are getting more vulnerable to haphazard urban settlement. Accordingly, the risk is alarmingly growing mostly in bigger cities in frequent manner due to rapid unplanned development with poor maintenance system, inadequate fire safety rules and lack of authorization control. As a result, urban cities are truly confronting this peril where Dhaka has the highest rate at present.

According to BFCD there were a total 215301 number of fire incidents happened in between the year 1996 to 2016 throughout the country with numerous loss of lives and business. In recent times, most of the deadliest incident took place in garments industry. According to Fire Risk Index (FRI) report, it demonstrates that the mean FRI

is 2.8 on a scale of 5.0 for the fire danger condition of our RMG segment which is very frightening to nation (Rashid, 2017). Safety and security becomes a challenge for the country due to lack of public awareness about the fire safety management. a weak emergency response system results negligence from the organization's end in times of emergency. The main reason leading behind the fire crisis is not only absence of awareness among individuals, also lack of implementing the strategic administrative framework in post construction phase in Bangladesh AEC industry. The resources available in-house is also not sufficient such as skilled personnel and precautionary fire equipment to the deal fire danger itself. Then again, the clients or the building owners are mostly reluctant to fund these services due to economic reasons. Whereas, facility manager can cut expected extra cost without effective the standards through an effective design and construction management additionally with maintenance facility. As an absence of government direction on implementing building code and compromising safety measures increase deeper threat for the people's life day by day.

In perspective of the above issue, this study intends to analyze the major facts of fire safety crisis with possible solutions and the difficulties of emerging facility management in AEC industry's means to discover.

1.3 Research questions:

- 1) What is the fire safety rules and regulation for the buildings in Bangladesh?
- 2) Why crisis arising regarding safety issues?
- 3) Why regulation is overlooked on fire safety in Bangladesh?
- 4) Which buildings are affecting more of fire and safety measures?
- 5) What is the level of awareness about facility management in Bangladesh?
- 6) What are the main flaws and factors effecting in fire and safety in Bangladesh?
- 7) Major flaws of AEC in Bangladesh?

1.4 Objectives and goals of the research:

This study intensifies the core problem in fire threat for further development by fulfilling some specific goals as an objective, follows:

- 1) Identify the causes of fire risks and its consequences.

- 2) Identify the buildings which are affecting more in terms of fire safety hazards.
- 3) Identify the major flaws that act as barrier for effective fire safety management practice.
- 4) Finding difficulties of practicing facility management in building's post constructional phase and factors specially opposing firefighting.

1.5 Limitations:

This research study addressed fire hazard only in industrial sector and not in residential sector. It is limited on fire hazard in industrial sector and other hazard (building collapse and earthquake) not considered in this study. all the case studies taken within Dhaka district, not other cities in Bangladesh to get available resources easily. Moreover, the study also focused in post construction phase of building parameter not in the design phase parameter. Due to the limitation of time, it was not possible to visit and do site survey in Bangladesh. Therefore, all the data in this study works based on secondary data which from online resources.

1.6 Methodology:

In research methodology it adopted mixed method; with case analysis and qualitative questionnaire survey as research strategies, used to complete this qualitative research. First, all necessary information was gathered by analyzing literature review along with four deadliest fire case studies, to identify existing fire hazard condition and causes which subjected to research questions and an overview of general knowledge of FM practices. All the secondary data of case studies were collected through the secondary sources such as reviewing articles, journals, books, national and international newspapers, web sites, online sources and other relative resources.

As *"A case study is an in-depth analysis of people, events, and relationships, bounded by some unifying factor"* (Research Rundowns, 2009). Therefore, the case study has been choosing to understand the problem, characterizing the causes with data inquiries to achieves its intended results. Four different fire case studies were chosen in view of the similarity and data accessibility and has been discussed detail in two sections to evaluating the case issues, as follows:

- Background analysis
- Facts of the case findings.

Later comparison between different cases and has been discussed in research report. Reviewing all the scopes of fire hazard to decrease risk from case studies, a qualitative questionnaire survey done with output based on primary data with standard questionnaire analysis to conclude the last two final research objectives. The survey aim was to validate the data which derived from the case study analysis and also appropriate for the research tools as observing, and proper understanding the actual situation of practicing FM and awareness of users on FM quality services as well as on fire safety measures in Bangladesh's AEC industry. All the responses from respondents were analyzed and conducted later in discussion and proposed workable solutions in recommendation for future aspect.

1.7 Structure of the research study:

Chapter one: In chapter one, the thesis research starts with research background, statement of problem along with developing research questions, objectives, limitation and research methodology.

Chapter two and three: This both chapter discuss the literature review. Chapter two describes the general overview of Bangladesh, numbers of fire incidents and their consequences, fire causes and the reason behind the fire safety crisis in AEC industry of Bangladesh. And Chapter three describes the overview knowledge of facility management in brief in term of theoretical perspective. The aim is to understand the contribution of Facility management services that covers all business aspects to achieve maximum productivity for the infrastructure and people. Furthermore, it's means of necessity on architecture construction industry purposely.

Chapter four and five: in this chapter focuses on research methodology. Analyzing data from the case studies for further findings of the thesis followed with questionnaire survey analysis discussed in chapter five.

Chapter six: All the data collected from analysis part following case studies and questionnaire survey analysis has been compared and discuss to achieve the desired results which meet research objectives.

Chapter seven: Finally, the conclusion will be drawn based on results discussion Followed with the recommendation to improve the current scenario of fire hazard in chapter five which will be conclude with conclusion.

2. Overview of fire crisis in Bangladesh

2.1 Overview of Bangladesh:

Bangladesh is a nation enriched with natural abundance, rich agriculture territories, bounteous water with the world's biggest delta, and significant stores of natural gas and coal, at the same time it is one of the struggling economy and utmost densely populated nations. A substantial portion of the population lives on under \$1.25 a day, 84% on under \$2 a day. While the nation remains generally rustic with 45% of Bangladeshis working in horticulture. For the environment change and with frequent natural disaster it is becoming more threat for the farmers of rural livelihoods. Therefore, the urban areas are developing quickly. Dhaka, the capital, is required to wind up plainly world's fourth biggest city with 22 million tenants by 2025. And fifty-five percent of the urban populace is packed together in just four urban cities (Claeson, 2012). As a result, urban settlement growing very fast because huge population demand. Therefore, it is involving more people in business activities such as economic, industrial and other sectors.

Bangladesh is now a fiscally grown up nation. And RMG sector is playing a vital part to enhance our economy sector. Though there is greatest number of natural disaster and man-made hazards, but Bangladesh has gained impressively progress in social and economic ground in the past decade, according to the world bank report (Claeson, 2012).

2.2 Economic growth condition:

After the independence in 1971, Bangladesh as war ravaged country confronted with the biggest challenge to rebuild the country for its limited resources. Bangladesh market economy began to taking steps to encouraging private enterprise and investment and denationalizing public industries. The private sector has developed unevenly, with major portions of the banking and jute sectors still under government control (Claeson, 2012). For quite e long time jute industry plays very vital role to the nation's financial crucial contribution. But after the end of golden period of jute industry, the RMG (readymade garments industry) sector was flourishing which replace the jute industry becomes the only major export earner of Bangladesh. More than three fourth

(around 81%) of total export earnings Bangladesh received from readymade garments sector (woven and knitwear) (Hasin, 2016).

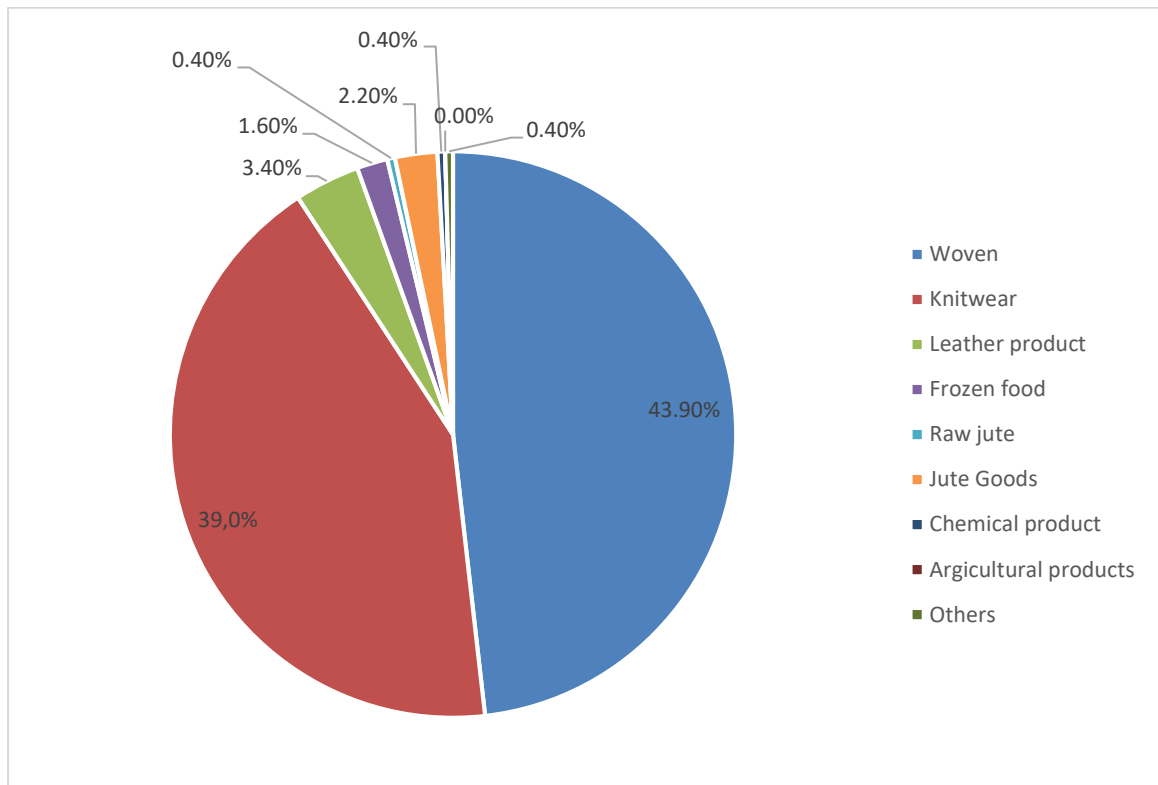


Figure 1: Product wise export earnings July-March 2015-2016 (BGMEA, 2013)

(BGMEA, 2011), The nation with its limited assets has been keeping up 6% yearly normal GDP development rate through RMG business which has brought about remarkable social and human development, according to BGMEA.

According to International Trade Statistics data of the World Bank in 2014, “Bangladesh is the second largest apparel exporter in the world, after China. The market share of Bangladesh, in the \$503 billion global garment items is 5.1 percent” (Mridha, 2016)

2.3 Fire incidents in Bangladesh:

All over the country fire outbreak exploding as consequence of unplanned city growth and violating the rules and regulations of national building code for constructing new structures. This below table will show the total number of fire incident each year fire between 1996 to 2016.

Sl. No.	Year	Total Count of Fire Incident	Approximate Loss (in Bangladeshi Taka)	Injured People	Death People
1	1996	5376	633868587		
2	1997	5802	903492606		
3	1998	5003	445772598		
4	1999	5207	1074041427		
5	2000	5315	814875923		
6	2001	5971	3241673311		
7	2002	5404	1122190748		
8	2003	6289	1105986926		
9	2004	7140	2137823627		
10	2005	5475	2729673648		
11	2006	9542	2387586609	971	92
12	2007	9196	3092378689	1535	160
13	2008	9310	2309317105	1412	233
14	2009	12182	3058972104	1270	120
15	2010	14682	3256507908	794	63
16	2011	15815	2934859751	1479	365
17	2012	17504	4823914850	803	210
18	2013	17912	7797148389	1471	162
19	2014	17830	3593169203	250	70
20	2015	17488	8569529386	254	68
21	2016	16858	2404340822	267	52
Total		215301	58,437,124,217	1595	10506

Table 1: Numbers of total fire incident, approximate loss, rescued amount, injured and death people from 1996 to 2016 are given below (BFCD, 2018).

