FIRE HAZARD VULNERABILITY MAPPING: A CASE OF DHAKA METROPOLITAN AREA

A Dissertation submitted to the University of Dhaka in Partial fulfillment of the Requirements for the Degree of

Master of Philosophy
in
Geography and Environment

RAM KRISHNA NATH
Registration No. 279/2001-02

SUPERVISOR
Dr. Amanat Ullah Khan
Professor
Department of Geography and Environment
University of Dhaka

March, 2009

Dated: March 08, 2009

Letter of Approval

I have the pleasure to approve the thesis entitled "Fire Hazard Vulnerability Mapping: A Case of Dhaka Metropolitan Area" prepared by Ram Krishna Nath (Reg. No. – 279/2001-2002) to be submitted the department of Geography & Environment, Faculty of Earth & Environmental Sciences, University of Dhaka, Bangladesh in partial fulfillment of the requirements for the Degree of Master of Philosophy (M.Phil).

Amanat Ullah Khan 8-3-09

Professor Dr. Amanat Ullah Khan
Supervisor
Department of Geography & Environment
University of Dhaka
Dhaka – 1000
Bangladesh

Fire Hazard Vulnerability Mapping: A case of Dhaka Metropolitan Area

(Proposal Abstract)

Due to unplanned and uncontrolled urbanization the physical growth of Dhaka has become a cause of concern with respect to a number of hazards .Fire is one of the most important of such a potential hazards.

The aim of this dissertation would be to explore the event of current fire hazard vulnerability of the Dhaka Metropolitan Area and to suggest mitigating measures. In order to do so the research will investigate the city's current land use pattern, Road networks, the location of the most vulnerable areas with respect to potential fire hazard. It will also study the current fire disaster mitigation procedure in place.

Mapping using GIS and Remote Sensing techniques will mainly be used to analyze the current situation and to suggest mitigating measures.

ACKNOWLEDGEMENT

First and foremost the author expresses his indebtedness and deep sense of gratitude to his honourable supervisor Professor Amanat Ullah Khan, Department of Geography & Environment, University of Dhaka for his constant guidance, supervision, inspiration and encouragement to complete the research work.

The author is sincerely thankful to Professor Borhan Uddin, Department of Geography & Environment, Professor Dr. Nurul Islam Nazem, Assistant Professor Md. Sofiullah and other honourable teachers of the Department for their help, cooperation and suggestion at various stages of the research.

The author wishes to express his heartfelt thanks to Quazi Md. Fazlul Haque, Office of UDD, Dhaka, Principal Mr. Liaqat Ali, Rajarbag Police Line College, Dhaka for their sincere and suggestions.

The author thankfully acknowledges the intensive help of Assistant Professor Mr. Eftekhar Hossain, State University, Dhaka and further extends his heartfelt thanks to Mr. Abdur Rauf, Md. Shaheen, Md. Masud, Md. Abdul Bakky, Kazi Ahmedul Islam (Technical Officer), University of Dhaka Inspector Mr. Md. Salam, Head Quarter, Bangladesh Fire Service & Civil Defense (BFSCD), Dhaka.

Finally, the author is obliged to his parents & grateful to his wife, Shephali Chakraborty for their continuous inspiration and encouragement to shape the thesis present form.

Key Definitions

1. **Combustion:** A rag rid Chemical process that involves reaction of an oxidizer (usually oxygen in air) with an oxidizable material, sufficient to produce radiation effects i.e. heat or light.
2. **Combustible:** In a general sense any material that can burn. This implies a lower degree of flammability, although there is no precise distinction between a material that is flammable and one that is combustible.
3. **Fire:** A combustible vapor or gas combining with an oxidizer in a combustion process manifested by the evolution of light, heat and flame.
4. **Flammable:** In a general sense refers to any material that is easily ignited and burns rapidly. It is synonymous with the term inflammable that is generally considered obsolete due to its prefix which may be incorrectly misunderstood as not flammable (e.g. incomplete is not complete).
5. **Risk:** the combination of expected likelihood or probability (events/year) and consequence or severity (effects/event) of an accident.
6. **Hazard:** A hazard is a situation which poses a level of threat to life, health, property or environment.
7. **Fire hazard:** A fire hazard is any situation in which there is a greater than normal risk of harm to people or property due to fire.
8. **Risk:** Risk is generally defined as the uncertainly of loss. Fire loss is usually measured as number of deaths or dollars of property damage, but include, significant intangible losses such as business interruption, mission failure, degradation of the environment and destruction of irreplaceable cultural artifacts.
9. **Vulnerability:** Vulnerability is a condition. Vulnerability is predisposition .It applies to individuals, groups of individuals or communities, but it can be used also when referring to structures, etc. The poorer one is .the more one is predisposed to suffer damage when a negative event occurs. It is the predisposition to suffer damage due to external events.

Abbreviation

AAT	-	Arc Attribute Tables
ARC	-	Arcedit Module
BFSCD	-	Bangladesh Fire Service & Civil Defense.
CUS	-	Centre for Urban Studies
DCC	-	Dhaka City Corporation
DOE	-	Department of Energy
FEI	-	Fire Explosion Index
FEMA	-	Federal Emergency Management Agency
FHA	-	Fire Hazard Analysis
FMEA	-	Failure Mode and Effect Analysis
FRAM	-	Fire Risk Assessment Method.
FSES	-	Fire Safety Evaluation System
FTA	-	Fault Tree Analysis
GIS	-	Geographic Information System
HAZID	-	Hazard Identification
HAZOP	-	Hazard and Operability Study
IRFH	-	Index Relative Fire Hazardousness
ISO	-	Insurance Service Office
LIS	-	Land Information System
NFPA	-	National Fire Protection Association
PAT	-	Point or Polygon Attribute Tables
SCOPES	-	Specific Commercial Property Evaluation Schedule
SMA	-	Statistical Metropolitan Area
USFA	-	U. S. Fire Administration
UVP	-	Urban Volunteer Programme

Contents

List of Maps

List of Tables

List of Figures

Chapter-One

Chapter-One

1.1: Introduction:

The uses of fire have enhanced the human civilization to extreme heights. Fire has been used to provide heat in cold climate, cook food, to run machine and so on. Although other forms of energy are now often used to perform many of these functions, these alternative forms of energy can create fire in an unwanted manner while fire is indispensable to human society, failure to control it can unleash its inherent destructive power and cause great harm to society. Fire is then becomes a disaster.

Disasters are often categorized as being either natural or man-made. Fire is a form of disaster that can have its origin either in nature or in human activities. Whatever the case, fire is a phenomenon that usually involves a process of occurrence, spread in human countermeasures and then disappearance (Yan & Kubo, 1996). Fire can occur almost anywhere where inflammable materials are present, spread in any direction depending on topographic and climatic factors and elements on the ground and sustain itself for any period varying from a few minutes to days or weeks, depending on the fire load, effective countermeasures or natural deterrents before finally dying out.

Although other forms of disasters like cyclones and floods have overshadowed the threat from fire hazard, fires do cause considerable damage in our country. In Dhaka City much loss is caused every year due to incidents of fire and establishment of settlements, industries and expansion of trade and commercial activities with inadequate provision of mitigation facilities for fire hazard. Apart from human death and injury, damage of property in Dhaka City worth more than taka 6 crore on the average is caused by fires every year (Sayeeduzzaman,1990).

Bangladesh is known to be a land of hazards. Fire is both a natural and an artificial hazard. Due to unplanned and uncontrolled urbanization the physical growth of Dhaka has become a cause of concern with respect to a number of hazards. Fire is one of the most important of the hazards. It is a daily and regular occurrence in Bangladesh. Dhaka is a substantial fire prone area.

Urban fire occur primarily in cities or towns with the potential to rapidly spread to adjoining structures. These fires damage and destroy homes, schools, commercial buildings and vehicles.

A hazard is a situation which poses a level of threat to life, health, property or environment. Most hazards are dormant or potential, with only a theoretical risk of harm, however, once a hazard becomes 'active', it can create an emergency situation.

A fire hazard is any situation in which is a greater than normal risk of harm to people or property due to fire. Fire hazards can take the form of ways that fires can easily start, such as a blocked cooling vent or overload electrical system, ways fires can spread rapidly, such as an insufficiently protected fuel store or areas with high oxygen concentrations or things which in a fire, pose a hazard to people, such as materials that produce toxic fumes when heated or blocked fire exits.

Risk is generically defined as the uncertainty of loss. Fire loss is usually measured as number of deaths or takas of property damage but includes significant intangible losses such as business interruption, mission failure, degradation of the environment and destruction of irreplaceable cultural artifacts.

Vulnerability to natural hazards is an integral factor in understanding the true extent of risk. Although there is no single definition for vulnerability, it generally refers to the impact a hazard has on people, infrastructure and the economy. The concept of vulnerability is complex and cannot be comprehensively answered by a single research method. However, aspects of vulnerability to natural hazards can be measured which value-adds to hazard models and provides a greater appreciation of total risk. Exploring quantitative methods for assessing vulnerability is essential to ongoing risk research, in particular risk decision making which is a fundamental part of natural hazards risk management. Vulnerability factors can be divided into three main areas, physical, social and economic.

1.1.1: Causes of fires:

Prevention is better than cure and fire prevention is better than fire fighting. It is important that we understand how fires break out. Fires can occur when a source of heat and fuel react in oxygen.

Sources of heat: The sources of heat are as follows:

1. Electricity
2. Static electricity
3. Sparks
4. Friction
5. Mechanical heat
6. Chemical reaction
7. Compressed gas
8. Nuclear heat
9. Lightning
10. Flames

Fuels	Examples
1.Combustible solids	Wood tables, chairs, paper , jute, cotton etc
2.Combustible liquids	Petrol, paraffin, diesel ,methanol, ethanol etc
3.Combustible gases	Hydrogen, methane, butane, carbon monoxide.
4.Combustible metals	Sodium, potassium, calcium, magnesium etc

1.1.2: How and why fires happen:

We should understand how and why fire happens. The main contributing factors of fire are as follows:

1) Natural factor: Example- fire caused by a disaster or a natural factor.

2) Accidental factor: Example- Fire caused by negligence, carelessness of human error.

3) Incendiary factor: Example- fire caused by a deliberate of treacherous human act.

1.1.3: How fires spread:

Fires can spread in the following way:

1) **Conduction:** Metals such as copper, aluminium and steel are good conductors. These metals become hot when exposed to fire. The heat is spread along the length of the metal. If the metal is in direct contact with a fuel, the temperature of the fuel will rise to the ignition temperature where spontaneous combustion will come.

2) **Convection:** When fire occurs, the surrounding air is heated and expands ,thus becoming buoyant. The light air rises and is replaced by cool air, causing air circulation. This process transfers the hot air and other fire products to the upper floors through the lift shaft, escalator unprotected duct. This phenomenon will result in the vertical spread of the fire to the upper part of the building, thereby preventing the occupants from leaving the building.

3) **Radiation:** Fire spread can occur through radiation, Radiation is heat transferred through electromagnetic waves. When fire occurs, heat is transferred through radiation whereby heating up the surroundings and when a certain combustible is exposed to radiation becomes extremely heated to the point of ignition, the process of decomposition occurs and the combustible involved will spontaneously solf- ignite.

1.1.4: Fire classification:

Fire has been classified into four classes. (Ali, M, 2006: Fire Service & Civil Defense Week – 2006).

1) Class-A:

Fire involving solid hydrocarbon materials such as wood, paper, textile and rubbish, when a solid fuel is heated, combustible vapour/gases are released at the ignition temperature point. The vapours are ignited when they mix with oxygen.

2) Class-B:

Fires involving hydrocarbon liquid materials or liquids with a hydrocarbon composition such as petrol, gasoline, paraffine, naptha, diesel, asphalt and other petroleum products such as paint, varnish and turpentine.

3) Class-C:

Fires involving gases such as methane, propane, butane, hydrogen, acetylene and others which are combustible, when mixed with oxygen, these gases need only a spark to ignite a fire. The fire spreads quickly and may at times cause an explosion.

4) Class-D:

Fires involving metals such as potassium, sodium, calcium and magnesium, if the metal reacts with oxygen and ignites, it will burn quickly and release extreme heat.

1.2: Background:

The use of fire has been indispensable to man since the very inception civilization. Fire has been put to provide heat in a cold climate, to cook food, to run machine. While fire is essential for human society, failure to control it can unleash its inherent destructive power and cause great harm to society, Fire is then considered a disaster.

Natural disaster can be linked to human intervention into the environment if traced back through successive links in a chain of triggers. Fire is a form of disaster that can have its origin either in nature or in human activities. Whatever the case, fire is a phenomenon that usually involves a process of occurrence, spreading, human countermeasures and then disappearance (Yan and Kubo, 1996). Fires can occur almost anywhere where inflammable material are present, spread in any direction depending on topographic and climatic factors and elements on the ground and sustain itself for any period varying from a few minutes to days or weeks depending on the fire load, effective countermeasures or natural deterrents before finally dying out.

Although other forms of disasters like cyclone, earthquakes and floods have overshadowed the threat from fire hazard, fires do cause considerable damage in our country. Official records from the Fire Service and Civil Defense (FSCD) show that material damage due to fire in the greater Dhaka district alone were to the tune of Tk 384.59 million in 1997 (Quazi Md. Fazlul Haque, 2001). In Dhaka city much loss is caused every year due to incidents of fire and establishment of settlements, industries and expansion of trade and commercial activities with inadequate provision of mitigation facilities for fire hazard. Apart from human death and injury, damage of property in Dhaka city worth more than taka 6 crore on the average is caused by fires every year (Sayeeduzzaman, 1990).

Urban settlements are particularly vulnerable to fire hazard. Urban areas are characterized by intense human activities in production, transport, service provision etc and in virtually all these activities the danger of a fire breaking out exists to varying degrees.

Urbanization is taking place in Bangladesh very rapidly. Much of the measured urbanization is due to the migration into existing urban area from the countryside. Dhaka as the capital of Bangladesh is growing both in area and population since after the war of liberation of the country. Dhaka grew by 6.7 percent between 1970 and 1990 and grew by more than 3 percent per year between 1990 and 2000 which is much higher than the national growth rate. In recent days its area and population is increasing at a faster rate and it is expected to emerge as a megacity in 2015 (UNFPA, 1996), but this expansion of Dhaka City is taking place in a haphazard and unplanned

manner with little or no attention to the issue of land use planning, which leads to increased occurrence of fire hazard.

Still now, fire risk areas in the city have not been identified. Moreover, due to lack of segregation of land uses, traffic congestion and narrow roads, in many cases, fire- fighting vehicles cannot reach the site of fire in time. Again, due to lack of adequate mitigation facilities, i.e. shortage of water supply and filling up of water bodies in Dhaka City, fire fighting appears to be facing severe operational problems. Therefore, the city seems to have suffered from more severe fires in the recent period, compared to those in the past.

1.3: Objectives:

The principal objects of the research would be to explore the extent of current fire hazard vulnerability of the Dhaka Metropolitan. Area and to suggest mitigating measures. The specific objects of the case study are:

- to identify hazard areas/zones and their characteristics
- to determine the types of fire hazards.
- to examine the relationship of land use with incidents of fire.
- to measure the degree of vulnerability in terms of some indicators.
- to find out the reasons of fire hazard zones.
- to suggest mitigating measures
- to raise awareness in public about fire hazards.

1.4: Limitations of the Study:

The scope of the study is finite within the framework of fact finding towards identifying the characteristics of the zones of the Dhaka City Corporation where incidents of fire occurred, relationship of incidents of fire with land use, determining the possibility to occurrence of fire and developing a methodology for fire hazard mapping and assessing the performances of fire service station in extinguishing fire.

For the purpose of this research, only those fire incidents that were reported to fire service station or fire service headquarter have been considered. But there may have been other unrecorded fire incidents of fire in the study area during the specific time period.

The model of fire hazard vulnerability mapping has been developed for Dhaka City Corporation. Due to limitation of time and resources, the study was kept confined to only within the service of fire station for DCC zones. But the model can be applied for any part of the country.

The finding of the study would hopefully add to the knowledge and practice in planning & improvement of strategies for reducing fire hazard vulnerability in DCC of Bangladesh.

It is expected that the study will generate interest to among the future researchers to improve upon it taking care of others factors for reducing the vulnerability of fire hazard.

Chapter-Two

Chapter-Two:

Methodology:

In order to achieve the objectives of this study as described in the chapter one the following method was followed.

2.1: Research Design:

To fulfill the requirements of this research, the following research design was implemented:-

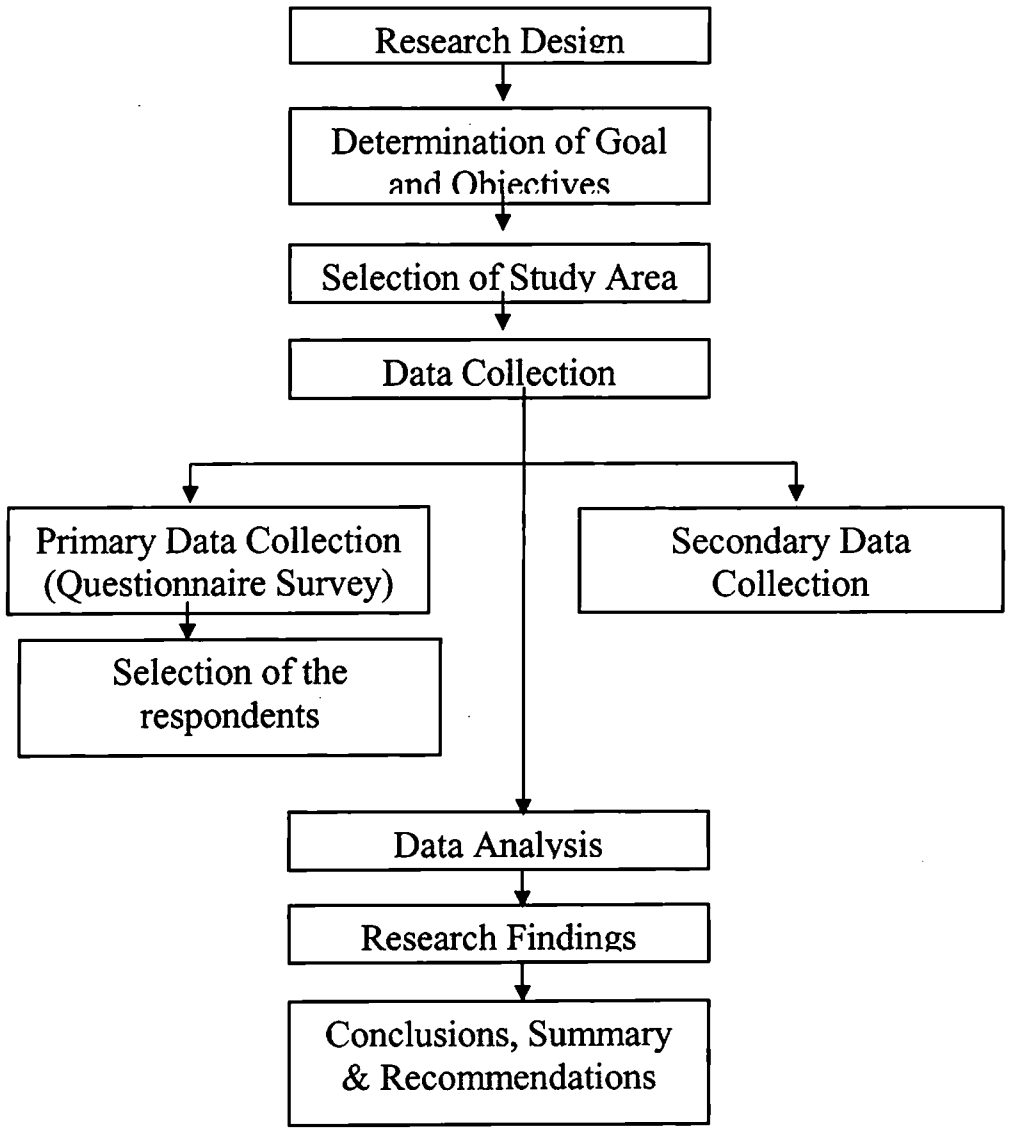
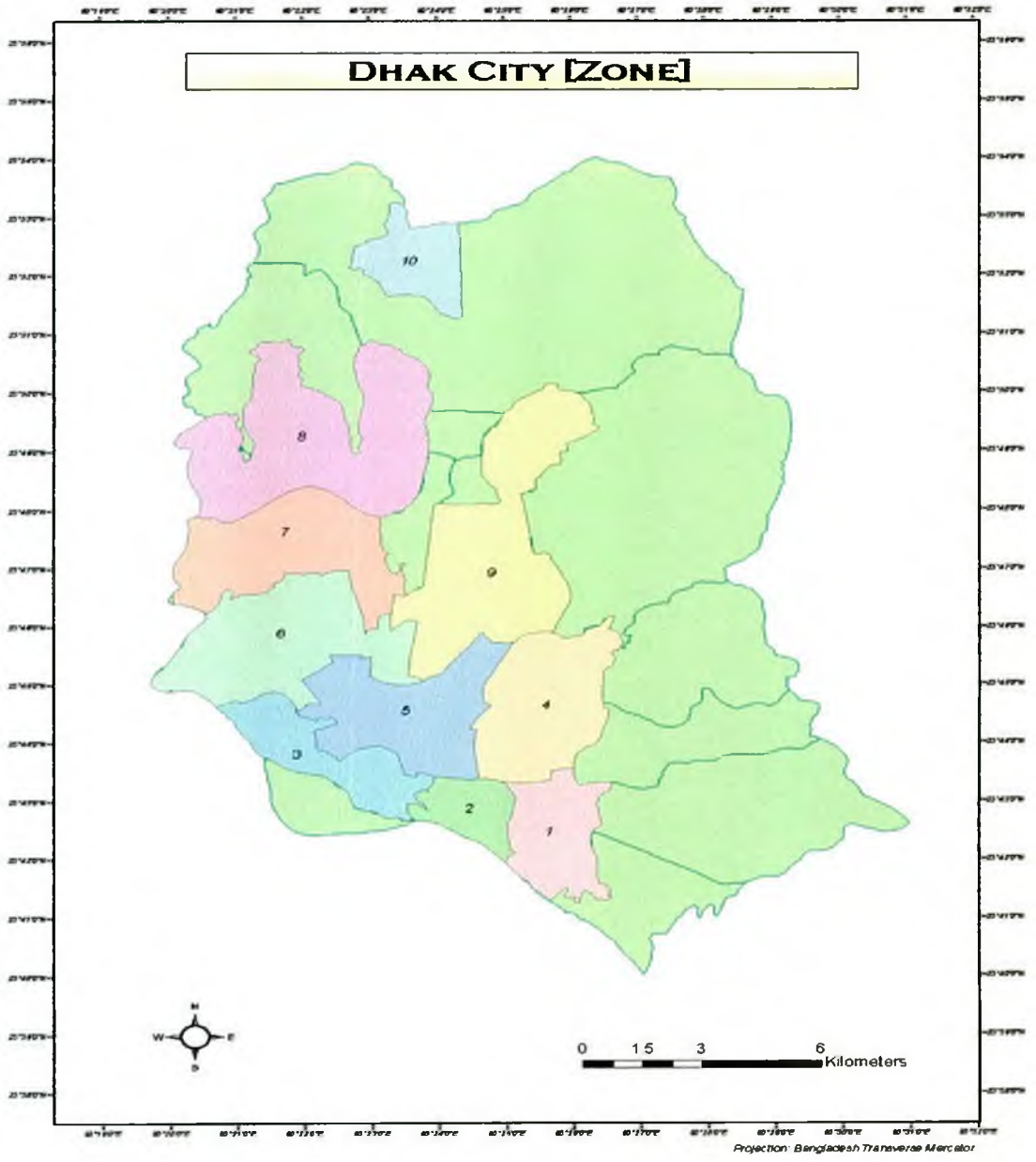


Figure- 1: Research Design

2.1.1: Selection of Study Area:

Dhaka city corporation area was selected for the study .It has a wide variety of land use and a diverse physical character. There are residential, commercial, some industrial and mixed land use in the area as well as a number of educational institutions. Some portions of the area are planned; the rest has developed in an unplanned organic fashion. This varied quality of the area would suit the purpose of the study.



