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THE CHALLENGES IN PREVENTING AND FIGHTING STRUCTURAL FIRES IN NAIROBI'S INFORMAL SETTLEMENTS

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DECLARATION

I, the undersigned declare that this project is my original work and has not been submitted in any other university for a degree award.

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DECLARATION BY SUPERVISORS

This project has been submitted for examination with our approval as the university supervisors.

Dr. Robinson Ocharo _____ Date 08/10/07

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DEDICATION

This project is dedicated to my dear Mum and Dad,

Mum and Dad you are the most wonderful parents in the whole world. Thank you for your love, care and support without which I would not have come this far. You are the shining star in my life. You always guide me in the right direction. I owe everything that I am to you.

Thank you also for being patient with me through out my education and may the Lord Almighty bless you abundantly

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ABSTRACT

Fire prevention and control are sometimes thought of as separate and apart from routine fire prevention activities that are carried out. There may be some justification for this if one thinks of fire losses in terms of property damage only. But fires carry a serious injury potential. Fires cause many serious injuries and deaths each year. Since this is the case, the prevention and control of fire should be a part of every community's program.

This study was designed to investigate the challenges in preventing and fighting structural fires in Nairobi's informal settlements. Specifically the study sought to: identify policy guidelines in Kenya and the extent to which they have been violated within the informal settlement sector, establish the extent to which the violations of these guidelines lead to vulnerabilities to fire hazards in the informal settlements, assess the capacity of the community and other support systems to respond to fires, examine the mitigation and preparedness strategies that have been put in place.

Data was collected by use of both quantitative and qualitative methods with the interview as the main technique of gathering data. A total of 133 respondents were interviewed. They included 118 residents of the informal settlements, 10 fire officers from the Nairobi Fire brigade and 5 officials from the Kenya Red Cross Society. Descriptive statistics were used to analyse the data.

There were various reasons that the respondents cited as being the contributing factors to the rising cases of fire outbreaks in the informal settlements. These included stove explosions, improper installation of electricity, use of tin lamps, use of highly flammable construction materials and use of charcoal burners.

The study established that despite the high cases of fire incidents in the informal settlements, the residents of the informal settlements did not have any fire preventive or

response equipment installed in their houses and this was due to their low income levels. Among all the respondents only 17% had attended any fire drills and 97% of the respondents did not consider fire prevention a priority. This makes the residents of the informal settlements highly vulnerable to fires.

The study established that despite the high cases of fire incidents in the informal settlements, about 95% of the residents did not consider fire security to be an immediate priority although important. Due to low incomes, fire incidents are considered as mere bad lack for which resources for prevention should not be spared. Lack of fire prevention measures really makes the informal settlements vulnerable to fire hazards.

The study established that there were various challenges that were faced when it came to preventing structural fires in Nairobi's informal settlements. These included the lack of a fire policy and a fire act that would give guidelines to the fire personnel on how to go about responding and fighting structural fires in the informal settlements. The fire act would also empower the fire personnel in enforcing fire regulations in the informal settlements. Another challenge was the lack of access to slum areas which hampered effective employment of fire tenders whenever they reported to assist in controlling the fires.

There are various strategies that this study recommends to be put in place to help curb the rising cases of fire incidents in the informal settlements. These included holding of workshops and trainings on fire prevention and response in the informal settlements to make them fire resistant, enforcement of fire prevention regulations and building up of more and fully equipped fire stations.

In conclusion it is noted that disasters related to fire hazards is a problem that requires further study focusing on ways in which fires can be more effectively prevented through technological advances, construction techniques and improved inspection procedures.

CHAPTER ONE: INTRODUCTION

1.1 Background

Thorton (2002:2) defines fire as a chemical reaction between three elements: Oxygen, Heat and Fuel. If any of these three elements is not present, then there is no fire. If conditions are right a fire can start almost anywhere at any time. Most fire hazards occur when the weather is dry and hot. The heat source for starting a fire can be natural, for example a lightning strike, or human-made, like careless use of fire or even cigarettes. Fuels include anything from dry grass and leaves to branches, wood or houses. Different types of fuel burn at different temperature, because each substance has a so called "ignition temperature". This is when the substance becomes hot enough to burst into flames. For example because of its low "ignition temperature", the oil in the leaves of eucalyptus trees is one of the most explosive fuels.Fires may occur independently or as a by-product of other forms of disasters such as earthquake, lightning, air crash and bomb/chemical.

Structural fires are those fires that happen in structures such as buildings. Thorton states that structural fires have the potential to cause significant damage to structures and cultural resources in, around, and outside of nationally protected areas. In addition to this irreversible damage, structural fire threatens the safety of human life and can result in tragic injuries or even death. Protection of life is the number one priority of all fire management programs. Structural fire management is defined as the protection of people, content, structures, resources, and the landscape surrounding the structure from the effects of fire.

Thorton further states that it is vital to implement a professional structural fire management program in effort to prevent the occurrence of structural fire disasters. These programs address and take action to correct structural deficiencies. Improving the fire prevention and protection of a structure may include new code-compliant construction, upgrading of existing structures, standardized and regularly scheduled fire inspections, and properly installed and maintained detection and suppression systems. It is equally

important to educate people about structural fire prevention, resource protection, and hazardous conditions. The effect on human life, personal property and irreplaceable cultural resources can be prevented or at minimum reduced when the appropriate structural fire prevention actions are taken.

World history is rife with stories and lore that blame great fires for the destruction of vast areas or entire cities. From the great fire that destroyed Rome in 64 B.C. to the fires that raged through the Australian landscape in 2002, fire fighting remains one of society's most difficult battles (FEMA, 2005:3). Other famous fires that occurred in the last few centuries include the Great Chicago fire, which occurred on the evening of October 8, 1871. This fire killed 300 people and destroyed more than 17,000 structures - over 2000 acres in 27 hours (FEMA, 2005:4). Next to the Great Chicago Fire, London's historical fire is probably the second most famous. This fire began in a baker's shop on September 2, 1666 and lasted for several days. It destroyed more than 13,000 structures (FEMA, 2005:4).

According to Republic of Kenya (2004:3), the majority of major disasters in Kenya have been fire disasters. Every year lives are lost, people injured, homes and property worth millions of shillings are destroyed in fires. Destructive fires experienced so far in the country have either been accidental fires e.g. misuse of appliances, dropping a heat source such as a candle or a cigarettes on fuel, equipment failure including electrical malfunctions and overheating or deliberate fires (Republic of Kenya, 2004:3).

Losses and destruction due to fires can be prevented if only special attention is given to minimising negligence and address some of the apparent gaps in fire management which include outdated and inadequate codes, regulations and legislations, laxity in the enforcement of law, lack of public awareness conflict of interest between stakeholders, insufficient fire early warning systems, shortage of trained personnel, lack of National standardisation of fire appliances, equipment and systems, inadequate inspection, risk assessment and maintenance and absence of proper co-ordination to enable active participation of the public and private sectors (Republic of Kenya, 2004:3).

1.2 Problem Statement

Structural fire hazards are a major concern worldwide due to their rapid onset and destructive consequences, if not brought under immediate control. The prevalence of fires even in developed countries underscores the need for comprehensive management measures. In the USA, concern to address fire problems countrywide created the need to have a full-fledged body within the Federal Emergency Management Agency. The United States Fire Administration commissioned a study which concluded that despite the enormous resources made available to combat fire hazards, research into methods of effectively responding to fire hazards is inadequate (Berneisten, 2000).

According to Republic of Kenya (2004:4), statistics on the city of Nairobi alone indicate that calls received by the city fire department requesting for assistance average at 300 a month. This gives us a mean of 10 reported incidents a day. Besides these, there are other hundreds of incidents of destructive fires, which ordinary men and women manage to successfully fight but not without fatalities. Overall, the country is to -date counting huge losses as a result of fire incidences not only in the city of Nairobi but also in other parts of the country.

Notable cases of structural fires that have happened in the informal settlements in Nairobi in the recent past include incidents such as the Mukuru Kayaba slum fire in February 2006, which according to Kenya Red Cross Society (2006:9) rendered 1565 families homeless. Earlier on, on 17th January, there was a fire in Kibera Laini Saba that burnt down houses and destroyed property worth thousands of shillings (Kenya Red Cross, Society 2006:9). There was also a fire in Mathare Valley on 21st November 2005 which killed two children and left thousands of people homeless (Kenya Red Cross Society, 2005:10). There was an earlier fire in Dandora on 10th July, 2004 that killed three children and left more than a thousand families homeless (Kenya Red Cross Society, 2004:7). Other incidents that underscore the seriousness of fire hazards in Nairobi include fires in public premises, such as the City Hall fire that burnt the entire third floor on 14th May 2004; and in private premises, such as the fire that razed down a shopping mall in Westlands, Nairobi, on 20th April 2004 and destroyed property worth 50 million shillings

(Republic of Kenya, 2004:25). In some of these cases, innocent lives are lost and/or property damaged, but no serious steps to avert recurrence are put in place (Republic of Kenya, 2004:26).

Slums form a potential hazard in their own right, due to type of structures, population in a given area and space between structures. According to Republic of Kenya, (2004:3), the fire problem in the informal settlement areas in Nairobi has mainly been compounded by the poor types of building materials used and the construction methods, which hardly conform to the Nairobi City Council Building Code (The Local Government Adoptive By-Laws Building Order 1968 sec 69-87). The building code specifies the minimum distance to be maintained between adjacent buildings, construction materials to be used and the minimum time a building should withstand fire. These provisions are made to guarantee a degree of safety against fire for the occupants. The code is enforced by making it mandatory for submission of drawings of proposed new building to be inspected and approved by the local authority.

Lack of access to slum areas hampers effective employment of fire tenders whenever they report to assist in controlling the fires. Due to lack of social infrastructure and the level of poverty in these areas, it is likely that lives and property will continue to suffer from fire disasters in the future unless urgent preventive and response measures are introduced. In other areas of the city, the policy of destroying illegal structures and forcefully evicting squatters has been practiced. This, however, has not been effective in preventing fires as the squatters simply shift to other areas within the city, thereby perpetuating favourable conditions for fire hazards.

Informal settlements prevail in every municipality of Nairobi (Republic of Kenya 2005) and this presents a special fire risk situation that requires a liberal outlook as the current legislation and planning do not usually cater for informal settlements. Due to fluid property ownership it is difficult to insure the properties and their contents. A fire outbreak occurring in this areas result to loss of lives, injuries and loss of property which isn't insured for.