The data presented from Civil Defense source (BFCD), shows that in from year 1996 to 2016, there were a total 215301 number of fire incidents happened throughout the country with a loss of TK 58,437,124,217 BDT (566,385,213.56 EUR) (BFCD, 2018) see from (Table 1). Most of this fire incident occurred in two major cities in Dhaka and Chittagong. Data also shows, the total number of death due to fire hazard was 1595 and as a result 10506 people were injured in the last 20 years.

Director of fire service and civil defense May AKM Shakil Newaz claimed that the uprising events of fire incidents spreading due to lack of absence awareness and negligence of maintaining built structures properly.

“Most people do not follow the National Building Code to construct a high rise building and also do not bother do not get the certificate as assurance of fire safety from the Fire Service or install fire safety tools in the building,” said by electrical engineering teacher at Buet Prof Mahbubur Rahman (Mamun, 2017).

2.4 Hazard on the inhabitants of Dhaka City:

Dhaka capital of Bangladesh considered as center of the country, which reflects the blend of overall life in aspect of social, economic and political manner. The number of inhabitants in the city is expanding quickly due to country urban migration. The World Population Review Indicated that, Dhaka area has a population of over 18 million as of 2016, while the city itself has a population estimated at about 8.5 million. Making it a standout amongst the most densely populated zones on the world, with a density of 23,234 people per square kilometer within a total area of 300 square kilometers. Dhaka was incorporated into the class of "megacity" in 2001, with a population of 10.7 million, holds 15.4 million populations in an area of 1530 square kilometer and becomes the world's 8th largest megacity (Ishtiaque, et al., 2014). With an annual development rate of 4.4%, (Chowdhury, 2017) (see figure 2) Dhaka is one of the fastest developing urban city and have been distinguished as a standout amongst the disaster-prone megacities.

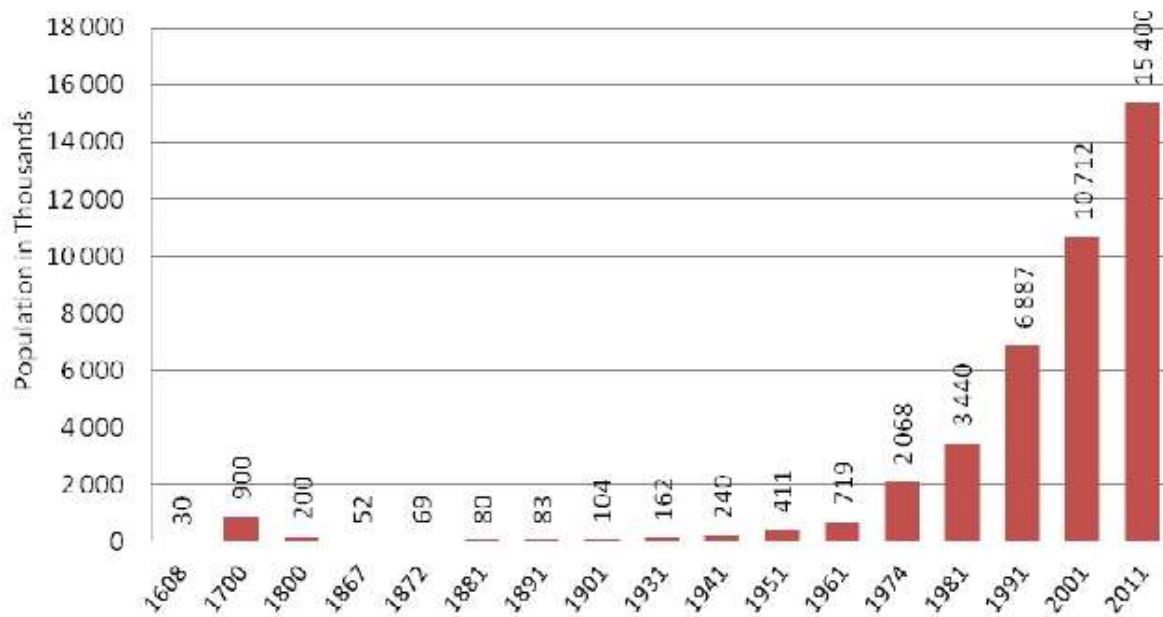


Figure 2: Dhaka city population growth rate from BBS 2003 (Chowdhury, 2017).

Lately a great economic development has begun after 1971 war in Dhaka. Dense population is one of big reason, where industrialization is taking control and influencing environment to pay for it terribly.

As industrialization took control and the migration rate was expanding (Chowdhury, 2017). Subsequently, the city was growing with improper planning buildings which affecting total city urban planning area. As a result, those faulty planning structures, industrial building and factories are not just contaminating the urban areas, furthermore are making more peril for the city dwellers gradually without attention of the authorities. Risk are causing because of practicing poor infrastructure development and insufficient providing public services in the city. Furthermore, this disorganized urban planning, faulty building construction, constant propensity of narrowing streets, unapproved electric line installation, usage of combustible building materials and insufficient resources for fire precaution with unskilled services have brought risk in vast scale. Unfortunately, fire incidents becoming more vulnerable particularly to densely unorganized urban city like Dhaka.

2.5 An outline for deadly fire:

Developers and property owners disregard building codes and safety regulations where cheap construction is the objective for their benefits as space is becoming costly due to rapid urbanization. This overgrowing high demands making cities growing very unplanned way which authorities paying less attention respectively to control over the growth trend. The safety and security come to an issue as serving a country's high rate of urbanization. The buildings which were designed for residential and commercial purpose often used for industrial purposes. Violating rules and regulations is like a common phenomenon as granted to benefits of the landowners. The residential buildings using as factories unable to serve their industrial needs properly. For an example, the space designed for five to ten people become very congested and overcrowded as a workspace. As a result, installing unsafe number of electronic appliances, such as fans and different machines, using excessive electric power load, causing electrical circuit damage, overheating, fire or blast. Avoiding Electric lines grounded properly also worsen the situation consequently. Moreover, poorly implemented buildings codes also a reason for increasing building fire frequency rate. And the property owners likewise overlook numerous things that related to workers health and safety day to day basis.

2.5.1 Some of Major Fire Occurrences in Dhaka:

Fire is turning into an unmanageable risk especially in tall structures generally built disregarding the building code regulation. Different frequencies of major event of flames, mostly happened in Dhaka and Chittagong are given beneath.

- Fire on BSEC Bhaban:

For the 3rd time fire broke out at Bangladesh Steel and Engineering Corporation (BSEC) building at Karwan Bazar in Dhaka. No casualty, however, it was reported that 3 persons were killed and more than 50 injured in the third fire incident on February 2007. Several witnesses said the fire originated from electric oven; while some others said it was sourced from electric short-circuit. In this incidence NTV, RTV offices totally burnt and went off air (Chowdhury, 2014).

- Bashundhara city complex in fire:

On 13 March 2009, Friday a hell fire engulfed the upper levels of 22 storied Bashundhara City Complex, a mega shopping complex at Panthopath, Dhaka where 7 people were killed and injured around 50 people (NTV, 2016).

- Frightful fire incident in Nimtoli:

On 3 June 2010 a devastating fire broke out in Nimtoli situated in Old Dhaka. 117 people were instantly burnt to death and hundreds were injured (Imam, 2010). Most of the people were women and children who were fighting till death. Its assume that, fire started because of two electrical transformers exploded. But later found that, it started from an oil stove and spread fast to close chemical warehouse. The fire blowout to the neighboring congested buildings including residential houses, shops trapping many inhabitants.

- Huge blaze in Tampaco Foils factory:

On September 10, 2016 a boiler exploded at the Tampaco Foils, a food and cigarette packaging factory in Dhaka, killed at least 39 people and injured dozens more (Reuters, 2016).

Here, the table 2, presented numbers of fire incidents occurred in RMG sector from 1996 to 2016 with number of death and casualties due to fire hazard below:

Table 2: Devastating fire incident in RMG sector between year 1996 to 2016 (Hasan , et al., 2017).

Factory name	Location	Time	cause	Death	injury
Lusaka Garments	Dhaka	1996	Fire	22	33
Nouvelle, Florence Fabrics, Modern Garments	Dhaka	1997	Fire	5	50
Unknown factory	Dhaka	1999	Fire	0	100
Chowdhury Knitwear and Garments	Dhaka	2000	Fire	0	100

Factory name	Location	Time	cause	Death	injury
Europe Sweaters, AJAX Sweaters and Macro Sweater		2001	Fire	24	100
Shifa Apparels and Omega Sweaters	Dhaka	2004	Fire	7	50
Shan Knitting and Processing	Narayanganj	2005	Fire	28	100
KTS Textile Factory	Chittagong	2006	Fire	63	150
Multiple factories	Chittagong	2006	Fire	0	100
Saiem Fashion	Gazipur	2006	Fire	6	45
Garib & Garib Sweater Factory	Gazipur	2010	Fire	21	50
That's It Sportswear, Dhaka	Dhaka	2010	Fire	29	25
Eurotex,	Dhaka	2011	Fire	2	62
Tazreen Fashions Ltd	Dhaka	2012	Fire	112	300
Swan Garments Ltd.	Uttara	2012	Fire	1	0
Section Seven Garments	Chittagong	2012	Fire	0	50
Crescent Leather Ltd.	Savar	2012	Fire	0	16
Vision Apparels Ltd	Savar	2012	Fire	0	100
BD Hechong	Gazipur	2012	Fire	0	15
Pacific Blue Jeans	Savar	2012	Fire	0	24
NRR Fashion Ltd	Narayanganj	2012	Fire	0	5
AKH Stretch Garment	Beribadh	2012	Fire	1	50
Active Composite Ltd	Ashulia	2012	Fire	0	50

Factory name	Location	Time	cause	Death	injury
Nasa Basic Limited group	Ashulia	2012	Fire	0	20
Cotton Club Limited	Gazipur	2012	Fire	0	6
Bonded Fashion	Tongi	2012	Fire	0	30
New Age Apparels Ltd.	Ashulia	2012	Fire	0	5
Sagar Garments Ltd	Uttara	2012	Fire	0	5
Ither Tex Ltd.	Savar	2012	Fire	0	40
Ananta Knitwear Ltd	Ashulia	2012	Fire	0	10
Epic Garments Ltd	Narayanganj	2012	Fire	0	15
Smart Export Garments	Dhaka	2013	Fire	8	50
Rana Plaza	Dhaka	2013	Building Collapse	1132	2400
Aswad Composite Mills Ltd.	Dhaka	2013	Fire	7	50
Pacific Jeans	Chittagong	2013	Fire	0	35
Abonti Colour Text, Unit 2 (Crony Group)	Narayanganj	2013	Fire	0	50
Polycon Fashion	Gazipur	2013	Fire	0	0
Smart Export Garment Ltd	Dhaka	2013	Fire	7	15
Abdullah Spinning Mill	Narayanganj	2013	Fire	0	0
Envoy Garments Ltd.	Ashulia	2013	Fire	0	100
A factory of Nisa Group	Comilla	2013	Fire	1	2
Kang Book BD	(CEPZ)	2013	Fire	0	5