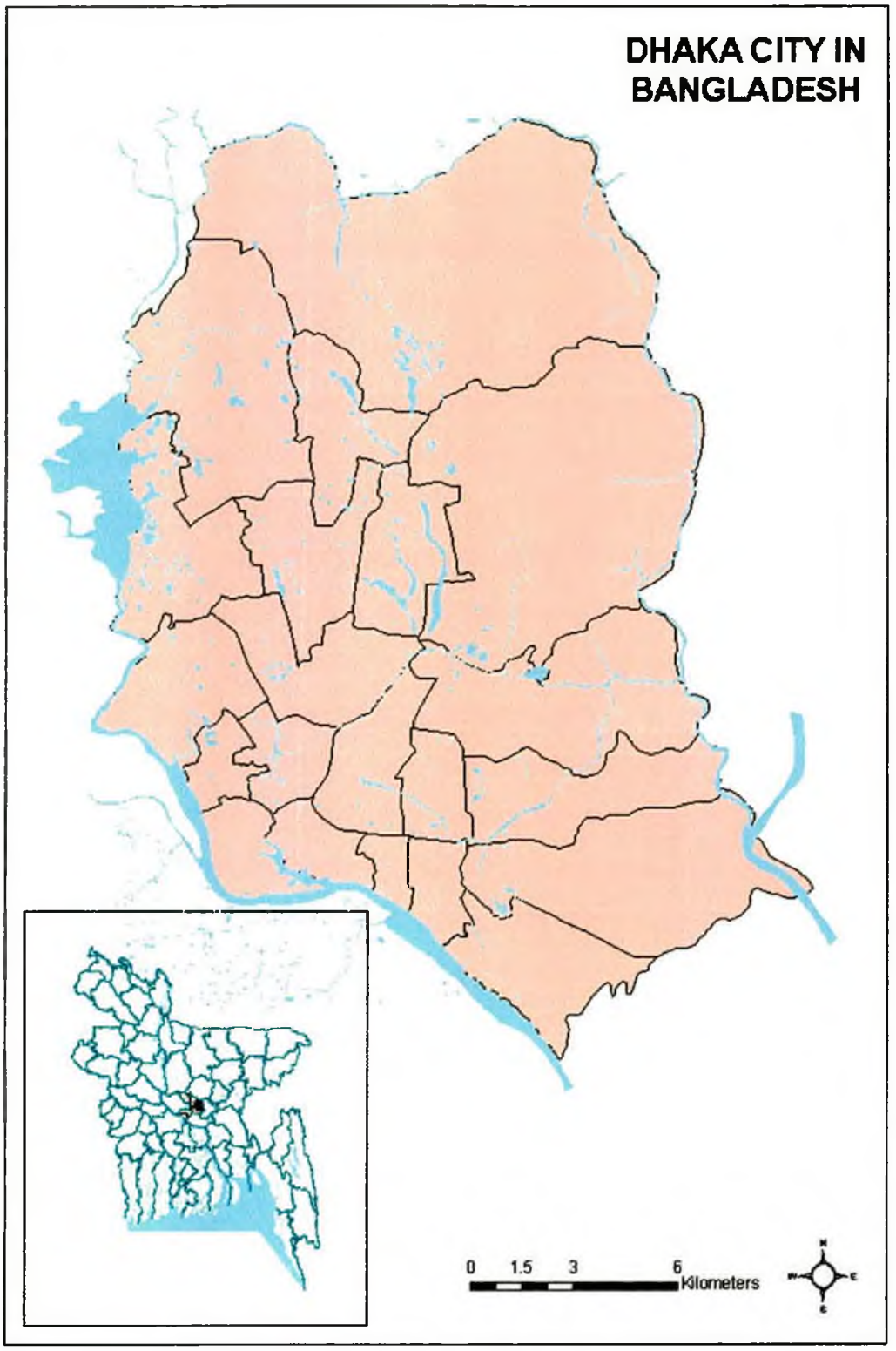
Map-1: Study area Dhaka City Corporation.

2.1.2: Historical and Geographical Background:

History of Dhaka stated in the 1st Millennium but did not rise to prominence until the 17th century when it served as Mughal capital of Bengal Province,from 1608 until 1639 and later again from 1660 until 1704. It was the centre of a flourishing sea trade, attracting English, French and Dutch traders. With the removal of the provincial capital in 1704 to Murshidabad and the decline of the Muslim industry, Dhaka entered a period of decline. It passed under British control in 1765, was constituted a municipality in 1864, but continued to decay until it was designated capital of Eastern Bengal and Assam province (1905-1912). During the early 20th century, Dhaka served as a commercial centre and seat of learning. In 1947, it became the capital of

East Bengal province and in 1956 of East Pakistan. Dhaka suffered heavy damage during the war of independence in 1971, but emerged as the capital of Bangladesh. Over the past decade Dhaka has had the highest population growth rate of any major city in the world. With more than 13 million inhabitants with an area of 1,353 km2, it is now the 8th largest city of the world and by 2015 it is forecast to be the world's second largest with around 23 million people. At present Dhaka mega city comprises one City Corporation and 5 municipalities. These are Dhaka City Corporation (DCC) and municipalities of Narayanganj, Kadamrasul, Savar, Tongi and Gazipur.

DCC is centrally located and have all major administrative offices and central business districts. The city is also surrounded by a river system comprising the Buriganga, Balu, Turag and Shitalakhya rivers. The physical growth of the city basically started from the current extreme south and advanced along the Buriganga River and then expanded towards the west (Hazaribagh) and the east (Gandaria) and later to the north Mirpur).Development of industries, commerce and business, housing and infrastructure is being occurred in the last few decades along with population growth. This growth has significantly expanded the city's physical.



Map-2: Dhaka City Corporation

Boundary all around but not at the same scale. Core service providing agencies are facing difficulties to meet enormous demand of the growing population and sometime is going beyond their capacity. As a result, key components of the city environment both physical and social are greatly impacted and most of them are in a continuous trend of deterioration.

Dhaka is the capital of Bangladesh and the principal city of Dhaka District. Located on the banks of the Buriganga River, Dhaka, along with its metropolitan area, has a population of 11 million, making it the largest city in Bangladesh. Dhaka is located in central Bangladesh at 23°42′0″N, 90°22′30″E, on the eastern banks of the Buriganga River. The city lies on the lower reaches of the Ganges Delta and covers a total area of 815.85 square kilometres (315 sq mi). It consists of seven principal thanas-Dhanmondi, Kotwali, Motijheel, Paltan, Ramna, Mohammadpur, Sutrapur, Tejgaon and 14 auxiliary thanas-Gulshan, Lalbagh, Mirpur, Pallabi, Sabujbagh, Dhaka Cantonment, Demra, Hazaribagh, Shyampur, Badda, Kafrul, Kamrangir char, Khilgaon and Uttara. In total the city has 130 wards and 725 mohallas. Water bodies and wetlands around Dhaka are facing extinction as these are being filled up to construct multi-storied buildings and other real estate developments.

2.2: Collection of Data/Information:

i. Literature Survey:

Survey of relevant literature has conducted for obtaining a thorough understanding of the problem. Special attention was given to risk /hazard analysis /assessment in this study with data from secondary sources. Relevant reading materials have been collected from various organizations such as Federal Emergency Management Agency (FEMA), U.S. Fire Administration (USFA), National Fire Protection Association (NFPA), etc and relevant organizations in Bangladesh .Besides, the internet was explored to obtain relevant information about fire hazard analysis.

ii. Collection of data from BFSCD :

The study was based on data covering 389 events of fire which took place in Dhaka city and were reported to BFSCD in 2005. The registers of the control room of the Headquarters of BFSCD were taken as the basic source of data used in this study. The dependence on this very source followed from (a) appearance of a convincing degree of validity of number of fire reports randomly copied from the registers (b) The assurance that all fire stations of Dhaka city abide by a standing order that they are to report to Headquarters through telephone or wireless immediately after receive a fire call from any source.

iii. Collection of Base Map:

Cadastral survey (CS) map which was used as base map had been collected from the Geographic Solution Research Centre (GSRC, Dhaka).

iv. Primary Data:

A set of questionnaire was prepared to collect data /information for the subject under study. The questionnaire was prepared for collection of information about the instruments and manpower of the fire stations. A checklist of the aspects included in the questionnaire is presented in the Annexure.

v. Field Survey:

The field survey was conducted to identify the locations where incidents of fire occurred. During the survey work, location of fire service station, garments industry, filling station, shopping centre, slums etc also been identified.

2. 3: Digitization of Spatial Data and Database preparation:

Spatial data collected from field survey and other relevant sources were then digitized and prepared for further progress and analysis. The different steps of digitization and data base preparation are discussed below:

a) Digitization of spatial data:

The base map and transportation network map collected from secondary sources have been digitized as different coverages. Broad land use data of the area including settlements, industrial and residential areas and water bodies and different locations where incidents of fire occurred as identified from the field survey were digitized in two separate coverages.

b) Editing Digitized Data and Removing Errors:

The digitized maps were not free from errors. To remove the errors the digital maps were edited with the application of different editing commands of the Arcedit module of pc ARC/INFO.

c) Building Topology:

The CLEAN and BUILD commands have been executed after removing errors to build topology. After cleaning and building topology PAT(Point or Polygon Attribute Tables) and AAT(Arc Attribute Tables) have been prepared for further analysis.

Chapter-Three

Chapter Three:

3: Review of Literature:

3.1: Relevant Fire Researches

3.1.1: Early History of Fire Research

Until the 1970's there had been a limited amount of research in the field of structural fire prevention. On the other hand, there had been some excellent research in forestry fire prevention. A great deal of research effort has been expanded in both structural and forest fire prevention during the last quarter of the 20th century.

A revealing research project was conducted in the 1950's by the Ithaca (New York), Fire Department. The department decided to have feature articles written for the local newspaper to depict dangers inherent in the use of portable kerosene heaters and also to discourage its use. They learned that the newspaper campaign was of practically no value in reducing fire losses (Robertson, 1989). As a result of this experience, a survey was conducted to determine the newspaper reading habits of the individuals with the portable heater problem. An analysis of the city's fire records showed that practically all of the fires involving portable heaters occurred in lower-income residences. But most of them did not read the feature page of the newspaper.

3.1.2: U.S. Forest Service Fire Prevention Research

The Forest Service of the United States Department of Agriculture has carried out a number of excellent fire prevention research projects. Among them, the significant researches are: (i) smoking regulation sign (Folkman, 1965), (ii) children with matches (Folkman, 1966), (iii) public awareness of fire prevention importance (Folkman, 1965), (iv) research in fire prevention promotion and enforcement (LaMois, 1961), (v) research on arson fire (Bradshaw and Huff, 1985) etc.

3.1.3: High Risk Area Research in U.S.A.

New Orleans was the site of two significant research projects in fire prevention carried out with US federal government support. Both the studies were conducted by

Planning and Research Associates, Inc. with the assistance of the New Orleans Fire Department. The researches are:

The first study concentrated on the human factor in high risk urban neighborhoods (Planning and Research Associates, Inc.,1976), The goal of the study was to determine the economic, cultural, and demographic variables related to fire occurrence in a high fire risk urban residential area. The findings of the study are as follows: (1) the types and kinds of fire in the study area were similar to those found in high-risk areas in other cities, (2) fires are primarily caused by careless behavior, by tolerant attitudes towards trash and debris and behavior of juveniles and vagrants, and (3) fire proneness in the result of some human factors with specific sub-cultural characteristics such as (i) lack of strong spirit of the community, (ii) lack of fire safety training, (iii) lack of practice of fire precautions, (iv) lack of fire fighting facilities, and (v) an attitude towards fatalism towards fire.

The second study was on fire prevention program planning in a social action perspective. It was an exploratory study of knowledge, attitudes and leaders in a high fire risk area of New Orleans, Louisiana (Planning and Research Associates, Inc., 1977). The study attempted to determine what social action could be initiated at the local level to reduce the rate of fires and fire losses in residential areas with high-risk characteristics. It was found that there was often a distrust of outsiders in neighborhoods. There was also a fear of involvement and distrust of programmes as well as a casual attitude towards fire prevention. It was also found that the residents of the area studied has a strong awareness of fire prevention programmes at the city level.

3.1.4: Fire Research in Australia

Jordan (1989) developed a fire hazard assessment model for the Country Fire Authority (Victoria), Australia. In developing the model he used the product of fire frequency and average sum insured, as the determinant of the level of fire hazard proneness of any property. Due to the absence of detailed damage statistics, he used the average sum insured for any property as the prime indicator of the consequence that may result if that property is under fire.

3.1.5: Research on Investigating City Characteristics and Residential Fire Rates

Tridata Corporation (1998) conducted a research on city characteristics and residential fire rates for United States Fire Administration (USFA), Federal Emergency Management Agency (FEMA) and National Fire Data Center. Objective of the study was to identify relationship between city characteristics and residential fire rates and also to help identify and clarify relationships between characteristics of people and places and fire risk. The causes included fire due to arson, children playing, careless smoking, cooking, heating, electrical distribution, appliances, and open flames. This represented that eight leading causes of fire account for over 90 percent of all residential fires in the U.S.A Predictions about the relationship between city characteristics and city fire rates were tested by computing correlation coefficients and performing multiple regression analysis. It was found from the study that a high proportion of all fires that occur in the residential structures are directly attributable to human activities. Among the major findings of this study are: (i) particular city characteristics were found to be strongly related to fire rates. Cities with worse climates and older housing stocks had a greater likelihood of fire, (ii) fires due to arson, children playing, careless smoking, heating, and electrical distribution were found to be strongly related to at least one city characteristic, and (iii) cooking fires were not found to be strongly related to city characteristics.

3.1.6: Fire Hazard Research in Bangladesh

It was found from the literature survey that so far only two studies have been conducted on fire hazard in Bangladesh. One dealt with fire hazard analysis and the other concentrated on fire safety.

The only known research relating to fire hazard analysis in Bangladesh had been conducted by Sayeeduzzaman (1990). The main objective of this study was to develop a model to classify Dhaka SMA according to an index of relative fire hazard of various thanas and also to present a fire hazard assessment model and to delineate the fire hazard zones identified by the model to help identify area-specific mitigation strategies.

An Index of Relative Fire Hazardousness (IRFH) was developed in this study as a product of fire frequency and mean fire duration. It was found from the study that

the higher population density accompanied by congestion, and lack of segregation of land use appeared to augment the probability of incidents of fire hazards. According to the findings of the study, higher mean duration has been observed in those thanas which are located in the peripheral regions of Dhaka SMA. According to the researcher, lower mean duration was mainly due to easy access to fire fighting services. But since access was not correlated with duration of fire in the study, the basis of this claim is dubious. The study area was classified into four-hazard zones viz. (a) highly hazardous zone, (b) moderately hazardous zone, (c) less hazardous zone, and (e) least hazardous zone. The IRFH was also correlated with the density of population, and the result suggested that higher population density, with consequent congestion, have a significant role to play in determining the fire hazard of areas.

Another study was on developing criteria for fire safe shopping centres in Dhaka City, which had been conducted by Hossain (1995). The objectives of the study was to establish design guidelines on fire prevention, precaution and control measures of substandard shopping centres of Dhaka City, and also to set standards that might be included into building legislation and growing general awareness to encourage holistic approach against the current unsafe growth of shopping centres.

Qualitative standards of fire safety were developed in this study to provide gridelines to an appropriate design for fire prevention, precaution and control measures in planning shopping centres of Dhaka City. In establishing the design guidelines and standards the researcher reviewed the history of commercial growth, particularly of shopping centres in Dhaka City including the role of public agencies in controlling the growth of shopping centres and also the history of shopping centres in the developed countries. Fire science and fire safety aspects, legislation relating to shopping centres in UK and in Bangladesh also had been reviewed. The researcher also surveyed several aspects of shopping centres such as location, site, access, parking space, existing facilities, physical aspects of building service lines, fire incidents and fire safety measures and so on. Finally the researcher compared the situation of shopping centres of Bangladesh with that of developed countries and recommended design guidelines and set standards of building regulation.

3.2: Fire Hazard Analysis

3.2.1: Definition of Urban Fire and Hazard:

Urban Fires in cities or towns involve buildings with potential for spread to adjoining structures. Although the statistics show a decline in fire casualty rates in recent years, the U.S. rate remains much higher than the yearly reported fire death and damage rates for Australia, Japan and most of the Western European countries. The urban fire hazard in Kent involves areas where single family homes, multifamily occupancies and /or business facilities are clustered close together, increasing the possibility of rapid spread to another structure. Other areas are characterized by adjoining buildings. Adjoining buildings are found in the downtown region of the city or include other closely spaced wood frame structures. The causes of fires in urban areas usually includes one of the following:

- Criminal acts (arson, illegal explosive devices, acts of terrorism)
- Residential accidents (improper use of electrical appliances, faulty connections, grease fires, smoking, heating appliances or improper disposal of wood ashes)
- Industrial accidents (hazardous material incidents, explosions, transportation accidents)
- Acts of nature (lightening strikes, earthquake byproduct)

3.2.2: Hazard Identification and Vulnerability Assessment:

A fire hazard is any situation in which there is a greater than normal risk of harm to people or property due to fire. Fire hazards can take the form of ways that fires can easily start, such as a blocked cooling vent, or overloaded electrical system, ways fires can spread rapidly such as an insufficiently protected fuel store or areas with high oxygen concentrations or things which in a fire, pose a hazards to people, such as materials that produce toxic fumes when heated or blocked fire exits.

1. The purpose of hazard Identification is to support development of scenarios that produce undesirable unwanted impacts, followed by selection of scenarios for use in assessment.

2. The threat posed by a hazard is an appropriate basis for defining a fire scenario or type of scenario worthy of consideration.

3. Identification of hazards must fit within the goals and objectives.

In Washington State, 38 percent of identified structure fires occur where people live and 75 percent of all fire deaths occur in homes. People are more at risk from a fire where they feel safest, where they live. The leading causes of residential fires in Washington State are from heat from properly operating electrical equipment, matches or lighters, electrical short- circuit or arc and heat from wood/ paper fueled equipment.

Heat from properly operating electrical equipment includes electric stoves, electric heaters and other electrical appliances. Cooking is a leading cause of residential fires and home heating is the second leading cause as reported to the United States Fire Administration through the National Incident Reporting System. In Washington State, more than 24 percent of residential fires start in the kitchen cooking area. Fires caused by home heating are usually caused by portable space heaters. In Washington State, fires from wood or paper fueled equipment are also significant. The chimney is the third leading area of fire origin.

Hotels, businesses and educational buildings follow as the next leading building in which fires occur. These occupancy classes and others have special considerations that must be understood in order to protect citizens from fire dangers. Large assemblies such as coliseums, retail facilities and shopping malls are the types of buildings that make communities unique. Communities activities often concentrate large numbers of people, creating the risk of large loss of life should a fire occur. To help these buildings be safe from fire, the Uniform Fire Code's international fire safety requirements have been adopted Washington State.

Arson is a violent crime against people. Arson when combined with suspected arson was the leading cause of fire deaths in Washington State in 1998. Arson and suspected arson killed one of every eight people who died in a structure fire during that year. There were a total of 1113 arson fires in Washington State in 1998.

Urban communities with newer industrial and business facilities are reasonably secure from potential conflagration. These buildings are generally constructed of fire

resistive material, protected with automatic sprinkler systems, and reasonably well separated. Although a major fire may occur in such facilities, it would most likely not spread into adjoining structures. This observation is based on the following:

- The Uniform Fire Code has required sprinklers in certain industrial and business buildings since 1985.
- Fire extinguishing and fire detection systems were installed during construction.
- Fire stations are strategically located nearby.

In Washington State, 7 percent of all fires involve vehicles, an increasingly large share of total fires. Fires occurring in the engine, running gear and passenger areas account for 77 percent of vehicles fires start in engine compartments, brake systems, by driver or passenger smoking.

3.2.3: Types of Hazards & Events

1. A hazard is a condition or situation with potential for undesirable consequences. As such a hazard is a characteristic of something. If a hazard relates to a physical object, the hazard will normally be more specifically definable as a physical or chemical state. If a hazard relates to a person or a group the hazard will normally be definable in terms of a state. If a hazard relates to a person or a group, the hazard will normally be definable in terms of a state of knowledge, attitude or belief. A fire hazard is a hazard whose undesirable consequences arise from unwanted fire.

2. If the potential for undesirable consequences manifests in an occurrence, that constitutes an 'event'. A fire scenario is a fire incident characterized as a sequence of events.

3. In a fire scenario, the last event is called the 'outcome'.

4. A strategy to reduce the frequency of an initiating event (i.e. fire ignition) is a 'Prevention' strategy. A strategy to reduce the severity of a fire that has not been

prevented is a 'mitigation' strategy, sometimes also called a 'fire protection strategy'.

5. Hazards can be addressed by fire protection measures (hardware) and/or by management systems (Software) by engineered or by safety management procedures.

6. The undesirable consequences (e.g., injury, property damage, business interruption, environmental impact) that occur are called the 'impact' of the scenario. Undesirable consequences are typically associated with the outcome but can also be associated with any of the prior events.

3.2.4: Hazard Identification Process

1. The process of identification of hazards typically includes a review of fire events in similar occupancies, a walk-through of the building or other space of concern of similar occupancies, and fire protection engineering judgment. The review of past fire events is logically the first step in the process, but it is unlikely that past fire events will capture all possible hazards.

2. Identifying hazards through a systematic hazard analysis process encompasses detailed analysis of system hardware and software, the environment in which the system will exist and the intended usage or application.

3. It is important to identify not only hazards currently in place but also past hazards that could recur and foreseeable future hazards (e.g., future fuel packages).

4. The hazard identification process needs to identify initiating hazards, enabling conditions, and vulnerabilities, which are described in the next steps.

3.2.5: Initiating Hazards

1. **Heat sources.** One type of initiating hazard is defined by a type of heat source and an associated status of that heat source.

   A. Types of heat sources. Any object that emits sufficient heat to ignite combustibles, based on proximity and ignitability, is by that fact an

initiating hazard, having potential to initiate an unwanted fire. Candidate heat sources can be of a type specific to the kind of building being analyzed and the activity conducted there or generic heat sources found in any building. Examples of such hazards include the following:

- ❖ Cigarettes or other smoking materials (e.g., lighters, matches)
- ❖ Torch, hot work, or other open flame devices.
- ❖ Heating, refrigeration, and air conditioning equipment.
- ❖ Cooking equipment
- ❖ Tools and appliances
- ❖ Process or service equipment, including separate motors or internal combustion engines.
- ❖ Electrical distribution equipment (e.g., wiring, switches, outlets, cords and plugs, light fixtures, transformers).
- ❖ Hot object, most of which also fall into one of the above categories, such as a light bulb or the heating surface of heating equipment.
- ❖ Vulnerability to lightning or static electricity.
- ❖ Chemicals capable of spontaneous heating
- ❖ Wildfire or other exterior exposure fire.

B. Heat source status. Heat source status is a factor in the relative potential of a hazard to initiate an unwanted fire, and so identified initiating hazards should have their status identified as well, in order to support frequency estimation. Examples of heat source status conditions that can imply a heightened potential include the following:

- ❖ Physically damaged equipment or other heat source.

- ❖ Improperly designed equipment or other heat source (e.g., cigarette with heightened ignition strength).
- ❖ Improperly installed equipment or other heat source.
- ❖ Improperly used or applied equipment or other heat source (e.g., overloaded equipment not rated for application)
- ❖ Equipment or other heat source that shows signs of overheating in normal use of (e.g., by touch, smell, or sight such as smoking).

C. **Hazards that create heat sources.** Some hazards are not heat sources themselves but are hazards whose potential is to create heat sources. Earthquakes or floods can damage containers or reticulation pipe work and release flammable liquids or gases while also damaging electrical equipment and creating short circuits. Floods can also directly ignite water-reactive chemicals or solids. Earthquakes can cause unanchored, gas-fired water heaters, ovens, or industrial heat exchangers to topple. Floods can cause igniters in gas-or oil-fired ovens or heaters in low-lying areas to be extinguished intermittently, promoting delayed gas ignitions in confined spaces. Examples of such natural and other indirect hazards include the following:

- ❖ Earthquake
- ❖ Storm (e.g., hurricane, tornado, rain, snow, hail)
- ❖ Flood
- ❖ Other natural hazards
- ❖ Vehicle impact.

Conditions that create heat sources need not do so suddenly or due to catastrophic events. For example, a steady but not severe rainfall can lead to an accumulation of water in an improperly sealed conduit or junction box, and that accumulation can then result in electrical short circuits.

2. **Fuel sources.** One type of initiating hazard is defined by a type of initial fuel source and an associated condition of that fuel.