The Local Authority Act Cap 265 Section 160 sub-section (K) compels local authorities to establish and maintain at least one fire station and a fire brigade for the prevention and extinguishing fires in their areas. This section however needs to be strengthened. By laws of the local authorities in respect to fire are intended to regulate safety measures on life and property .The existing By-laws relating to fire prevention and management in current use deal with various areas of fire related issues including means of escape in case of fire, fire resistance-small houses, fire resistance in buildings, fixing of fire hydrants, fire prevention inspections, obstruction of fire personnel while executing their duties and supply of water for fire fighting purposes. The current by-laws in use at the municipal level (adoptive By-laws) Building order 1 and 11 of 1968 however has not been reviewed since its publication, and yet more advanced changes in technology have taken place and greater fire risks have emerged.

Research on fire has primarily been focused on bushfires whereas in our Kenyan situation cases of fire outbreaks in slums continue to occupy newspaper headlines, while costing the victims thousands of shillings in damages. Fire disasters continue to be the leading cause of damage to property to slum residence in Nairobi. In spite of the recognition and attention that fire disasters have received, there is still lack of adequate empirical information on the causes, prevention and response to fire disasters in the slum settlements. This study will contribute to existing literature and fill the gaps in understanding of fire disasters in Kenya. There is need to investigate the interventions put up by the responders in responding to fire disasters. This will enhance the development of well defined plans by the Local Authorities and all stakeholders including the slum residents in addressing fire disasters.

The unique characteristic of fire disasters is a major concern to disaster managers, who are challenged to devise methods of prevention and response. It is desirable, therefore, to have a well-trained, organized firefighting brigade as the first line of fire defence. It is sound practice to secure the cooperation of the local fire department at training sessions. (Grimaldi and Simonds, 2001:580).

Fire hazards therefore require greater attention than they have been paid partly because disasters associated with fire occasion a lot of economic damage and claim many lives annually in most countries. Moreover, most established emergency structures depend on fire and rescue services as first responders in their disaster response (USFA, 2001:7). Fire management services therefore should be given central attention in order to reduce vulnerability of a community, individuals and societies in handling the effects of a crisis.

1.2.1 Research Questions

1. What are the policy guidelines on settlements in Kenya and to what extent have they been violated within the informal settlement sector?
2. To what extent does the violation of these policy guidelines lead to vulnerability to fire hazards in the informal settlements?
3. What is the capacity of the community and other support systems to respond to fires?
4. Are there any mitigation and preparedness strategies put in place?

1.2.2 Objectives of the Study

The general objective of this study was to establish the challenges encountered in preventing and fighting structural fires in selected informal settlements in Nairobi.

The specific objectives of this study were to: -

1. Identify policy guidelines on settlements in Nairobi and the extent to which they have been violated within the informal settlement sector.
2. Establish the extent to which the violations of these guidelines lead to vulnerability to fire hazards in Nairobi's informal settlements.
3. Assess the capacity of the community and other support systems to respond to fires in Nairobi.
4. Examine the mitigation and preparedness strategies put in place to combat fires in the informal settlements

1.3 Scope and Limitations of the Study

This study was mainly concerned with fire hazards in the slum areas of Nairobi. Slum areas in the City of Nairobi can be said to face hazards of mainly three types namely; health hazards, insecurity and fire hazards. The study mainly focused on the challenges in preventing and fighting structural fires in Nairobi's informal settlement. It also looked at the social, economic and political challenges in preventing and responding to these fires. The study was carried out in Mukuru, Dandora, Mathare and Kibera. Although informal settlements are found in many parts of Nairobi and the country, the study focused only on the mentioned areas due to time and funds constrains.

CHAPTER TWO: LITERATURE REVIEW

2.0 Vulnerability and Hazards

According to Bethke et al (1997) vulnerability is the lack of ability or capacity to resist, cope with, and recover from a potentially damaging hazard event. It is the greatest among the poor, but may also include large segments of the population. Those who must seek housing in marginal, undesirable sites, and those with the least money available for providing adequate shelter will be the most vulnerable.

Hazard is defined as the potential occurrence, in a specific time period and geographic area, of a natural phenomenon that may adversely affect human life, property or activity to the extent of causing a disaster (Bethke et al 1997)

To understand disasters it is vital to understand these complementary processes of cause and effect which are examined in the Disaster Crunch Model in figure 1.The Disaster Crunch Model begins from the premise that a disaster happens when and only when, a hazard impacts on vulnerability. A population may be vulnerable to a disaster for many years, yet without the trigger event there is no disaster. A disaster happens when these two come together, when a hazard impacts on a people who are vulnerable to that hazard; then it becomes a disaster, with wide scale loss of life and damage to property (Davis and Wall 1992). This concept can be expressed graphically as is shown on figure 1.

Davis and Wall argue that a hazard is the Trigger Event which sets off the disaster. It could be any unsafe conditions which make that population vulnerable to that particular hazard. They further argue that the trigger event, the hazard, is often blamed for the disaster yet in many situations the underlying cause is actually the Unsafe Conditions which make people vulnerable. They however note that, careful assessment often reveals that these two are not in isolation. They in turn are caused by Dynamic Pressures within the society as shown in figure 1.Yet the Dynamic Pressures are not the root of the problem. They note that beneath these pressures are underlying Causes-basic fundamentals and ideologies on which the society is built-which cause sections of the population to be unsafe and vulnerable. Therefore vulnerability isn't a situation that just

happens, most often it has developed as a progression from Underlying Conditions, to Dynamic Pressures, to Unsafe Conditions. Understanding this is important-particularly as it helps stakeholders to understand how they can be seeking to address the situation.

By understanding the complexity of the build-up of vulnerability, key players can then also seek to address the situation at each of the different level. Davis and Wall note that addressing the disaster event with relief event is important, but if that is all that is done, ignoring the fundamental causes, then the situation will soon repeat itself. They note further that likewise though, it is impossible to only address the deep causes without addressing the human need and suffering. Therefore the approach to disaster management requires balance. It needs to understand the complexity of the situation and seek to find solutions at each of the different levels.

2.1 History of Informal Settlements in Nairobi

According to Temple (1974) "Slums" in Nairobi is almost as old a Phenomenon as the city itself. During the colonial era, physical mobility of Kenyans was severely restricted. Equally restricted was their choice of places of residence and their ability to participate in National Building.

Temple adds that a variety of laws, prohibited non working Africans from living in towns. The most oppressive of these laws were the vagrancy ordinances and a pass law though both had to be dropped latter paving way for a rapid population influx into the urban areas, especially Nairobi.

He further adds that at the same time, urban African housing was highly neglected. Residential land was discriminatively allocated to the various racial groups in the city. African settlement in urban areas had to be isolated from European areas in order to "protect" the Europeans. Supportive to this idea was the Simpson report after the 1912 plague which advocated for well defined and separate quarters for Europeans, Asians and Africans. Europeans were allocated land to the Western and North Western parts of the city. Asians were settled at Parklands and Pangani areas. Africans were left overcrowding

in the area immediately to the East of the Industrial Area in what in now the Pumwani Estate.

Van (1994) also notes that land scarcity and overcrowding in the African settlement grew with time due to rapid population growth there. This was mainly due to both natural growth and rural-urban drift; the latter playing a major role in the whole system. Given the limited land available within the confines of the African settlement and the spontaneous population explosion, the resulting overcrowding pressure forced large numbers of Africans to move out of their original areas of settlement to other areas outside the city where they had no title-this is termed squatting.

He however notes that the Africans were very cautious in their movement as concerned the distance covered from their new settlements to their places of work-these mainly being the Industrial area and the city centre. They had to ensure they maintained a walking distance between their new areas of residence and their places of work.

Uncontrolled housing is the most familiar example of this independent development and this is a really common scene in the city of Nairobi. In Nairobi areas with such independent development can be found in various parts of the country including Mathare Valley, Kibera, Dandora,Kangemi and Kawangware just to mention a few. The main problem experienced in these areas can be attributed mainly to the fact that development there proceeded planning and in simple terms such development is termed illegal. Although most of the squatter settlements were originally outside the city, the 1993 extension of the city's boundary brought most of these within the jurisdiction of the city's authority. As the majority of the slum residents did not pay any rents or service rates to the Council, they were left on themselves in terms of fire service provision. Consequently, the informal settlement areas have been the worst affected by fire due to high population concentration and due to lack off good will by the City Council (Feasibility Study on Fire Disaster Prevention and Management-Interim Progress Report).

Living conditions in the slum areas of Nairobi have been worsening with passage of time since independence. The united mission that was called in to study and report on the housing problem in Nairobi in 1965 said in their report that housing problem was of greatest concern in the city but added that the African housing standards were the poorest .This situation manifests itself in the slum areas of the city where we have an acute problem of overcrowding and lack of basic social facilities such as water, sewers and lighting. In addition to the large number of people living in overcrowded conditions, one third of Nairobi's population lives in uncontrolled and illegal housing."

2.2 Causes of Fires

Frequently serious fires have resulted from overheated buildings on power transmission shafting or machinery in buildings where dusts and lint accumulate. Grain elevators, cereal, textile or woodworking mills, and plastic or metal working plants are places where such fires are very common. Frequent inspection should be made to see that all bearings are kept well\oiled and not allowed to overheat. Accumulations of flammable dusts or lint should be periodically removed (National Safety Council, 1974-901

NFPA (1986) also state that portable heating devices, such as electric or gas soldering irons, portable forges, gasoline torches, gas or electric space heaters, glue (ots,salamanders) and similar heating units, are very frequently a source of ignition. Gasoline or alcohol torches should never be used where their flames will come within 18 inches of combustible surfaces. NFPA adds that they should not be used around flammable liquids, paper excelsior or such materials and extreme caution should be exercised in fuelling this equipment, and any spillage should be cleaned up immediately

According to Turner and Creery (1981), outdoor housekeeping is just as important as housekeeping within the buildings themselves. Rubbish, weeds and grass should not be allowed to accumulate in yards, particularly near buildings or combustible material. If space permits, every building should consider establishing its own dump for disposing and burning waste trash. This area should be kept free from weeds and might contain a

" D.Etherton and N.Jorgerson: (1971) Mathare Valley; Nairobi HRDU 1971,(Page 4)

pit where flammable liquid products can be dumped and burned. They also add that particular care should be taken to see that dust or trash of any kind is not allowed to accumulate in air shafts, elevator shafts, or stair wells, since it not only creates a fire hazard but also provides a chance for a fire to spread easily. Because class A fires have been caused by burning rubbish too close to combustible buildings sheds lumber piles, or fences, be sure that rubbish or scrap metal, brick or concrete. Stacks should be fitted with a screen cover to prevent the escape of embers. Good practice dictates that fires should not be started within 50 feet of combustible buildings or stored material, unless an approved incinerator is used (National Safety Council, 1974:90).