Factory name	Location	Time	cause	Death	injury
GM Garments Factory	Gazipur	2013	Fire	0	3
Tung Hai Sweater Limited	Mirpur	2013	Fire	7	0
Bandu Design Ltd.	Ashulia	2013	Fire	0	20
Uni Garment	Chittagong	2013	Fire	0	14
Arba Textile Ltd	Ashulia	2013	Fire	0	10
Nakano International Co. Ltd.	Ishwardi	2013	Fire	0	7
JK Group Factory	Savar	2013	Fire	0	10
Sicily Garments	Dhaka	2013	Fire	0	3
Aswad Composite Mills	Gazipur	2013	Fire	10	50
Riyad Dying	Gazipur	2013	Fire	0	15
Aman Spinning Mills Ltd.	Ashulia	2013	Fire	0	25
Mondol Group's garment factory	Ashulia	2013	Fire	0	15
Green Leaf Apparel	Dhaka	2014	Fire	0	1
Karnaphuli Knitting, Siddique Knitting Fashion and Park International Ltd.	Chittagong	2014	Fire	2	0
ZA Sweater Factory	Dhaka	2014	Fire	0	4
Syntax Industries Ltd.	Savar	2014	Fire	0	2
S S Sweater Ltd.	Gazipur	2014	Fire	0	10
Mayer Doha	Dhaka	2014	Fire	1	3
Amina Exports Wear Limited	Ashulia	2014	Fire	0	10
Mega Yarn Dyeing Mills Limited	Gazipur	2014	Boiler Burst	1	4
Ishrak Spinning Mill	Gazipur	2014	Fire	0	3

Factory name	Location	Time	cause	Death	injury
Kader Synthetic and Compact Spinning Mill	Gazipur	2015	Fire	0	4
Supreme Jute and Knitex	Ashulia	2015	Fire	0	4
Next Collection	Ashulia	2015	Fire	0	30
Tampako	Tongi	2016	Boiler burst and building collapse	34	70
Total				1626	4829

From this Table 2, it clearly shows most of the incidents occurs in RMG (ready-made garments) factories. 68 numbers of fire incidents occur in last 20 years with the huge loss. It also shows that fire incidents are very frequents hazards in ready-made garments industries within Dhaka city. 2 or 3 incidents were related to building collapse out of rest due to fire which is a huge for the nation. The easily noticeable fire occurrence which considerable as deadliest amongst others, was Tazreen fashion limited, Garib & Garib sweater factory and Tampaco foils limited. etc.

2.6 Reasons for fire hazards in Dhaka:

It is obvious, fire accidents in any situation causes a greater risk than as normal risk which damages on people's life and their property. the communities bear unimaginable damages such as due to urban fire that cannot be repaid at once. The enormous economic loss and the tragedy of human deaths going in a frequent manner. If we go through in details of the fire accidents in Bangladesh we could see most of the fire incidents happened in mostly in Dhaka city rather than the other city in Bangladesh. As garments industry plays a very vital role in Bangladesh economic activities. The unsystematic urban city planning, narrow roads, condensed building concentrations, poor maintenance of flammable products, poor maintenance electrical system, inappropriate gas line developing danger of huge scale, numerous structure fires are the common phenomenon in Bangladesh specially densely populated city like Dhaka.

Fire risk is one of such occurrence which is at current causing immense financial damage and disaster of human death in a regular way. The reported fire rates according to BFCD was from 2004 to 2006 in Bangladesh numbers of incidents were 7140, 7135 and 9642 individually; while inside Dhaka City the rates were separately 803, 984 and 1161 in every year. In 2006, nation's 12% fire occurrence happened in Dhaka city which were 13.79% and 11.2 % in the times of 2005 and 2004 respectively (BFCD, 2018).

Aside from human passing and damage, the harm of property in Dhaka city was assessed to be more than Tk. 6 crore on a normal because of flame mischances in consistently (sarkar, 2014).

Bangladesh has an exceptionally poor fire security record and in Fire incidents in the clothing industry sectors are extremely severe. Not just in human death and injury, it also causes property damages in Dhaka city projected more than 70016000 USD on an average because fire hazard every year (sarkar, 2014). As most of the cases it occurs due to electric short circuits, locked emergency exits and so on. Thus, the common causes of fire accidents founded which could be summed up are as follows:

- a) Electrical short circuit.
- b) Boiler explosion.
- c) Chimney spark.
- d) Burning electric stove/ gas stove.
- e) Miss fire of machineries.
- f) Fault of electrical equipment.
- g) Extreme heat.
- h) Careless usage of gas cylinder.
- i) Chemical storage.
- j) Sabotage.

This figure 4 was developed by Bangladesh fire service and civil department to find out the main reason of fire happened from the number of incident happened between year 2007 to year 2009. It shows the greater reason for the fire hazard was electrical wiring and the second cause was after the electrical is cooking appliances.

SL	Cause of Fire	Number of Fire Incident					
		2007		2008		2009	
1	Electric Wiring	3,334	36%	3,760	40%	4,520	37%
2	Cooking Appliance	1,929	21%	2,137	23%	2,787	23%
3	Cigarette	885	9%	828	9%	1,401	11%
4	Suspected Arson	1,000	10%	726	8%	1,073	9%
5	Incinerator	267	2%	358	4%	412	3%
6	Playing with Fire	204	2%	161	2%	255	2%
7	Heating Appliance	170	2%	244	3%	231	2%
8	Arson	149	2%	104	1%	133	1%
9	Agitate Mob	241	3%	78	1%	141	1%
10	Open Fire	628	7%	450	5%	643	5%
11	Others	389	4%	464	5%	586	5%
	Total	9196	100%	9310	100%	12182	100%

Figure 3: Major reasons for the fire department (sarkar, 2014).

2.7 Consequences of Fire Peril:

Many people died and get injured by the fire incidents. Other than loss of lives, fires also cause huge financial misfortunes, through damage to property, loss of business.

Fire service officials reported that, “the country has witnessed as many as 18,048 fire incidents in last one year causing an estimated loss of Taka 430 crore” (The Daily star, 2017). Bangladesh Fire Service and Civil Defense Director also confirmed that to BSS (Bangladesh Sangbad Sangstha), “In the last one year from July 2016 to June this year, some 18,048 fire incidents (see table 3) took place in the country which caused losses of BDT 429 crore 93 lakh 78 thousand” taka (The Daily star, 2017).

Year	Nationwide fire mishaps	Economical loss	Casualty / Injured
2016	16,858	240 crores	152 / 247

Table 3: Economical loss and number of casualty happened till 2016 through nationwide.

It is also stated that (The Daily star, 2017), 16,857 fire incidents were occurred across the nation latest by in June 2016, which killed 152 people. Dhaka, it self-recorded 3,020 fire incidents lately (see table 4).

Year	Dhaka fire mishaps	Economical loss	Casualty / Injured
2016	3,020	100 crores	15 / 81

Table 4: Economical loss and no of casualty till 2016 (BFCD, 2018).

Specifically, from all the above discussion, it is clear that in garment sector fire is more frequent than other sectors resulting economic loss along with huge casualty and death. The below (table 5) will show the consequences of fire occurrence of some selected garments factories.

Name of Company	Date of Occurrence	Causes of Occurrence	Total Workers	Death	Injured	Jobless	Total Loss of the Company (Approximate) BDT
Tazreen Fashion	24-Nov-2012	The fire, presumably caused by a short circuit	1400	111	300	700	5654166667
Smart Fashion Export Factory	26-Jan-2013	There was a tire repair and welding workshop downstairs, so officials say that the fire could have started from this point.	450	10	35	400	1295750000
Tung Hai Sweaters Ltd	08-May-2013	The fire, presumably caused by a short circuit	2700	08	03	0	1999250000
Aswad Composite Mills Limited	08-Oct-2013	The cause of the blaze was not known	2550	10	50	2000	2251493510
Standard Group	29-Nov-2013	Sabotage	25000	0	0	20000	19278750000
Mega Yarn Dyeing Mills Limited	28-Sep-2014	The fire, presumably caused by a short circuit.	500	01	04	0	631300000
		Total:	32,600	140	392	23,100	31110710177

Table 5: Fire Occurrence & Impacts Scenario of the Observed Garments at a Glance (Mizanuzzaman, 2016).

This table 5 also shows Most of the fire occurrences was from electric short circuit. 140 people got died, 392 people got injured. Moreover, 23100 people out of 32068, got jobless due to fire hazard.

2.8 Existing Legal Provisions in Bangladesh for Fire Safety:

For constructing a new infrastructure in Bangladesh needs to follow the fire provision act along with Bangladesh National Building Code. The BNBC first published in 1993 which made legitimately revised in 2006. The BNBC has structured outlining for fire security, and it approved that if the code maintain properly would diminish fire danger to an acceptable limit. Though most of the garment industry unfollow the strict fire safety regulations because of an absence of implementation. Currently, the legal provisions for controlling the fire hazards in Bangladesh are stated below:

- 1) Fire Protection Act, 2003
- 2) Labor Act, 2006.
- 3) The 2006 Bangladesh National Building Code (BNBC) was enacted into Bangladesh Law on November 16, 2006.
- 4) Dhaka Metropolitan Building Construction Act, 2007 (Mannan, 2016).

2.8.1 Fire Protection Act 2003:

The Fire Protection Act 2003 mentioned the provisions for all the buildings, including high-rises and commercial establishments, to have sufficient firefighting equipment's and confirmed the measures of public security (Islam & Adri, 2008). The act also declared that the buildings of six stories and above must have an emergency exit, elevator and emergency security supply; in addition, each buildings has to have individual control room compliant with gas and heat detection system. But, the act is often not followed by the building owners. It also mentioned as a rule that every building must have professional expertise to follow the stands in case of fire event which is hardly maintained in infrastructures.

2.8.2 Bangladesh Labor Act, Section 62:

Safety measure if there should arise an occurrence by fire (Claeson, 2012) are listed below:

- 1) Every establishment shall be provided with at least one alternative connecting stairway with each floor.
- 2) If it appears to the Inspector that any establishment is not provided with the means of escape, he may order the measures to be adopted by a certain date.
- 3) The doors affording exit from any room shall not be locked or fastened so that they can be easily and immediately opened from inside and shall be constructed to open outwards and no such door shall be locked or obstructed while work is being carried out in the room.
- 4) Every window, door, or other exit affording means of escape in case of fire shall be distinctly marked in Bangla.
- 5) There shall be provided effective and clearly audible means of giving warning in case of fire.
- 6) A free passageway giving access to each means of escape in case of fire shall be maintained.
- 7) Effective measures shall be taken to ensure that all the workers are familiar with the means of escape in case of fire and have been adequately trained in the routine to be followed in such case.
- 8) Factories wherein 50 or more workers are employed shall arrange at least once in a year mock firefighting (fire drill).

2.8.3 Bangladesh National Building Code (BNBC):

Covers planning administration and implementation, general building codes and regulations, different uses requirements, fire protection, planning and services. In addition, it considers guideline for building use (occupancy classes) and building height. Therefore, BNBC authorized to provide is listed below (GOB, 2013).

- a) General building requirements, control and regulations.
- b) Fire protection.
- c) Building materials.
- d) Structural design.
- e) Construction practices and safety.
- f) Building safety.

- g) Alteration, addition to and change of use of existing buildings.
- h) Sign and outdoor display. And
- i) Material relating to administration and enforcement of the above matters.