A. **Types of fuel sources.** Any combustible item capable of being ignited by a heat source, subject to proximity and heat intensity, is an initiating hazard, because it has the potential to initiate an unwanted fire. Candidate fuel sources can be of a type specific to the kind of building being analyzed and the activity conducted there or generic fuel sources found in any building. Examples of such hazards, defined by a combination of the purpose of the object and the composition of the object, include the following:

- ❖ Upholstered furniture
- ❖ Mattresses, bedding, clothing, or other textile-based products
- ❖ Wooden furniture or exposed structural elements
- ❖ Books, magazines, papers, ordinary trash
- ❖ Flammable or combustible liquids or gases
- ❖ Plastic appliance housings or other plastic components of contents or furnishings.
- ❖ Sources of combustible dusts (which can be airborne or deposited on surfaces)
- ❖ Stored combustible goods
- ❖ Cleaning supplies
- ❖ Room linings (e.g., ceiling, wall, or floor coverings)
- ❖ Concealed combustibles (e.g., insulation, wiring)
- ❖ Chemicals in a reaction process.

B. Condition of fuels. Condition of fuels is a factor in the relative potential of a hazard to initiate an unwanted fire, and so identified initiating hazards

should have their condition identified as well, in order to support frequency estimation. Examples of such conditions that can imply a heightened potential include the following:

- ❖ Proximity to heat sources
- ❖ Faulty design that increases ease of ignition or decreases fire performance if ignited.
- ❖ Ignitability of form
- ❖ Pre-ignition damage to combustibles (e.g., vandalism of upholstered furniture, exposing filling material) that increases ease of ignition or reduces fire performance of product if ignited.
- ❖ Presence or absence of fire-resistant barriers (e.g., containerization, barrier layers)
- ❖ Presence or absence of flame-retardant treatments.

3. **Hazardous practices.** Any practice or behavior that makes ignition more likely is an initiating hazard. Examples of such practices and environments include the following:

- ❖ Inadequacy of hot-work or other processes and activities involving active use of potential heat sources.
- ❖ Inadequate security (e.g., easy access for arsonists or other fire-setters)
- ❖ Inadequacy of maintenance practices (e.g., increasing the probability of equipment failure).
- ❖ Inadequacy of personnel training in safe practices.

4. **Hazardous environments.** An condition or environment that invites or encourages hazardous practices or that makes a degradation in heat source status or fuel condition more likely is a hazardous environment and hence an initiating hazard. Such an environment does not manifest as fire ignition but as

events that create the hazards that manifest as fire ignition. Examples of such practices and environments include the following:

- ❖ Attractiveness to potential terrorists or other fire-starters (e.g., attractive nuisance)
- ❖ Presence of oxygen-enriched atmosphere
- ❖ Vulnerability to damage from earthquake, flood, or other natural hazard.

3.2.6: Fire Hazard Analysis

Historically, most fire safety regulations have been on the basis of fire hazard analysis, where such assessments were based on the judgment of "experts". Today formal, scientifically based fire hazard analysis (FHA) is common and increasingly being required as a means to avert certain outcomes, regardless of their likelihood. Hazard analysis can be thought of as a component of risk analysis.

3.2.6.1: Steps in Performing an FHA

Performing a FHA is a fairly straightforward, engineering analysis. The steps include (Bukowski, 1997):

1. Selecting a target outcome
2. Selecting an appropriate method(s) for prediction
3. Analyzing the impact of exposure
4. Accounting for uncertainty

3.2.6.1.1: Selection a Target Outcome

The target outcome most often specified is to avoid fatalities of occupants of a building. Another might be to ensure that fire fighters are provided with protected areas from which to fight fires in high-rise buildings. The U.S. Department of Energy (DOE) developed a set of objectives for performing an FHA for all DOE facilities (U.S. DOE, 1991). In Boston, the Office of the fire Marshal has also established a set

of objectives for FHAs performed in support of the prescriptive requirements of the applicable code.

3.2.6.1.2: Selection an Appropriate Method(s) for Prediction

Fire models: A recent survey (Friedman, 1991) documented 62 models and calculation methods that could be applied to FHA. Thus the need is to determine which ones are appropriate to a given situation and which are not. The key to this decision is a thorough understanding of the assumptions and limitations of the individual model or calculation and how these relate to the situation being analyzed.

Fire is a dynamic process of interacting physics and chemistry; so predicting what is likely to happen under a given set of circumstances is daunting. The simplest of predictive methods are the algebraic equations. Often developed wholly of in part from correlations to experimental data, they represent, at best, estimates with significant uncertainty. Yet, under the right circumstances, they have been demonstrated to provide useful results, especially where used to assist in setting up a more complex model.

Even if the model is correct, the results can be seriously in error if the data input to the model does not represent the condition being analyzed. Proper specification of the fire is the most critical, and was addressed in detail in the preceding subsection on selecting the design fire(s). Next in importance is specifying source of air supply to the fire.

3.2.6.1.3: Analyzing the Impact of Exposure

In most cases, the exposure will be to people, and the methods used to assess the impacts of exposure of people to heat and combustion gases involves the application of combustion toxicology models.

3.2.6.1.4: Accounting for Uncertainty

Uncertainty accountability refers to dealing with the uncertainty that is inherent in any prediction. In the calculation, this uncertainty is derived from assumption in the models and from the representative ness of the input data. The FHA report should include a discussion of uncertainty. This discussion should address the representative

ness of the data uses and the sensitivity of the results to data and assumptions made. If the sensitivity is not readily apparent, a sensitivity analysis should be performed.

Finally it can be said that quantitative fire hazard analysis is becoming the fundamental tool of modern fire safety engineering practice, and is the enabling technology for the transition to performance-based codes and standards.

3.2.7: Tools For Hazard

There are several tools and techniques that practitioners can employ to carryout hazard assessment and some components

Therein could assist in hazard identification. Such tools include but are not limited to the followings:

1. **HAZOP:** Hazard and operability study (HAZOP) uses a deliberately chosen balanced team to systematically brainstorm the plant part by part and to review how affect the situation.

   Consistency between team members is supported by the use of standard terminology and choices for observed conditions and other variables. Appropriate remedial action is then agreed.

   HAZOP requires a full description of the design (up-to-date engineering drawings, line diagrams, plan views etc.) and a full working knowledge of the operating arrangements.

   AHAZOP is usually conducted by a team that includes designers and operators (including plants, process, maintenance and instrumentation staff) as well as the safety engineer/officer.

   Hazard identification techniques similar to HAZOP include HAZID (Hazard Identification) and the consequences only component of HAZAN (Hazard Analysis)

2. **FMEA:** While HAZOP and Similar techniques identify the hazards in Failure mode and effects Analysis (FMEA), the cause of the hazard is evaluated from knowledge of equipment failure, error modes or damage mechanisms.

FMEA consists of assessing the effect of each component part failing in every possible mode. The process consists of defining the overall failure modes (usually more than one) and then listing each component failure mode that contributor to it.

Failure rates are then assigned to each component level failure mode and the totals for each of the overall modes are obtained.

3. **Fire Safety concepts Tree:** NFPA 550, Guide to the Fire Safety Concepts Tree, describes a "Success Tree" the inverse of a fault tree. Its paths define all the possible strategies for achieving success in meeting fire safety objectives. The means of mitigating any fire hazard can be identified with the fire safety concepts tree.

4. **Fault Tree Analysis (FTA):** The output of a FMEA is often in corporate in a graphical network model known as a fault tree. This tool identifies all credible ways that a specified undesired event can occur. It portrays various parallel and sequential combinations of faults that will result in a predefined undesired event. These faults may be associated with initiating events, component hardware failures or human errors. A fault tree depicts logical interrelationships of basic events that lead to the top event in the tree the undesired event.

5. **What If Analysis:** What If Analysis is a simplified technique that involves asking what happens if a particular failure or event occurs. The answer will be an opinion based on the available knowledge of stake holders answering the question. The process can be enhanced by brain storming among multiple stakeholders. The method seeks consistency through use of standardized questions regarding practices conditions and failure modes of equipment. Appropriate remedial action is then agreed. The "What If Analysis" team usually includes designers and operators as well as the safety engineer/officer.

3.3: Fire Risk Analysis

Fire risk analysis is the most comprehensive form of analysis that can be applied to any fire safety choice. It provides a flexible framework for estimating the impact of any type of fire safety programme of strategy in terms of actual reductions in

loss-deaths, injuries, property damage-and in terms that can be compared to the costs of those programs and strategies.

A measure of fire risk always has two parts: (1) a measure of severity (2) a probability distribution. The severity measure may also be separated, for the sake of clarity, into two parts. The first part is a specification of the scale that measures severity. The second part is a specification of the rules for calculating the specific severity measure to be used for particular fire. The probability distribution gives a probability for each value that the severity measure can take. Most often, a probability distribution gives a probability for every type of fire, and then rules for calculating the value of the severity measure for each type of fire provide the translation to a probability distribution for the measure of severity.

Three key elements of the fire risk analysis approach are; (1) the explicit estimation of all relevant probabilities, (2) the use of well-defined measures of severity, and (3) the explicit consideration of the uncertainty attached to all estimates developed in the analysis.

The term fire risk analysis has sometimes been used to refer to an exercise of listing locations under the jurisdiction of the analyst that present the greatest potential for fire damage of for demand on fire suppression resources. Fire risk analysis can sometimes be separated into (1) risk estimation and (2) risk evaluation. Risk estimation includes the estimation and analysis of the measures of severity and probability and their associated uncertainties. The most common approach to risk evaluation is cost-benefit analysis, a technique in which all benefits of risk reduction are translated into monetary equivalents. A variation is cost effectiveness analysis, in which the benefits of risk reduction are translated into a single non-monetary scale.

3.3.1: Methods of Fire Risk Assessment

Formal fire risk assessment evolved with the insurance industry in the 19th century. However, in the last few decades, there has been a move to develop more wide spread analytical procedures. Methods of fire risk analysis may be classified into four analytical procedures. Methods of fire risk analysis may be classified into four categories: (1) narratives, (2) check lists, (3) ranking, and (4) probabilistic methods (Watts, 1981).

Narratives: In the narrative risk assessment procedure, the information is presented in the form of descriptions of various hazardous conditions and ways to reduce or eliminate them. Narratives do not attempt to evaluate the fire risk quantitatively, rather, a risk is judged acceptable if it complies with published recommendations.

Checklists: A common accessory of fire safety is listing of hazards and recommended practices. These checklists are valuable tools for identifying fire risk factors. Checklists attempt to identify important fire risk features.

Ranking: Quantitative fire risk assessment originated with the insurance rating schedule. The approach has broadened to include a wide variety of applications (Marchant, 1984; Nelson, 1988; Watts, 1992). In general, fire risk rating schedules assign values to selected variables based on professional judgment and past experience. The selected variables represent both positive and negative fire safety features and the assigned values are then operated on by some combination of arithmetic functions to arrive at a single value. This single value can be compared to other similar assessments or to a standard to rank the fire risk.

Probabilistic Methods: Growing interest in analytical fire risk assessment and an increasing data base have led to the use of more sophisticated mathematical techniques. Probabilistic methods manipulate fire safety variables according to recognized theoretical principles. These methods include computer simulation, linger regression, network analysis, and stochastic modeling.

3.3.2: Models of Fire Risk Assessment

The major aspects to be modeled can be grouped into six models (Hall, 1997): (1) decision model, (2) ignition-initiation model, (3) post-ignition model, (4) loss evaluation model, (5) cost model, and (6) cost-benefit comparison model.

Decision Model: In addition to defining types of fires and specifying general building and occupant characteristics, it is necessary to specify all the differences that would occur if the proposed changes were made. These specifications will dictate precisely what fire protection and fire-related features would be in place to influence the course of fire if one occurs.

Ignition-Initiation Model: The ignition-initiation model is needed to produce estimates of the probability of ignition per year, by type of fire, given a structure of fire scenarios and fire-relevant characteristics of the building and its occupants. The ignition-initiation model is device for combining known probabilities in order to infer unknown probabilities.

Post-Ignition Model: The post-ignition model is used for estimating the severity of specified types of fires, given specified building and occupant characteristics and the status of all systems, features, products, and other changes being analyzed. It is a model of fire development and the outcomes consist of a set of linked time functions of fire characteristics and their effects.

Loss Evaluation model: The explicit or implicit assignment of monetary values to lives saved and injuries averted is the key element of this model. It is a difficult step that many people find distasteful of even immoral. The first and most important point to make is that individuals are not being asked to name a price for which they would be willing to die or suffer crippling injury. Instead, they are being asked to name a price they would be willing to accept to allow their current low risk of incurring death of injury in fire to increase or what they would pay to make that risk still smaller. If that point is made, the next task is identifying what particular figures should be used for the value of life and the value of injury when considering alternatives that change risks in the range characteristic of fire risk.

Cost Model: Cost may be divided into; (1) initial costs of the proposed changes being studied (2) the ongoing costs of these changes once they have been made and (3) the ripple effects on other costs, such as the need to increase the water supply to support a sprinkler system. The last could involve cost increases or cost reductions, including calculation of costs for many years into the future. To make this task manageable, the analysis can be set up in terms of the normal periods of maintaining, repairing, and replacing the items being analyzed. This is called life cycle costing.

Cost-Benefit Comparison Model: The cost model and loss evaluation model produce time streams of costs and risk reduction benefits that is, year-by-year estimates of costs and of reductions in fire deaths, injuries, and property damage, with

the latter expressed as total monetized losses. To compare the costs to the benefits, the two time streams need to be combined into a single, manageable, indicator of net benefits. To compare future and present costs and benefits, it is necessary to decide what the future costs and benefits are worth in the present. This involves the concept of opportunity cost.

3.3.3: Steps of Fire Risk Assessment

Fire risk analysis is a technique capable of pulling together, reducing, and providing perspectives on large quantities of data from many sources. Recent rapid advances in the size and quality of fire-related data bases and in the power and affordability of computers have helped turn fire risk analysis into a practical tool for individual decision making and especially for large-scale decision making by governments and companies. The accelerating pace of development of computerized models of the development and occupant behavior will eventually produce integrated deterministic/probabilistic models, providing even more powerful tools for fire risk analysis.

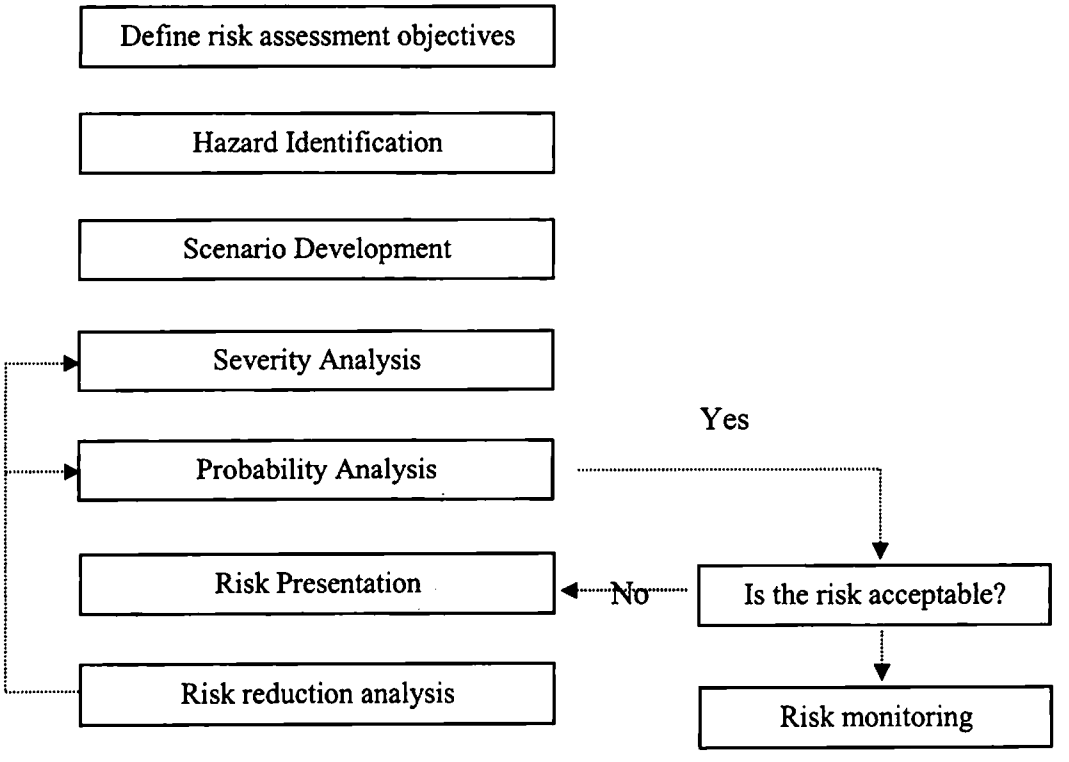


Figure-2: Steps of Fire Risk Assessment

At present there are only a few abbreviated published examples of fire risk analysis. The largest single source of developmental studies in general-purpose fire risk analysis in the United States has been the National Fire Protection Research foundation, whose multi-year developmental project led to a method called FRAME works (for Fire Risk Assessment Method) (Emmons, 1990). Until better materials are available to demonstrate the specific analytic techniques of fire risk analysis, it is useful to recognize the essence of fire risk analysis. Whether the estimates consist of nothing more than a series of guesses or are the result of an elaborate network of sophisticated models, laboratory tests, and fire experience, the framework in principle remains the same. Task of probability analysis and risk presentation arte specific to finding a solution for the project but are dependent on the completion of the other tasks.

3.4: Fire Risk Ranking

Fire risk ranking is link between fire science and fire safety. Fire risk ranking is evolving as a method of evaluating fire safety that is valuable in assimilating research results. Detailed risk assessment can be an expensive and labor intensive process, and there is considerable room for improving the presentation of results. Ranking can provide a cost-effective means of risk evaluation that is both useful and valid. Fire risk ranking systems are heuristic models of fire safety. They constitute various processes of analyzing and scoring hazard and other risk parameters to produce a rapid and simple estimate of relative fire risk.

Fire risk raking has gained widespread acceptance as a cost-effective prioritization and screening tool for fire risk assessment programs. It is a useful and powerful tool that can provide valuable information on the risks associated with fire. As defined here, it is the process of modeling and scoring hazard and exposure parameters to produce a rapid and simple estimate of relative risk. Fire risk ranking can be considered to at the other end of the quantitative assessment spectrum. It defines the relationship between hazard and exposure by using more simplistic models requiring less data and less analysis. This approach produces measures of relative risk that can be compared to one another or to a standard.

3.4.1: Different Approaches to Fire Risk Ranking

It is difficult to describe a typical fire risk ranking method. The practical necessity of trying to assess dozens of hundreds of risks with limited resources has led to the creation of an array of fire risk ranking systems. Approaches to fire risk ranking are virtually limitless in their possible variations. Few examples of fire risk ranking are as follows (Watts, 1995)

3.4.1.1: Insurance Rating

The purpose of risk analysis is to facilitate the process of risk management. One of the most fundamental tools of risk management is transfer of risk by insurance. To be acceptable to an insurer, the risk is rated by actual means, applying principles of mathematics to the particular pricing problems of the insurance industry.

ISO Specific Commercial Property Evaluation Schedule: The most commonly used insurance rating schedule in the U.S. is the ISO (Insurance Services Office) Specific Commercial Property Evaluation Schedule (SCOPES). An important concept of insurance rating is the use of loss experience. In general, tabulated values and conversion factors are based on actuarial analysis of fire losses paid by insurers and reported to the insurance industry.

Gretener Method: In 1960, M. Gretener of the Swiss Fire Prevention Service began to study the possibility of an arithmetical evaluation of fire risk in buildings. His premise was that determining fire risk by statistical methods based on loss experience was no longer adequate for the some specific reasons (BVD, 1973).

As a result of this work, a new approach to schedule rating, the Gretener method, has been developing in Switzerland and Austria (BVD, 1973; Kaisar, 1980). The basic idea of the process consists of expressing, in relative, empirically derived numerical values, factors for a fire to start and spread and factors for fire protection.

3.4.1.2: Dow's fire and Explosion Index

Today there are many risk assessment methods available that can examine a chemical plant in great detail. The Fire and Explosion Index (FEI), developed by Dow Chemical Company, remains a valuable screening tool that serves to quantify the

expected damage from potential fire, explosion, and reactivity incidents and to identify equipment that could likely contribute to the creation or escalation of an incident (Scheffler, 1994). The concept of the Fire and Explosion Index (FEI) is to divide a process plant into separate operations or units and consider each of these individually. The key feature of the method is to identify the dominant combustible material in the unit being studied and assess its thermodynamic properties.

3.4.1.3: Fire Safety Evaluation System

The Fire Safety Evaluation System (FSES), (Benjamin, 1979; Nelson and Shibe, 1980) is a Schedule approach to determining equivalencies to the NFPA Life Safety Code (NFPA, 1994) for certain institutional occupancies. The technique was developed at the Center for Fire Research, National Bureau of Standards in cooperation with the U.S. Department of Health and Human Services in new editions of the Life Safety Code and is presently published in NFPA 101A, Alternate Approaches to life Safety (NFPA, 1995).

Equivalency Concept: The FSES was developed to provide a uniform method of evaluation health care facilities to determine what fire safety measures would provide a level of fire safety equivalent to that provided by the Life Safety Code.

Fire Zone Concept: Unlike the Life Safety Code, the FSES subdivides a building into fire zones for evaluation. A fire zone is defined as space separated from other parts of the building by floors, fire barriers, of smoke barriers.

Risk: Also unlike the Life Safety Code, the FSES begins with a determination of relative risk deriving from characteristics of a health care occupancy. Five occupancy risk parameters are used: (1) patient mobility, (2) patient density, (3) fire zone location, (4) ratio of patients to attendants, and (5) average patient age. Occupancy risk factor for a zone is calculated as the product of the assigned values for the five risk parameters.

3.4.1.4: Hierarchical Approach

Development of a hierarchical approach to fire risk ranking was initially undertaken at the University of Edinburgh, sponsored by the U.K. Department of Health and Social Services. This approach was further developed at the University of Ulster for application to dwelling occupancies. Most recently, it has been refined and implemented for the assessment of fire risk in telecommunications facilities. A generalized procedure for ranking fire safety parameters to determine their relative importance are as follows: (1) identify hierarchical levels of fire safety specification, (ii) specific items comprising each level, (iii) construct and assign values to matrices of each sequential pair of levels and, (iv) combine matrices to yield importance ranking of items.

The purpose of fire risk ranking is to provide a useful aid to decision making. It must be easy to apply but sophisticated enough to provide a minimum of technical viability. Credibility can also be improved through consistency and transparency.

From the above discussion, it is clear that since the beginning of fire research, a lot research has been conducted and much are still under way. As a result of such research, many models and methods have been developed mainly in the field of fire hazard analysis, risk assessment and fire risk ranking as an integral part of fire risk assessment. Particular field of spatial risk analysis, which is important to understand the land use impact of fire hazard. Hence, an attempt has been made in this study to spatially analyze the risk of fire.

3.5: Vulnerability:

3.5.1. Definition:

Vulnerability is condition vulnerability is predisposition. It applies to individuals, groups of individuals or communities, but it can be used also when referring to structures, etc. The poor one is, the more one is predisposed to suffer damage when a negative event occurs.

3.5.2: Vulnerability is about susceptibility and Resilience:

Susceptibility is the fact of being exposed. We can be susceptible but not vulnerable. E.g. the landslide is threatening a house but the owners have built a wall to protect it and to divert the landslide. Susceptibility is also exposure it is fairly easy to assess.

Resilience is a capacity to adjust and recover. E.g. the owners of the house threatened by a landslide have a second house in town. One can be susceptible, but if he/she is resilient, one is not vulnerable. Resilience is made of many things, it implies access to resources, individual skills, beliefs etc. It is more difficult to assess.

Therefore, vulnerability is about.

i. Susceptibility: i.e. proximity and exposure.

ii. Resilience: i.e. access to resources, capacities and capabilities.

3.5.3: Identification of Vulnerabilities

Identification of Vulnerabilities requires on understanding of impact mechanisms, i.e. manner in which the physically described quantities and types of five effects combine with characteristics of the targets (e.g. exposed people, exposed property) to product a particular level of impact.

For fire, thermal exposer and combustion are two frequent mechanisms for impact.

For explosions, over pressure with response to the load is the impact.

For smoke from five, toxicity or hypoxia can be two types of impact.

Examples include the following:

- Unusual vulnerabilities of occupants (e.g. disabilities),
- Age related limitations, drug or alcohol use, limited ability to learn or execute safe practices.

- ❖ High number or density of occupants.
- ❖ Unusual vulnerability of property (e.g. clean rooms, very easily contaminated materials such as pharmaceuticals, delicate textiles, museum holdings).
- ❖ Unusual vulnerability of operations (e.g. absence of alternate source for rare product).
- ❖ Vulnerability of structure to fire induced collapse
- ❖ Vulnerability to radiological release due to five induced failure of containment.
- ❖ Vulnerability of height boring infrastructure (e.g. communications, electrical road network, water supply, gas supply).