Another cause of fire according to Grimaldi and Simonds (2001) are flammable liquids. Fires in flammable liquids, such as the industrial solvents, alcohol, or petroleum products, are best prevented from occurring by controlling the accumulation of flammable vapour from this material. Some flammable liquids will give off flammable vapours at normal air temperature, whereas others will give off flammable vapours only after being heated. They add that Flammable liquids become fire hazards when their vapours reach flammable or explosive concentrations in air. Some flammable liquids, gasoline for instances, are hazardous at normal temperatures. Materials like Stoddard solvent, kerosene, or fuel oil will not liberate flammable vapours until they are heated to temperatures above the normal air temperature, usually above 100F.

They further state that the flash point of a liquid is the temperature to which it must be heated to give off enough vapour to form flammable mixtures with air and produce a flame when a source of ignition is brought close to the surface. To help control exposures to fire, solvents should have as high as a flash point as possible. Areas should be well ventilated.

Grimaldi and Simonds further note that if flammable liquid vapours exist in areas where electrical equipment is used sparks or overheating may become a source of ignition. In such areas electrical wiring should be installed and maintained in rigid conduits, with

fittings approved by the Underwriters' laboratories, Inc. for explosive atmosphere. In addition, explosion-proof fixtures should be used.

Another cause of fire according to Watts (1986) is static electricity. The danger of ignition from static electricity discharges exist when flammable liquids are transferred from one container to another. For instance as gasoline moves along a hose from a pump to a tank, a considerable static charge may accumulate at the nozzle. Unless the receiving tank and the tank from which the gasoline is being withdrawn are bonded together electrically, there is a good chance that a spark may jump from the nozzle to the receiving tank and ignite the flammable vapours which are liberated as the gasoline discharges.

2.3 Aspects of Fire Safety in Buildings and their Environment

Blake (1963) defines fire as a simple chemical process involving oxidation of ignitable gases emitted by combustible materials when heated. It can also be defined as the manifestation of rapid combustion or combination of materials with oxygen.

Van (1994) notes that man's life and fire tend to be completely entwined. From the beginning of civilization man has used fire in several ways such as in cooking, warming himself, lighting as well as a weapon against his assailants in times of war.
He further notes that properly generated trapped and used, fire provides a great benefit as the only source of power and heat to meet our industrial and domestic needs. But if unchecked, fire can cause unheard of material damage and even loss of human life.

We can always recall the catastrophic effect of fire on man and his property from the days of Sodom and Gomorrah in the Holy Bible. "The sun had just risen over the land as lot entered Zoar and then the lord rained down fire and brimstone from the skies on Sodom and Gomorrah. He overthrew those cities and destroyed all the plains with everyone living there and everything growing in the ground" (Genesis 19:23-25).

The Great Fire of London of 1666 isalso an event which marked a great turning point of English Fire History because it helped in clearing away all the old, out moded and

insanitary buildings of the capital city and made possible its rebuilding to an improved plan and with more fire resistance construction (FEMA 2005).

It is a well known fact that fire has been a notorious military weapon since the day when a soldier of Titus army Plug a torch into the temple at Jerusalem but it remained a primitive weapon until the invention of the incendiary bomb during the world war11.The military men engaged in studying the bomb were surprised in that although their initial intention was to study the incendiary bombing system, at the end they came to discover that they were infact scrutinizing the behaviour of fire itself in buildings and built-up areas. The bomb was infact no more than a mere means of igniting material already in existence. The results of these men helped in establishing the principles of fire defence which could also be applied in times of peace (Budnick 1986).

Today a lot of research has gone into establishing the behaviour of materials in fire as well as in setting up guidelines to be followed in construction of buildings. In Kenya such guidelines are contained in the building code ((1968-adoptive bylaws).This Code gives the minimum design requirements, modes of construction and materials to be used in construction of different types of urban buildings so as to achieve a high level of fire safety in buildings and their environment.

The passage of such regulations as laid down in the building code (Kenya) is not something new. In England during the reign of Richard (in 1189) one such a regulation was issued that "whosoever wishes to build let him take care, as he loveth himself and his goods, that he roofs not with reeds nor rush, not with any matter of litter, but with tile only or shingle or boards or if it may be with lead".[5]

Likewise households in medieval cities were also required to observe regulations to prevent the occurrence and spread of fire.[6]

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[5] Bird Erick and Stanly I.D:Fire in Buildings (Page 24)
[6] Thorncroft Micheal:Principles of Estate Management (Page 30)

In every country or urban authority such regulations are passed and enforced to ensure that due consideration is made in designing and construction of buildings for the sake of ensuring that adequate fire safety is maintained in the buildings and their environment.

The sad part of the story is that fire outbreaks in buildings is not something easy to entirely eliminate from a civilized community. In a perfect world fire hazardous structures would not be put up, education would make man shun from the habit of storing combustible materials and recklessness could be eliminated .Nevertheless such a world has never existed and even if it could do we still have the irresponsible members of the community such as children, drunks and the feeble minded whose conduct calls for special precautions. Again educating man on fire risk will prove to be of no use because man rarely realizes the danger inherent in careless handling of fire or in putting up fire hazardous structures until experience comes to teach him the hard way. Quite often a building owner will be heard saying "I had no idea it could burn like that" (Bryan 1986).

2.3.1 Enhancing Fire Safety in Buildings and their Environment

Watts (1986) notes that safety against fire in buildings is mainly the duty of the designer. A tolerable level of fire risk can be attained in buildings if due care is taken at the design and construction stages. He also states that it is true that most errors leading to fire hazardous buildings are made on the drawing board. He further states that to avoid this, a careful designer should always have the following objectives in his mind:

i) Minimise risk of occurrence: - This may be achieved through proper planning of space within the building. Stores for combustible materials should be isolated from the rest of the building by use of fire resisting walls and floors. Combustible material should not be used in the structure near sources of ignition.

ii) Delay Spread of Flame: - This ensures that enough time is allowed for man and property in a building to be saved from fire once it occurs in the building. It also allows enough time for the fire service team to be alerted and so fire can be put off before it does much damage to the structure of the building. Total isolation should be ensured of any two adjacent but

detached buildings. Where buildings share common walls party walls of appropriate fire resistance should be employed. Abutting roofs should be avoided because these aid flame spread between buildings. In attached buildings screen walls erected between the buildings and raised some distance above the roof level may effectively bar flames from spreading from one building's roof to another. To delay fire spread within buildings, every building should be divided into fire tight compartments bound by walls and floors of appropriate resistance. Openings to these walls should have at least the safe fire resistance as that of the walls. All these lead to fire resistance construction. All building elements such as columns and lintels should be designed in such a way as to make them as much fire resistance as it may be economically feasible. Reinforcement rods used in these elements should be provided with at least a 15mm thick concrete cover to protect then from the effects of fire because steel will normally collapse under high heat intensities.

iii) Provide for adequate escape routes: - Every building should be provided with adequate escape routes from each floor to a final exit. Such escape routes include corridors and stair cases and should be enclosed in fire resistant walls and floors. The distance of travel along these routes should be kept at a minimum depending on the number of people using the building, which may act as death traps causing panic as well as death. All escape routes should be kept clear of all sorts of obstructions such as carelessly placed furniture. Exit doors to these routes should be fire resistant and should open automatically on being hit to the outside or on both sides because there is no door. These exit doors should be painted clearly usually in red and be clearly marked for ease of identification. The paint used should be fire resistant. On stair cases, uniformity must be maintained among the risers and treads for ease of use. The stair case pitch should be kept at a minimum depending on the number of people using the building and whether they are used to the stairs or not. All escape routes should be wide enough for ease of movement of people and goods

depending on the density of occupancy of the building. These routes should also be properly illuminated all the time for their easy use in an emergency even during the night. People will normally rush towards familiar means of circulation such as stair cases, corridors and doors in the event of fire and so it is desirable that every required means of escape should also be part of the normal circulation. Finally these routes should be continuously maintained to avoid structural failure when being used in an emergency.

iv) Plan for satisfactory fire defence system:- Satisfactory fire defence implies a fully linked implies a fully linked four-part system consisting of:-

-detection

-warning

-immediate attack and

-calling the fire brigade team.

The designer should consider the design of a suitable system for every building however small it is. Many cases have occurred of deaths, injuries or narrow escapes because occupants in parts of buildings remote from the outbreak did not know of it until too late. Small fires may grow to uncontrollable size due to lack of a proper system for summoning the fire brigade office in the event of fire. We have both automatic and manually operated fire alarms. The former is a device which is highly sensitive to heat and/or smoke while the latter has to be operated by man to send out an alarm or a warning to the occupants to leave the buildings in the event of fire as soon as it is detected. At the same time they send out an alarm to a fire report centre from where the fire brigade can be alerted of the outbreak. Manually operated fire alarms should be located along escape routs so that people may be able to identify and operate them with ease even in the confusion of trying to rush out of the building-for that matter, these devices should be clearly marked. Fire fighting equipments should also be planned for and installed together with fire alarms so that in the

event of fire immediate attack may be exercised as soon as an alarm is sent out to check the fire before the arrival of the fire brigade team.

A bucket of water or sand kept ready for attacking small fires may also prove to be of help. Care should be taken in choosing the appropriate agent for attacking different types of fire: In liquid fires, water will prove to be ineffective because most of the volatile liquids such as petrol float on water. In such cases foams, carbon dioxide and or inert powder are the most appropriate agents because these are capable of covering the fire and suppressing it by denying it oxygen supply. A bucket of sand if poured over small liquid fires will also prove to be effective because sand will normally absorb the liquid or cover the fire completely given that it is non combustible. In very hot electrical apparatus fires, water or foam is likely to cause damage to materials. The appropriate agents here will be carbon dioxide or inert powders both of which are non-conductors of electricity unlike water or the foam. All the same water is the most commonly used agent due to its efficient cooling effect. Whenever apparatus employing water as the fire fighting agent are installed, water should always be available in sufficient amounts. There are other facilities which are required to be installed for use by the fire brigade team in fighting fire. These include fire brigade hydrants provided along water authorities' water mains as well as dry and wet risers which are installed in such a way as to be easily approachable by the fire brigade team. The main objective of any effective fire defence system is to ensure that any outbreak of fire is extinguished as quickly as possible, at minimum risk to personal safety and with minimum damage to the building structure or its contents.