2.8.4 Dhaka Metropolitan Building Construction Act:

This act also mentions some building measures for the fire safety at the individual building premises. The 67 sections of building construction act 2007, confirms all the provisions mentioned in fire protection act 2003 and additionally fixes up some standards, requirements and location of an emergency exit at the individual building level and provides the option to keep the directional marking to the emergency exist (Islam & Adri, 2008).

2.9 Modifications in Legal Provisions in Fire Safety After 2012:

- Bangladesh Labor (Amendment) Act 2013 (Issued on September 2015) Bangladesh Labor (Amendment) Act, 2013 (Issued on September 2015)
 - i. Emergency Exits.
 - ii. Access to stairs, etc.
 - iii. Mandatory use of personal safety equipment.
 - iv. Formation of a safety committee
- Adoption of National Occupational Health and Safety Policy, 2013
- New Fire Regulation, 2014
- Bangladesh National Building Code (under review) (Mannan, 2016).

For the approval of fire license, Bangladesh Fire Service and Civil Defense Authority (BFCD) gives fire license by the subsection of 7 and 8 of Fire Service Ordinance 1959 to warehouse and manufacturing plant (Islam & Adri, 2008).

It has been declared by BFCD in regulations, each garment factory needs to get a fire safety license at first from the officials to begin the business and renewed each month

by a meeting auditor from BFCD (Wadud, et al., 2014). The purpose all this legal provision for fire act to confirmed that to provide a safe working environment for people to save them from danger. But people are hardly maintained any of this regulations in practice so far.

Wadud also added that, "*although on paper all the garment factories are compliant with fire regulations at the time of inspection, they may not always remain so at any random point in time, which is more important from the safety perspective*" (Wadud, et al., 2014). And those inspection held usually once or two times every year because of insufficient manpower.

3. Facility Management Overview

3.1 Facility management roots:

Facility management was first evolved in USA from property management concerned with services and maintenance (including cleaning, caretaking, and waste disposal and catering) in traditional manner but from 1980s this discipline turned into more proactive, strategic perspective. the design of property and maintenance, purchasing and future management, work environment theses all 'none-core' activities subsumed in a broader sense.

Facilities management has been promoted as the solution to most problems encountered by building occupants, owners, managers as well as architectural designers (Oladejo, 2009). Facilities management is a relatively new field, in United States, it has been in practice for over 20 years with designed of 12,000 professionals from the United States, followed by Canada, Japan, Europe, Australia, Netherlands, Switzerland, United Kingdom and Germany apart from Japan, facility management function has been promoted through independent professional associations (Oladejo, 2009).

FM is the abbreviation of facility management which is impartially new for the private sector in line of business work and management discipline. Whereas in public sector FM has been performed as post engineering, public works or plant administration for several years (Cotts, et al., 2010). Also, in profession field it titled as property management or building operating management in leasing a property business. But outside of north America, still the functions of facility management were frequently rooted deep for both public and private sector's administrative structure (Cotts, et al., 2010). Facility management ensures the commercial services to be done professionally and effectively related to the property that meets the needs and requirements for the living being exclusively. For its operational work they include some utility services such as lighting, air conditioning, cleaning, maintenance and so forth to keep the physical plant working. They also responsible for the security and safety issues, risk management, leasing, cost and budget planning.

3.2 Definitions:

There is so many definitions of facility management some of them addressed here are following:

1. Most commonly used one is “*an integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of that organization*” (Atkin & Brooks, 2015).
2. According to International facility management association FM is “*Facility management is a profession that encompasses multiple disciplines to ensure functionality of the built environment by integrating people, place, process and technology*” (IFMA). In this explanation, facility management refers the organization of a facility’s operations intended to make the organization more effective on their activities .it deals with the expediency and budget for the infrastructure including everything all through their lifetime to serve both people and properties.
3. The definition provided by the British institute of facilities management (BIFM) is, “*Facilities management encompasses multi-disciplinary activities within the built environment and the management of their impact upon people and the workplace*” (BIFM, n.d.).
4. The G. cotts and lee defines, facility management is: “*The practice of coordinating the physical workplace with the people and work of the organization, integrates the principles of business administration, architecture, and the behavioral and engineering sciences*” (Cotts & Lee, 1992).
5. “An integrated approach to operating, maintaining, improving and adapting the buildings and infrastructure of an organization in order to create an environment that strongly supports the primary objectives of that organization” (Barrett & Baldry, 2003).
6. Lavy (Lavy, 2008)in his view describes, “Business success is characterized not only by annual revenue and profit margins, but also by the way various aspects of the building portfolio and environment are maintained: monitoring daily maintenance, operations, and energy consumption; conducting condition assessments and benchmarking studies; adapting and aligning with policies;

and assisting with the implementation of the organization's strategic and tactical planning".

7. Facilities management works, "*as the systematic method of inventorying, planning, designing and maintaining space, equipment and furniture for general or special purpose facilities that are subject to a need to be flexible to accommodate change*" (Hamer, 1988).
8. Facility Management Association of Australia included "*Facilities Management (FM) involves guiding and managing the operations and maintenance of buildings, precincts and community infrastructure on behalf of property owners*" (FMA, 2012) and also mentioned Facilities management is well-established practice which has existed out of necessity since structures were first built to help public communal activities. The FM business is commonly acknowledged as having stemmed from facilities provided by custodians and caretakers during the 1970s.
9. "FM intend to create an environment that is conducive to carrying out the organization's primary operations, taking an integrated view of the service infrastructure, and using this to deliver customer satisfaction and value for money through support for enhancement of the core business" (Amaratunga, 2001).
10. "This multidisciplinary function requiring a deep knowledge of the entire business and physical planning cycle, including the buildings, infrastructure, and people. Technology systems, disaster recovery planning, zoning compliance, furnishings, recycling programs, grounds maintenance--it all falls under the facility management umbrella" (Roper & Payant, 2014).
11. German facility management association defined FM is a management discipline which fulfils people's basic requirements at work, supports companies' primary processes and increases return on capital by economic use of facilities and services within the framework of planned, managed and controlled facility processes (GaoJi & Cao, 2011).
12. FM is the discipline responsible for coordinating all efforts related to planning, designing and managing buildings and their systems, equipment and furniture to enhance the organization's ability to compete successfully in a rapidly changing world (Xin, et al., 2013).

13. "FM is a balance between technical, managerial and business acumen that may be related to operational, tactical and strategic decision-making processes" (Kamaruzzaman & Zawawi, 2010)
14. "FM as the management of premises and services required to accommodate and support core business activities of the client organization, while constantly adding value to the stakeholders" (Mudrak, et al., 2004).
15. "Facilities management involves the entire building as a whole, it's structure, fabrics, components, services, space dimension, story height and its special attachment from substructure to the apex of the super structure" (Oladejo, 2009).

From all these stated definitions facilities Management is the combination of multi-disciplinary operations within the constructed environment and the management of their effect upon individuals and the work environment. The 'facility' term itself states to any scope of foundations that serves a more prominent requirement, for example, giving goods and facilities. This alludes to most structures and workplaces in the conventional sense, however the term facilities likewise incorporate schools, sports centers, museums, health facilities, office buildings and retail complexes.

3.3 Concepts of FM:

The concept of facility management represents an interdisciplinary field primarily devoted to the maintenance and care of commercial or official buildings, such as hotels, resorts, schools, office complexes, sports arenas or convention centers (French, 1990).

In AEC (architecture, engineering and construction) real estate considered FM as relatively newcomer. In traditional sense it serves the purpose of domestic property services such as cleaning, maintenance, janitorial services and repairing. However now it includes real estate management , financial management, human resources management, health, safety and environment (HSSE), change management and contract management, in addition to minor building works, building maintenance, building service engineering maintenance, domestic services and utility supplies (Atkin

& Brooks, 2015) and also mentioned that to be more effective in practicing FM, both hard issues, such as building services engineering maintenance, and the soft issues, such as managing people and change, have to be considered.

(Atkin & Brooks, 2000), further added that an important idea of outsourcing in the facility management, where the owner enters into a planning with external organizations to deliver more than one services in preference to their being provided through internal arrangements. The idea was to reducing cost from all functions of administrations costs. Additionally, outsourcing serves expertise in particular field and utilization resources which is not available in-house.

This FM not only embraces the idea for cost saving but also aims quality of life by the arranging, sorting out, coordinating and controlling, productivity development, maintaining of work force for the reason to contributing to association, personal and community objectives.

It is widely applied to the range of buildings, structures, infrastructures, roads and related equipment such as academic institution, industries, health services, offices, shopping centers and so forth which denotes to a solitary administration unit for economic, operational, support or different purposes (Bagshaw & Peters, 2015).

3.4 General purpose of Facility Management:

The FM care about the organizational process of organizing, cost estimating, planning and maintaining their agreed management services to support and improve their commercial and industrial properties. Because these functions of FM services are essential, not a luxury. According to (Patanapiradej, 2017) FM is the multi-disciplinary kind of work that covers a widespread range of various activities, responsibilities and knowledge, because every aspect of an organization will come under the purview of FM.

According to (Cotts & Lee, 1992),The common functions of Facility that covers in the organization divided these functions into 14 different classes are listed below:

- Management of Organization.

- Facility Planning and Forecasting.
- Lease Administration.
- Space Planning, Allocation and Management.
- Architectural/Engineering Planning and Design.
- Workplace Planning, Allocation and Management.
- Budgeting, Accounting and Economic Justification.
- Real Estate Acquisition and Disposal.
- Construction Project Management.
- Alteration, Renovation and Workplace Installation.
- Operations, Maintenance and Repair.
- Telecommunications, Data communications, Wire and Network Management.
- Security and Life-Safety Management.
- General Administrative Services.

All these functions clarify the necessity for any built structures to run efficiently. The rundown covers everything else than the significant business. To conclude, its various perspective of services is a long term function which needs to be planned and It is also important to understand that facility management is not done alone. A successful facility management organization is a team (Lindberg, 2010).

The two areas that facility management usually work on, one known as 'hard' services and the other one 'soft' services. The hard services relate to the actual fabric and building systems and might also be considered as the more traditional PM services (Wallace, n.d.) are listed below:

Hard services	Soft services
Building fabric maintenance	Cleaning
Air conditioning maintenance	Recycling
Decoration & refurbishment	Security
Lift & escalator maintenance	Pest control
M&E plant maintenance	Handyman services
Fire safety system maintenance	Grounds maintenance
Plumbing & drainage	Waste disposal
Minor project management	Internal plants

Table 6: Traditional FM services (Wallace, n.d.)

3.5 Scope of FM:

Figure: FM triangle model of 'Ps'

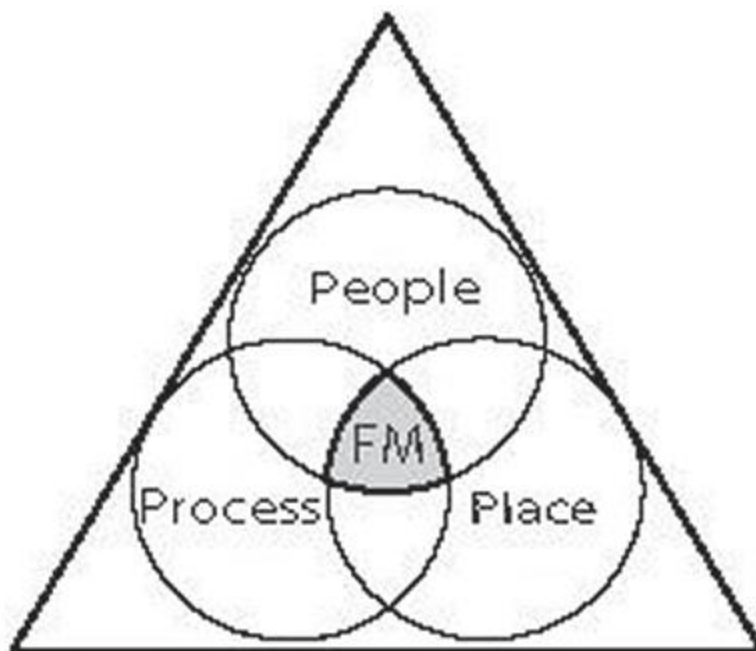


Figure 4: FM triangle model of 3 'Ps' by IFMA (Patanapiradej, 2017).