3.5.4: Causes of Vulnerability Zones

There are 10 zones in the Dhaka City .On the basis of frequency of fire incidents these 10 zones are identified as high, medium, low vulnerable zones. But there are various reasons for vulnerable of fire hazard. The main cause of vulnerable for fire hazard are as follows:

(a) Direct Cause:

i. Unplanned and over uses of flammable materials.

ii. Lack of awareness about five incidents.

iii. Unplanned settlement specially the presence of slums.

iv. Violently of fire created materially for taking action against opponent.

(b) Indirect Causes:

i. Narrowness of the width of the roads.

ii. Shortage or absence of water body.

iii. Shortage of supplied water the closet/nearest to the fire incident.

iv. Lack of modern equipment of fire fighters for high rise building fire.

v. Unnecessary movement of mob of the locality.

vi. Weak of number of employed of a fire station etc.

3.5.5: Vulnerability Assessment:

The housing of low income persons is often in older structures which do not conform to modern building and fire codes and do not contain fire detection devices. These structures are also prone to faulty electrical, heating and other utility systems due to age and lack of proper maintenance. Many of these older structures were constructed in very close proximity to one another, enabling fire to spread rapidly from one structure to another. Older apartment buildings and hotels also face increased risk of rapid fire spread due to inadequate firewall protection and the lack of fire detection and sprinkler systems. Some of the newer residential structures and hotels, though still susceptible to high population risk, are not as vulnerable to fire as are older structures. These structures were designed and built to include fire resistive features which conform to modern fire and building codes. Fire detection and/or extinguishing systems were also installed in these buildings at the time of construction. Though a major fire could certainly occur in these structures, the likelihood of its spreading to adjoining structures or units before it can be brought under control is significantly reduced. Commercial, industrial and multi-family fires present their own unique hazards. Some newer structures, like residential occupancies ,are built with fire resistive construction and fire detection and/or sprinkler systems there by reducing the risk of major fires. Older structures and single family dwellings however, share many of the same problems as older housing and are at greater risk of fire. Many commercial and industrial occupancies within Kent store and use hazardous materials. Kent houses the second largest quantity of hazardous materials sites in all of King Country. The storage and use of these materials not only in increases the risk of but also pose a significant threat to fire fighters and community if the

material should become involved in a fire. A sizable earthquake in Kent could damage any or all of the city's main water supplies, transmission lines and/or feeder lines. Without adequate water reserves, automatic sprinkler protection would fail and fire fighters would be unable to attack a wide fire front. In such a setting, a small fire could easily spread beyond control

This is semi-quantitative method to priorities target groups or areas for prevention or response activities. Each of the for levels of susceptibility (Very low, Low, Medium and High) can meet with any of the four levels or resilience (High, Medium, Low and Very low). Vulnerability results from the combination of susceptibility and resilience. If susceptibility is very low and resilience very high, one has minimum vulnerability. When susceptibility is high and resilience very low, one has maximum vulnerability.

A vulnerability assessment identifies areas in the Dhaka City corporation that may be affected, individuals in the DCC who may be subject to injury or death and what facilities, property or environment may be susceptible to damages should a fire occur.

a) Electrical Power

Electricity is supplied in the Dhaka City by DESA (Dhaka Electricity Supply Authority). Electricity is transmitted to Dhaka City from the electrical power station. Electrical transmission system is usually reliable but is sometime vulnerable to fire. Loose joining of cable wires and other equipments leads to electric fire.

b) Transportation Routes:

The city or town must have 30% of is area corned by road. But Dhaka has less than 20%. Most of the roads or streets are narrower and a few roads have no divider which causes traffic jam. As a result, the fire fighters vehicles are late to reach the fire incidents. It is a big problem for the fire fighters to mitigate the level of degree of fire destruction. Most of roads are so narrow that two vehicles cannot pass side by side.

In many instances, housing subdivisions have a single access road that could easily be blocked by vehicles in a regular time that lead to increase the intensity of fire incidents.

c) Local Fire Response:

The following analysis is conducted as part of the vulnerability assessment to establish those challenges facing the local fire response elements.

- Lack of adequate water supplies, water distribution system etc.
- Inaccessible structures.
- Narrow roads and bridges.
- Load limits on bridges.
- Inadequate Protection codes and code Enforcement.
- Lack of integrated communications, planning, preparedness and response protocols.
- Lack of Resources, assistance in obtaining grants and other funding.
- The need for additional manpower, vehicles, equipment and training are all common challenges facing the urban fire.

For the assessment of the fire vulnerability, the following score (table-1: susceptibility and resilience value/score) is used.

Table-1: Vulnerability Assessment Score Table

Susceptibility	Resilience	Vulnerability
Very Low	High	1
Very Low	Medium	2
Very Low	Low	4
Very Low	Very Low	16
Low	High	2
Low	Medium	4
Low	Low	16
Low	Very Low	256
Medium	High	3
Medium	Medium	9
Medium	Low	81
Medium	Very Low	6561
High	High	4
High	Medium	16
High	Low	256
High	Very Low	65536

To evaluate the vulnerability, tangibles and intangibles vulnerable elements are used in the following table (tables-2).

Table-2: Vulnerability Evaluation

	Principal Vulnerable Elements	
	Tangibles	**Intangibles**
Floods	Everything located in flood plains or tsunami areas. Crops, livestock, machinery, equipment, infrastructure, Weak buildings.	Social cohesion, community structures, cohesion, cultural artifacts.
Earthquakes	Weak buildings and their occupants. Machinery and equipment, infrastructure. Livestock. Contents of weak buildings.	Social cohesion, community structures, cohesion, cultural artifacts.
Volcanic eruption	Anything close to volcano. Crops, livestock, people, combustible roots, water supply.	Social cohesion, community structures, cohesion, cultural artifacts.
Land Instability	Anything located on or at the base of steep slopes or cliff tops, roads and infrastructure, buildings on shallow foundations.	Social cohesion, community structures, cohesion, cultural artifacts.

Strong winds	Lightweight buildings and roots. Fences, trees, signs: boats fishing and coastal industries.	Social cohesion, community structures, cohesion, cultural artifacts.
Drought/ desertification	Crops and livestock, Agricultural livelihoods.	Destruction of the environment. Cultural losses. Possible population disruption.
Technological disasters	Lives of those involved or in the vicinity. Buildings, equipment infrastructure, crops and livestock.	Destruction of the environment. Cultural losses. Possible population disruption.

Chapter-Four

Chapter Four

4: Application of GIS and Fire Hazard Mapping In Land Use Planning

4.1: Introduction

In order to reduce the possible risk of fire hazard, there are two considerations to follow: (1) fire safety and/or prevention and (2) fire detection and control (protection) (Grimaldi and Simonds, 1996). All the aspects of fire protection, prevention and fighting involve site planning, internal planning, and the forms and materials of construction. Access roads for operating fire brigade appliances distance between buildings to reduce radiation hazard and spread between buildings and access from roads and open spaces into the buildings for fire fighting must all be provided for effective fire protection (Ahmed, 1992). Along with these architectural treatments, land use planning in combination with hazard analysis and hazard mapping can play a vital role to mitigate fire hazard.

4.2: Land Use Planning and Control

The task of physical planning and design of any given area (city, district, region) is to translate the socio-economic aims of development into physical patterns of land use and to achieve an appropriate quality of organized environment necessary for human activities, well-being and satisfaction (UNDRO, 1976). Many communities, both developed and developing, continue to develop social activities, create new industry and invest in areas which have been recognized as risk areas without taking any protective measures or even bothering to estimate the risk (Akther, 1998). Inadequate land use also decreases resistance against disaster (Ogawa, 1995). Therefore, defining areas of potential risk and of differentiated risk level is one of the most important initial steps for physical planning (UNDRO, 1976). Many disasters can be reduced through a clear understanding of the natural phenomena, and careful planning before the disaster happens (EIDeen, 1981).

Whenever a disaster strikes, it strikes a certain type of land use. Within built-up areas of the cities there are some areas with a higher level of risk than

others. Land use planning operates to prevent the market from developing at cross-purposes with the goals of other plans. This becomes a crucial issue for disaster prevention and it is particularly important that land use be regulated in disaster prone areas. Poor or nonexistent land use control not only maintains risk at a higher level but also but also has a cumulative effect, compounding and magnifying disaster over time (Akther, 1998). To deal with any specific hazard land use regulation and land use zoning as an integral part of land use planning can be an effective measure.

4.2.1: Land Use Regulation

Land use regulation and development restriction are the best long term means of firstly, planning of land to reduce hazard and secondly, of limiting the future growth in hazard prone areas. The purpose of these controls is to ensure that developments are appropriately sited and are used to prevent potential damage from unwise use of land in hazard prone areas.

4.2.2: Land Use Zoning

Zoning is the legal tool that is to zone the hazard prone lands in accordance with the probability of the land being an event taken place. It is used by towns, cities and countries to control and direct the use and development of land and property within their jurisdiction.

As a matter of fact, land use planning alone can do little to prevent any hazard. Risk analysis and hazard mapping in combination with land use planning can play a vital role to deal with.

4.3: Significance of Hazard Mapping in Preventing Hazard

The effect of disasters and its consequences on man and his physical environment depends on the location of socio-economic development as well as the magnitude of disaster. Hazard mapping tries to identify the land use at risk. It is the superimposition of risk zoning map over the existing land use map. Thus hazard mapping tries to identify the areas at risk. In drawing fire

hazard map, fire probability map, accessibility map, population density map, land use map etc. are needed.

For preparing a comprehensive and more detail hazard map all necessary facts regarding the use of land including total number of population, population density, zone of influence of the service, building standard, etc. should be incorporated. Hazard map can be done for applications at different levels i.e., for urban, regional and national planning. The degree of complexity of hazard map depends upon usage and data required for specific application in a particular disaster zone. The map should be simple and understandable by the authorities and general public and also should avoid irreverent and sophisticated detail.

4.4: Scope of GIS in Potential Risk Analysis and Hazard Mapping

At present there is very little use of Land Information System (LIS) or Geographic Information System (GIS) in the whole planning process in third world countries including Bangladesh. Moreover, most of the planning is done in large scale with little detail.

GIS offers a valuable suite of tools and techniques for identifying and measuring hazard and assessing its spatial manifestation. Since GIS allows a researcher to identify both the composite hazard and vulnerability index, and the underlying dimensions of hazard and vulnerability, it might be interesting to study the difference in public policy interventions that might be needed in different areas in the event of a hazard. One of the key advantages of the GIS is the ability to very parameters in a model to look at various outcomes in the form of "what if" analyses. Data on socio-economic classes could be incorporated into the study and the different impact of the variables on them may be studied (Remchandran and Ronald, 1999). If socio-economic data along with location of incidents of a particular hazard and their magnitude, accessibility, human attitude and behavior, mitigation facilities and so on, this would help to understand the magnitude of the effect of the hazard in a particular area.

For better understanding of potential risk of fire hazard, fire probability map including frequency, duration and magnitude along with location of occurrence, extent of damage, accessibility, distance from safer zone (such as water body, fire service station), ratio of structures, building material, human attitude and behavior, existing mitigation facilities and so on should be incorporated into the hazard analysis model. GIS, as a decision support tool, allows the researcher to include all these parameters into the model as input indicator to obtain a clear picture of fire hazard proneness of the area.

4.5: Integration of Hazard Mapping with Land Use Planning

The prerequisite for producing a synthesis in the planning is a normative model of optimum land use or clear identification of tolerable risk (EIDeen, 1981). The location of each class of land use in different risk zones should be based on judgment by the technical person in consultation view the technical body, In zones of greater risk only restricted land use should be permitted. In zones of lesser risk, buildings that might be used during and after disaster (for example, flood shelter, temporary hospital) would be allowed. Certain activities (like storage of dangerous materials, communication facilities) should be located in non-hazardous areas or areas of least risk (Akther, 1998).

Hazard mapping as component of hazard analysis evaluates and estimates the level of potential risk of a particular land use in an area. This could be integrated with risk zoning. Risk zoning can be used to identify the probability of damage for the particular land use. Hazard mapping is currently only aimed to identify the land use in risk. But with the integration of risk zoning it would be able to determine the extent of that risk. Moreover, as the high-risk areas are identified in detail, it would be possible to perform the estimation in much more detail and reduce the impact.

Hazard reduction should be considered a significant parameter in development planning of a community and to do so hazard analysis should be incorporated as an integral part of the total development process. Every proposed development must analyze the risk of the location of an investment. New establishment should be encouraged to develop in low risk areas. For this hazard analysis is a must.

Chapter-Five

Chapter – Five: Analysis & Findings

5.1: Introduction:

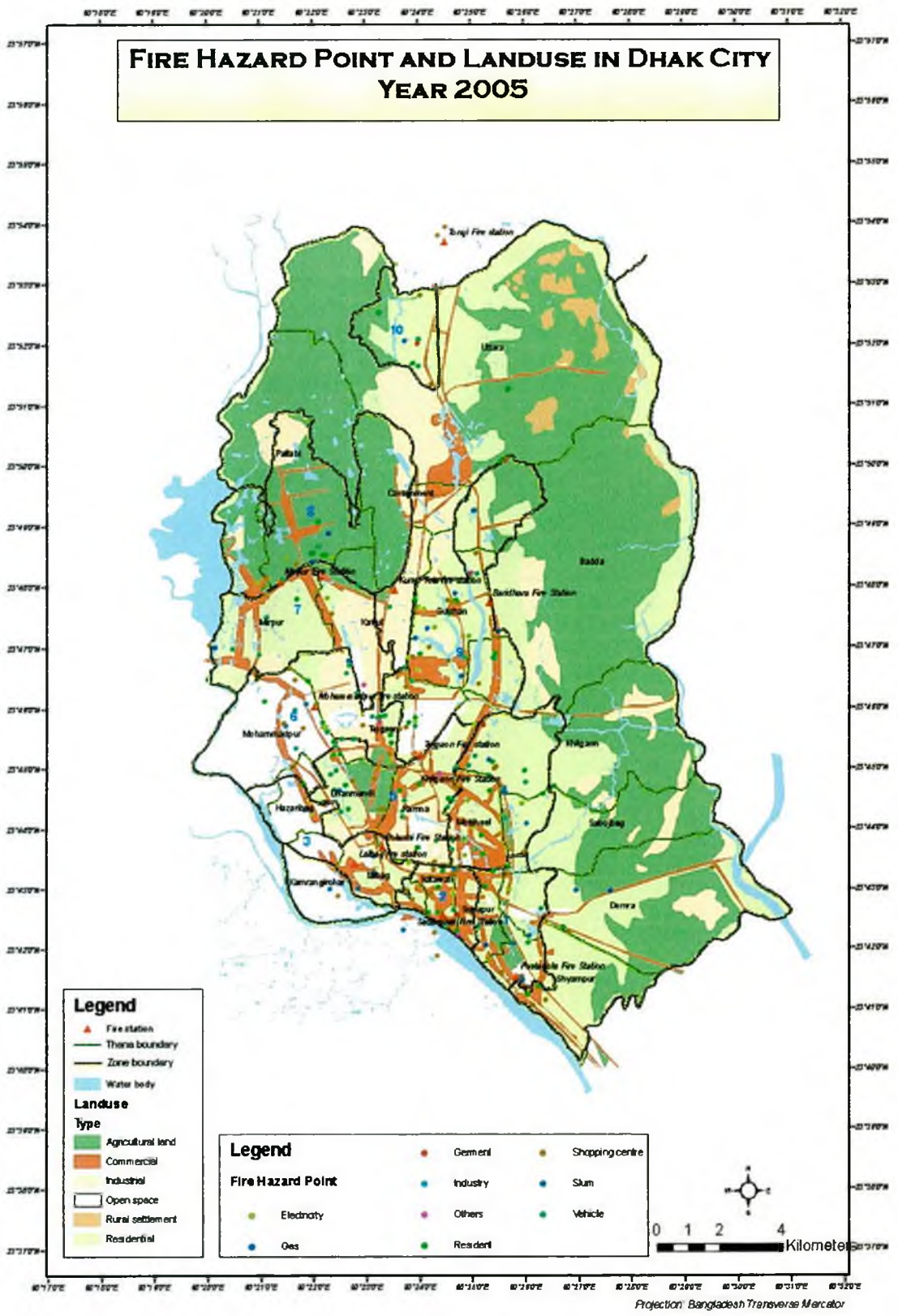
The study area was divided into 10 zones/categories (Map-1) for identifying location of slums, slums coverage map of 1996 produced by centre for urban studies (CUS) has been used. The slum coverage map appeared to be useful, because the slums are temporary settlements and at present, the most of the slums had been converted into other uses. Residential use includes detached house, flat/apartments, Govt. residential quarters, semi-pucca houses etc. Commercial land use includes shopping centre and others. But fire incidents of shopping centre indicates the fire of shops, fillings stations, banks, workshops, warehouse, auto repair shops, and restaurants and so on. Garments other industries bakeries etc. are included as industrial land use. But the case of fire incidents has discussed different types. The fire incidents of hospitals, religion place like mosque, temple, church, etc. Clubs, public office buildings and so on are discussed as other types of fire. Actually, there is a relationship between land use and fire incident types.

From observation it has been found that residential area is used in various purposes in an unplanned and haphazard way. It is common sight in the study area that the same plot is being used for example, for welding workshop, restaurant, different shops rickshaw depot etc. along with residential use in an unplanned way. In some cases, residential structures have been converted into garment and other industries. As a result, electricity, gas and other combustible materials are highly used.

In the study area, a large concentration of shopping centre and agglomeration of different commercial activities have been considered as commercial areas. There areas are most susceptible to incident of fire, the frequency of fire reported in these area is quite high.

5.2: Distribution of Fire Hazard Point And Land Use In The Study Area :

The map of fire hazard point and land use in Dhaka City (Map-3) indicates hazardous and incompatible land uses including garments, factories, shopping centres and filling stations are located in an unplanned way over space. In the zone-2 of Dhaka City Corporation is the most hazardous zone where the land use is more complicated and unplanned, hence the frequency of fire incidents in here is high and more clustered. The Zone-6 is also hazardous because of high frequency of fire incidents which were happened due to over population, unplanned residents, presence of slums, lack of water body and industrial land use etc.



Map-3: Fire Hazard Points & Land use in Dhaka City.

On the other hand, Zone-10 of DCC is very low hazardous of fire due to planned land use i.e. planned residential area of Dhaka City. So , the perfect, planned land use can reduce the degree of level of fire hazard . But the complicated and unplanned land use leads to the high hazardous of fire . Due to the pressure of over population the open space or water bodies of DCC is converted into the high rising building /apartments that creates the different types of hazards in city life.

5.3: Distribution of Fire Incidents all over the Bangladesh

Fire incident is a daily and regular event in Bangladesh. Degree and frequency of fire incidents all over the Bangladesh through the year is not same. From the figure no.-3 and table no.-3 we can assume that February is the crucial month for fire incidents because highest number of fire frequency and of casual death (146) were happened in 2005. But May, June and July are considered as low level of fire frequency over the country. Among the types of fire frequency electricity and gas is occupied at the top list of fire incidents. Residents hold the 2nd place among the types of fire incidents. But shopping centre & industry are also considerable and threaten able types of fire incidents.

Lack of conscious of general public about fire incident, unplanned urbanization, shortage water bodies, unplanned roads, lack of proper, supervision of electrical equipments and restless usage of over heating machines, political violence etc are more responsible for the fire incidents.

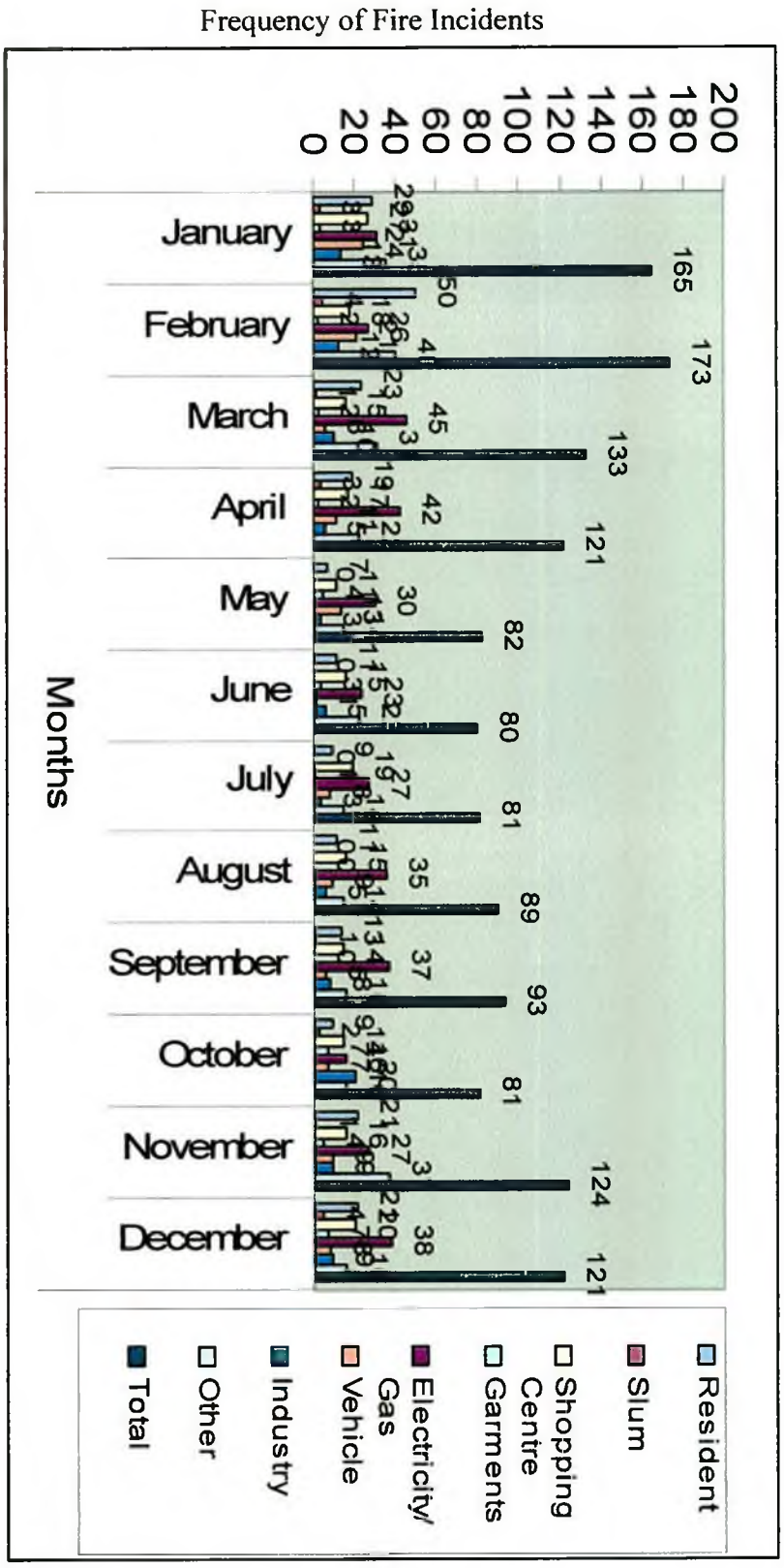


Figure-3: Types of Fire Incidents across the Bangladesh in 2005.

Table-3: Distribution of Fire Incidents in 2005 across the Bangladesh.

Types of Fire Incidents	Months											
	January	February	March	April	May	June	July	August	September	October	November	December
Resident	29	50	23	19	07	11	09	11	13	09	21	21
Slum	03	04	01	03	00	00	00	00	01	02	01	04
Shopping Centre	27	18	15	17	11	15	19	15	14	14	16	20
Garments	03	02	02	02	04	03	01	00	00	07	04	07
Electricity/ Gas	31	26	45	42	30	23	27	35	37	16	27	38
Vehicle	24	21	06	11	13	01	08	09	05	07	09	08
Industry	13	12	10	05	03	05	03	05	08	20	09	09
Other	35	40	31	22	14	22	14	14	16	16	37	16
Total	165	173	133	121	82	80	81	89	93	81	124	121
No. of wounds	47	63	16	37	20	12	07	01	12	09	05	24
No. of Causal Date	30	146	03	51	07	03	03	17	09	02	00	02

Source: BFSCD, Head Quarters, Dhaka.

5.4: Pattern and Distribution of fire:

Fire incident is regular event in the Dhaka City. It is happened in the daily. But most of the incidents are recorded is the head quarter of BFSCD and few are not recorded because they were controlled before the vehicle of the fire station came to the incident point. The fire incidents are of various types (Map-4). To keep pace with the types of the fire incidents of the BFSCD, the fire incidents are of the following types.

i. Resident fire.

ii. Slum fire.

iii. Gas fire.

iv. Industrial fire.

v. Garment fire.

vi. Electricity fire.

vii. Vehicle fire.

viii. Shopping centre fire.