V) Ensure accessibility for fire brigade team:-Every building should be planned for and designed in such a way as to make it quite easy for firemen to maneuvers their way around it and equally easy for them to reach every part of the building . To meet this requirement; building regulations with respect to plot boundaries as set out in the Building Code

(1968-adoptive by-laws- Kenya); section 17 and 18, should be strictly adhered to. Under Section 17 of the code, it is provided that there shall be left an open space immediately infront of every domestic building, such a space extending along the entire width of the front of the building and shall not be less than 20ft wide measured at right angles therefrom. If the building fronts on a street less than 20ft; the width of such open space is to be at least the width of the street plus one half of the difference between that width and 20ft. Any part of this open space which is within the plot is to be free from any building thereon above the ground level except a fence, wall or gate not exceeding 4ft.6in. in height or a port, step or other like projection from the building. Section 18 of the code gives provisions for side spaces to be left with respect to residential buildings. An open space is to be 8ft. or more in width measured from the boundary of the nearest plot facing that side at right angles to the nearest point of the building thereto. Where the above simple fire protection measures are not observed in planning, designing and construction of buildings, a high fire risk is bound to prevail. It is in such situations that chances of fire outbreak are quite high, flame spreads quite rapidly, the chances of man escaping safely from a building on fire is likely to grow unchecked into an uncontrollable size due to lack of adequate fire defence systems as well as lack of access to and around the buildings for fire brigade team . This is seemingly the situation prevailing in slum areas of Nairobi and especially Mathare Valley and Mukuru where fire outbreaks are becoming quite frequent.

2.3.2 Protective Considerations in Building Design

OSHA'S far reaching influence covers fire protection requirements for buildings where residents live and also where employees work. The specification may be considered also meritorious for similar construction that may not fall within OSHA'S scope (Grimaldi and Simonds, 2001:555).Certain general considerations concerning

buildings, their use, contents, process arrangements, and safeguards from fire may be applied as a means for fire protection.

Grimaldi and Simonds state that the buildings and the process areas should be evaluated for their vulnerability to fire and explosions. Such factors as the concentration of flammable vapors, gases, dusts or highly combustible materials and the presence of possible sources of ignition (for example, sparks from welding operations, hot surfaces, open flames, heat from electrical overloads and friction sources, explosive and exothermic chemical reactions, static electricity) should be considered in the evaluation.

According to Grimaldi and Simonds (2001:556), building construction will vary according to the use to which it will be put. For customary occupancies it is generally required that the building be only of heavy plank or timber or steel-framing construction. They further state that buildings housing highly combustible operations or materials however should be of reinforced concrete or protected steel construction. Areas that contain highly critical or valuable processing equipment or machinery or in which hazardous operations are located should be segregated and isolated by means of fire-resistive enclosures, partitions, fire walls, or cutoffs, according to the degree of hazard. They further note that it is desirable that the general structural layout be arranged with enough spacing between process equipment so that a fire in any one unit will not materially affect the other). In instances where operations present a high hazard, they should be located in detached buildings separated by sufficient distances from other structures to offer the protection. They also state that where there are operations that have a heavy explosion potential, should be located in building of light construction; or, if climate is suitable housing provided for the protection of gauges, meters, and valves and that the outdoor installation facilitates maintenance operations and permits easier and safer movement of personnel to and from the installation under emergency conditions. They also add that where process units are confined behind enclosures, there should be at least two independent routes for personnel to enter or leave the contained area.

Consideration must be given also to the roof structure. It has been found necessary for roofs to be as fire-resistant and structurally sound as the buildings on which they are erected (Barry 1984). Open steel beam roofing may involve a special hazard due to twisting in extreme heat conditions. Protection may be secured through appropriate use of standard sprinklers and the stopping of drafts or the correct use of asbestos cement covering, precast concrete slabs, or other equally fire-resistive roofing materials (Grimaldi and Simonds, 2001:556).

The desirability of controlling or localizing possible fires to minimize damage to the building suggests the use of automatic sprinkler protection (Grimaldi and Simonds, 2001:556). Barry (1984) state that as a step toward confining the area of burning, consideration must be given also to such ready routes for the spreading of a fire as open stairways and elevator shafts, air conditioning, ducts, conveyor and floor openings, hallow spaces in the ceilings and walls, and chutes According to Grimaldi and Simonds control measures of inhibiting the spread of fire by means of these routes include the installation of such design barriers as automatic fire-resistive doors and shutters, and fixed water sprays which operate when a previously determined temperature setting is reached. They also state that air-conditioning and ventilating systems should be equipped with controls that automatically close dampers, stop blower fans, and the installation of fire-detecting and fire extinguishing systems over hazardous processes and operations.
They further note that new devices are continually being developed to deal with special situations. For example, Monsanto chemical company has made use of an explosion suppressor using highly sensitive instruments which detect slight atmospheric pressure changes that occur just before an explosion, and then automatically trigger extinguishing agents and shut down machines.

They also note that when considering the designed fire protection of buildings, an understanding of certain loosely interpreted terms is necessary. For example, the common word fireproof is responsible for a widespread false sense of security with

respect to the possibility of damage to materials due to fires .When a fire has reached a sufficient intensity and duration, it will damage most materials. Perhaps the misinterpretation of fireproofing may be traced to an assumed synonymy between it and non-combustible. The latter word is applicable only to building materials like masonry, asbestos, cement, concrete, tile, and structural steel that will not ignite or burn when exposed to fire (Grimaldi and Simonds, 2001:557). Also according to Council on Tall Building and Urban Habitat (1992), the confusion occurs in specialized situations where unprotected structural members of non-combustible buildings used to store, for example, steel or cement might be considered to be fireproof, since there is nothing there to burn. The Council however notes that if the same structure is used to store large quantities of combustible materials, it is almost certain that a fire would totally destroy the building and its contents. Therefore according to Grimaldi and Simonds, (2001:557) the term fire-resistive is preferred and is used officially to indicate a prescribed degree of fire stability).According to them it is expressed as the time in hours that a material or construction will withstand an amount of heat under the standard of fire exposure specified by an approved test. They further state that fire durability for construction or material, therefore, is expressed as its having a one-, two-, three-, or four-hour fire-resistance rating. They add that in general, reinforced concrete structural elements, conservatively designed, are the most fire-resistant materials. On occasion such structures have demonstrated they have a fire durability significantly exceeding the stated fire-resistance rating.

2.4 Organizing For Fire Protection

When a fire occurs, it is necessary to take prompt, definite, and correct steps to defend against it Barry (1984).Certain preliminary knowledge therefore, should be gathered during the period of organizing for the fire-protection phase of the disaster control plan. According to Grimaldi and Simonds (2001:558) the information indicated by the following items, when applied during the training sessions for the fire brigades, for example will assist in saving valuable time when the need for efficient action is paramount:

1. A plan of the grounds and buildings comprising the installation should be obtained.
2. The location of all main control valves (process equipment, water supply, standpipes and hydrants should be plainly marked, easily accessible, and also identified on the plan.
3. A plan should be prepared of each available water-supply source (private and public), such as ponds, lakes, rivers, water mains, tanks and pumps, with their estimated capacities and available pressure and ground level.
4. A knowledge of first-aid fire extinguishing equipment, its applications, limitations, and maintenance is essential. All such equipment should be easily reached and identified, and its location in the buildings and on the grounds should be indicated on a ground plan.
5. It is advisable that the director of disaster control should acquire information on alarm systems and automatic sprinkler, foam, and water-spray or fog systems, even if this equipment may not be installed in the plant at present. The economic and protective advantages derived from such equipment may encourage his or her recommending its installation. The director should also know the limitations, under emergency conditions, which may exist for the automatic equipment which may have been installed.

Selection of fire control equipment will vary according to types and number from building to building (Grimaldi and Simonds, 2001:559).Practical suggestions can be obtained from the engineer representing the fire insurance carrier. In general, water is the best fire extinguisher. Therefore it is necessary that considerations be given to securing a supply independent, if possible, of the city water mains. Such sources as the sea, lakes, rivers, canals, and perhaps ponds should be considered. In certain circumstances, the

erection of water storage tanks of steel or concrete may be advisable. Large volumes of water are generally needed in the fighting of fires. For example it is not unusual for a large fire to require 200 gallons of water per minute in order to be extinguished. The extent of such preparations is dependent upon the type of operations with which the installation is concerned. Such factors as the flammability of the product, the raw materials used in the operation, and whether water is best for extinguishment must be considered (Grimaldi and Simonds, 2001:559)

According to Blake (1963) all hydrants and standpipes should be clearly marked, unobstructed, and their location should be known to each member of the fire unit Blake adds that a hose house, adjacent to each hydrant, should be equipped with at least 200 feet of hose, two nozzles, two hydrants wrenches, four spanners, an axe, a steel pry bar, and spare hose washers. Each hose house should be inspected at regular periods in order to ascertain that all equipment is present and in good working order, the hose should be examined carefully to determine whether there are any signs of its deteriorating or whether there are any breaks in the surface.

Portable fire-extinguishing equipment (first – aid equipment) cannot be considered as a substitute for hose apparatus or automatic sprinklers. Its principal purpose is for prompt use on small beginning fires. It is necessary that all fire brigade personnel should receive training and regular drills in the use of the installation's first-aid fire equipment. Each extinguisher should bear a marker indicating the approval of an authoritative testing agency such as Underwriters Laboratories (Grimaldi and Simonds, 2001:559) However, not all extinguishers are suitable for use on every type of fire.

2.5 Fire Response

According to IFRC (2000), detection of fire can start from the suspicion of a foul smell, usually petrol or paraffin to the physical sight of smoke or flame. Smelling of smoke fumes also forms a part in the detection of fire outbreaks.

Response is the sum of action by people and institutions faced with a fire emergency, which can later transform into a disaster. These actions commence with the warning of an oncoming threatening event or its occurrence without warning. Response includes aspects that must be put in place prior to, during and after a disaster has occurred. The end of response in real sense never comes as a disaster so alters a community that it is forever transformed rather than recovered and more so when death is involved. Response to fire disasters includes aspects that must be put in place prior to a disaster and the implementation of disaster plans. Emergency response activities are carried out immediately prior to the emergency or during the first phase of a disaster. These include servicing at water tenders, running tests on water hydrants and the actual fighting of fire using available materials or utilizing traditional skills that have worked over time (IFRC 2000).

Any person immediately on detecting a fire outbreak should raise the alarm by signaling all the rest, these could be done through shouting for help/raising the alarm, Calling 999, and reporting and finally warning others from going towards the fire direction. If the worst occurs then ensure your safety first and if an extinguisher is available then attack the fire. The following is a guide to fire extinguishers as provided by Fire Cone Kenya (2000) and Safety Management 5th Edition (2001).