According to The IFMA model of a triangle of 'Ps', it clarifies facility management in today's workplace that consists of people, place and process. These three aspects are dependent and have coordinate equal connections. From the figure it explains that,

FM finds management solutions by positioning itself at the intersection of these three factors (Patanapiradej, 2017).

People, place and the process are the core factors of the strategy management to run their whole organization. As stated FM is a multi-functional organization which covers services inside the built environment and the administration of their effect upon individuals and work environment. The position of FM at the midpoint indicates enhanced cooperation among the key factors in any organization. However, FM is most active with factors relating to place, moreover it leads to work places which better support the flow of productive processes while adding value and reducing costs. (Patanapiradej, 2017).

Kincaid explained framework for facilities management as a support role or facility, part of the organization's non-core business (supply side) and serving the requirements of major activities or core business (demand side) (Kincaid, 1994). The FM accommodate, organization's demand and supply needs accordingly through time.

The levels of FM works, from one viewpoint, it gives a safe and productive workplace, which is basic to the execution of any business. Then again, FM can include a few vital issues, for example, property portfolio management, facility planning, strategic property decision and improvement, which are identified with strategy and policy development of the association (Marco & Mangano, 2012).

Nine major functional areas mentioned by Rondeau et al. (2006) listed these functional areas as:

- 1) long-range facility planning;
- 2) Annual facility planning (tactical planning);
- 3) Facility financial forecasting and management;
- 4) Real estate acquisition and/or disposal;
- 5) Interior space planning, work specifications, and installation and space management;
- 6) Architectural and engineering planning and design;
- 7) New construction and/or renovation works;

- 8) Maintenance and operations of the physical plant; and
- 9) Telecommunications integration, security, and general administrative services, e.g. food service, records management, reprographics, transportation, and mail services (Lavy, 2008).

3.6 Facility manager roles:

The facility manager has two key roles. The first part includes utilizing the property's capital assets, particularly property, services. The second part of administrator is to deal with the organization's support services standby. These two management parts integrate three main activities:

1. Property management (real estate).
2. Property operations and maintenance.
3. Office administration (Patanapiradej, 2017).

So, facility manager is a strategic organizer who sorts out the everyday activities of a business. This individual supervises a wide range of parts of a company's operations through managing sellers and workers support and searching for better approaches to bring down expenses. Having the capacity to multitask is basic for making progress as a facility manager.

According to fire safety they have key part in managing installation to meet authorized standards. They are regularly engaged to design and manage the installation of new facilities and to guarantee fire security protection. The facility manager has important impact on the upkeep of the safety measure through planning and control.

4. Research Methodology

The research study adopts mixed method in research methodology, case studies and questionnaire survey has explained into two parts. Case studies was done in the first part based on qualitative materials and derived from secondary sources such as scientific article, journals, international and local newspaper, online sources and other literature. And the second part was done with a qualitative questionnaire survey. The study is carried out with 4 case studies consist of 3 garments factory and 1 packaging factory. All the case studies were taken within Dhaka city to analyze their fault in safety status and core problem of the fire hazard. Three garment factories along with one packaging industrial factory which has been chosen for case studies are:

1. Tazreen Fashion Limited
2. Garib and Garib Factory
3. Ham-meem Factory
4. Tampaco Foils Ltd.

4.1 Case study: Tazreen Fashion Limited:



Figure 5: Tazreen Fashion Limited condition after fire hazard from outside (Akash, 2012).

Background:

In November 24th of 2012 fire broke out around 19:00 at Tazreen fashion limited, during the working hour, where more than 1,150 persons were working inside the building, running overtime shifts to meet the orders received from numerous international brands (Manik & Yardley, 2012). The fire broke out from the open ground floor which killed 123 people (THE Guardian, 2012) 200-300 people were injured, estimated by researchers and investigators later, because of the conflicting reports of columnists and the media for their inconsistent reports (Chowdhury & Tanim, 2016).

Tazreen fashion limited is one of the garment factory of Bangladesh situated in the Ashulia area, periphery of Dhaka city. The factory opened in May 2010, employed about 1,500 workers, and had sales of \$35 million a year from the production of clothing such as T-shirts, polo shirts, and fleece jackets (2013). This factory is a sister concern of the tuba group, known as one of the large corporate company in Bangladesh which produces It produces apparel for American, British, German, Italian,

Spanish and Swedish buyers including Carrefour, Delta Apparel, Dickies, Disney, Edinburgh Woolen Mill, El Corte Ingles, Enyce, IKEA, Karl Rieker, KiK, Piazza Italia, Sears, Teddy Smith, Walmart, and the U.S. Marine Corps (Chowdhury & Tanim, 2016).



Figure 6: View of Tazreen Fashion Limited from inside after the fire hazard (Getty, 2012).

The blaze which started from the open ground floor where the heavy mound of yarns and fabrics were piled up unlawfully, as they ought to be store in a fireproof warehouse. As Bangladeshi required law it mentioned such combustible materials should be kept in an area with fire-resistant walls. shortly fire spread across the ground floor to nine-storied building, where the top three floors was in under construction. Soon fire and smoke spread throughout the upper floors which caused fire and toxic smoke spread to the upper floors, which cause employees unable to escape the smoke-filled stairways. Many employees tried to escape via the interior staircase, as the factory lacked a sprinkler system or an outdoor fire exit (Manik & Yardley, 2012). Nonetheless, it was likewise revealed that the supervisors on a couple of floors command laborers to keep working in spite of hearing the fire alert, expecting it to be a fire drill. The gates were locked in most of the floors and iron grills on many windows left numerous workers caught inside when the fire overwhelmed the whole building. While some

workers are managed to escape by breaking some windows grills and jump to the roof of a nearby building. Others simply jumped from upper floors to the ground, which left them seriously harmed or dead (Manik & Yardley, 2012).

The fire division additionally experienced issues in with the equipment satisfactorily close to battle the fire. The fire burned for over seventeen hours as long as the firefighters were effective in dousing it. According to the Bangladesh Fire Service and Civil Defense officials report, most of the workers who died due to the lack of adequate exits and suffocation by smoke were on the first and second floors. In addition, these officials highlighted that the factory lacks necessary closed-circuit television monitoring system and had not received an operating license from the fire service authority upon the expiration of the previous one (Chowdhury & Tanim, 2016).

Tazreen fashion limited company profile:

Factory name	Tazreen Fashions Limited
Launch	6 th May 2010
location	252, 253, 258, Monoshontospur, Ashulia, Savar, Dhaka-1341, Bangladesh.
Building structure	9 storied
Floor description	Total area: 16400x7 + 16950 =131750 sqft (40157 sqm)
Employee breakdown	Total :1500 Office: 21; Production:115; Loader:13; Security:24; Cleaner:16; Cutting:53; Sewing:1055(male:400+female:655); Inspection:98; Finishing:105.
Total Sewing Lines	24 lines (12 lines knit + 12 Lines Woven)

Production Capacity	Tshirt:	400000 pcs
	Knit polo shirt:	240000 pcs
	Fleece jacket:	124800 pcs
Total machines	1200 pcs	
Turn over	Monthly: 03 Million US\$	
	Yearly: 35 Million US\$	

Table 7: Tazreen fashion limited profile (Zach Seward, Quartz, n.d.).

Major causes and failures:

Tazreen fashion limited carried out by the Bangladesh Occupational Safety, Health and Environment Foundation (OSHE) are (Mizanuzzaman, 2016) listed below:

- a) Fire apparently triggered from the electrical short circuit in the ground floor warehouse.
- b) The fire easily spread quickly on the huge stuck of fabrics and yarn, which were stored unlawfully in the ground floor.
- c) It had three staircases which were not spacious for the factory workers, however the rest staircases had been already eliminated from the ground floor plan.
- d) As a matter of fact, the factory lacked emergency fire exits and staircases from outside of the building.
- e) In the ground floor there was electric transformer located alongside that staircase and all those electrical cable lines were linked with that transformer.
- f) The materials for fire defense were insufficient and unused. Besides that, workers were not able to use those fire resistance material.
- g) Windows were locked with iron shields.
- h) The fire defense system was not automated either. There was no fire sprinkler were installed in to the ceiling.
- i) Fire extinguishers were faulty to operate.
- j) There was no emergency light as a backup during electricity failure.

- k) The Tazreen factory did not have a renewed fire security declaration either when the fire occurred.
- l) The building did not maintain the standard building code. It had the permission for built three stories whereas the owner built 9 storied.
- m) Supervisors refused to let workers go downstairs after the fire and when employees hurried to leaving, it was locked from outside.
- n) There was lack of water sources from inside and outside of the factory building.
- o) The top three floors were under construction at the time and it was impossible escape from the roof.
- p) Before the accident Five months ago, Tazreen Fashion limited had lost their fire safety certificate. Fire authorities had denied permit of license approval due to factory's unsafe condition (Besliu, 2012).

4.2 Case study: Garib and Garib Factory Limited:

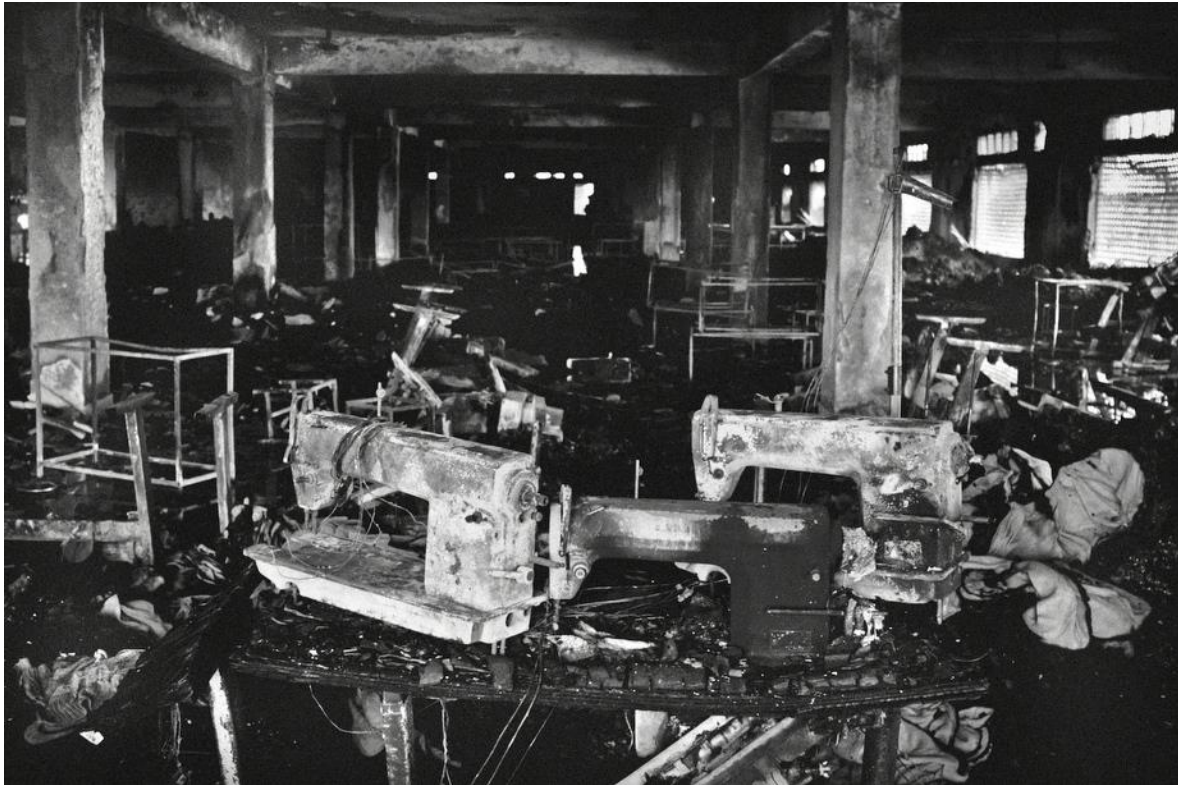


Figure 7: Garib and Garib factory condition after the fire hazard (Asad, 2010).