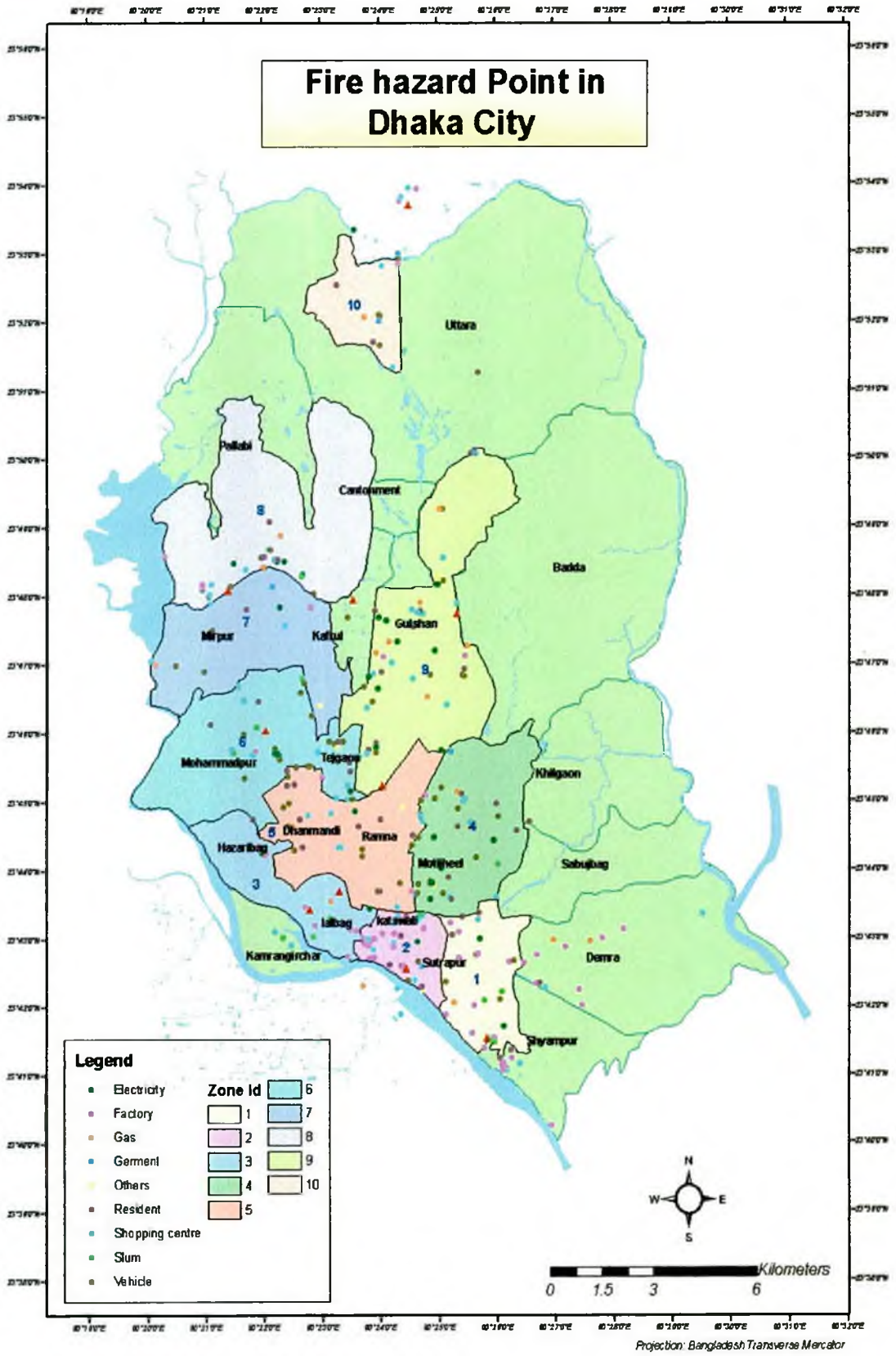
ix. Other fire.

5.4.1: Resident fire:

Resident fire incident is a common event in the Dhaka City. Due to unconsciousness about flammable materials which are responsible to fire, the resident fire is happened. In 2005, among the types of fire, resident fire occupied 18.38% in Dhaka city. The unplanned houses are dangerous for fire incident. In this case, zones 9, 4, 5 and 8 of Dhaka City Corporation are more vulnerable than other zones.

5.4.2: Slum fire:

The slum area is the dwelling place for lower incoming people, most of them migrated to Dhaka from the different parts of the country to find work. The slum residents are illiterate, ignorant. Little educated and so on. The slum dwellers having no common senses of good citizens do not care the fire incident. Unplanned and illegal use of flammable materials as well as electricity and other materials. Sometimes fire is bit to the slum by forcefully to prevail dominant or enhance the power of political interest. Among the fire incidents slum fire occupied 5.51% in 2005. Among the city corporation, zone-1, 3 and 6 are dangerous and reported for slum fire.



Map-4: Fire Hazard Points in Dhaka City.

Dhaka is the largest city in the country with a population of about 8 million in 1998, up from 1.7 million in 1974. At the current rate of growth (6-7%), it is expected to be the ninth largest mega city of the world by the year 2,015 with a population of 19.4 million. The Dhaka city is divided into ten administrative zones. Each zone is further divided into wards - the lowest administrative urban units. Approximately, 30 percent of the Dhaka city's population, live in slums in sub-optimal living conditions, and the living standard of at least half is below poverty line. Since 1991, serious efforts have been taken by different organizations to understand the dynamics of the burgeoning slum and squatter settlements in the Dhaka city. The Centre for Urban Studies (CUS), in collaboration with Urban Volunteer Programme (UVP) of ICDDR,B, conducted a survey on slums in the Dhaka metropolitanl area in 1991. The CUS, however, repeated the survey in 1996. Similarity in the distribution of slums was observed in the two surveys. On an average, 75 percent of the slums were located in the privately-owned land, and the remaining 25 percent were located in the public land. It was also revealed that 96.5 percent of the slums and squatter settlements were located within the boundaries of the Dhaka City Corporation

Table-4 shows a comparative picture of the findings from these surveys.

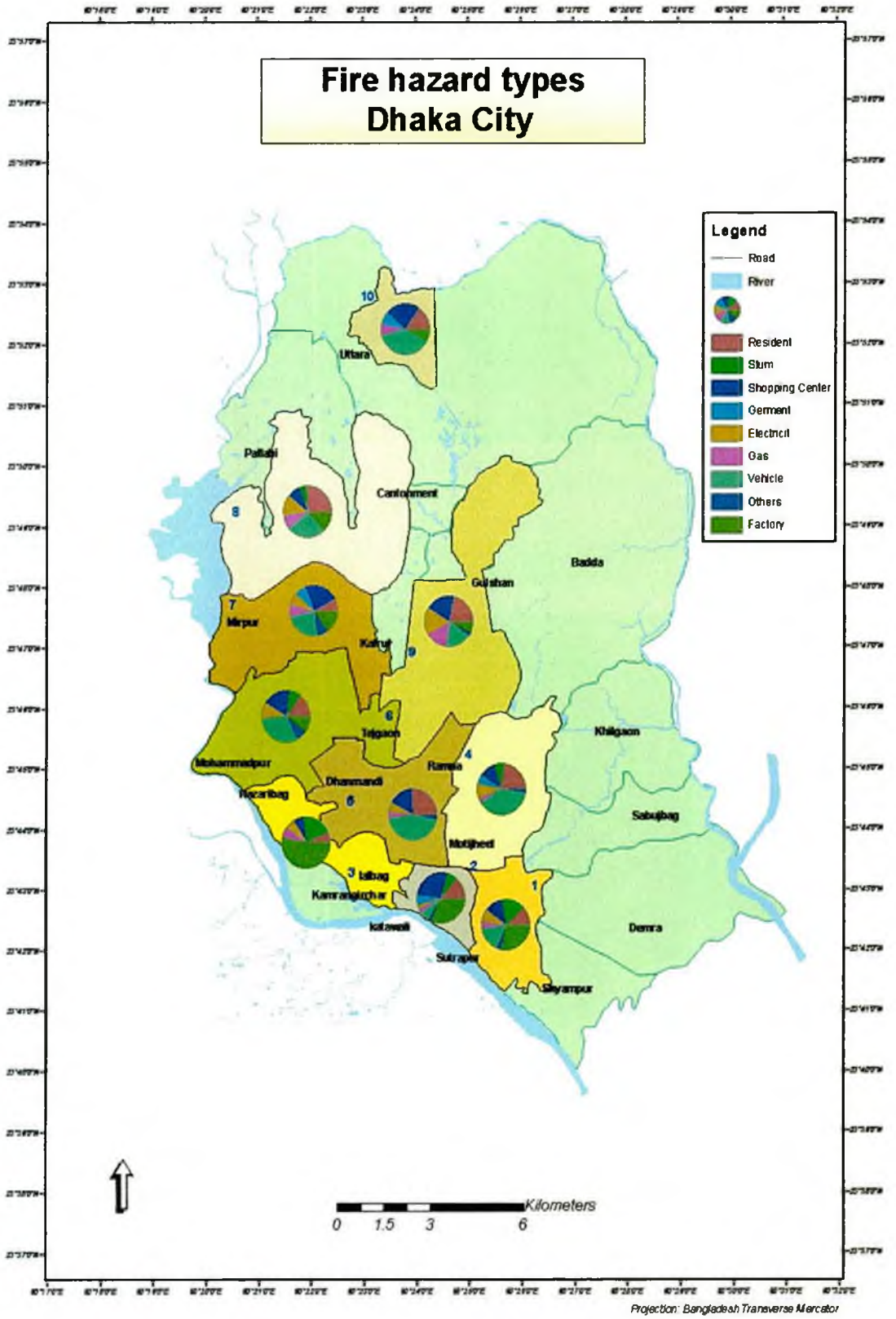
Table-4. Comparative data from urban slum survey of Dhaka metropolitan area

Organization conducting survey	Year of survey	No of slums & squatter settlements	No of Households	Total population	Population density/per acres
Centre for Urban studies	1991	2156	129700	718415	910
Centre for Urban studies	1996	2887	220920	1104600	1065

Source: CUS.

5.4.3: Garment fire:

Garments are the leading industry of Bangladesh. About more than 60% foreign income of Bangladesh comes from Garments Sectors. There is a lot of discrimination and imbalance between the owners and worker groups. As a result, sometimes garments factories are faced to fire by devastating and illegal way by naughty groups of people and cadre groups whose aim is perfectly decline the industry. In 2005, garment fire occupied 2.21% (Map-5) among the various types of fire incidents. But the zones-2 and 4 are comparatively hazard zones for garments fire.



Map-5: Fire Hazard Types in Dhaka City.

5.4.4: Industry fire:

Bangladesh is an agricultural country. Bangladesh is not well established in the industrial sectors. However, the different industries play a vital role to the economy of Bangladesh. But industry is not free from fire danger. In 2005 15.07% fire incident occupied by industry fire. Among the zones of DCC 2.1. and 3 were identified as more vulnerable of fire hazard than other zones. But industry is not free from fire danger. In 2005 15.07% fire incident occupied by industry fire. Among the zones of DCC 2,1 and 3 were identified as more vulnerable of fire hazard than other zones

5.4.5: Gas:

Gas is our most important and multi-used natural fuel. it has changed our economy radically. But gas is one of the sources of fire incident. In 2005 5.51% fire incidents occupied by gas zone 9 of Dhaka City Corporation was identified as the most vulnerable for gas fire and zone 6 was free from gas fire incident.

5.4.6: Electricity fire:

Electricity is the main key to the industrial development without electricity the city life will be still stand. But short circuit is the main source of electrical fire incidents due to the use of old fashioned wires and illegal connection of electricity. In 2005, among the recorded fire incidents electrical fire occupied 8.82% and zone 9 of DCC was recorded of high frequency of electrical fire incidents and identified as more vulnerable.

5.4.7: Vehicle fire:

Vehicle fire is an other regular event. Due to the various cause the vehicle five is happened. Political issues, student, legal and illegal demands, demands from their groups of people etc are the root cause of vehicle fire. But the crones of the engine of the vehicle are also responsible of fire. Among the fire incidents, vehicle fire occupied 24.26% in 2005. Zones 8, 4, 5 and 6 area identified as more vulnerable for vehicle fire frequencies.

5.4.8: Other fire:

Besides these, there are other fire incidents like educational. Religious institution, hospitals etc. In 2005, other types of fire incident occupied 3.31% among the fire incidents. Zone 6 was identified as hazard zone.

5.5: Source of Fire:

The sources of fire are not equally destructive. According to the field survey report (Table-5), the root cause of fire has been found to be in electric short circuits (58.03%). It was the major source in all types of land use except in slums where only a few fire incidents had originated in an electric short circuit. Gas came to the second principal cause of fire.

However, all other sources of fire are not negligible factors. Among them burning cigarette, arson, mosquito coil, open lamp/candle and over heated machine etc are the well known sources of fire.

Table-5: Sources of fire

Source of fire	Frequency	Percentage
Electric short circuit	65	58.03
Gas line leakage/kerosene stove	20	17.48
Open candle	5	4.46
Cigarette burning	10	8.93
Arson	3	2.68
Over heated machine	3	2.68
Mosquito coil	2	1.79
Unknown	4	3.57
Total	112	100

Source: Field Survey, 2006

5.6: Spatial Relationship of Fire Points

To determine the spatial relationship of fire hazard Nearest- Neighbour Algorithm of cluster Analysis has been carried out by adopting and Avenue scrip of Arc view to know whether the locations of fire incidents are randomly distributed or clustered. Finding of the analysis are discussed below:

5.6.1: Cluster Analysis:

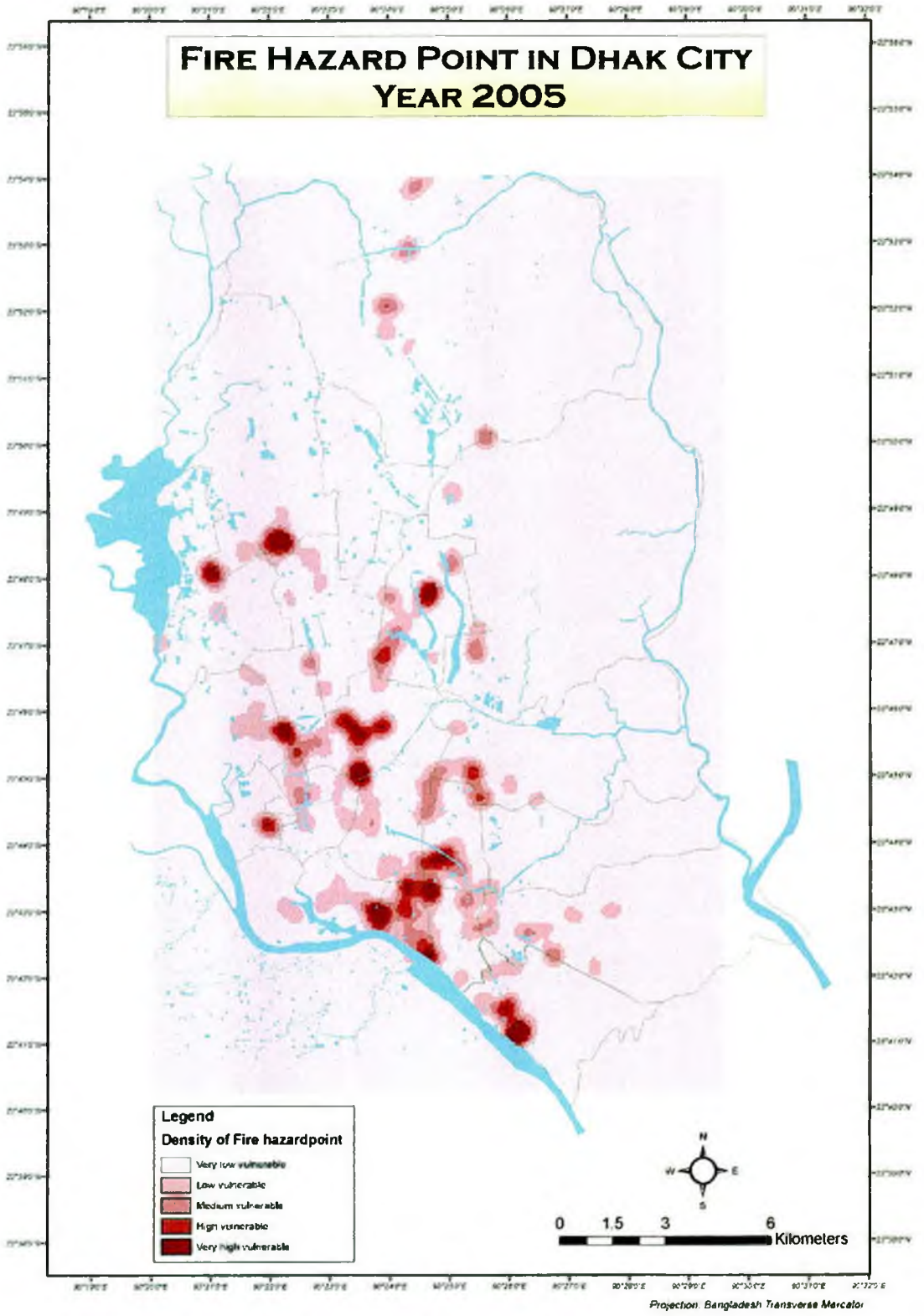
Cluster analysis involve, the grouping of entities that are similar to are another. The entities may be observations. Several decisions brust be made by users of cluster analysis. The user must decide how the similarity or dissimilarity between entities is to be measured. Different algorithms of cluster analysis are (Jackson 1983):

* The nearest - Neighbour Algorithm.
* Farthest - Neighbour
* Minimum- Squarel error Method.
* Will and valley Methods.

For the purpose of the required analysis the nearest – Neighbour Algorithm was used.

5.6.2: The Nearest Neighbour Algorithm:

The nearest neighbour analysis is a common procedure for measuring the spatial arrangement of a pattern of points within a study area. Geographer have applied the technique is numerous research problems, including the study of settlements in central place Theory, Economic functions, within an urban region and so on.



Map-6: Fire Hazard Point in Dhaka City in 2005.

The first practical method for grouping i.e. agglomerative method, which is used in nearest -neighbour algorithm. The nearest neighbour hood techniques was applied to ascertain the pattern of the locations of the fire incident.

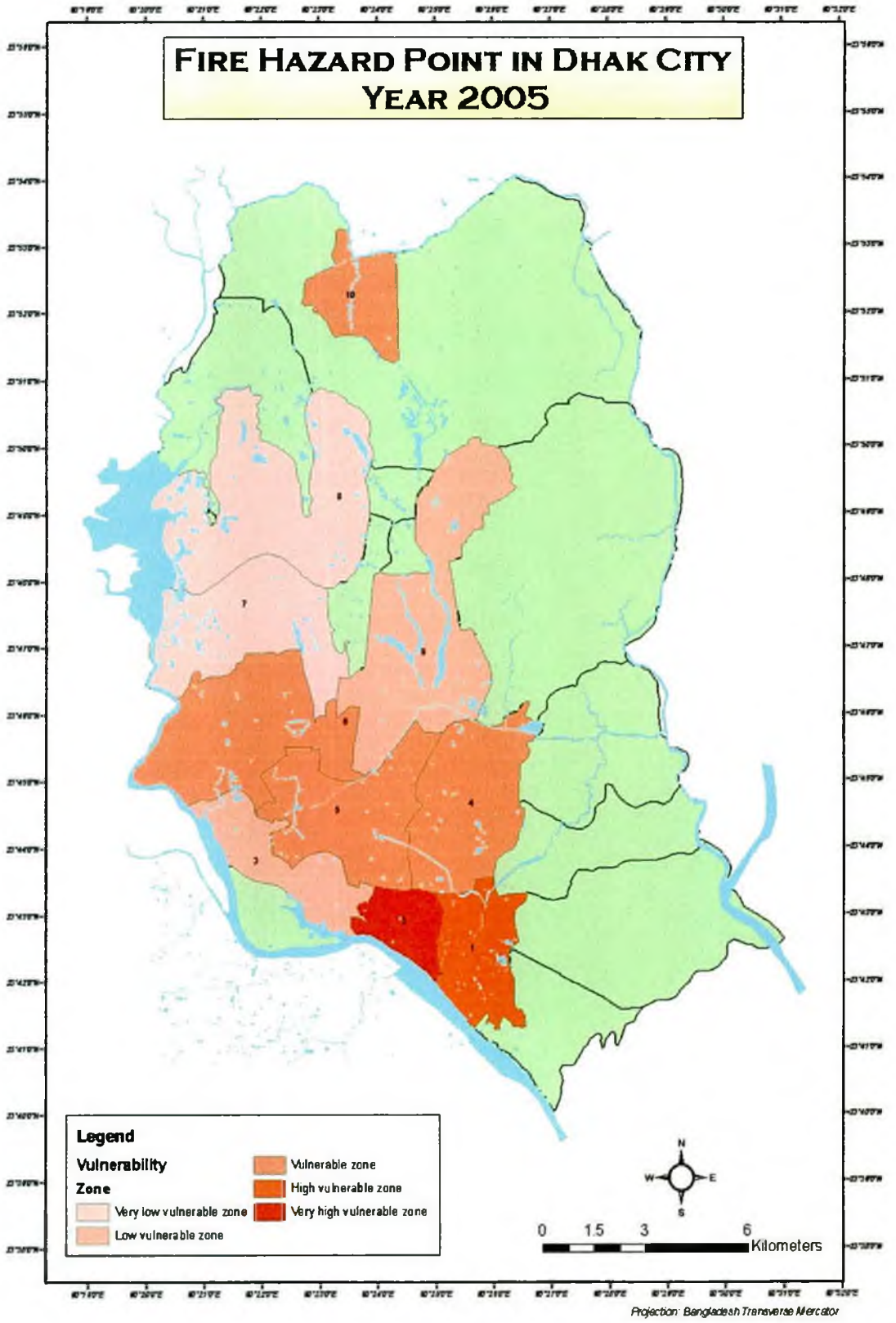
In the study area where the zone -2 is highly clustered of fire points (Map-6). On the other hand zone-7 is randomly distributed of fire points.

5.6.3: Fire hazard proneness of the study area by land use category:

The fire hazard prone areas are guided by land use category. Recreational and open space, water bodies are less hazardous region because there are no built up areas. But mixed residential and industrial areas are high hazardous regions. The zone 2 and 6 of DCC are high hazardous regions, but zone 7 and 10 are less hazardous zone because of planned residential area. Hence, commercial area and residential (mixed) areas is hazardous region in the study area.

5.6.4: Final Ranking of Fire hazard vulnerability and Hazard mapping:

Map-7 and Table-6 show the hazard map indicating final ranking of five categories of vulnerability. On the basis of fire point ratio (fire points and zonal area), the ten zones of DCC are ranked into five categories of fire hazard vulnerability.



Map-7: Fire Hazard Vulnerability.

Table-6: Density of Fire Incidents by zones and types of fire

AREA	PERIMETER	ZONE_	ZONE_ID	ZVAL	Resident	Slum	Shopping Centre	Garment	Electricity	Gas	Vehicle	Others	Factory	Total point	Area point
6008270.000000	11976.490000	3	10	0	2	0	3	1	0	1	5	0	1	13	0.0021
23416900.000000	33127.610000	4	8	0	6	1	2	0	3	2	6	0	3	23	0.0009
21836800.000000	28970.490000	5	9	0	9	0	8	0	7	6	7	1	3	41	0.0018
14509700.000000	22154.200000	7	7	0	1	0	3	1	1	1	3	1	2	13	0.0009
16976600.000000	24992.050000	12	6	0	6	3	7	0	4	0	12	3	4	39	0.0022
13394800.000000	16671.330000	16	4	0	8	2	4	2	3	1	13	1	0	34	0.0025
13410800.000000	22061.020000	17	5	0	8	0	5	0	2	1	14	1	0	31	0.0023
8028600.000000	18587.830000	21	3	0	1	3	1	0	1	1	0	0	8	15	0.0018
7974390.000000	15207.470000	27	1	0	3	4	3	0	2	1	4	1	7	25	0.0031
4313750.000000	10073.730000	28	2	0	5	2	10	2	1	1	2	1	11	35	0.0081

The zone 2 is very high vulnerability zones. And, zone-1 is recorded as high vulnerable zone. Zones 4,5,6 & 7 are regarded as vulnerable zones. Where as zones 3 and 9 fell into vulnerable zones and zone 8 is recorded as very low vulnerable zone.