Table1: Fire Classification and Extinguishers

Class	Description	Extinguisher	Extinguished by
A	Fires involving solid materials, usually organic in nature e.g. wood, paper/ cardboard	Red	Quenching/cooling effects by use of water or any solution with a high concentration level of oxygen.
B	Fires involving flammable liquids e.g.oil,gases,rubber and plastic material	Blue, Cream	Surface blanketing or exclusion of oxygen by smothering
C	Fires involving electrical equipment	Blue	Use of non-electrical conducting agents through smothering
D	Fires involving materials e.g. Magnesium, Sodium or Titanium	Blue	Exclusion of oxygen and cooling y use of metal powder to form a crust to smother.

Source: Fire Cone Kenya (2000) and Safety Management 5th Edition (2001)

Table 2: Extinguisher content and servicing

Body Colour	Content	Class of fire	Recharging
Blue	Dry Powder	A,B,C/D	On site
Black	Carbon dioxide	C	By arrangement
Cream	Foam	A/B	On Site
Red	water	A	On Site

Source: Fire Cone Kenya (2000)

ASTM(1985) state that if a fire happens to engulf victims in a building or an area, then a safe evacuation of all victims would be the most appropriate move to take. All residential houses need to have in place plans that would come in handy during fire emergencies. Budnick (1986) notes that escaping from a shelter requires calmness, courage and above all the will to come out alive and safe. With respect to safety, escape plans and routes should be drawn up using floor plans of specific buildings.Budnick further notes that Floor plans vary from building in respect to direction the building faces, number of floors

and surroundings. He adds that every fire is unique on its own and requires different ways to escape.

During evacuation the following skills will come in handy as noted by Hackett and Robbins (1980):

Smoking Proofing:-This is the ability to prevent smoke filling the room by obstructing the bottom and edges of doors using personal clothing or other available materials. Wet the clothes if possible and affix them on the edges of the door and windows of the room on fire. If the room is smoky stay next to a window or crawl low as smoke goes up because it contains carbon which is lighter than oxygen.

Personal conduct: - Being patient and calm during such instances will go along way in preventing unnecessary panic and damage, while giving the mind a greater chance of formulating safe escape ideas. Do not try to pick valuables or possessions. Make your way out as quickly as possible.

Blaze proofing: - By touching and feeling the door and walls one can tell the amount of fire on the other side by the amount of heat felt, if doors are warm avoid opening them.

If walls are hot avoid moving to their direction. If not move on and close the doors behind you. "Never go back into a flaming building even if it is to save a life".
Problems that may arise during evacuation include:

(i) Hesitancy by victims to leave their homes for fear of theft

(ii) High levels of confusion caused by panic.

(iii) Passions to save or salvage the little that one can

Assembly point:- after evacuation, all occupants should assemble at a pre-planned point for a close down procedure if not pre-planned try and gather victims around and collect as much information as possible which include:

- Taking roll call and any volunteered information.
- Account for people present and missing
- Any other cause of action to be taken with or without fire sprinkles and extinguishers in a building a fire assembly point is a must for any given habitat if the success of an evacuation is to be evaluated and lessons learned. Later records should be kept and a copy presented to the chief of the area.

The assembly stage marks the final stage of response to fires and is closely followed by the recovery phase. It also forms a good basis to gather information for the overall evaluation on how the response was conducted. A good evacuation should be done not more than twelve hours after the fire has been contained (KRCS 2000).

2.5.1 Procedure When an Emergency Fire Has Started

Immediately after a fire is detected, all fire doors leading to the area should be closed, as well as all windows. Blowers, ventilators, and conveyors should be shut off (Budnick 1990).

According to Grimaldi and Simonds (2001:559), the public fire department should be notified immediately unless it seems obvious that first-aid-extinguishing equipment can control the fire; and even in that case personnel should call the public department at the first signs raising any doubt as to their ability to handle the situation. Also, the fire alarm that summons the fire brigades to the scene of the fire should call the public department at the first signs raising any doubt as their ability to handle the situation. Also, the fire alarm that summons the fire brigades should be sounded so that they can go into immediate action. Fire fighters should keep their means of exit clearly in mind and place themselves between the fire and the exit to avoid the possibility of being cut off. Grimaldi

and Simonds state that for this reason, it is necessary that all first-aid fire equipment, particularly fire pails, should be located so that exit facilities are easily accessible in the event that a quick retreat becomes necessary. They also state that when placing fire pails, it is advisable that they are located in racks in groups of at least five, rather than being hung singly. They further note that grouping the pails reduces the possibility that time will be lost looking for next pail after one is used. Dust fire requires a special technique for extinguishing. They also note that it is necessary to attack the fire in such a manner that deposits of dust are not disturbed, causing a dangerous cloud of fire particles to be raised with the possibility of dust explosion. The extinguishing agents that are preferred are foam, steam, or fog (water spray). These will wet down the dust without agitating it. For any fire in dusty atmospheres, the public fire department should be called immediately (Grimaldi and Simonds, 2001:561).

In every instance during a fire, combustible materials should be promptly moved away from the fire and wetted down. After the fire has been extinguished, all debris should be wetted down thoroughly to make certain that the fire will not recur. If there is any doubt about the fire starting again, a person with a fire extinguisher should be stationed near the spot at least for several hours (Council on Tall Buildings and Urban Habitat)

According to Grimaldi and Simonds (2001), when a fire breaks out in an adjacent building, the other buildings should be protected by:

1. Closing every window facing the burning building.
2. Stationing people with fire extinguishers at each window nearest the fire.
3. Stationing occupants on the roof of the adjacent buildings with hose lines to keep the roof wetted down and with extinguishers to put out burning embers.

When putting out fires near electrical equipment, it is necessary to use special care. The fire-extinguishing compound should be of a type that will not conduct electricity and endanger the operator of the extinguisher. For this reason, only carbon dioxide, dry chemical or vaporizing liquid extinguishers are recommended. When these are not available, a stirrup pump may be used, if the stream is broken into a fine spray and the

nozzle is held at least 4 feet from the nearest conductor (Grimaldi and Simonds, 2001:561).

2.6 Theoretical Framework

Theory in the social sciences is any set of hypothesis or propositions linked by logical or mathematical arguments, which is advanced to explain an area of empirical reality or type of phenomenon (Jary and Jary, 1995:686). According to Singleton et.al. (1988:24-25) all empirical studies should be grounded in theory .Theory is an assumption or system of assumptions, accepted principles, and rules of procedure based on limited information or knowledge, devised to analyse, predict, or otherwise explain the nature or behaviour of a specified set of phenomena; abstract reasoning (Microsoft Encarta Encyclopedia 2002).Kerlinger (1964:11) defines theory as a set of interrelated constructs (concepts), definitions, and propositions that presents a systemic view of phenomena by specifying relations among variables ,with the purpose of explaining and predicting the phenomena.

Again according to Abraham (1992:3) a theory is a logical deductive-inductive system of concepts, definitions and propositions which states a relationship between two or more selected aspects of phenomena from which testable hypotheses can be derived.
This study was guided by the Chaos, Hazard Management and Rational Choice theories.

2.6.1 Chaos Theory

Chaos is one possible result of the dynamics of nonlinear systems. Nonlinearity refers to behavior in which the relationships between variables in a system are dynamic and disproportionate. In nonlinear systems small changes or small errors can have big effects. And, in nonlinear systems outcomes are subject to high levels of uncertainty and unpredictability. In nonlinear systems behavior is erratic and filled with surprises. Our world is filled with nonlinearity.

Disaster and emergency situations epitomize the nonlinearity of human events. These are events in which the relationships between relevant variables is churning. Even in our desire to create order and control the situation, events often seem to churn one step ahead

of our best efforts. Heinz Pagels (1988, p.56) noted that, "life is... nonlinear. And so is everything else of interest." Clearly, what makes disaster situations particularly interesting and challenging is the inherent nonlinearity in such events.

The best way to understand how disaster and emergency events are nonlinear systems is to compare the behavior of such systems with that of linear or simple systems. In linear systems the relationships between relevant variables is stable. In linear systems the relationship between cause and effect is smooth and proportionate. In short, linear systems respond to big changes in a big and proportionate manner and linear systems respond to small changes in an equally small and proportionate way.

If disaster and emergency response processes were linear system we could predict the number of fatalities or the amount of resources and personnel required to bring order to chaos. We could predict how long reconstitution of the previous environment would take. We often make these linear estimates because we are limited by linear tools for prediction and response.

Nonlinear systems exhibit three distinct types of behavior over time. These behaviors are labeled as (1) convergence to stability or equilibrium; (2) stable oscillation; and (3) chaotic. Each behavior can appear over the long term behavior of a nonlinear system. Disasters, emergency response, and changes in quality all occur over time. Thus, in real work processes, each behavioral type does not reflect permanent commitment only to that behavior, because the real world generates many different patterns in the data organizations create (Drabek 1994).

In a nonlinear world, one must wonder how many work or organizational systems will show such extremely stable behavior over time. Even the most stable work outputs, such as fire station equipment inspections, show some variation in output from month to month.

In short, the work output is perfectly stable. In such a case, management could predict output perfectly because management knows exactly what to expect on a consistent basis. As Cavaleri and Obloj (1993, p.57), note, "The behavior of virtually all systems

important to organizations varies over time and does not follow a straight-line pattern". As Drabek (1994, p. 30) has also noted, "Disasters do not constitute a simple straight line extension of an auto accident or house fire." *Rhythms in Time*

A second type of nonlinear time series that can occur in the real world of organizational data is rhythmic or oscillatory behavior. This type of behavior is generally labeled as stable oscillation because work output, such as, service responses to citizens calls shift fluidly up and down in a patterned and stable fashion. This type of smooth change is incremental change that moves up and down in a predictable manner. This is because the cycle repeats itself every two time periods or every two data points; the cycle stabilizes at about point 20. Such periodic, or cyclical, time series can have varying periods such as 4, 6, or 8 periods before the cycle repeats itself. So rhythmic data can have lots of short little cycles or big, longer cycles.

One can imagine many agency and organizational systems relevant to emergency management that operate in such a cyclical manner. For example, calls for local emergency fire services are generally cyclical and rhythmic: messy and noisy, but rhythmic and continuous. Professionals involved in emergency response to disasters are what should be labeled "maximum uncertainty managers". Disasters reveal a level of uncertainty for public managers that is likely only equaled during battle in war. The key here is continuous learning. Furthermore we learn, in an uncertain world where history does not necessarily repeat itself, that the rapid capacity to learn may be more important than experience. As Cavaleri and Obloj (1993, p. 387) write, "The discipline of management is itself at a bifurcation point in its evolution. Managers of today have more incentive than ever to explore new ways of managing and viewing the world. Another goal for the managers at should be the development of preparedness systems and action plans that do not require excessive management control and oversight. The notions of self-organization that apply to natural systems can be applied to management. The best organizational systems are ones that can do without management. These are systems that

have the response capable to solve problems with maximal learning and minimal top down direction.