Background:

In 25th February 2010, Thursday massive fire breaks out at 9:30 pm in Garib and Garib sweater factory. Fire occurred on the first floor of Garib and Garib's seven storied building due to failure of electrical short circuit. When the fire hits most of the workers luckily had left from the factory, however a number of people were still working there to sewing all pieces of clothing on fifth and sixth floor. The Smoke filled the upwards remaining rest floors of the building through the stairways and created a huge number of casualties including 21 dead and 55 injured people (Sugahara, et al., 2011).

The factory Garib and Garib situated in Gazipur, Dhaka. The factory opened in February 1994, employed about 3,500 workers. Its main production business was exporting sweater to the US, Canada and Europe buyers including H&M, Mark's work warehouse, Terenora and Zemman; listed from company profile. From the local news reporter stated that, the blaze started on first floor. The other floors of factory were congested with piles of flammable goods and materials such as wool and threads and even kept in the staircases rapidly spread to alternate floors. The factory's electrical

system also got collapsed by the fire. The workplace which required emergency lighting, rendered whole building in darkness. The Enduring almost two hours in fire, before the fire service took charge the air gets contaminated with huge black toxic gas. The building also lacked with proper ventilation system ventilation with windows fixed metal screens, smoke and vapor quickly filled the building and the exit doors were locked, maximum workers get died on suffocation. The workers tried to find a way to escape by roof which was also obstructed by metal sheet structure to storage highly combustible materials on the top of the building.

The firefighter rescued the trapped workers by cutting some of the metal sheet grills which was implied to keep safe and secure the building. According to the fire service and civil defense, it was later discovered that the factory had a setup of firefighting equipment remained “untouched” (or was inappropriate for the factory) during the disaster, as no one was trained on operating the fire safety gears (Firoz, 2011).

Garib and Garib factory company limited profile:

Factory name	Garib and Garib Company Limited
Launch	16 th February 1994
Location	Vogra, Chowdhury Bari, Gazipur-Sadar Joydevpur, Gazipur, Dhaka, Bangladesh.
Building height	7 storied
Floor description	Total area: 120000 sqft +75000 sqft unit = 195000 sqft (18116.09 sqm)
Number of employee	Total :4500
Production	Sweater, pullover and cardigan for men, women and children.
Production Capacity	454000 pcs per month
Total machines	1800

Turn over	Yearly: 25 – 30 Million US\$
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Table 8: Garib and Garib Company profile (Garib and Garib, 2017)

Causes of fire at Garib and Garib Factory:

- a) The Factory structures were arranged in an extremely congested manner. No standard had been kept up for production line arranging. The work zone was not properly organized.
- b) The most fire touchy hardware and combustible products and highly fire prone machineries were kept in a similar floor where from the fire was begun.
- c) After the fire the power supply got disabled, workers got panicked because there was no emergency lighting on that building which make difficult to find stairways to evacuate for the workers.
- d) The Emergency exit were blocked with goods and the front door was locked too.
- e) The smoke could not move out due to the poor system of ventilation.
- f) The windows were shield with heavy metal frames which put them to pass on from suffocation.
- g) The factory lacks following the standard rules for stacking products and goods in proper way.
- h) Combustible goods such as wool, acrylic yarn were piled up disorderly in the factory floor which blocked the circulation routes.
- i) The factory's fire extinguishers were useless or malfunctioning. During fire hazard they remain untouched.
- j) There was no safety management drill and fire prevention practice ever performed to workers of the factory.
- k) There was no rooftop exit door.
- l) The authorities ordered to maintain the precautions for fire and safety issues in August 2008, just six months back before the fire held, which had been totally ignored.

4.3 Case study: Ha-meem Factory:



Figure 8: Ha-meem factory condition during the blaze (The Daily Star, 2010).

Background:

In Friday 14th December 2010, around lunch break time fire broke out at Ha-meem factory. Fire occurred on the 10th floor due to failure of electrical short circuit. The factory consists over 5,000 workers but luckily that time due to lunch break most of the workers went outside for lunch. There were the finished products were stored on 9th floor from where the fire began and quickly spread to the upper floor of the building. Meantime on 10th floor around 450 workers were having lunch (Mizanuzzaman, 2016). 27 people got died and more than 100 people got injured in this fire blazed (Taylor & Hammadi, 2010).

The 11 storied Ha-meem factory building situated in Ashulia, suburb in the northwest part of Dhaka. The plant is 11 storied (reinforced concrete structure) was considered a modern building along with workplaces and sewing plant. The factory opened in 1984, employed about 50,000 workers. This Ha-meem group of company is owner of 26 garment factories and renowned for its wholesale clothing business in both Europe

and America. Authorities has claimed that the fire first broke out on the factory's 10th floor, where trousers were put away for shipment, and after that spread up to the 11th floor where there was a canteen and manufacturing facility. From the 10th floor fire spread to the 11th floor through it's opening on the outer wall shown in the image and from the shaft of a lift.

Fire transmitted through the opening and the spandrel (Sugahara, et al., 2011)



Figure 9: Factory view from outside (Sugahara, et al., 2011).

Workers of the plant said that they could use three emergency stairs out of six. Though those staircases were not fire protected nor there was any fire door or shutter installed. smoke vertically spread upwards through the staircases easily to the upper floor. It is also reported that there would have been less losses if all the exits were left unlocked for evacuation. some workers jumped off the windows and others using rolls of cloth to get down from the floor to escape because they were unable to use the nearest staircase due to excessive heat and fire smoke. Though, they did not fail to succeed to evacuated. From BFCD (Bangladesh fire and civil department) reported, it took 7 hours to took put off the fire.

Ha-meem factory company profile:

Factory name	Ha-meem factory
Launch	1984

Location	Ashulia, Dhaka, Bangladesh.
Building structure	11 storied
Area per Floor description	4000 sqm per
Number of employee	Total: 5,000
Production	All types of bottom and tops, jeans and outwear
Production Capacity	1.8 Million pcs garments and 250000 pcs sweater monthly
Total machines	300 production lines, 7 washing plant
Turn over	550 Million US\$

Table 9: Ha-meem company website (Hameem Group, 2017)

Causes of fire at Ha-meem factory:

- a) Fire occurred from the electrical short circuit.
- b) It was accounted for that legitimate fire drills were not carried out.
- c) Three out of six exits were blocked during fire crisis.
- d) The space organization of the factory was not satisfactory, and workplace was never maintained and supervised according to the factory norms.
- e) Workers were unaware to uses fire equipment.
- f) No access from roof.

4.4 Case study: Tampaco Foils LTD:

Background:

The fire occurred in Saturday 10th September 2016 at Tampaco Foils Ltd. early in the morning time. when the blast happened there were 100 people were working, and most people were in public holiday of Eid festival. Fire spread rapidly from the blast as there were combustible chemical were stored in that plant which also cause partial collapse. The devastating blast took 39 lives (Reuters, 2016) and injured more 100 people.



Figure 10: Distraction situation of Tampaco Foils Ltd. after the fire occurrence (The Sun, 2016).

The 5-storied factory is situated at Tongi industrial zone in Gazipur which is only 12 miles away north part of Dhaka. Tampaco Foils Ltd. remain one of the Bangladesh's flexible and tobacco packaging company since 1978. From its company website (Tampaco Foils Ltd, 1978) the organization records real global brands, for example, British American Tobacco and Nestle, among its clients.

Primarily it is assumed that the devastating fire had triggered from the boiler explosion but later the investigation directed by Titas Gas officials, have found both boilers were intact and suspected that the explosion occurred from the booster machine which

brought up such destruction due to extreme pressure of gas. They also specified “the factory was consuming ‘at least twice the permitted amount’ of gas when the explosion occurred” (Ahmed, 2016). The factory was also using illegally two boilers without official authorization.

The factory's Production Officer mentioned, there was several kinds of chemicals factory was using such as adhesives, including ethyl acetate which very vulnerable to catch fire easily (bdnews24, 2016).

The factory was ill functioned in terms of international safety standards. There is only one exit with improper staircase. A steel staircase had been added on the outside of the five-storied building (shown in figure 11), as had two lifts, which were used to convey ingredients for cigarette packet foils (Ahmed, 2016).



Figure 11: Tampaco Foils Ltd condition after fire hazard (bdnews24, 2016).

Tampaco Foils Ltd Company profile:

Factory name	Tampaco Foils LTD
Launch	1978
Location	2 BSCIC Industrial Estate Tongi, Gazipur, Bangladesh

Building height	5 storied
Production	Paper backed aluminum foil, cork tipping paper, plug wrap paper, pre-printed tipping paper, inner frame board etc.

Table 10: Tampaco company profile (Tampaco Foils Ltd, 1978).

Major causes which lead to devastating hazards in Tampaco Foils Ltd:

- a) The explosion occurred from the booster machine due to extreme pressure of gas. Though initially consider that it occurred from the boiler explosion.
- b) Illegal amount of Gas using without official permission.
- c) The factory lacks safety precaution as there was unauthorized 2 boilers which were not been taken into consideration.
- d) There was combustible chemical stored in ground floor which cause partial collapse of that plant, also not taken care of from the authority.
- e) The factory floors had been built more than its approval plan.
- f) The factory had only one exit and there were no proper fire exits.
- g) One external fire exit shows in the image was also defective. No openings were designed from inside to use the fire stair (see figure 11).
- h) Tampaco license was renewed two times without inspection from the authority because of the shortage of the faculty staff.

5. Analysis:

5.1 Part one: Comparison between case studies:

Factors	Tazreen Fashion Limited	Garib And Garib Factory	Ha-meem Factory	Tampaco Foils Ltd.
Location	Ashulia, Dhaka.	Gazipur, Dhaka.	Ashulia, Dhaka	Tongi, Dhaka
Building Description	9 storied	7 storied	11 storied	5 storied
Occupancy type	Garment factory	Garment factory	Garment factory	Packaging factory
Quality of the structure	poor	poor	good	Moderate
Occurrence type	Fire	Fire	Fire	Fire and partial collapse
Reason of the incident	Electric short circuit	Electric short circuit	Electric short circuit	Explosion of gas booster pump
Time of incident	7:00pm	9:30pm	1:30 pm	8:am
Number of people working that time	1150	80	300	100
Are combustible materials stored in open space?	Yes	Yes	No	Yes
Open flammable liquids	No	No	No	Yes
Storage areas separated from fire-resisting walls and doors?	No	No	No	No
Fire resisting enclosure.	No	No	No	No
Presence of fire equipment	Not sufficient	Not sufficient	yes	Not sufficient

Are fire extinguishers fully equipped and checked?	No	No	Yes	No
Automatic sprinkler system	No	No	No evidence	No evidence
Fire detection and alarm systems tested regularly.	Negligence	Negligence	No evidence	Negligence
Emergency lighting	No	No	Yes	No evidence
Narrow and insufficient number of staircase	Yes	Yes	No	No
Exit door condition	Poor	Poor	Poor /locked	Poor
Roof door exit	No access	No access	Damaged	
Corridors and doorways kept free and clear of obstructions.	No	No	Yes	
Are means of egress (i.e., aisles to fire exits) clear and unobstructed?	No	No	No	No evidence
Violation of rules and regulation of BC ACT in planning	Yes	Yes	No	No
Unauthorized electricity and gas line connections	No evident	No evident	No evident	Yes
Improper ventilation	Yes	Yes	No	
Escape route with proper sign and plan	Not defined	Not defined	Not defined	No evidence
Fire and safety management drill	Yes	No	No	

Table 11: Comparison between Tazreen fashion limited, Garib & Garib factory, Ha-meem factory and Tampaco folis ltd.