Again, the zones are also classified into five vulnerable zones depending on the nearest distance of fire points (Cluster method). In the map-6 where zone 2 and 6 are very high vulnerable zones. Zones 4, 9 are high vulnerable zones whereas zone 3, 5 are recorded as medium vulnerable zones. Zone 10 is regarded as low vulnerable zone & zone 7 is very low vulnerable zone. Because of planned urbanization, zone 10 is recorded as low vulnerable zones.

But the characteristics of land use of zones of DCC are now fully changed and they are originated as planned way and are converted into mixed character in terms of time and demand of the locality. For an example Dhanmondi once upon time recorded as high classic residential area but the present situation is its opposite, population growth. Only one centre of all resources, power administration, job facilities unplanned urbanization and so on Dhaka is now more vulnerable zone compared to the other cities or towns in Bangladesh to the context of fire hazard.

5.7: Loss

The role of fire in the devilment of civilization is indispensable. But lack of awareness, longtime used electric wire, overheating machine and so on sometimes fire is orated and is also responsible for loss of lives of human as well as animal beings and property. Due to fire damages are of two types based on overcome the economic condition they are (i) Short term damage, (ii) Long term damage.

5.7.1: Short term damage

Sometimes fire causes the damage of property which can be overcome with in a short time. In this case fire spreads in a short space and intensity of damaging power is not strong so that damaging property is limited.

5.7.2: Long term damage

When the fire is spread violently it causes a great deal of damage like property lives which are not easily overcome by the affected people. But the sources of both damages may be same. Due to touch of more flammable materials fire quickly spreads on large area and damages our valuable property and lives. Fire on high rise building shopping centre, industries, power station and so on are of this type.

In 2005 the fire damaged the property worth Tk. 104131000 (Appendix-1) and caused of casuals death of in Dhaka city. Earth quake and volcanic eruption are the causes of long term damages. Destruction of fire on Banga Bazar Market in 2004 is well known example of long term damage. On some political caise or clean the slum or to acquire the land occupied slum dwellers, fire is lit on the slum manually as result huge amount of property as well as lives are damaged.

If we are always careful/awake about fire incidents we can minimize the damage of the fire by following the rules:

(i) To increase the public awareness about fire

(ii) By regularly checking the electrical equipment

(iii) By avoiding over heat which is caused by excessively use of electrical machine

(iv) More fire flammable area must be declared as strictly non smoking area etc.

5.8: Causes of death in fires

When a fire breaks out, the first minute is the most critical period. Building occupants need to act fast to put out the fire or evacuate. Failure to act fast may result in injury or loss of life.

At the early stage of a fire, the building will be engulfed in thick smoke and gases like carbon dioxide, carbon monoxide and sulphur dioxide.

Visibility will be impaired by darkness. This may cause an individual to fell claustrophobic and subsequently suffer from delirium. The individual may also lose his direction and become trapped in the fire.

The Second factor is, thick smoke from the fire, which will affect the respiratory system, causing asphyxia and subsequent death. It is important to note that in most fires, smoke is the main causes of death.

The third factor causing death is heat. When the flames are intense, the temperature could rise up to 800 degrees Celsius and may cause of death.

The Fourth factor, which is of no less important, is time. Fire spreads very quickly, causing an individual to be trapped. All actions need to be carried out quickly as smoke kills in seconds, fire spreads in minutes.

5.9: Assessment of Existing Fire Mitigating Facilities

Assessing the existing fire protection facilities requires investigation into the community participation, role played by BFSCD, and existing fire protection facilities within the structure Community participation and existing fire protection facilities have been identified through the questionnaire survey in the study area.

5.9.1: Community Participation in Extinguishing Fire

The survey revealed a high level of community participation in fire fighting when a fire breaks out in the neighbourhood. This may be due to both altruistic intentions and the self-serving urge to control the fire before it spreads and engulfs other structures. In 44.80 percent of incidents the fire was extinguished by local people without the intervention of BFSCD. The local people assisted the BFSCD firefighters in extinguishing the blaze in 39.20 percent of cases. The Fire Service personnel had put out the fire without community assistance in only 16 percent of the cases. Most of these cases were serious incidents of the where the local community could do very little except call in the professional firefighters.

5.9.2: Time of Arrival of BFSCD Personnel in Relation to Duration of Fire.

Table (7) shows BFSCD's performance in reaching the fire scene vis-a-vis duration of the fire Even when only the short-lived fires (lasting for up to 15 minutes) are considered, fire trucks had reached the site before the fire had been put out in almost a fourth of all cases. In a little less than half of the cases they did not reach the scene at all and in the other cases they reached the scene too late. In fires that lasted for more than half-an-hour, there was no case of failure to reach the site, though in nearly a fourth of the cases, they reached there after the fire had been extinguished. This did not happen for the fires that lasted for over 45 minutes.

Table-7: Time of Arrival of BFSCD Personnel with Respect of Duration of Fire.

Duration of Fire (Minutes)	Time of Arrival of BFSCD Personnel			Total Number of Fire
	Before fire was put out	After fire was put out	Did not arrive	
0-15	11	13	10	34
15-30	18	11	2	31
30-45	21	08	00	29
45+	24	0	12	24
Total	74	32		118

Source: Field Survey, 2006.

5.9.3: Existing Fire Fighting Facilities

The survey revealed that water is the most commonly used material to fight fires. It used to extinguish 82.40 percent of the fires. In nearly a quarter (26.40 percent) of the cases the electric and/ or gas supply limes were truned off. Fire extinguishers and foam were used in 10.40 percent of cases. While water is the most important fire extinguishing material, its scarcity is becoming a critical issue, raising the potential damage from fire incidents. In nearly one in five (20.61 percent) of the surveyed cases lack of water was cited as a hindrance to fighting the fire. Water hydrants for the fighting are not installed in the city, they were not that essential either, in view of the abundance of canals, ponds, ditches, marshes etc. within a short distance from every point of the city except in small pockets of the most densely built-up areas. However, with increased urbanization and filling up of such water bodies, the availability of water to fight can no longer be taken for granted Other major fire fighting hindrances reported include obstruction created by the crowd of onlookers (16.80 percent), lack of knowledge of the people about tackling fires (13.60 percent), and difficult access to the fire scene (8.00 percent).

A general lack of preparedness to fight fire was observed throughout the study area. Although shopping centres had a significant share of the reported fires, none of them had any fire warning or fighting facilities. Of the 53 residential establishments where incidents of fire took place, only one had a fire extinguisher. Apart from the some petrol pumps, the some banks and some of the restaurants, the commercial establishments had no fire fighting equipment either.

5.9.4: Universal laws to prevent the occurrence of fire.

i. Control or eliminate the sources of ignition.

ii. Control or eliminate materials that are easily ignited.

iii. Use non-combustible materials.

iv. Use and select materials with low ignitability.

5.9.5: Universal extinguishing methods

Fire extinguishing techniques may be carried out by separating or reducing one or more of the causative factors of fire. The methods are as follows;

i. Starvation: Reducing or removing the fuel from this scene of the fire.

ii. Smothering: Reducing or cutting off the oxygen supply from the scene of fire.

iii. Cooling: Lowering the temperature or reducing the heat.

5.10: Preventive Strategies

5.10.1: Environment

i. Ensure that all entrances to the building are secured from intruders.

ii. Ensure that approaches to the building entrance are not obstructed.

iii. Objects placed outside the building should be orderly and free from obstruction.

iv. Ensure trees are not obstructing and in contact with wire or distribution lines.

v. Have safe facilities for waster disposal.

vi. Ensure that fire trucks and equipment of the Fire Brigade may approach the building to save lives and fight fires.

Extinguishing Methods

STARVATION	1.Cut off fuel supply 2.Close valve. 3.Remove combustible materials
SMOTHERING	1.Cut off oxygen supply 2.Apply foam 3.Use carbon dioxide of dry powder
COOLING	1.Remove heat 2.Use water, water absorbs heat and cools the fuel.

5.10.2: Storage

Haphazard storage could hasten the spread of fire and prevent fire fighters from discovering the seat of fire or restrict the effectiveness of the automatic sprinkler system.

i. Items should be neatly stored and there should be adequate pathway.

ii. Items should be neatly stored and there should be adequate pathway.

iii. The storage area must be accessible to fire fighters.

iv. Signs prohibiting smoking must be clearly displayed.

v. Fire extinguishers must be placed at suitable location.

vi. Combustible materials must be segregated.

5.10.3: Smoking

Smoking is one of the main causes of fire, Take control by:

i. Providing enough ashtrays that will not burn.

ii. Clearing the ashtrays at the end or each day of shift. Do not dispose cigarette stubs in wastepaper baskets.

iii. Clearly display sings prohibiting smoking.

iv. Ensure the ashtrays have handles.

v. Implementing the rules and regulations prohibiting smoking at workplaces.

5.10.4: Common source of electrical installation fire includes:

i. Short circuit due to worn out cabling and insulation.

ii. Overloading electrical outlet.

iii. Localized heating at a terminal as a result of loose connections.

iv. Incorrect installation use of undersized wiring or poor quality electrical joints.

v. Current leakage due to worn out cabling.

vi. Existing electrical circuit load exceeding the safe limit.

vii. Lighting.

viii. Attention should be given to storage are as where lights are situated close to combustibles.

5.10.5: Management of electrical equipment and installation

i. Keep electrical heating devices at a safe distance from combustible materials such as wood and construction materials.

ii. Damage to electrical equipment must be attended to immediately.

iii. All electrical installations are to be inspected and tested at least thrice a year.

iv. Temporary wiring connections should be reduced and due care must be given to ensure the circuit is not overloaded.

v. Ensure that all main switches are off when not in use.

vi. All electrical repair and management work should be handled by qualified personnel.

vii. Temporary paper or interior decorations should be kept at a distance from light and not attached to electrical wiring.

5.10.6: Control Strategies

i. Ensure that the fire fighting equipment is adequate.

ii. Ensure that all fire fighting equipment is properly handled and in good working condition.

iii. Employees should be trained in using fire fighting equipment.

iv. Fire fighting equipment should be located at the fire fighting access area and clearly displayed.

v. Emergency telephone numbers are to be displayed at strategic places.

vi. All employees should be instructed to call the fire Service and Civil Defense.

vii. Department if a fire break out.

viii. A first aid kit should be available and its contents checked periodically.

ix. Any damage to fire fighting equipment should be attended to immediately and recorded.

x. Tests and inspections on the fire fighting equipment should be doe periodically.

xi. Directions to the location of the pump and generator rooms should be displayed.

xii. Ensure that all fire protection equipment and system are free from obstruction.

xiii. The building should have fire resistance grid to limit the floor area without obstructing the exit.

xiv. Ensure that any opening in a separation wall is protected by fire doors.

xv. Ensure that all fire doors at the fire fighting access area are shut at all times.

xvi. Ensure that all interior decorations such as carpets, curtains and paints are approved by the Fire Service and Civil Defense Department of Bangladesh.

xvii. All construction and renovations must comply with the conditions of the laws of the local authorities.

5.10.7: Evacuation Strategies

i. Every employee must be familiar with all the methods of evacuating.

ii. Every employee must know how to use the break glass unit and shout fire! Fire!

iii. All escape routes must be lit by an emergency exit sign light.

iv. Landings and corridors must be lit by emergency lights.

v. All doors heading towards the emergency staircase must be fire doors which close automatically.

vi. The Staircase width must be able to accommodate all the building occupants.

vii. All protected staircases must lead directly to the final exit.

viii. All safety staircases must be free from obstruction and fire hazards.

ix. Ensure there are no other opening at the staircase enclosure apart from the fire resistant door.

x. Any temporary construction of storage is not allowed below the safety staircase.

xi. The secondary sources of power supply must be in working order at all times.

xii. Do not use the lift during a fire.

xiii. The emergency exit doors must not looked or obstructed.

xiv. All final emergency exit doors must lead to the outside.

xv. All exit doors of protected staircases must open into the staircase.

xvi. All employees must be familiar with the evacuation drill of the building.

xvii. All employees must be aware of the employers emergency action plan.

5.10.8: Necessary immediate action upon hearing alarm.

i. Stop all work immediately.

ii. Ensure safety of work area before leaving.

Example: Close drawers and cabinets, switch off electrical appliances, close door.

iii. Safe yourself through the nearest or designated staircase/door.

iv. Inform other building occupants and guide visitors out of the premises.

v. Immediately evacuate to the designated assembly area and wait.

5.10.9: Necessary action during a fire

i. Act immediately! Sound the alarm and shout Fire! Fire!

ii. Try to save the injured and avoid being exposed to smoke and vapours.

iii. Give priority to your own safety.

iv. Put out the fire with a suitable fire extinguisher if it safe to do so.

v. Do not try to extinguish the fire on your own.

vi. If you are not trained to fight fires, leave immediately and shut the door.

vii. Call the Fire Service and Civil Defense Department immediately and inform your supervisor of the fire.

viii. If trapped in a smoke-filled area, do not run. Crawl to the lowest level with your head facing down and outwards.

ix Do not try to re-enter the building once you have left it.

x. If the fire is not threatening:

-shut down the machinery.

-turn off gas supply and electrical appliances but leave the lights on.

5.10.9.1: Duties and Responsibilities of the Safety Officer/Manager.

i. Hold induction training for new employees.

ii. Plan and organize fire drills for all employees on prevention and systematic fire control methods.

iii. Collaborate with the Fire Service Department in aspects of training services and audit advice.

5.10.9.2: Office Safety Management:

5.10.9.2.1: Summary

The main factor influencing the and effectiveness of Office Fire Safety Management is managements responsibility towards Fire Safety including the total support of every individual in the organization. Fire prevention awareness is a commitment that should be imbued in each citizen in manifesting a progressive and empowered mentality in line with the nation's policy for a developed nation. Each individual in an organization must be safe from fire hazards. Protection from fire, a healthy attitude and keen awareness of the implications of a fire disaster are combined elements towards FIRE SAFETY CULTURE from the aspect of fire prevention. Burning is an unavoidable activity, but fire is a tragedy that can be prevented or even zeroed through a society that is highly aware of the macro implications of fires:

5.10.9.2.2: Positive steps towards offices Safety Management

i. All organizations must prepare a sufficient budget for Fire System management every year.

ii. All organizations must elect an individual responsible for employee awareness of fire safety.

iii. The management must ensure that an annual fire drill is held involving the building.

iv. All evacuation routs (doors and staircases) must be free of obstruction.

v. Any interior design change or extension must be referred to the fire Service Department.

vi. A representative from the organization must have frequent consultations with the Fire Service and Civil Defense Department.

Chapter-Six

CHAPTER SIX

Conclusion & Recommendations

6.1: General

There is a general lack of awareness or sense of emergency regarding fire hazard Dhaka City. There is gross negligence & ignorance with regard to fire prevention & precautions. This lack of awareness and preparedness has been reported by others such as Ahmed (1992, 1998). This is in inspite of the fact that fires cause considerable damage and the media have given sensational coverage to major incidents of fire in the city. The rapid growth of the city, filling up of water bodies and open spaces, cramped living conditions is exacerbating the situation. The Bangladesh National Building Code has elaborate directives for making building relatively safe from the hazard of fire but they largely ignored by the builders.

The study attempted to assess the risk of fire and existing fire mitigation facilities with a view to fulfillment of the objective, the study provided a framework for assessing the potential risk fire. If more parameters were included in this model more detail and comprehensive hazard assessment could be possible.

6.2: Recommendations/Policy Implication for Further Improvement

Marked improvement is necessary in both fire prevention and fire fighting. Fire prevention can be improved by strict enforcement of planning regulations to prevent hazardous land use from locating in densely built up areas. Proper fire inspection and maintenance of electricity supply lines can reduce the hazard of fire. To improve the fire fighting aspect, indiscriminate filling up of water bodies must bee prevented and adequate right-of-ways should be ensured. This is particularly important in the fringe areas where new developments are taking place. Public awareness campaigns, including fire drills, may be conducted. Also, careful planning of the number and Locations of fire stations is needed.

Following aspects should be considered for reducing fire hazard:

6.2.1: Fire Disaster Prevention Planning

The developed fire hazard map can be used to identify fire risk area and hazardous and incompatible land use in an area, which can help exploring corrective measures and undertaking both fire prevention and mitigation planning. The hazard map can also help in formulation of land use control and zoning plan.

6.2.2: Development of Fire Risk Management System

There is virtually no legislation specifically designed for disaster management. There exists a Famine Manual (1967), Drought Code (1980), Standing Order for Flood (1984), Standing Order for Cyclone (1985). These manuals, codes and orders provide instruction for the government agencies including the ministry to organize their work and priorities during and after disaster. They also provide specific tasks for every government body (Akther, 1998). But fire hazard did not get its due importance from the planners and policy makers.

Department of Fire Service and Civil Defense has developed and is being directed by the "East Pakistan Fire Service Ordinance 1959". There has been no attempt to review this ordinance to reflect the changing circumstances over the decades. Even the provision of penalties made by the ordinance is not being enforced properly (Sayeeduzzaman, 1990). The ordinance, if not reviewed, should be enforced properly. This ordinance alone is not adequate to reduce the threat of fire hazard. A comprehensive risk management system should be developed like the United States Fire Administration (USFA). While developing a comprehensive risk management system it should be remembered that it is a dynamic system and not a fixed solution to fire hazard (USFA, 1996).

6.2.3: Enforcement of Building Code

Excellent provisions have been made for fire protection and safer buildings under the National Building Code 1993. Fire zones have also been defined in the code. The code is a system of risk management designed to

provide socially acceptable level of risk for the public. It is implicitly balanced against cost. Since it is a system, it is possible to change components within the system and maintain the overall level of safety (Benjmin/Clarke Associates, 1984). But the code is not being following by the occupants of property and also is not being enforced properly by the enforcing authority. The proper enforcement of the code might reduce the possible risk of fire hazard.

6.2.4: Development of Land Information System (LIS)

An effective land information system should be developed which shall contain plot-to-plot structured-based data including function of a particular type of structure in a given land use. This will help to obtain current and updated data about the use of land in different areas and also help in preventing land from hazardous. Geographic Information System (GIS) could be used as an effective tool for developing an LIS.

6.2.5: Development of Land Policy for Disaster Mitigation

At present, there is no such land development legislation like "The town Planning Act of 1907" of Sweden or the Town & Country Planning Acts of the UK to safeguard public interest (Huque, 1987). A detailed and comprehensive land development policy should be evolved; special consideration should be given to disaster management. The land policy should impose bar on filling up of water bodies, and ensure preservation of adequate open spaces as safer zones and so on, which shall help in mitigating various hazards including fire hazard. A policy guideline for land use regulation and zoning, and sub-division law should be incorporated in the policy paper on land use and development policy. Necessary steps should be taken to define fire zones in hazardous areas.

6.2.6: Provision of Necessary Utilities And Services And Co-Ordination Among Different Agencies

Utilities and services that are necessary for fire fighting should be installed properly. For example water supply is the most crucial element for fire fighting. But currently adequate water is not available for fighting fire. During collecting data on fire incidents from the register of BFSCD, it was found that in many cases due to unavailability of adequate water for fire fighting, the fire engines had to go far away from the fire location for fire to fetch water, which contributed to the duration of fire in some cases. Provision has been made in the Town Improvement Act, 1953 for providing adequate water supply for public use. This implies that supply of adequate water should be made for all necessary purposes including fire fighting. But roadside water hydrants for fire fighting have not been installed by the concerned agency; even adequate head pressure for fire fighting is not available. So provision should be made for roadside water hydrants and adequate head pressure of water supply for fire fighting, particularly in highly hazard prone areas.

Coordination among these agencies should be institutionalized and should be an integral part of a risk management system.

6.3: Area for Further Research

The study dealt with fire hazard mapping with a view to identify fire hazard prone areas. Although a methodology for fire hazard mapping has been developed for an urban area, there is still ample opportunity to develop it further. Duration of fire, human death and injury, fire damage, population density, density of structure, people's attitude and behavior, accessibility, impact of fire incidents on weather condition and its seasonal variation can be incorporated in future research.

Organizational and operational risk management and, information management and institutional development for fire hazard management and development are other important areas of study, which can help in responding fire disaster (USFA, 1996). These fields are still unexplored by researchers in Bangladesh.

Optimum location of fire service station is a crucial factor for fire hazard response, which has not yet been determined. Travel time should be the most crucial factor to consider rather than physical distance in determining such locations. Because the travel time of fire engines may not be proportionate to the distance of the fire station from the location of fire, but may depend on other factors such as traffic conditions and the width of roads on the routs taken.

6.4: Conclusion

The ultimate goal of fire hazard analysis is to develop a fire hazard implementation policy for reducing the impact of fire hazard and also to reduce private and public losses resulting from fire hazards, which is a responsibility of the policy makers. The development and implementation of fire hazard prevention policy generally involves the formulation and execution of fire prevention measures and management plan. This process may be thought of as a series of distinct but interconnected steps. These steps consist of:

- Identification of goal.
- Assessment of problem
- Identification of alternative strategies.
- Identification of criteria.
- Evaluation of alternatives.
- Selection of appropriate strategy.
- Implementation of the selected strategy.
- Operation and management.

The various steps are part of a continuous process, with the output of each phase providing the input for the next phase. Finally, it is clear that hazard maps, which have been produced in this study, can play a major role in risk assessment and developing fire prevention plan.

While developing a fire hazard prevention plan, it must be borne in mind that wholesale replication of fire prevention and fire fighting strategies from other countries may not work. It is necessary to gauge the overall attitude of the people towards fire involving perception of fire hazards by people, planners, policy makers and the way these perceptions influence the fire hazard to identify culturally viable fire prevention procedure (Robson, 1988; Seley, 1979). More research is required in this end.

Reference

Anderson, M. B. (1993), Disaster Vulnerability and Sustainable Development: A General Framework for Assessing Vulnerability, The Collaborative for Development Action Inc, Cambridge.

Ahsan, R. M. (2005), Oriental Geographers, Vol-49, No-2, The Bangladesh Geoographers Society, Dhaka.

Alam, M. M. U. (2004), "Yearly Report of Divisional Activities", Fire Service & Civil Defense week – 2004, Special No – Fire Protection, Dhaka.

Ali, M. (2006), "Fire Safety Management at Government and Private Offices", Fire Service and Civil Defense Week-2006, Special Number: Fire Protection, Dhaka.

Babbitt, B. (1999), "Making Peace with Wildland Fire," Wildfire 8:12-17 (January).

Bangladesh Disaster Preparation Forum, (2001), "Urban Disaster", Bangladesh Disaster Report–2001, Dhaka.

Bangladesh Disaster Preparation Forum, (2000), "Incidents", Bangladesh disaster Report 2000, Dhaka.

Benyamin Clarke Associates Inc (1984), Fire Deaths, Control, causes and Strategies for control, Technomic Publishing Company, Pennsylvania.

Bishop, M and Denise, D. (2004), "Accidental Ignition of a Christmastree: Very Unlikely", Fire and Arson investigator.

Biswell, H.H. (1959), "Man and Fire in Ponderosa in the Sierra Nevada of California," Sierra Club Bulletin 44: 44-53.

Bukowski, R. W. (1997), Fire Hazard Analysis in Cote. A.E (Editor in-Chief), Fire protection handlook, Eighteenth Edition, National Fire Protection Association, Quincy

BVD (1980), Fire Risk Evaluation," Association of Cantonal Institutions for Fire Insurance, Society of Engineers and Fire Architects (SIA) and Fire Prevention Service for Industry and Trade (BVD), Zurich.

Biswell, H.H., Gibbens, R. P. and Buchanan, H. (1968), "Fuel conditions & Fire Hazard Reduction Costs in a Giant Sequoia Forest," National Parks Magazine 47:17-19.

Burrough, P.A. and Mc. Donnell R. A. (1998), Principles of Geographical Information Systems, Oxford University Press, New York.

Cooper, C. F. (1961), "The Ecology of Fire," Scientific Amercian, April.

Cardona, C.R., Davidson and C. Villacis, (1999), "Understanding Urban Seismic risk Around the world," Summary Report on the Comparative Study of the United Nations International Decade for natural Disaster Reduction, RADIUS Initiative.

Cortner, H.J. and Gale, R. D. (1990), "People, Fire and Wildland Environment, Population and Environment", 11(4): 245-257.

Cotton, L. and Biswell, H. (1973), "Forestscape & Fire Restoration at whitaker's Forest", National Parks & Conservation Magazine 47: 10-15.

Eldeen, M. T. (1981), Disaster preparedness: Risk zone Mapping and Vulnerability Analysis for disaster preparedness, KTH, Stockholm.