2.6.2 Hazard Management Model

In this model, a number of studies by disaster scholars (Quarantelli 1994,Roger Kauperson 1998 and Walter Haus (1993) envisioned the model hazard comprising events consequences with three broad classes of hazard management. First-preventing events, second-preventing consequences...after they have occurred. Third-mitigating consequences...after they have occurred.

These evolutions of events (consequences) chain into a multi-stage structure with "upstream" and "downstream" components provides a standardized means of structuring hazards and identifying systematic opportunities for hazard control.Roger Kausperson (1994:18) concluded that each in the hazard evolution is connected by links, each of which represents an opportunity for blocking the hazard.

The hazard management therefore should consist two essential functions mainly intelligence and control with the former providing the information needed to determine whether a problem exists, define choices and predict whether success is a problem exists, define choices and predict whether success is achievable while control consists of design and implementation of measures aimed at preventing, reducing or mitigating.

2.6.3 Rational Choice Theory

Although it influenced the development of exchange theory, rational choice theory was generally marginal to mainstream sociological theory. It is largely through the efforts of James S.Coleman that rational choice theory has become one of the "hot" theories in Contemporary Sociology (Ritzer, 1996:289)."The Paradigm of rational action" as Coleman (1989:5) calls it, is the only theory with the possibility of producing paradigmatic integration. Coleman does not hesitate to argue that the approach operates from a base in methodological individualism and to use rational theory as the micro-level base for the explanation of the macro-level phenomena.

Broadly speaking, the rational choice approach as used in exchange theory, game theory and in economics begins with the assumption that men have given wants, goals, values or "utility functions". It then assumes that these goals cannot all be equally realized. Men live in a world of scarcity and therefore must select between alternative causes of action. They will it is assumed, do so rationally, selecting the course of action which is the most effective means of their goal or selecting the course which leads to the most preferred goal (Heath,1976:3).

Coleman's rational choice orientation is clear in his basic idea that "persons act purposively toward a goal, with the goal (and thus the actions) shaped by values or preferences" (1990:13). There are two elements in his theory-actors and resources. Resources are those things over which actors have control and in which they have some interest.

The basic principles of rational choice theory are derived from neo-classical economics (as well as utilitarianism and game theory; Levi et al 1990). Based on a variety of different models, Friedman and Hechter (1988) have put together what they describe as a "Skeletal" model of rational choice theory.

The focus in rational choice theory is on actors. Actors are seen as being purposive, or as having intentionality. That is, actors have ends or goals toward which their actions are aimed. Actors are also seen as having preferences (or values, utilities).

Rational choice theory is unconcerned with what these preferences or their sources, are of importance is the fact that action is undertaken to achieve objectives that are consistent with an actor's preference hierarchy (Ritzer, 1996:263).

Although rational choice theory starts with actors purposes or intentions, it must take into consideration at least two major constraints on action. The first is scarcity of resources,

the achievement of ends may be relatively easy. However, for those with few if any resources the attainment of ends may be difficult or impossible (Ritzer, 1996; 263).

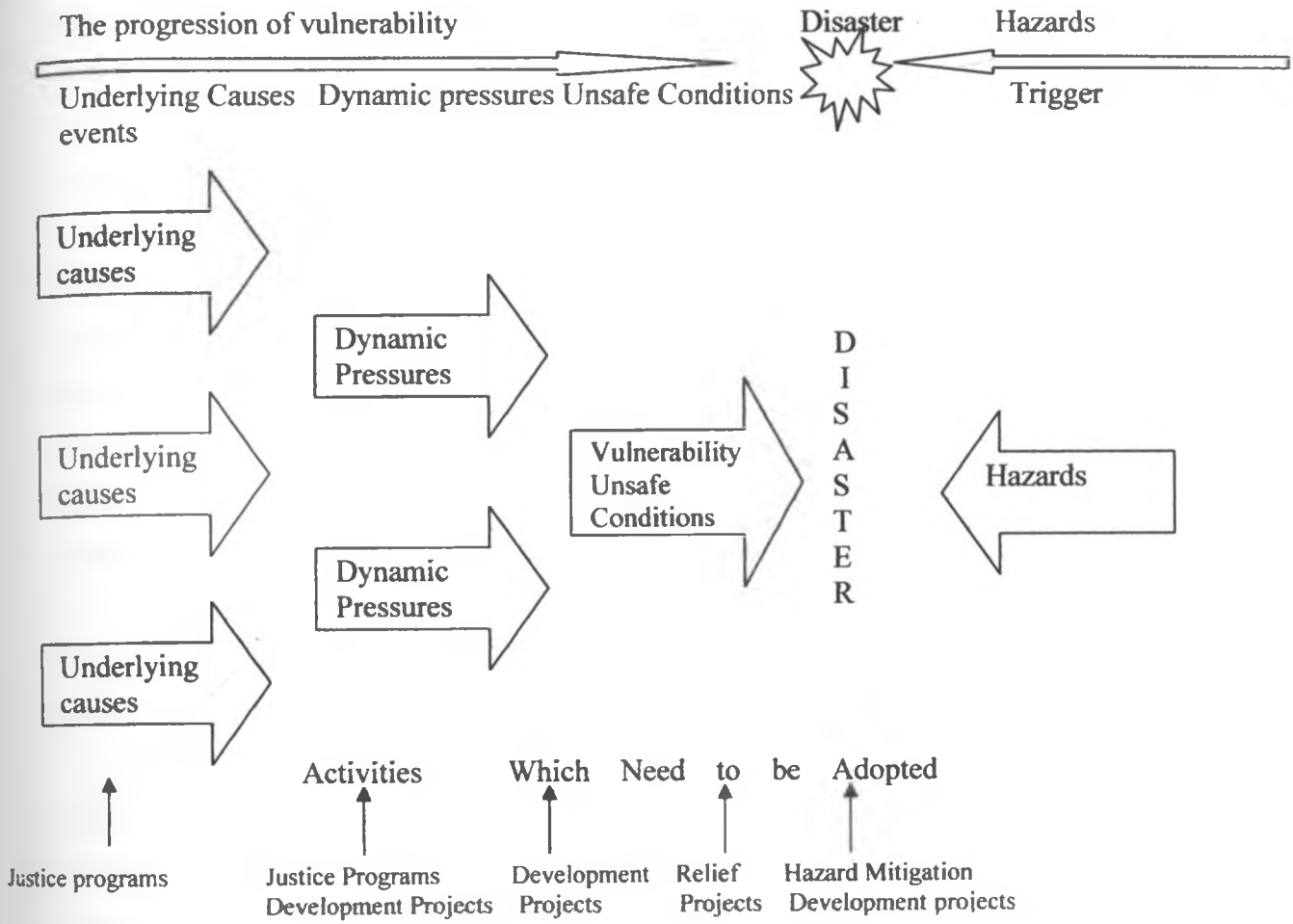
Related the scarcity of resources is the idea of opportunity costs, or "those costs associated with forgoing the next most attractive course of action (Friedman and Hechter, 1988:202). In pursuing a given end, actors must keep an eye on the costs of forgoing their next-most attractive action. An actor may choose not to pursue the most highly valued end if here resources are negligible if as a result the chances of achieving that end are slim, and if in striving to achieve that end he/she jeopardizes her chances of achieving her next-most-valued end. Actors are seen as trying to maximize their benefits and that goal may involve assessing the relationship between the chance of achieving a primary end and what the achievement does for chances of attaining the second most valued objective.

Friedman and Hechter (1988:203) enumerate two other ideas that they see as basic to rational choice theory. The first is an aggregation mechanism, or the process by which "the separate individual actions are combined to produce the social outcome". The second is the growing sense of the importance of information in making rational choices. At one time it was assumed that actors had perfect or at lest sufficient information to make purposive choices among the alternative courses of action open to them. However, there is a growing recognition that the quality or quantity of available information is highly variable and that variability has a profound effect on actors' choices (Ritzer, 1996:264).

Social life no less than economic life is characterized by scarcity. The slum dwellers may be faced with scarcity of resources, but it is true nonetheless that one cannot have all that they want. Accordingly men must choose and make decisions although with unforetold effects. The study examined the challenges faced in preventing and fighting structural fires in Nairobi's informal settlements.

Figure 1.CONCEPTUAL FRAMEWORK

Understanding Vulnerability: The Disaster Crunch Model



Definition of Terms

A Hazard is defined as "the potential occurrence in a specific time period and geographic area, of a phenomenon that may adversely affect human life, property or activity to the extent of causing a disaster. The Probability that a hazard will or will not occur, and its magnitude when it does occur contribute to risk" (Bethkel ynne, James Good and Paul Thompson 1997).

Risk is defined differently by people in different situations. Risk is the expected losses to a community when a hazard event occurs, including lives lost, persons injured, property damaged and economic activities or livelihoods disrupted. The greater the potential occurrence of a hazard and the more vulnerable a population, then the greater the risk. It can be expressed as: Risk=Hazard × Vulnerability (Bethke Lynne, James Good and Paul Thompson 1997).

Mitigation: - Measures that are adopted to prevent disasters in the event that prevention fails, the same measures should minimize the destructive efforts of the disaster.

Response: - A set of activities implemented once a disaster has struck, aimed at firstly satisfying the immediate needs of victims, their rehabilitation, reconstruction of infrastructure and the recovery of the overall economic activity.

Vulnerability is "the lack of ability or capacity to resist, cope with and recover from a potentially damaging hazard event. Human vulnerability is the relative lack of capacity of a person or a community to anticipate, cope with, resist, and recover from the impact of a hazard. Structural or Physical Vulnerability is the extent to which a structure or service is likely to be damaged or disrupted by a hazard event. Community Vulnerability exists when the elements at risk (people, buildings, or equipment) are in the path or area of the hazard and susceptible to damage by it" (Bethke Lynne, James Good and Paul Thompson 1997).

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CHAPTER THREE: METHODOLOGY

3.0 Introduction

This chapter is organized along the following sections: Research design, sampling design, study population, unit of analysis and unit if observation, sources and techniques of data collection and methods of data analysis.

3.1 Research Design

According to singleton (1988:102) research design is the arrangement of condition for collection and analysis of data in a manner that aims to combine relevance to the research with economy in procedure". A research design guides researchers in collecting, analysing and interpreting observed facts. The study was an exposé design. It entailed the examination of the challenges in preventing and fighting structural fires in Nairobi's informal settlements. More specifically the study combined both survey and field methods.