Some points have been derived from the table 11 for fire hazardous situation after comparing and analyzing the data are given below:

- 1) The building code were not followed in factory planning design.
- 2) There is violation in adding more floor without planning approval.
- 3) Lack of adequate fire exits.
- 4) Fire exits were not protected by fire resistant material.
- 5) Disorganized working place, factory goods and combustible materials were kept open to factory floor.
- 6) Fire occurred from electrical short circuit because electrical wiring condition were poor.
- 7) Excessive use of the factory machineries and appliances without calculation their power load caused electrical power failure.
- 8) Combustible materials were kept open space which create extreme firetrap.
- 9) Explosion of gas booster for using excessive gas without permission form the authority.
- 10) Lack of adequate fire appliances and sprinklers to prevent the fire.
- 11) There was no emergency light as a backup during electricity failure.
- 12) No fire drill ever happened to the workers for fire preparedness.
- 13) Negligence from the authority and the building owner.
- 14) Expired fire license and even approving without proper inspection.

5.2 Questionnaire survey analysis:

The questionnaire survey has been completed for this research study. This survey data is based on qualitative survey. The aim is to produce qualitative data of facility management sector of detailed information (based on limited number of individuals) about the present condition. The survey consists of 12 questions for 50 respondents focusing on basic facts of the existing situation to achieve the understandings and keep it simple to interact easier with the participant opposed to quantity. The questionnaire format design is constructed with closed-ended questions to meet the research objectives precisely.

The survey had conducted with the professionals who have good experience in AEC industry in Bangladesh. The data in research basically relies on respondent's depth of view regarding the issue and probability of its future aspects. Respondent has been chosen wisely who is qualified in construction industry and garments business such as top-level executives of the companies, project manager, architects, engineer and supply chain manager etc. (see figure 12).

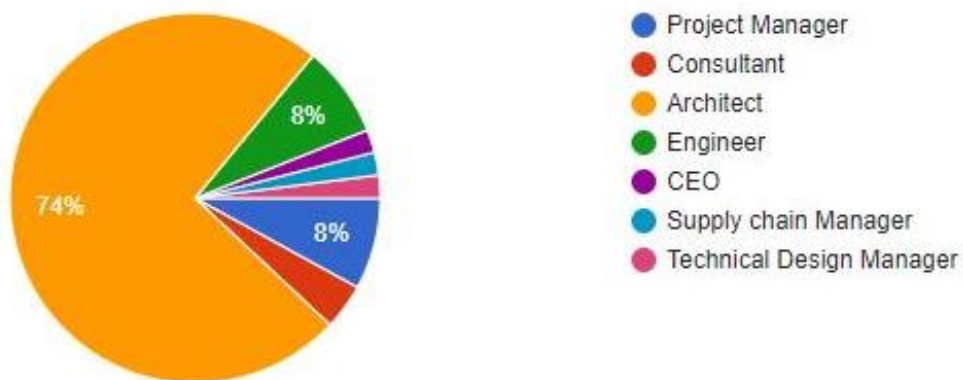


Figure 12: Figure of participants information from the Author.

Years of experience (see figure 13) was one more consideration to make data more precise to achieve the quality feedback to cover all aspects of research scope in depth. The questionnaire was outlined in online using Google docs programming software. sent through respondent's email address.

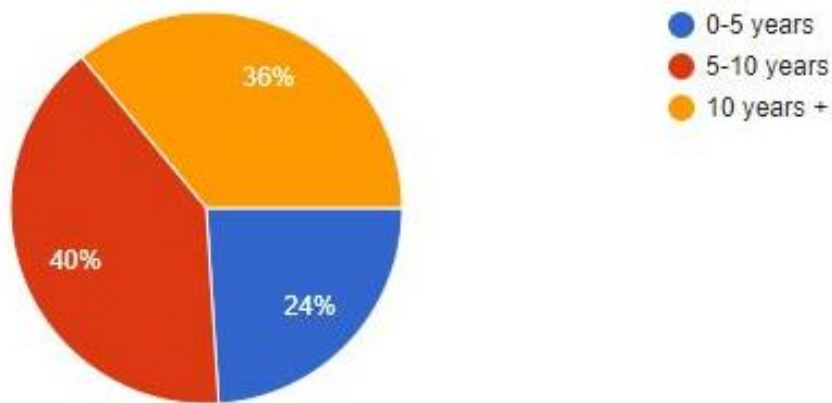


Figure 13: years of work experience individuals from the Author.

5.2.1 Part two: Questionnaire survey data analysis:

No.	Questions for investigation	Yes (%)	No (%)	Maybe (%)	Total (%)
1	Do you know about Facility management?	75.5	24.5		100
2	Do you have any experience related to facility management field and their services?	24	58	18	100
3	Does your office provide any facility management services?	18	82		100
4	Is there any facility management services provided in Bangladesh regarding building life-cycle?	26	16	58	100
5	Is there any facility management service provider company in Bangladesh?	75.5	24.5		100
6	Do they provide any building service facilities professionally in post construction phase?	52.1	47.9		100
7	Do you prefer to avail facility management services from the concern organization?	70	6	24	100
8	Is the quality of services available in-house meet customers need?	10	42	48	100

9	Does your company have any proper strategy in terms of fire and safety issues and do they maintain it appropriately?	48	52		100
10	Does your company offer health and safety training to employees?	34	66		100
11	Is there any awareness for fire and safety through management services?	70	30		100
12	Do you think facility management can improve existing disorder in Bangladesh architecture and construction industry?	96		4	100

Table 12: Survey data from the participants.

The survey concluded some key facts as shown in (table 12) is almost three quarters people have the basic knowledge about what “Facility management (FM)” and also acknowledged that they unaware of FM work accordingly. The least number of people even not a quarter had working experience with FM services which is very low to consider. Since Bangladesh has a lack in Practice of FM, it’s been criticized by Construction professionals which shows there is need to make sure that FM services should be operated in house.

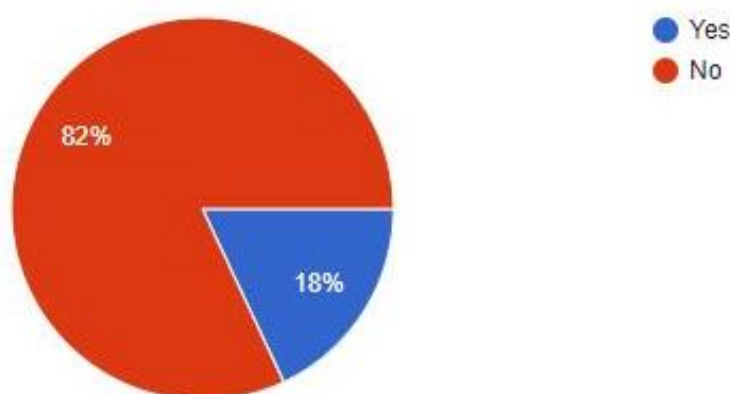


Figure 14: Results of companies serve in-house FM services from Author.

It is very promising fact that FM service has already started as a business in Bangladesh lately but limited facilities. According to this survey, the respondents

mentioned that it got a lot of attention after the devastating collapse of Rana plaza yet could not move forward with broader impact .The survey came across some interesting results by talking to some of respondents who have a basic knowledge about FM services but surprisingly those services are tied with janitorial building services like cleaning and repairing excluding other FM services such as operational, fire safety and security etc. In comparison, international chain hotels have established their own in-house facility management services to go along with their other necessary services.

In line with people response of higher percentage, are approaching more positive vibe in occupying FM sector to avail services through concerned organization. Because they believe it will meet their requirements which cannot be fulfilled by in-house services as lack of resources and professional expertise as stated by a respectable number of people according to the chart. However, almost half of the respondents revealed their limited knowledge about facilities management as well. Additionally, they mentioned, most of these company they did not provide any fire strategies for safety concerns. There is no fire safety training for evacuation in a fire hazard due to a lack of training from a technically sound person. Businesses have fire safety awareness on surface, but it is not as apparent and effective as it should be. In reality they are not being offered form the companies. So, 96% of the respondents recommended that, if companies could collaborate with facility management services in Bangladesh post construction phase it would mitigate the existing fire risk in AEC (Architecture, Engineering and Construction) industry (see figure 15).



Figure 15: Participants response about aligning the FM services in AEC industry from the Author.

6. Findings and Discussions

6.1 Part one: Case Studies:

To sum up, going through all the deadly mishaps at Tazreen, Garib and Garib and Ha-meem and most recently in Tampaco foils ltd., shows fire occurs due to carelessness to meet up proper security measures and consistently violating building code by the authority and the owners. As a consequence, it took several lives and resulted in significant economic loss for the nation. All case studies illustrated that, the point that garment factories lacked is adequate fire equipment and compliances such as battery-operated emergency lights, fire hose, fire sprinkler nor even signs for the evacuation route during an emergency response. Besides that, proper fire exits were missing, and the existing fire exits were in poor conditions such as in Tazreen and Garib and Garib factory whereas Tampaco foils had only one main exit. On the other hand, the Ha-meem factory, though the building was well designed compare to other factories but most of the exits were locked during the emergency time. People got trapped inside, unable to evacuate because of locked fire exits and most of them were padlocked or chained from outside. According to the fire safety law of Bangladesh it has been clearly stated that, *“In every establishment the doors affording exit from any room shall not be locked or fastened so that they can be easily and immediately opened from inside while any person is within the room, and all such doors, unless they are of the sliding type, shall be constructed to open outwards or where the door is between two rooms, in the direction of the nearest exit from the building and no such door shall be locked or obstructed while work is being carried on in the room”* (Mizanuzzaman, 2016). The study also found the fire exit were not even protected by any fire-resistant wall, they were open to the workplace.

Moreover, overcrowded workplace, faulty electrical line, uncovered operating machines, openly kept combustible material and chemical were also reason for the hazardous situation. There is huge fault in planning design to function as an industrial facility. Floors, corridors and stairs used as storage of factory goods and doors stay shut even in crisis. There was no fire safety drill ever performed to the workers and

the supervisors except the Tazreen fashion limited. The absence of adequate fire equipment's and poor preparedness to deal with mishaps paid extensively to the occurrence.

From the analysis it also shows that, the Tazreen fashion limited, Garib and Garib and Tampcao foils ltd continued to build more floors above than its approval plan which confirmed that the negligence from the owner and the authority of not practicing the rules and regulation effectively.