Emmons, H.W. (1990), "Fire Safety Science: The Promise of a Better Future" fire technology, Vol. 26, No 1, P.1.

Firedman, R. (1991), Survey of computer models for fire and smoke, second edition, Factory mutual research corporation, Norwood, M. A.

Folkman, W.S. (1966), "Children with Matches: Fires in the Angeles National Forest Area," U.S. Forest Service Research Note, PSW-109 Pacific Southwest Forest and Range Experiment Station, Berkeley.

Grimaldi, J.V. and Simonds, R.H. (1996), Safety management, Fifth Edition, A.I.T.B.S Publishers & Distributors, Delhi.

Haessler, W.M. (1984), Fire: Fundamentals and control, Marcel Dekker, New York.

Hall, J. R. (1997), Fire Risk Analysis, in Cote, A.E. (Editor in Chief), Fire protection Handbook, Eighteenth Edition, National Fire protection Association, Quincy.

Heywood, I, et. al, (2002), An Introduction to geographic information Systems, Pearson Education, Delhi.

Hartesveldt, R. J. (1964), "Fire Ecology of the Giant sequoia: Controlled Fires May Be one Solution to survival of the Species", Natural History Magazine – 73: 12-19.

Huxhold, W. E. (1991), An Introduction to Urban Geographic Information Systems, Oxford University Press, Oxford.

Islam, M. Aminul (1995), Environment Land Use and Natural Hazards in Bangladesh, Dhaka University, Dhaka.

Islam, M. N. (2008), An Introduction to Research Methods, Mullick & Brothers, Dhaka.

Islam, N. (1996), Dhaka from City to Megacity, Urban Studies Programme, Dhaka.

Jackson, L. P., Rohlik, A. R. & Conway, R. A. (1983), Hazardous and Industrial waste: Management and Testing ASTM Publication, Philadel Phia.

Jordan, D.W. (1989), Hazard Assessment Model for the Classification of Fire Brigades in the country Area of Victoria, Country Fire Authority, Malven.

Lamois L.M. (1961), "Research in fire prevention" second General session, Third Annual Governor's state wide Conference on fire prevention, Anna polis, MD.

Marchant, E.M. (1984), "A Cost Effective Approach to Fire Safety" Paper–1 Points Scheme, International Fire Security and Safety Conference.

Me Master, R.B. (1990), Introductory Readings in Geographic Information Systems: Modeling Community vulnerability to hazardous materials using geographic information system, Taylor & Francies, London.

Nelson, H. E. and Shibe, A. J. (1980), "A System for Fire Safety Evaluation of Heath care facilities", NBSIR 78-1555, Center for Fire Research, National Bureau of Standards, Washington.

NFPA (1995), NFPA-101, Alternative Approaches to life Safety, National Fire Protection Association, Quincy.

Nolan, P. Dennis, (2004), Hand Book of Fire and Explosion Protection Engineering Principles for Oil, gas, Chemical and related facilities, Chest Publishing House, New Delhi.

Ong, D. (1989), "Fighting Fire with Fire: How Fire plays a Beneficial Role in the Heath of the Forest", UC Davis Magazine, May-June 1989: 8-11.

Ramachandran, G & Hall, J. (2002), Measuring Fire Consequences in Economic Terms, SFPE Handbook of Fire Protection Engineering, National Fire Protection Engineering, National Fire Protection Association, Quincy.

Rabash, D.J.G., et. al, (2004), Law, Evaluation of Fire safety, John wiley, London.

Rahman, M. R. (2005), "Yearly Report of Divisional Activities", Fire service & Civil Defense – 2005, Special No. Fire Protection, Dhaka.

Ramchandran, M & Earlman, J.R.(1999), Application of GIS to Vulnerability Mapping: A west African Food Security Case study, the Clark Labs for cartographic Technology and Geographic Analysis, Worcester, U.S.A.

Robeson, P.D. (1988), "Attitudes Towards Fire: A Challenge to Fire Protection Thinking", Fire Journal: Protection, Prevention & Suppression, Sept. PP. 24-25.

Robertson, J.C. (1984), Introduction to Fire Prevention (3rd Edition) Macmillan Publishing Company, New York.

Scheffler, N.E. (1994), "Improved Fire and, Explosion Index Hazard Classification", AICHE Spring National Meeting.

The Bangladesh Observer (2007), "Cos owed by Tarique, Falu, Bengal Group damaged," February, 27th.

The Daily Star (2007), "Post–BSEC, Fire case studies: March- 2007, March, 30th.

The Independent, (2006), "Fire Fighters", The unsung Heroes: Fire Fighting –A History", February, 10th, Dhaka.

The Independent (2006), "Fire Devours Spinning mill, 6 burnt alive, February," 10th.

The New Nation (2007), "Devastating fire at BSEC Bhaban: NTV, RTV Suspend Transmission," February, 27th.

Tridata corporation (1998), "An NFIRS Analysis: Investigating City Characteristics and Residential Fire Rates," United States Fire Administration (USFA), Washington D.C.

Tweed, W. (1987), "Born of Fire", National Parks Magazine, 61:23-27, 45.

The Daily Ittefaq, (2006), "Fire in Chittagonj K.T.S. Textile Mill", February, 24th, Dhaka.

The Daily Star, (2006), "10 Killed in Chittagonj R. M. G. Factories Fire", February, 24th, Dhaka.

The Daily star, (2006), "Incidents of fire on rise". February 15th, Dhaka.

USFA (1996), "Risk Management Practices in the Fire service", United States Fire Administration (USFA), U.S.A.

Vankat, J. L. (1977), "Fire and Man in Sequoia National Park," Annuals, Assoc. Amer. Geog. 67:17-27.

Watts, J & Chapman, R (2002), Engineering Economics, SFPE Hand Book of Fire Protection Engineering, National Fire Protections Association, Quincy.

Watts, J (1981), "Systematic Methods of Evaluating Fire Safety: A Review," Fire Prevention, Vol. 18, No. 2, PP. 24-27.

Watts, J. M. Jr. (1992), "Fire Risk Rating Schedules" Fire Hazard and Fire Risk Assessment, ASTM STP 1150, Hirschler, M.M. ed., American Society for Testing and Materials, Philadelphia

Wuerther, G. (1995), "Fire Power," NPCA-National Parks Magazine, May / June 1995: 32-37.

Appendix-1

Distribution of Fire Incidents of DCC in 2005.

Date	Location-1	Location-2	Location-3	Types of Fire	Description of Fire	Amount of loss(Taka)	No of Casualties :Death	No of Casualties :Wounded
01.01.05	Mirpur	Section-1	6789 plot, Block-c	Electricity	Short circuit of electricity	10000		
01.01.05	Postogola	Galli no-3	287EastDholaipar	Slum	Electricity	100000		2
02.01.05	Postogola	Jurain Railgate	Acota Bahumukhi Samata	Shoppingcentre	Cause of burning candle	30000		
03.01.05	Banani	Block -E	17/A	Electricity	Disorder in Electric Post	5000		
03.01.05	Mirpur	Section-1	95 South Bishil,section-1 n	Factory	Ice Factory	50000		
05.01.05	Gulistan	R. Hamid Lane	H # 7	Garments		200000		
05.01.05	Natun Bazar	Vatara Union	Bir protic Market	Shoppingcentre	Cause of electricity			
06.01.05	Farashganga	K.M.Das lane	24 Mohini K.M.Das Lane	Hospital	Disorder of Electricity	50000		
07.01.05	MirHazirbag	Rail Line	GuntiDhar Basti	Slum		30000		1
07.01.05	Hazipara	Petrol pump	Near petrol pump	Vehicle	Aggressive people lit fire N.Pariban	150000		
08.01.05	Shyampur	Kadamtala	Oriental United Industry Ltc	Factory		50000		
09.01.05	Tejgaon	Old Airport	Runway	Clean Jungle	To clean jungle and lit fire	5000		
09.01.05	Magbazar	Wireless	Wireless railgate	Storehouse	Cause of electricity	50000		
11.01.05	Demra	Sanarpar	West Sanarpara	Factory	Biscuit factoy	100000		
11.01.05	(Dhanmondi)	IBAISUniversity	H#21, R #-27	Residencial		50000		
12.01.05	Hazaribagh	Boubazar Basti		Slum		200000		
12.01.05	Sadarghat	Patutoli	H #61	New resident	Cause of burning cigarette	5000		
14.01.05	Nayabazar	Nawab Market	Shop no-14,15, 6no Bhaba	Market		200000		
16.01.05	Gulshan	Link Road		Vehicle		60000		
18.01.05	Baridhara	Nayanagar	Block -J,Beside Charch	Shoppingcentre		15000		
19.01.05	Chakbazar	Moulibazar	3 no Mukim katra	factory	Plastic toys			
19.01.05	Madhyabadda	Mollapara		Resident	Cause of electricity	100000		
19.01.05	Ransad Tower	KaziNazrulAvinew	H #113	Electricity	Disorder of electricity			
21.01.05	North South road	Shila garments	H # 39/A	Garments		20000		
21.01.05	Jhikatala	Tanari More	53 Shere Bangla Road	Factory	Shoe Faotory	under investigation		
22.01.05	Mohakhali	Filling Station	Mohakhali Rasulpur Aman	Vehicle	Minibus(Aggressive people)	under investigation		
22.01.05	Maibag	Hazipara		Factory	Gengi Factory(Cause of iron)	500000		
23.01.05	Postogola	Shyampur	Alibahar	Shoppingcentre		20000		
23.01.05	Kaptan bazar	Complex Bhaban	Bhaban -2	Shoppingcentre		300000		
24.01.05	Islambagh	South Islambagh	H# 58/12/C/1	Factory	Factory of plastic powder	200000		
27.01.05	Tejgaon	Bijoy Smarany		Vehicle	Aggressive people lit fir on vehicle	300000		
27.01.05	Agargoan	B.N.P. Bazar	WestAgorgaonBNP Bazar	Slum		5000		
27.01.05	Demra	Jute Mill	Latif Bhayani Jute Mill	Factory		50000		
28.01.05	Gulistan	New Banga	New Banga Market	Shoppingcentre	Burning Cigarette	10000		
28.01.05	Dhaka University	Doyel Chattar	Doyel Chattar, D.U.	Vehicle	Aggressive people lit fire on it	under investigation		
28.01.05	Sutrapur	Murgitola	Murgitola New Chourasta	Vehicle		100000		
28.01.05	Mirpur	Section -10	Block -A	Shoppingcentre	Cotton shop (Dying)	1000000		
28.01.05	Mirpur	Section-1	Infront of TaninBhaban	Vehicle		200000		
29.01.05	Demra	Sanarpar	Sanarpar, Demra	Resident		10000		
29.01.05	Jhikatala	Rifle Square	Jhikatala Rifle Square	Vehicle		200000		
29.01.05	Khilgaon	Bishwaroad	Infront of T&T Bhaban	Vehicle		200000		
29.01.05	Mirpur	Section-10	Infront of General Hospital	Vehicle		50000		
29.01.05	Malibag	Chowdhuripara	Near Padma Cenema Hall	Vehicle		50000		

29.01.05	Khilgaon	Bishwaroad	Infront of T&T Bhaban	Vehicle
29.01.05	Mirpur	Section-10	Infront of General Hospital	Vehicle
29.01.05	Malibag	Chowdhuripara	Near Padma Cenema Hall	Vehicle
29.01.05	Mirpur	Gabtali	Infront of Gabtali Beauti Ce	Vehicle
30.01.05	Khilgaon	Flyover	Near Flyover	Vehicle
30.01.05	Motijhil	Dainik Bangla	Dainik Banglar Mor	Vehicle
30.01.05	Ramna	Topkhana	Tokhana Road	Vehicle
30.01.05	Khilgaon	Chowdhuripara	Infront of Al Modina Hotel	Vehicle
30.01.05	Agargoan	Passport office	Infront of Passport office	Vehicle
30.01.05	Motijhil	Dilkusha	Dilkusha Road	Vehicle
30.01.05	Tongi	Abdullahpur	Near Abdullahpur Bridge	Vehicle
30.01.05	Mohammadpur	Sir Sayed Road	Sir Sayed Road	Vehicle
31.01.05	Mirpur	Section-14	Mirpur 14 no More	Vehicle
31.01.05	Uttara	Azampur	149 Azampur(Kartoon Fac	Factory
2.02.05	Dhanmondi	West Dhanmondi	Road #19 , H#244	Gas
2.02.05	Gulistan	Bangabazar	Bangabazar Supermarket,I	Shopping centre
2.02.05	Motijheel	Bijoynagar	Infront of Hotel Royel	Vehicle
3.02.05	Kanchpur	Police Box	Infront of Police Fari	Vehicle
4.02.05	Gulistan	Bangabandhu Ave.	Bangabandhu Aveneu	Vehicle
4.02.05	Mirpur	Section-10&half	Mirpur 10 &half	Vehicle
4.02.05	Sadarghat	Gudge Court	Infront of Gudge court	Vehicle
4.02.05	Palton	Baytulmokaram	South Gate of Baytulmokar	Vehicle
4.02.05	Mohakhali	Flyover	Infront of Flyover	Vehicle
5.02.05	Mirpur	Gabtali	Khaleq Enterprize	Vehicle
5.02.05	Goran	Tempustand	Infront of Tempustand	Vehicle
5.02.05	Gulshan-2	Road #120	H #12	Gas
5.02.05	Badda	Natun Bazar	Infront of Natun Bazar	Vehicle
5.02.05	Dhanmondi	Satmaszid Road	Satmoszid Road	Vehicle
6.02.05	Nimtala	Anandabazar	Faruq Motors , Secretariate	Vehicle
6.02.05	Bhasantek	West Bhasantek-1	Muktijodha Dewan Para Sa	Slum
7.02.05	Motijheel	73Motijheel	Meghna Insurance compar	Shopping centre
8.02.05	Keranigang	Rupnagar	Rupnagar Tailogat	Shopping centre
8.02.05	Motijheel	Arambag	32/3Arambag	Resident
8.02.05	Kawranbazar	Washabhaban	Washabhaban Kawranbaza	Other
8.02.05	Mirpur	Kazipara	850/1East Kazipara	Electricity
9.02.05	Rayerbazar	Sultangang	3/3 Sultangang	Resident
10.02.05	Motijheel	Rajuk	28Rajuk Avenue	Electricity
12.02.05	Demra	Della	Demra road Della	Factory
12.02.05	Mugda	North Mugda	112/10 N. Mugda, Khalpar	Resident
12.02.05	Shahjahanpur	N. Shahjahanpur	582/1N. Shahjahanpur	Resident
12.02.05	Nayabazar	Zindabahar Lane	5/7Zindabahar Lane	Factory
12.02.05	Moulovibazar	Ali Hossain Road	1 Ali Hossain Road	Factory
13.02.05	Gulshan -2	Road -46	Sheva House	Resident
13.02.05	Gulshan	Gonapurta Nibas-1	Gulshan Aveneu Gonapurt	Resident

	200000
	50000
	50000
	505000
	40000
	500000
	50000
	50000
	100000
	50000
	20000
	200000
	50000
	500000
	20000
	under investigation
	100000
	150000
	300000
	50000
	100000
	150000
	150000
	205000
	10000
Fire spread from gas chula	10000
	600000
	250000
	500000
	200000
Cause of short circute	10000
	400000
Cause of short circute	20000
Fire from wastage	under investigation
Electric disorder	5000
Kanchaghor	50000
Electric Transformer burst	40000
Asia Textile	10000
Kanchaghor	100000
Cause of electricity	50000
Packeging factory	5000
Plastic Factory	10000
	100000
	25000

13.02.05	Motijheel	Arambag	Infront of Notre dam colleg	Vehicle
13.02.05	Mirpur	Section -12	Doyari para Pallabi	Resident
13.02.05	Ramna	Shahbag	Shahbag More	Vehicle
13.02.05	Kamlapur	Pagoda	Bishwaroad	Vehicle
14.02.05	Mirpur	Section-11 and half	Block-e	Electricity
15.02.05	Mirpur	Mazar road	137/17 Mazar road	other
15.02.05	Sastapur	House	Sastapur house	Resident
15.02.05	Shyampur	New Ali Bahar	91 new Ali Bahar	factory
15.02.05	Khilgaon	Hazipara	Mirer Tek	Gas
16.02.05	Postogola	Ullahbag	Karim Ullahbag	Shopping centre
16.02.05	Lalbag	Chakbazar	17/2 Urdha Road	Factory
17.02.05	Mohammadpur	Fire station	infront of fire station	Vehicle
18.02.05	Banani	Kamak Ataturk Ave.	69/b Banani Kamal Ataturk	Electricity
18.02.05	Mirpur	Section-11	H#1/2/2 Pallabi	Resident
21.02.05	Tejgaon	Industry Area	446Tejgaon Industrial area	Resident
24.02.05	Mirpur	Section-11	Palasnagar	Shopping centre
24.02.05	Chakbazar	Chak Circular road	37chak circular road	Storage
26.02.05	Postogola	Shyampur	Chakda Kadamtali Telcal	Resident
26.02.05	Mirpur	Section-12	Block -B , H#103 Road -6	Resident
26.02.05	Jigatala	Maneshwar Road	Gabtali	Resident
26.02.05	Kurmitola	Airbase head quart.	Airbase Head Quartar	Resident
27.02.05	Abdullahpur	Ashulia Road	Maolana Hospital	Shopping centre
28.02.05	Uttara	Sector-1	H #14 , Road #-14 (Storag	Shopping centre
28.02.05	Gulshan	Gulshan-1	71Shopping centre	Shopping centre
2.03.05	Badda	South Badda	34/1 South Badda	Shopping centre
2.03.05	South Azampur	Udyan Road	Munchi Market, Tangi	Shopping centre
2.03.05	Mohammadpur	Geneva Camp		Slum/Resident
4.03.05	Soyari Ghat	Nalgola Rajar ghat	Nalgola Rajarghat	Storage of dying
4.03.05	Mohakhali	ICDDRB		Electricity
5.03.05	Kawranbazar	BTMC	BTMC ,Ground floor	Electricity
6.03.05	Magbazar	Escaton	52 Escaton Road	Resident
7.03.05	Tanary More	Sherebangla road	118Sherebangla Road	Factory
8.03.05	Gulshan	Gulshan-2	Goalchakkar	Shopping centre
10.03.05	Green Road	Kathal Bagan	Kathal Bagan Bazar	Shopping centre
10.03.05	EPZ	Madras Road	Islampur Nagarhat	Electricity
11.03.05	Chankharpul	Nabab Katra	22/3Nabab Katra	Electricity
12.03.05	Baridhara	Road #6	House#37	Vehicle
15.03.05	Khilkshet	padira		Resident
21.03.05	Hazaribag	Sanatangar	42/7 Sanatangor	Factory
21.03.05	Tejgaon	Upa Anustanic bhaban	232/1Tejgaon Industrial An	Resident
22.03.05	Mirpur	Section-1	Mazar road Muktabangla s	Shopping centre
24.03.05	Gopibag	Ramkrishna Mission R	39Ramkrishna Mission Ro	Resident
28.03.05	Khilgaon	Railgate	Khilgaon Railgate kacha b	Shopping centre

	100000
Fire spread from gas chula	50000
	100000
	100000
Store of cotton	30000
Lit fire due electricity from cottonstorage	10000
Burning candle	100000
Cotton Factory	30000
Gaschula	160000
Cotton Dhunai ghor	40000
	under investigation
	5000
	50000
Cause of electricity	100000
	20000
	5000
	30000
Electric short circuit	200000
Cause of electricity	100000
	under investigation
	150000
Fire spread from Moscuitoe coil	under investigation
	50000
	100000
	150000
Lit fire from Chula	2000
	500000
Transformer	50000
	10000
Lit fire from Chula	50000
	800000
	100000
	20000
	150000
	.....
	40000
	350000
Rubber Factory	under investigation
cause of electricity	100000
	200000
	30000
	7500000

02.04.05	Tejgaon	Uttar Mottors	124 Tejgaon Industrial Are:	Electricity
03.04.05	Tejgaon	Rahim Metal	Rahim Metal adjacent to T	Vehicle
05.04.05	Mirpur	14 Mirpur Road	14 B, 4 no Ward B.N.P. off	Electricity
06.04.05	Matuail	Rahomatpur	Rahomatpur Matuail	Gas
06.04.05	Mirpur	Section-12	R#6, H#6, Block-C Pallabi	Gas
07.04.05	Mirpur	Section-11	Block-B, Bouniabad	Resident
08.04.05	Kaptan bazar	Kaptan Bazar Morh		Resident
09.04.05	Elephant Road	Super Market	125 Elephant Road Dayan	Shopping centre
09.04.05	Green Road	24/2 Green Road		Shopping centre
09.04.05	Elephant Road	New Elephant Road	92New Elephant Road, Su	Shopping centre
10.04.05	Mothertek	Madya Mothertek	64 Madya Mothertek	Electricity
11.04.05	Armania	Armania Street	21 Armania Street	Factory
13.04.05	Mohammadpur	College Gate		Vehicle
14.04.05	Dhanmondi	Road -11		Vehicle
14.04.05	Sadarghat	Bdamtali	Court Ghat	Resident
14.04.05	Lalbag	Nahidnagar	Beribadh	Slum
19.04.05	Jurain	Nababganga		Electricity
20.04.05	Tikatuli	K.M.das Lane	13 K. M. Das Lane	Chemical
22.04.05	Mohakhali	Red Cresent Tower	17 Mohakhali C/A	Factory
23.04.05	Mirpur	Section-1	Shah Ali Mazar Gate	Shopping centre
23.04.05	Hatkhola	Road Diganta	15/1/A Hatkhola	Resident
23.04.05	Gulshan	Gulshan-2	24 Hamid Tower	Electricity
24.04.05	Urdha Road	46-47 K. C.	46-47 K.C. Urdha Road	Factory
24.04.05	Mirpur	Section-10	Goalchakkar	Vehicle
24.04.05	Shyampur	Balur Math Plot-21	Packaging Dying & Printin	Factory
25.04.05	Azimpur	Azimpur Road	43 Azimpur Road, Faysal H	Gas
25.04.05	Khilkhet	Kha para		Resident
25.04.05	Mohammadpur	Lalmatia	6/21 Block-E Lalmatia	Storage of foam
25.04.05	Midford	Midford Road	23Midford Road	Factory
25.04.05	Sayedabad	Janapad Road	Sayedabad janapad Road	Vehicle
26.04.05	Sabujbag	North manda	Sabujbag I. C.D Morh	Shopping centre
28.04.05	Mirpur	Section-14	3 Damal Coat Basti	Slum
8.05.05	Lalmatia	H#2/7 , Block-C	B. S.O. International (NGO	Electricity
10.05.05	Rampur	East Rampur	380/6 East Rampur	Germents
13.05.05	Keraniganga	Alamnagar	Alam Market	Shopping centre
13.05.05	Nababpur	92 Nababpur Road	Infront of 92 Nababpur Roa	Electricity
15.05.05	Nakhalpara	West Nakhalpara	154/12B/13 West Nakhalpa	Resident
15.05.05	Agargaon	I.DB Bhaban	Infront of IDB Bhaban	Vehicle
20.05.05	Mohammadpur	Shahjahan Road		Vehicle
22.05.05	Gulshan	Gulshan-1	H# 54, Gulshan-1	Resident
23.05.05	Laksmibazar	Nabodi Prasad Lane	1Nabodi prasad lane, Brigh	Germents
28.05.05	Demra	Konapara		Vehicle

	100000
	25000
	10000
Lit fire from Chula	500000
cause of electricity	30000
	10000
	20000
	20000
	under investigation
Electric disorder	500000
Store house of medicine(cause of elect.)	1000000
	10000
	under investigation
	10000
	700000
	3000000
	50000
	5000000
	5000
	40000
	20000
Plastic factory	1000
	4500000
	20000
	500000
	150000
	under investigation
	700000
	100000
	60000
Lit fire from Chula	200000
	500000
	10000
	3000000
Transformer burst	10000
	300000
	50000
	Under investigation
	100000
	Under investigation
	30000