A survey design enabled the researcher to obtain information through the response of a sample of individuals to represent the population of study (Schutt,1996:225).A survey of households in the informal settlements was conducted to generate quantitative data. The data generated sought to assess the challenges faced in preventing and fighting structural fires in the informal settlements.

On the other hand, field research was used to generate qualitative data from the key informants. The researcher interviewed key informants who included officers from the local authorities and the Kenya Red Cross Society.

3.2 Sampling Design

Sampling is simply the process of choosing the research unit of the target population. A sample is a subset or a portion of the entire population under study. It should be viewed as an approximation of the whole rather than as a whole itself. In the study, the informal

settlement population was the total number of residents from Mukuru, Kibera, Mathare and Dandora.

3.2.1 Site Selection and Description

This study was carried out in Nairobi. Nairobi is the capital city of Kenya lying at a height of 1670m; the longitude is 36° to 5' East (3 hrs ahead of GMT) and latitude 1° 17' South, just 140 Km South of the Equator. The mean annual temperature is 19° centigrade and the mean maximum and minimum temperatures are 25° centigrade and 14° centigrade respectively. The mean annual rainfall is 1,080 mm falling in two seasons i.e. March to May(Long rains) and October to December (Short rains).Nairobi borders Central Province to the North, Eastern Province to the East, Rift Valley Province both to the South and West. Nairobi is selected by virtue of its status as a capital city. It hosts a larger population in more densely constructed informal structures than one finds in other towns such as Nakuru and Mombasa. Nairobi has got three fire stations: one is situated in the City Centre, the other is in Ruaraka and the other one is in Industrial area. In the 1999 national census, Nairobi's population was found to be 2.139 million and slums accounted for 0.6 million people or about 30 percent of the City's population. For census purposes, Kenya's Central Statistics Bureau (CBS) has divided Nairobi into 4700 Enumeration Areas of which 1263 are categorized as Enumeration Area ('EA5') or informal settlements. Therefore according to CBS there are 1263 informal settlements in Nairobi. The study was carried out in Mukuru, Dandora, Mathare and Kibera. These settlements are characterized by high population, unplanned developments and poor infrastructure and social services.

3.2.2 Target Population

According to Singleton (1993) a target population refers to all members of a real or hypothetical set of people, events or objects to which researcher wishes to generalize the research results. The target population in this study was the residents of informal settlements.

3.2.3 Selection of Informal Settlements and Respondents (Residents)

Nairobi was purposively sampled because of time, finances, and its accessibility. Republic of Kenya (2004) states that statistics on the city of Nairobi alone indicate that calls received by the fire department requesting for assistance average at 300 a month. This gives us a mean of 10 reported incidents a day. The selection of Mukuru, Kibera, Mathare and Dandora was informed by official records from Nairobi Fire Brigade and Kenya Red Cross Society on the frequencies of fires. Therefore these are the settlements with a high frequency of fire outbreaks. In each of the slums there are villages. Because of limited time and financial resources, the study targeted 9 villages from all the informal settlement as shown in Table 3. In the field each informal settlement was treated as a cluster or stratum.

Since the distribution of villages in each informal settlement was not uniform, proportionate random sampling was used as illustrated below.

$$\frac{\text{Total No. of units in cluster or stratum}}{\text{Total No. of units in universe}} \times \text{Target Units}$$

The study targeted 118 households from the informal settlements. These were selected by use of proportionate random sampling. In this study the sampling frame of informal settlements households was constructed from the records from the 1999 census by the Central Bureau of Statistics.

Table 3: Selection of informal settlements

Informal settlements	Existing villages	Villages to be randomly selected	No. of households in selected villages	No. of selected households
Mukuru	11	Kayaba	22,328	21
		Fuata Nyayo	10,224	10
		Kwa Njenga	16,139	15
Mathare	9	Ngei 1	16,242	16

		Mlango Kubwa Village 4A	9,135 6,119	9 6
Kibera	9	Makina Laini Saba	10,589 10,150	10 10
Dandora	2 phases	Dandora phase 11	21,788	21

3.2.4 Selection of Key Informants

Key informants were selected purposively from the local authorities and the Kenya Red Cross Society. There were 10 respondents from the Local Authorities and 5 respondents from the Kenya Red Cross Society. The number of respondents from the Local Authorities was higher than the total number of respondents from the Kenya Red Cross Society. This is because the local authorities are the ones with the responsibility of fire prevention and response. Their duties include putting in place measures to protect/mitigate against fires, they also inspect to ensure that people have adhered to the requirements of fire prevention before they construct houses. The choice of purposive sampling (judgemental) technique in selecting respondents for this research was based on the nature of the study. Fire disasters are sensitive because they destroy both lives and property.

In conclusion, a sample was used in the study because of the cost involved in studying an entire population. It was also because of the unmanageability of studying the entire population. The assumption in studying a sample is that the aggregate characteristics reflect the entire population from which it has been drawn. Sampling is necessary in research process due to reasons of cost and time limit in efficiency in information collection. The larger a population the more it is necessary to collect a sample or samples across the population that are representative. This fact has made social research to fully depend on good unbiased samples.

3.3 Unit of Analysis and Unit of Observation

Singleton (1993:241) defines a unit of analysis as "the entity about who or which a researcher gathers information". Babbie (1995:193) adds that a unit of analysis is that which the study attempts to understand. Schutt (1996:539) describes a unit of analysis as the "level of social life on which research questions focus". According to Baker (1994:102) units of analysis are the social entities whose characteristics are the focus of the study. Units of analysis can therefore be individual, people, social roles, positions or even relationships. Based on these definitions therefore, the unit of analysis for this study was structural fires in Nairobi's informal settlements. The unit of observation was residents of the informal settlements and Fire Officers from the Fire Brigade from whom the data was collected. Data was collected from the sampled residents and Fire Officers and the aggregates were used to describe the preventive and responsive measures put in place to manage fire hazards.

3.4 Methods and tools of data collection

There are a number of data collection techniques available for social science research. These tools and techniques are normally determined by the nature of the research. In addition factors like time, accessibility, and cost limitations determine the choice of methods used. This study benefited from both primary and secondary sources of data.

3.4.1 Primary data

Primary data involved first hand information that the proposed study sought to obtain from the respondents. The respondents were residents of the informal settlements' households and officials from the Kenya Red Cross Society and the Local Authorities.

All research questions were addressed through questionnaire and interview guide that were administered to the residents of the informal residents and key informants. The use of observation technique was limited to situations where formal interviews were not sufficient to capture or clarify important issues for the research. According to Koul

(1992:168) "Observation is the process in which one or more persons observes what is occurring in some real life situations and they classify and record potential happenings according to some planned scheme". The researcher observed lifestyles of the residents of the informal settlements.

The most useful tool for data collection was a questionnaire that contained both open and closed-ended questions. The questionnaires were administered to the residents of the informal settlements by the researcher. Face to face interviews were used and the responses recorded. In closed-ended questions, the respondents were offered a set of answers that closely represented their views to choose from. The open-ended questions allowed the respondents to communicate their views freely without being forced to fit within the answers.

The interview guide tool was used to address information from the key informants. The key informants were officials from the Kenya Red Cross Society and from the Local Authorities. Key informants are people with specialized professional background knowledge to issues being investigated on fire prevention and response. Key informants have access to other information which is of interest to understand the issues being explored. Key informants are people who are respected and ready to discuss matters of community and public interest. The interview guide contained questions that enabled the researcher to probe in order to clarify issues to facilitate collection of qualitative data. They were administered in confidence. That is the discussions were between the interviewer and the respondents. Prior to the interview the respondents were briefed on the purpose of the study and assured of confidentiality of their responses. This helped to minimize biases in their answers.

3.4.2 Secondary Data

The review of secondary data was used to supplement the primary data. Secondary data involved information that the study obtained from published and unpublished literature. This involved a review of books and information from organizations which deal with fire response. This included information from the Kenya Red Cross Society and Nairobi Fire

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Brigade. This information also included media reports, periodicals, books and magazines on fire response and protection.

3.5 Data Analysis

Data analysis is an exercise or process of searching and identifying meaningful patterns on the data. The raw data obtained from the field may not be important to research if it is not presented in a scientifically justified manner. In this study both quantitative and qualitative data were analysed.

3.5.1 Quantitative data

The raw data that was obtained from the field by use of questionnaires and interview guide was coded to enable compilation. Several methods were used to analyse the quantitative data:

Descriptive Statistics

The study made use of descriptive statistics. Descriptive Statistics are statistics used for the purpose of summarizing and condensing raw data into forms that supply useful information efficiently. Descriptive statistics comprise ways of reducing large masses of data into forms that can be clearly appreciated. It tends to describe the data to make more sense to the reader. These are important in giving information on totals of frequencies and percentages. Percentages were used in this study to sum up individual values. Percentages are easy to calculate and are usually arranged in percentage frequency distribution (Borhnstedt & Knoke 1982:28).Percentages were also used to demonstrate the knowledge of fire safety measures by respondents i.e. they demonstrated the percentage of respondents that are well knowledgeable about fire safety measures. Percentages were also used to display the fire training received by fire respondents.

Nominal Measurement

This scale mainly assigns names or numbers to classes of outcomes in a purely arbitrary sequence (Borhnstedt and Knoke 1982:18).There are no assumptions made about the relations between values. Each value defines a distinct category and serves merely as a label or name (hence "nominal" level) for the category. The values are exhaustive and mutually exclusive (Babbie, 1983:135).Nominal scale was adopted in this study to classify residents of informal settlements in the employment or unemployment category. Nominal measurements were also used to measure if the respondents had received any training on fire safety.

Frequency Tables

This method is concerned with displaying distributions by means of summary tables. Frequency tables were used to display the respondent's age distribution. Tables were also used to display the construction materials used in each of the informal settlements that were studied. They were also used to display the cooking fuels commonly used in these settlements. Tabulations were also be used to display the fire services that are available in Nairobi. They were also used to display the gaps in the fire policies. This technique was used to display the distribution of cases by their distribution.

3.5.2 Qualitative data

Bogdan and Biklen (1982) defines qualitative data analysis as "working with data, organizing it, breaking it into manageable units, synthesizing it, searching for patterns, discovering what is important and what is to be learned and deciding what you will tell others". Qualitative researchers tend to use inductive analysis of data, meaning that critical themes emerge out of the data (Patton, 1990).