Therefore, the crucial points coming forward from the above issues are, the negligence of the authority which increases the risk of fire disaster in infrastructure in a hazardous manner. Their negligence in planning and implementing proper staircase maintaining proper stair width, their negligence in maintaining fire and safety provisions, inattention towards training about fire safety knowledge to preparedness on crisis time, in addition negligence in faulty electrical line which is bringing unsafe work environment for the workers' health and safety issues.

6.2 Part two: Questionnaire Survey:

Findings: The survey was done based on qualitative questionnaires, aiming to find the existing status and the awareness for facility services among the people as it is mentioned. The common facts that emerged are listed below:

- Lack of standard facility management services.
- Lack of educational knowledge in facility management services.
- Absence of scope of work in strategic operational services.
- Existing in-house facilities are inadequately resourced to cover end-user requirements.
- Inexperienced professional personnel and inept client function.
- Insufficient knowledge of facility management scope and content of the support services.
- Insufficient resources for fire safety compliance, fire training and fire safety knowledge.

- And ensuring health and fire safety responsibilities for the staff in working environment ignored by the company.

According to work experience as an architect in Bangladesh, it has been observed that, the people were less concerned with facility management services as well as in fire safety measures. But from the findings, it is clear that people are concerned about their health and safety issues in their work environment. Though facility management practices could not spread in wider perspective as it also relatively new in practice. Every company do not yet possess their own facility management services due to lack knowledge and expertise. In most of companies, there is a facility team consists with architect, engineer specialist in MEP and IT specialist person which provide some form of maintenance installations on their facility but mostly not related to strategic operational and fire management services. This FM services Provider Company unable to assure the quality of services. According to one expert opinion; there are some renown Real Estate firms called “Bay Development” and “Shanta Properties” properties they have their own facility team for building maintenance services, but they also hire expertise for the building’s operational services. He also addressed, there is no proper facility management “organization” in post construction phase to meet all the FM core support services to ensure the building operation and supervision of infrastructures. So, the facility management services as a practice have not received enough market exposure yet in Bangladesh.

Based on the literature review, it shows importance of FM services; to support their core activities in organization to serve people and their work environment. As the research focuses on operational services designed for post construction phase in terms of fire safety crisis therefore it is stressing “FM” services to obtain their fundamental strategies to deal it professionally. And as facility manager plays a vital role on fire safety crisis as reviewed from facility management. Therefore, appointing facility manager for enforcing the policy to implement in every company is much needed. Because all the findings showed the gap between maintaining design standards, operational system of the infrastructure and their evacuation procedure.

7. Conclusion and Recommendations

7.1 Conclusion:

In the present situation of fire hazard and its effect on loss of lives and property in industrial building sector, has become an alarming issue for national awareness. It is a key point concerning health and life safety for people and property, ought to be executed as stated in the safety precautionary measures system. Incorporating facility management in support service could help to improve in operational support strategy and building regulation in terms of fire safety standards. At the same time FM strategies will provide the better work environment for the individuals and property accordingly. The study accomplished objectives through conducting literature review, case study analysis and questionnaire survey analysis solving all the research question respectively and discussed the findings briefly in results and discussion chapter. The overall assessment based on Bangladesh existing fire hazard condition and overall building operational management system in post construction phase, addressed in research respectively. It is observed that, every year “10765” number of fires incidents occurred in Bangladesh, leaving individuals in danger, damaging their infrastructure and business. Among them, the industrial areas are the most unsafe according to data of fire frequency rate. As Dhaka is playing major business hub for economic interest, the city was developed in very haphazardly due to rapid urbanization and the growth of population for the migration. The study found that most of the fire has been caused from the electrical shot-circuit and unauthorized chemicals and flammable materials kept in open space without any fire resistant.

Therefore, get the perspective in detail, the research decided to do case studies based on industrial factories as its affecting more threat to life and economic sector. Hence, after analyzing the case studies several issues have been addressed for deadly occurrence. Almost every factory reflects lack of proper building design and faulty structure through violating building code. Including disorganized work environment, poor ventilation system, poor maintenance, faulty electrical wiring, inadequate fire exits, inadequate fire equipment and extinguisher, inadequate means of egress and lack of fire safety provision. Additionally, in every case people were unaware of fire safety knowledge and fire safety training ignored by the authority to deal fire danger. Few of them offered for fire drill but that significant less compare to majority number.

Moreover, the negligence from the authority and the owners were found as the main leading reason to contribute the fire events worse.

The study recognized, there is multiple sector which is causing fire safety crisis. To achieve fire prevention, it requires a team collaborating with concern all sectors official personnel participation. First, there should be professional expert in facility manager role in every company who will ensure the fire safety management and building operational activities properly to meet end-user satisfaction.

Finally, the research has concluded with a qualitative questionnaire survey to meet the final objective of this study to contribute the result which reflects on real field perspective. Along with literature review of facility management, intend to gather the basic knowledge and idea of core strategic operational activities. In research, the study did not cover the parameter of before construction phase of building design it only covers the parameter of post construction phase design. From the questionnaire response the study found that the people have wrong conception about the FM business and their core functional activities and also discovered the quality compliance for the fire safety measure officially ignored by the organization. However, the survey also projected in the future scope of working facility management practice in Bangladesh as FM business started lately. The newly launched few companies are providing the janitorial services and repairing services along with event management. They have not become self-sufficient yet in terms of technical knowledge to ensure the quality services to meet all FM standard administrative functions. Furthermore, people are less aware of the buildings operational services that runs built structure efficiently because of their limited knowledge and experiences. As rules and regulations are hardly followed in Bangladesh therefore incorporating facility management in AEC industry to find the gap in management and construction will be profitable specially in fire safety crisis by stopping unwanted fire event. For further improvement possible solutions have been provided as for future enhancement in recommendation.

7.2 Recommendations:

To control the ongoing fire crisis in Bangladesh, the combined effort of all the concerned parties are required. The situation will not change overnight, it requires people's consciousness in terms of effective fire management planning and emergency preparedness outlined with standards and regulations to minimize the fire hazard. Therefore, a team should have combined with the effort of government official, facility manager and the property owners, and other personnel to cooperate the strategy run smooth. From above all the finding and discussion discussed above and with some participant opinion, the study identified some problem in some core areas need to pay attention and work on to minimize fire risk. They are:

- Rules and Regulation Sector.
- Property Inspection Sector.
- Facility Management Service.

1. Rules and Regulation sector/ concern or compliance with laws, rules and regulations:

The study recommends several government "inputs" on legislative requirements and regulatory framework in order to minimize unwanted fire hazard. They are as follows-

- Government should ensure the implementation of laws. Violation of rules and regulations by any responsible person should be subject to penalties.
- Prevent the Malpractice of the public officials in the government sectors.
- Penalty also to be implemented for acts of bribery and corruption in public procurement.
- Government should involve mobile courts for regular inspections especially in commercial sector to guarantee working safety and security.
- Government should recruit professional personnel in strategic and technical levels to support building inspection and develop separate review framework for RMGs.
- Government should develop an organization for facility management services to ensure the core services are integrated into the building life cycle.

- A mandatory educational training session should be carried out in an economic way and feasible manner. Due to the inflation and crisis in the market, it is difficult to afford such drills and practices but still a part of the budget should be spent on training of the personnel as life safety is important than money.

2. Property Inspection Sector:

To accomplish this goal the strategy may incorporate numbers of actions, follows:

- Due to a lack of inexperienced personnel, there is a need to assign professional inspectors in building inspection; who has the experience in inspection techniques, building regulations, fire safety management and other statutory acts.
- Developing a strategy that will surely identify risk prone buildings and relocate those building from residential zone to industrial zone.
- Most of the building owners should convert the residential building for factory use, which are to be equipped with facility management services.
- MEP work should be examined through expertise to ensure the monitoring of electrical appliances and other equipment installation, which comply with appropriate rules and regulation.
- Develop better communication among the building's stakeholders about the hazards of an unprotected building.
- Focusing more on operational planning design to ensure workspace requirement, adequate fire exits, storing flammable materials and liquids safely, adequate fire compliance, proper evacuation plans.
- The lapse between building inspection should be reduced. A lapse measured in building inspection should be reduced. Especially in commercial sectors buildings need to be inspected frequently.
- Ensure the quality in building structural and operational system by following the international standard for fire protection and life safety.
- Give more importance of inspection in installation of electric appliances, wiring and electric supply line. Proprietor of the processing plant should give

significant attention in constructing electric supply lines, wearing links and electrical gears.

3. Facility Management Service:

Incorporating FM in post construction phase has become an essential requirement for unwanted fire event. People usually face the fire at their working environment, as fire is unpredictable for presumption. And fire is very critical risk to handle so it requires specialized professional to implement the technical support through workspace design, fire safety management and fire safety training. In facility management, facility manager has vital role in fire safety sector by managing installation work that ensure fire provision standards for safety protection. Fire incidents could be preventable if the strategic objectives of fire safety properly managed and controlled by expertise personnel. Therefore, introducing facility management to improving the current haphazard situation on fire safety measures, the possible resolutions are:

- Incorporate the FM business in governmental organizational sector.
- Market exposure for future potential facility management practice among the people, property owner and government.
- Introduce Facility management course for every architectural and engineering bachelor's degree.
- Increase awareness about FM among peoples and its consequences by incorporating FM in building operational phase to mitigating fire risk.
- Technical skill is highly needed in fighting which only a technical expertise can offer. Therefore, there should be a Facility manager appointed in companies to ensure evaluating principal building parameter, the zoning, the technical support, fire safety standard compliances which meet international fire safety standard.
- Developing a strategy of fire safety model, checklist following international standard, which usually practiced in developed countries for fire safety measure.

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APPENDIX

Appendix 1:

Dear Participants,

I am Tanima Abdul Wahed, a full-time master's student at HTW Berlin. Currently working on my Master Thesis on "Impact of facility management on fire safety crisis in Bangladesh's architecture and construction industry". I would like to conduct a questionnaire survey aiming to fetch the overall idea of practicing Facility Management Bangladesh's Architecture and Construction industry. In the questionnaire those factors are mentioned, and I am seeking your response for the framework.

I would appreciate to all participants (Project manager, Consultant, Architect, Engineer, CEO.) to go through the questionnaire and fill the form as per the instruction.

I would also like to confirm that your identity will be kept confidential and it will be only used for my Master Thesis research resolution. Kindly respond to the survey and return the same in as soon as possible.

Thank you for your valuable time and I look forward to your responses.

Kind Regards,

Tanima Abdul Wahed

Master of Science (Construction & Real Estate Management)

HTW Berlin

Appendix 2: Questionnaire Survey: Impact of Facility Management on Fire and Safety Crisis in Bangladesh.

1) Do you know about Facility management?

a) Yes b) No

2) Do you have any knowledge about facility management and their services?

a) Yes b) No c) May be

- 3) Does your office provide any facility management services?
 - a) Yes b) No

- 4) Is there any facility management services provided in Bangladesh regarding building lifecycle?
 - a) Yes b) No c) May be

- 5) Do they have any service provider for facility management in Bangladesh?
 - a) Yes b) No

- 6) Do they provide any building service facilities professionally in post construction phase?
 - a) Yes b) No c) May be

- 7) Do you prefer to avail facility management services from the concern organization?
 - a) Yes b) No

- 8) Is the quality of services available in-house meet customers need?
 - b) Yes b) No

- 9) Does your company have any proper strategy in terms of fire and safety issues and do they maintain it appropriately?
 - a) Yes b) No c) May be

- 10) Does your company offer health and safety training to employees?
 - a) Yes b) No c) May be

- 11) Is there any awareness for fire and safety through management services?
 - a) Yes b) No

- 12) Do you think facility management can improve existing disorder in Bangladesh architecture and construction industry?
 - a) Yes b) No c) May be