28.05.05	Shahbag	Police control	Infront of Police Control, S	Vehicle
29.05.05	Pastogola	Dholaikhal		Vehicle
30.05.05	Kawran Bazar	ATN	20/21 Kawran Bazar	Shopping centre
31.05.05	Dayaganga	Dayaganga Bazar	28 Dayaganga Bazar Jelep	Chemical
31.05.05	Dayaganga	Dayaganga Bazar	18 Dayaganga Bazar Jele	Factory
31.05.05	Wari	Chandicharan Bose	4/7Chandicharan Bose Str	Factory
3.06.05	Lalbag	B. C. Street	32/3 B. Ciday Street Lalba	Factory
3.06.05	Shyampur	Commercial Area	21Shyampur C/A Chadni P	Factory
4.06.05	Arambag	143/1 Arambag	Haque Printers	Electricity
5.06.05	Mohammadpur	Townhall	Sweeper Colony	Slum
5.06.05	Shyampur	Kadamtala	Comulla dying spinning pri	Factory
7.06.05	Sayadabad	Uttara		Falling plane
8.06.05	Mirpur	Section-12	Block-E,Murapara, Pallabi(	Resident
10.06.05	Palas Bari	Savar		Vehicle
11.06.05	Kathalbagan	Katalbagan Bazar		Shopping centre
11.06.05	Mirpur	Darus Salam Road	2/C Darus Salam Road	Factory
12.06.05	Kaptain Bazar	Ershad Market		Shopping centre
14.06.05	Khilgaon	Railgate	Railgate Kacha bazar	Shopping centre
14.06.05	Kawran bazar	28/29Kawran bazar		Storage of cotton
16.06.05	Dhanmondi	R # 9, H # 2		Shopping centre
17.06.05	Dhanmondi	Road-7	House -1/2/1	Resident
17.06.05	Savar	ganakbari	Ring Sign Textile Ltd. Hop	Factory
18.06.05	Motijheel	Commercial Area	93 Motijheel C/A	Office(short circuit)
20.06.05	Siddique bazar	145 Siddique bazar		Factory
20.06.05	Tongi	Tongi Bazar	Anarkali Road	Shopping centre
21.06.05	Shahbag	Shereton Hotel	Near Shereton Hotel	Vehicle
21.06.05	Postogola	Rajabari		Factory
21.06.05	Kalayanpur	Natun Bazar		Shopping centre
22.06.05	Tongi	Duttapara		Storage
23.06.05	Mirpur	Shewarapara	Near Bus stand	Shopping centre
28.06.05	Savar	Talbag	Mudir dokan	Shopping centre
2.07.05	Mohakhali	New D.H.S.	H #373 ,R # 28	Storage of Cotton
2.07.05	Nakhalpara	East Nakhalpara	East Nakhalpara Bazar in I	Shopping centre
3.07.05	Motijheel	Motijheel C/A	100 Motijheel C/A , Air Off	Electricity
4.07.05	Mohakhali	Kachabazar		Electricity
5.07.05	Malibag	83 Malibag		Vehicle

	100000
Cause of electricity	100000
	900000
	900000
	2000000
	Under investigation
	300000
	300000
	40000
Electric disorder in saree and clothes	5000
Due falling Trainee plane fire lit on house	1500000
	.....
Cause of electric disorder	50000
Medicine factory	200000
Electric short circuit	50000
	200000
Electric disorder	1000000
Lit fire on switch board in resturant generator	5000
Electric disorder	30000
	Under investigation
AC, Computer, Furniture etc damaged onfire	4000000
Lit fire from the iron of shirt factory	10000
Electric disorder	150000
	100000
short circuit in Bum Mobile factory	500000
Lit fire from burning cigarette	8000
	500000
	50000
	15000
Lit fire on the storage due to short circuit	100000
	50000
Electricdisorder in Electric sub-station	100000
	10000
Disorder in electricity causes fire	Under investigation

7.07.05	Mitford	Mitford Road	9 Mitford Road Cosmatic sl	Shopping centre
8.07.05	Khilgaon	Taltala Super Market	Tayloring shop	Shopping centre
14.07.05	Baridhara	D.H.S	119 DHS Baridhara	Electricity
14.07.05	Nababpur	Khan Market	161Nababpur, United Elect	Shopping centre
14.07.05	Kazi Allauddin	Kazi Allauddin Road	37/3, 37/4 Kazi Allauddin F	Shopping centre
15.07.05	Banshal	Hazi Abdullah sarkar R	18/19 Hazi Abdullah Sarke	Resident
17.07.05			Road#11 , House #46	Resident
19.07.05	Tejgaon	Bitak Morh		Vehicle
20.07.05	Mirpur	Section	Goalchatwar	Vehicle
20.07.05	Uttara	Sector-3	Road # 18, H# 54	Resident
23.07.05	Maohammadpur	Lalmatia	6/3/A Lalmatia	Electricity
26.07.05	Dhanmondi	Lalmatia	R # !4/A , H #22/A(Electric	Electricity
26.07.05	ManikMia evenue	Manikmia Evenue		Vehicle
28.07.05	Mirpur	Gabtali	S. S. Filling Station	Gas
30.07.05	Kawranbazar	Kachabazar		Shopping centre
31.07.05	Demra	Dhania	449 Nayapara(Shop of eg(	Shopping centre
1.08.05	Badda	Madya Badda	Ideal nagar Road	Resident
1.08.05	Kawranbazar	Washa Bhaban	Infront of Washa Bhaban	Vehicle
2.08.05	Gulistan	Bangbandhu evenue	21 Bangabandhu Evenue	Factory
3.08.05	chhantek	School Road	357 chhantek School Road	Gas chula
4.08.05	Sadarghat	Ladis Market		Shopping centre
4.08.05	Mohakhali	Amtali	21 Amtali, Jahad khan hote	Gas chula
4.08.05	Dakhin Khan	Anal Dakhin khan		Resident
5.08.05	Gabtali	Asian Highway	57/K Bagbari	Shopping centre
6.08.05	Mohakhali	R#32, H# 471		Resident
7.08.05	Gingira	Haoli	Haoli Gingira	Gas
7.08.05	KaziNazrul Islam	22 kazi N I. Road	22kazi Nazrul Islam Road	Resident
9.08.05	Mirpur	Section-1	170South Bisil(Nudul facto	Factory
10.08.05	Banani	Block A	Road -11, House-84	Electricity
12.08.05	Uttara	Rab Office	Main Road infront of Rab o	Vehicle
12.08.05	Jurain	Medical Road	224/2 Jurain Medical Road	Factory
16.08.05	Kamrangichar	Kamrangichar		Shopping centre
17.08.05	Mohakhali	Commercial Area	5 Mohakhali C/A(Nion sign	Shopping centre
22.08.05	Baridhara	DOHS	H #366/1 ,R #6	Office
24.08.05	Tejgaon	Rahim Metal Mosque	Behind of Rahim metal Mo	Shopping centre
26.08.05	Mohakhali	Kachabazar		Shopping centre
26.08.05	Mirpur	Beribadh	Bania Beribadh(shoe facto	Factory

Lit fire on switch board due to disorder in elec	10000
Lit fire due to electric iron	150000
Lit fire on switch board due to short circuit	150000
Lit fire from electric wire	50000
	2000000
	50000
	100000
	20000
	20000
Disorder in electricity causes fire	20000
	10000
	Under investigation
	80000
gas cylinder burst during gas filling	50000
Lit fire from cooking chula	500000
Lit fire from burning candle	10000
Source of fire from open house	150000
Lit fire on oil tank due problem in engine	10000
Lit fire in chemical storage	500000
	4000000
Lit fire in jute&polthin shop due to electri disor	10000
	10000
Mad lit fire	80000
	100000
Electric disorder in Electric miter	10000
Gas riser burst	50000
	200000
	20000
	20000
	.....
	20000
	100000
fire in nion sign board	15000
	50000
	Under investigation
Disorder in electricity cause fire	65000
Disorder in electricity cause fire	30000

1.09.05	Bangabandhu	Bangabandhu Avenue		Vehicle
5.09.05	Kamrangichar	East Rasulpur	R# 9, Block-B	Shopping centre
5.09.05	Uttara	Ashakona	301/A Ashakona(Marium V	Gas
6.09.05	Alamganga	Millbarak	24Alamganga millbarak Ta	Factory
6.09.05	Mirpur	Section-2	983/A madyaManipur	Electricity
6.09.05	Badda	Barhaitala	H#1118/7 Khilbarir tek	Gas
7.09.05	Mirpur	Section-1	17/3/B Talarbag	Shopping centre
7.09.05	Sadarghat	Ladis market	germent shopping centre	Shopping centre
10.09.05	Mohammadpur	Shershahshuri road	100Shershahshuri Road	Shopping centre
10.09.05	Shyampur	R #20, Plot-20	Dhakames(Cotton Factory)	Factory
11.09.05	Midford	202Midford road		Plastic storage
12.09.05	Uttara	Mallartek	132 Mollertek	Resident
12.09.05	Tejgaon	New Tejgaon I/A	15 New Tejgaon I/A	Shopping centre
13.09.05	Badda	North Badda	308 Maynarbag	Factory
14.09.05	Sutrapur	Walter Road,Ward-2	New five star hotel	Gaschula
17.09.05	Gulshan	Gulshan Avenue	R.S.Centre 101Gulshan Av	Gaschula
18.09.05	Nakhalpara	East Nakhalpara	308East Nakhalpara	Resident
19.09.05	Demra	Shani Acra Baganbari	Soap, chanachur , freshwa	Factory
19.09.05	Demra	Amulia thana	Corrugated iron factory	Factory
22.09.05	Khilgaon	Taltala super market	TaltalaSuper market (Shoe	Shopping centre
22.09.05	Mirpur	Section-10	Mirpur1305,51/1 Senparap	Resident
22.09.05	Sherebanlanagar	Conferenceof chinmaitr	Infront of Chin-Maitra confe	Vehicle
23.09.05	Mohammadpur	Adabore	Mehedibag co. operative M	Shopping centre
27.09.05	Mothertek	Sabujbag	25/4 Idealpara	Resident
28.09.05	Jigatala	Tanarimorh	Sontala Sultangang	Electricity
28.09.05	Dhanmondi	Road-27	Infront of Rafaplaza	Vehicle
4.10.05	Nimtala	Narayanganga	H # 49 & 51 /B Das Road	Shopping Centre
5.10.05	Savar	Durgapur Katgar bazar	Shams Sweater Factory	Factory
8.10.05			Messers south china Blichi	Factory
8.10.05	Tejgaon	Tejgaon I/A	373Tejgaon I/A	Shopping Centre
8.10.05	Farashganga	Ultin Ganga Lane	6 Ultin Ganja Lane, City ice	Factory
10.10.05	uttara	Abdullahpur	Tongi Oils Mills Ltd	Factory
10.10.05	Hazaribag	Vagalpur Lane	135/2 Vagalpur Lane	Factory
10.10.05	Sadarghat	Meman Hospital	Meman Hospital In front of	Vehicle
11.10.05	Kotoali Thana	Tikatuli	5 Tikatuli Lane	Factory

	20000
Disorder in electricity cause fire	200000
Lit fire due to leak in gas jar	5000
	Under investigation
lit fire due to short circuit in dwelling house	320000
Lit fire in iron shop due to electric disorder	50000
Lit fire due to short circuit	500000
Disorder in electricity cause fire	50000
Disorder in electricity cause fire	60000
	400000
Disorder in electricity cause fire	20000
Due to short circuit	50000
Lit fire due to collision of foamcutter tools	1500000
lit fire from gas chula	20000
lit fire from gas chula	50000
Lit fire from burning cigarette	1000000
Lit fire from the burning chula	500000
Lit fire from elctric disorder	200000
	100000
Lit fire during welding in dinning room	30000
	200000
Lit fire from electric post	20000
lit fire from electric disorder	10000
Transformer burst	100000
	20000
	100000
	Under investigation
Lit fire due to leak in oilpipe in oil heater	200000
Lit fire from the chula of teastall behind B.G.P	75000
Lit fire from the electric sparking	50000
Lit fire from short circuit in electric panel board	20000
Lit fire from Bemish Factory	200000
Disorder in electricity	50000
Lit fire from short circuit in shoe factory	50000

12.10.05	Savar	Sreepur bazar	Sreepur Bazar	Shopping Centre
13.10.05	Kaptan Bazar		Middle between Kaptan & (	Slum
14.10.05	Savar	Nishchintapur	Nishchintapur Yearpur	Vehicle
15.10.05	Nababpur	38 Nababpur		Shopping Centre
15.10.05	Farashganga	Katpatti		Resident
16.10.05	Nandipara	1501 Nandipara		Resident
17.10.05	Demra	North Jatrabari	52/3 North Jatrabari	Factory
17.10.05	Gulshan	Gulshan-2	22/23Metropolitan Shoppin	Shopping Centre
20.10.05	Narayanganja	Rupganja	Pradhanbari ,Rupshi	Resident
22.10.05	Islampur	Patuyatuli	41Patuyatuli Islampur Roa(	Storage
23.10.05	uttara	Azampur		Vehicle
24.10.05	Fatulla	Haziganja	Sastapur Fatulla Haziganja	Chemical
26.10.05	Rajarbag	Rajarbag police line	Rajarbag police lines Field	Electricity
27.10.05	Kamrangichar	Asropabad	Asropabad madrasa para	Slum
27.10.05	ShereBangla	Shere bangla nagar	Manik mia avenue	Vehicle
28.10.05	ShereBangla	Shere bangla nagar	Manik mia avenue	Vehicle
29.10.05	Abul Hospital Rd.	K.M.Azam Lane	11/3K.M.Azam Lane, Abul	Factory
31.10.05	Tongi		Ashraf Textile Mills	Factory
31.10.05	Demra	Sarulia	Karim Jute Mills	Factory
31.10.05	Tongi	Abdullahpur	107paper Mills Road(APS '	Germents
1.11.05	Siddeswari Road	46Siddeswari Road	Easter House (2nd floor)	Resident
1.11.05	Mirpur	Section-10	203 Senpara Parbbata, Ro	Germents
1.11.05	Dhanmondi	Sobanbag	4/1 Sobanbag , Prince Pla:	Resident
2.11.05	Mohammadpur	Basbari	45/6 , Block-b, Chan Housi	Resident
3.11.05	Uttara	Sector-4	Dhaka Mymensing Road	Vehicle
3.11.05	Khilgaon	Taltala	259/b Taltala , Khilgaon	Resident
4.11.05	Mirpur	Senanibas	82 Ibrahimpur Senanibas	Factory
4.11.05	Matuail	Rayerbag		Factory
5.11.05	Moulibazar	Chakbazar	Kanchabazar	Shopping centre
6.11.05	Kuril	Bishwaroad	kazibari	Vehicle
6.11.05	Hazi A. Hadi lane	Hazi A. Hadi Lane	15 Hazi A. Hadi Lane(Shoe	Factory
6.11.05	Aga Sadek Road	Aga Sadek Road	61/1 Aga Sadek Road	Shopping centre
6.11.05	Darus Salam road	Darus Salam Road		Vehicle
8.11.05	Narayanganga	Murapara	Murapara ,rupganga, Nara:	Resident
12.11.05	Demra	Chittagong Road	Fruit Market	Shopping centre
12.11.05	Tejgaon	Tejgaon I/A	219/C Tejgaon I/A	Factory

Lit fire from short circuit in grossary shop	150000
Lit fire from short circuit	200000
Aggressive people lit fire	500000
	10000
Lit fire from Mosquito coil	20000
Lit fire from leak in gas pipe	65000
	1000000
Lit fire in fry berger machine due disorder inelec.	25000
Lit fire from gas cylender burst	200000
	1000000
	100000
	Under investigation
Lit fire from electric disorder in the pandel	30000
Lit fire from electric disorder in Kachagar	250000
	100000
Aggressive people lit fire	30000
Lit Fire in PV C pipe factory	50000
Lit fire in the cotton guid	600000
Lit fire from elecric disorder	200000
Lit fire from electric disorder	35000
Lit fire from short circuit	20000
	4000000
Lit fire from electric disorder in Electric power st	50000
	300000
	150000
Lit fire from the burning patka	40000
	400000
Lit fire from the Mosquito coil bhusi mill due E.D.	500000
	5000000
	700000
	20000
Electric disorder in grossary shop	50000
Lit fire from the leak in gas cylender	
	200000
	500000
	400000
Lit fire from candle during packing	50000

12.11.05	Hatirpul	Sonargaon road	345/3 Sonargaon Road	Shopping centre
13.11.05	Abul Hasnat road	Ali nekir Deuri	52/2-KA Ali Nekir Deuri	Factory
13.11.05	Shyampur	Saddam Market	Tushar Dhara Saddam Mai	Shopping centre
13.11.05	Mirpur	Section-2	Shere bangla Stadium	Shopping centre
13.11.05	Khilkshet	Joyar Sahara	Kh-49 Khilkshet, Joyara Sa	Germents
15.11.05	Tejgaon	Tejgaon I/A	440Tejgaon I/A, Haque bro	Factory
15.11.05	Moulibazar	Al Amin Market	9 Moulibazar Al Amin Mark	Factory
16.11.05	Imamgonga	Mohiuddin Lane	18 Mohiuddin Lane, Imamg	Factory
16.11.05	Shyampur	Factory Road	14/A Factory road,Mess. Fa	Factory
17.11.05	Mirpur	Section-10	Goalchattar	Gas
17.11.05	Shantinagar	Shantinagar Road		Vehicle
17.11.05	Mouchak	New Circular Road	93/A New Circular Road(F	Shopping centre
20.11.05	Narayanganga	Fatulla	Kamalpur Pagla(cotton stc	Storage
21.11.05	Savar	Spining mill	Uline Okazddin spining mill	Factory
21.11.05	Kakrail	Infront of Mofidul Islam		Vehicle
22.11.05	Lalbag	Debidas Lane	30 Debidas Ghatlane(Bisc	Factory
22.11.05	Shanir Akhra	Gobindapur	Rubber factory	Factory
22.11.05	Dhaka Cantoment	Stuff road	183/6 Stuff road	Vehicle
23.11.05	Shyampur	Dhaleswar	Gutharaghat	Factory
24.11.05	Malibag	DIT Road		Vehicle
24.1.05	Shyampur	Postogola	Washagate, Railline slum	Slum
27.11.05	Mohakhali	Gulshan Link road	Dhakin para	Shopping centre
28.11.05	Shymali	Shekher Tek	Road -6, Shyamoli housing	Resident
28.11.05	Farmgate	Bijoy swaroni road		Vehicle
29.11.05	Demra	Mandira	Balughat	Gas
29.11.05	Banani	H# 58-E, R#2		Gas
29.11.05	Bangladesh C.A.	Musium	Bangladesh Shisu Acaden	Resident
01.12.05	Shyampur	Palpara		Resident
1.12.05	Lalbag	Shahidnagar	Slum adjusted to Beribadh	Slum
1.12.05	Chhuritola	96Lutfor Rahman Lane	Shoe factory	Factory
4.12.05	Gulshan-2		Middle between road 46-9(	Shopping centre
6.12.05	Dhanmondi	Road-7, House-19	Beximco farmcuticals Ltd	Vehicle
8.12.05	Farmgate	BARC	House no -1, Airport Road	Office
9.12.05	Narayanganga	Sonargaon	Prince Textile Darikandi	Factory
9.12.05	Mohammadpur	Lalmatia	7/10 Lalmatia	Resident

	100000
Lit fire from making coil of mosquito	
	100000
Lit fire from electric disorder in chemical storage	1000000
Lit fire from electric goods in storage room	30000
Lit fire in the machines and germents	
	4000000
Lit fire from the chula during making semai	20000
Lit fire in the storage of aerosol due to elec. Disor.	5000
Lit fire in Redoxide powder in unknown cause	10000
	1500000
Lit fire from the leak in gas pipe in Titas gas sub.st	100000
	200000
Lit fire from electric disorder	100000
Lit fire from collition of machine	35000
Lit fire from colliton in cotton	50000
Aggressive people lit fire	500000
Lit fire due to electric disorder	120000
Lit fire due to electric disorder	200000
	250000
	15000
Aggressive people lit fire	50000
Lit fire from cooking chula	30000
Lit fire from cooking chula	150000
Lit fire from cooking chula	100000
	100000
Lit fire from the leak in Titas gaspipe	10000
Lit fire from leak in Titas gas riger	5000
Lit fire due to electric disorder	10000
Lit fire from open candle	50000
	400000
Lit fire from elctric disorder	100000
	200000
Lit from battery terminal	20000
Lit fire from storage of books	Under investigation
Lit fire from sparking of cotton duni	350000
	35000

9.12.05	Postogola	174,175Karimullabag	Burn mobil and sponge fac	Factory
10.12.05	Tejturibazar	62Tejturibazar		Resident
10.12.05	Rajabazar	Indira Road	56 West Rajabazar(Lijan H	Factory
12.12.05	Mohakhali	West side of busstand		Vehicle
14.12.05	Narayanganga	Kanchpur	Sonargaon(Nawab A. Male	Factory
14.12.05	Malibag	DIT Road	21 D.I. T. Road	Shopping centre
16.12.05	Uttara	Infront of thana	Optical Ltd Garments	Garments
17.12.05	Golapbag	Rishipara	16Golapbag	Shopping centre
17.12.05	Mirpur	Monipur	743/1 Monipur	Resident
19.12.05	Motijheel	Sonalibankbhaban	35-44Motijheel	Resident
20.12.05	Asadgate	Near Church		Vehicle
23.12.05	Rampura	Ullanroad		Electricity
25.12.05	Khilgaon	North Goran	215/2 North Goran	Resident
26.12.05	Kuril	Bishwaroad	Ka/120/A Kuril Bishwaroad	Gas
26.12.05	Lalbag	Jagannath shaha road	161 Jagannath shaha road	Factory
27.12.05	Tejgaon	145 Monipuripara	Continental Apperals Ltd	Shopping centre
28.12.05	Narayanganga	Siddirgang	Shaha dying and Printing, !	Factory
28.12.05	Shyampur	Washa and Railline	Slum adjacent area of Was	Slum
28.12.05	Savar	Madrasa road	Savar bazar	cotton storage
29.12.05	Maniknagar	Dhalpur	14Dhalpur	Electricity
31.12.05	Mohammadpur	38Ring road	Probash Housing	Shopping centre
31.12.05	Sabujbag	North Manda	Bashir mia road, Haq. Shal	Slum
31.12.05	Tongi	MillGate co.op.market	Mill gate cooperative mark	Shopping centre
31.12.05	Savar	New EPZ	Delimos Ltd Wiving Textile	Factory

Source: BFSCD, Head Quarters, Dhaka.

	800000
Lit fire from cooking chula	
Lit fire from storage	10000
Aggressive people lit fire	100000
Lit fire from elctric disorder	950000
Lit fire from biri	60000
Lit fire from overheated of iron	
	40000
Electrificatin during painting	
Lit fire from left materials	100000
	50000
Lit fire from electric transformer	50000
Lit fire from electric disorder	25000
Lit fire from gas rizer	5000
Lit fire from short circuit	25000
Lit fire from short circuit in storage	50000
	50000
Lit fire from cooking chula	300000
	120000
	1100000
Lit fire from electric disorder	50000
	1500000
	80000
	500000

12. What facilities were available for fire Prevention?

    i. Automatic Detection System.

    ii. Fire Alarm

    iii. Self Extinguisher

    iv. Automatic Sprinkler System

    v. Foam

    vi. Others (Specify)

Signature of the Interviewer: _____

Date of Interview: _____

9. What was the hindrance to fire fighting?

   i. No. access

   ii. Narrowness of road

   iii. Lack of water

   iv. Lack of sand

   v. Lack of knowledge of the victims

   vi. Obstruction by the crowd.

10. Who reported the incident of fire to BFSCD?

   i. Victim himself

   ii. Neighbour

   iii. General People

   iv. Police

   v. Others (specify)

11. How the incident of fire was reported to BFSCD?

   i. Over telephone

   ii. By messenger

   iii. Over wireless

   iv. Others

3. Duration of fire (in minute)

4. Who extinguished the fire?

   i. Owner/user/occupants of the property.

   ii. Neighbours/passers by

   iii. Bangladesh Fire Service and Civil Defense (BFSCD).

   iv. BFSCD with the help of local people.

5. Which is the nearest fire station?

6. Performance of BFSCD:

   i. Reached timely.

   ii. Reached after extinguishing the fire.

   iii. Did not reach the site of fire.

7. If FS reached the site of fire, how many vehicles were dispatched?

8. How was the fire extinguished?

   i. With water

   ii. With sand

   iii. By disconnecting electric /gas supply.

   iv. With extinguisher

   v. With foam

   vi. Others (specify).

Appendix-2

Dhaka University

Department OF Geography and Environment

Fire Hazard vulnerability Mapping: A Case of Dhaka Metropolitan Area

For Research only Confidential.

1. i. ID No.
   ii. Date of Fire incident
   iii. Identification
   iv. Location
   v. Type of Structure
2. Source of Fire :
   i. Electric short-circuit
   ii. Gas line leakage
   iii. Cigarette
   iv. Kerosene / Gas store
   v. Mosquito Coil
   vi. Arson
   vii. Open lamp
   viii. Others (Specify).