This study sought to capture different aspects on the challenges in preventing and responding to structural fires in the informal settlements. The data collected underwent several processes including data organization, clustering interpretation and conclusion. Data organization entailed "Cleaning up" of data by simplifying and transforming the data that is discussed. This was done through processes such as selection, summaries or

paraphrasing. This ensured that data was reduced to a comprehensive and manageable size. The aim of data reduction was to shorten, sort, focus, discard and organize the huge amounts of data from the field in a way that the data could be used for giving preliminary conclusions.

Analysis also included drawing conclusions and verifications. This is where data irregularities, explanations, causal flows and prepositions were discussed. Final conclusions were tested for their plausibility and conformability. The generalizations arrived at this stage were confronted with a formalized body of knowledge (Theories).

3.6 Problems experienced in the field

The study involved covering long distances to reach the respondents and this made it time consuming. It was sometimes difficult to have victims of fire disasters talk about their experiences since it brought sad memories. This was quite sensitive to some people who broke down in tears as they recalled how they lost their loved ones and hard earned property to the fire disasters that had happened. The researcher had therefore had to give time to cry and this proved quite time consuming. There were also some respondents who refused to co-operate with the researcher and demanded for payment before they offered any information and at times the researcher had to part with some money to be shown around.

Language barrier proved to be a big problem since some community members could not speak English and therefore the researcher had to translate the questions into Kiswahili and at times mother tongue.

CHAPTER FOUR: DATA PRESENTATION AND ANALYSIS

4.0 Introduction

This chapter elaborates on the findings of the research based on the specific objectives and using the data collected during the research. Data collection bore in mind the specific objectives for the research i.e. identifying policy guidelines on settlements in Kenya and the extent to which they have been violated within the informal settlement sector, establishing the extent to which the violations of these guidelines lead to vulnerability to fire hazards in the informal settlements, assessing the capacity of the community and other support systems to respond to fires and examining the mitigation and preparedness strategies put in place. The data is presented in percentages and frequencies, tables, pie charts and bar graphs, case studies, in-depths analysis of contexts and situations and conversational analysis.

4.1 Background characteristics of the respondents

A total of 118 respondents were interviewed and the key variables that were used to compare the behaviour and perception of respondents were age, sex and the level of education of the respondents. The findings on these key variables are presented below.

4.1.1 Age Distribution

The study captured the views of respondents who were between the age range of 15 to 56 years and above. Those who fell between the ages of 15-25 represented 34% of the entire population. Those who fell in the category of 26-35 represented 38% of the population. Those who fell in the category of 36-45 represented 17% of the entire population. Those who were in the category of 46-55 represented 7% of the population. Those who were above 56 represented 4% of the entire population. The table below shows the frequency and percentage of the total population of each category.

Table4: Respondent's Age Distribution

Age Group	Frequency	Percent
15-25	40	34
26-35	45	38
36-45	20	17
46-55	8	7
56+	5	4
Total	118	100.0

4.1.2 Respondent's Level of Education

The education levels of the respondents were classified into five categories i.e. those who had no education, those with primary education, those with secondary education, those with tertiary and those with university education. Out of the 118 respondents, 4 % had no education, 33% had primary level education, 51% had secondary education, 9% had tertiary education and those with university education were 3%.The table below shows the percentage and the frequency distribution of the total population of each level of education.

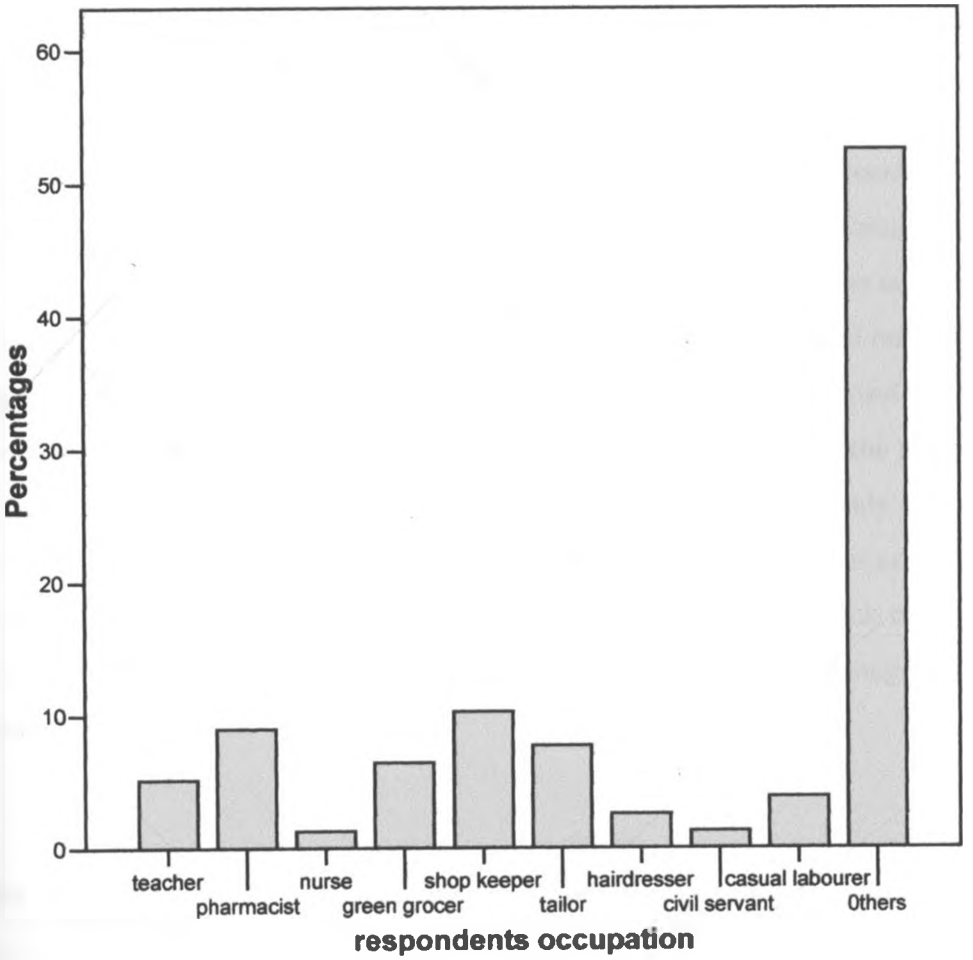
Table 5: Respondents Level of Education

Level of Education	Frequency	Percent
NONE	5	4
PRIMARY	39	33
SECONDARY	60	51
TERTIARY	11	9
UNIVERSITY	3	3
Total	118	100.0

4.1.4 Respondent's Occupation

Out of the 118 respondents who were interviewed, 78 were in some form of gainful employment. Their occupations were divided into ten major categories. These categories were teacher, pharmacist, nurse, greengrocer, shopkeeper, tailor, hairdresser, civil servant, casual labourers and 'Others". The "Others" category included all sorts of occupations such as mortuary attendants, shoe maker, carpenter, charcoal seller etc.The graph below shows the percentage of respondents in each category of occupation.

Figure 2: Occupation



The above background characteristics demonstrate that the slum residents generally belong to the economic underclass of the city's community. This can be seen from their

occupations and their education background. Those that had not gone beyond secondary education level represented more than 88% of the population. This means that the slum residents are highly incapacitated when it comes to fire prevention and response due to lack of resources. According to Bethke et.al (1997) vulnerability is the lack of ability or capacity to resist, cope with, and recover from a potentially damaging hazard event. It is the greatest among the poor, but may also include large segments of the population. Those who must seek housing in marginal, undesirable sites, and those with the least money available for providing adequate shelter will be the most vulnerable. Accordingly the residents of the informal settlements are the most vulnerable to fire disasters due to their low economic status.

4.2.0 Policies on Fire Security

The first objective sought to identify policy guidelines on settlements in Kenya and the extent to which they have been violated within the informal settlement sector.

The rural to urban migration has contributed to the proliferation of unplanned settlements and business areas commonly referred to as slums and jua kali areas. The constructions in these areas are uncontrolled and unplanned. The City Council of Nairobi recognizes these settlement areas as an inevitable nuisance hence for a long time in the past they were not covered by regulations applicable in the rest of the city. As majority of the slum residents did not pay any rents or service rates to the Council, they were left to rely on themselves in terms of fire service provision. Consequently, the informal settlement areas have been the worst affected by fire due to high population concentration and lack of goodwill by the Council (Feasibility Study on Fire Disaster Prevention and Management-Interim Progress Report).

Of late the government has embarked on a slums upgrading programme aimed at improving the condition of living in the areas. The programme which involves coordinated development of low cost housing and improvement of infrastructure will ultimately integrate the slums into the mainstream city planning scheme. Until this programme is finalized and proper fire prevention and fighting measures put in place, fire

outbreaks in the slums will continue to be ignored and treated as good riddance by the local authority whose resources are currently over stretched by the slum dwellers.

Ideally, every building should be planned for and designed in such a way as to make it quite easy for firemen to maneuver their way around it and equally easy for them to reach every part of the building. To meet this requirement; building regulations with respect to plot boundaries as set out in the Building Code (1968-adoptive by-laws- Kenya); section 17 and 18, should be strictly adhered to. Under Section 17 of the code, it is provided that there shall be left an open space immediately infront of every domestic building, such a space extending along the entire width of the front of the building and shall not be less than 20ft wide measured at right angles therefrom. If the building fronts on a street less than 20ft; the width of such open space is to be at least the width of the street plus one half of the difference between that width and 20ft. Any part of this open space which is within the plot is to be free from any building thereon above the ground level except a fence, wall or gate not exceeding 4ft.6in. in height or a port, step or other like projection from the building. Section 18 of the code gives provisions for side spaces to be left with respect to residential buildings. An open space is to be 8ft. or more in width measured from the boundary of the nearest plot facing that side at right angles to the nearest point of the building thereto.

Where the above simple fire protection measures are not observed in planning, designing and construction of buildings, a high fire risk is bound to prevail. It is in such situations that chances of fire outbreak are quite high, flame spreads quite rapidly, the chances of man escaping safely from a building on fire is likely to grow unchecked into an uncontrollable size due to lack of adequate fire defence systems as well as lack of access to and around the buildings for fire brigade team. This is seemingly the situation prevailing in slum areas of Nairobi where fire outbreaks are becoming quite frequent. The Building Code also specifies the construction materials to be used and the minimum time a building should withstand fire. These provisions are made to guarantee a degree of safety against fire for the occupants. The code is enforced by making it mandatory for

submission of drawings of proposed new building to be inspected and approved by the local authority.

It also came out clearly during the research that the existing regulations provide for the installation of basic fire fighting appliances in residential houses such as a fire extinguisher and a kitchen blanket which should be installed in the kitchen. However, none of the households observed had adhered to this requirement. This study also observed that none of the houses had chimneys although they are one of the building code requirements. It emerged that most residents did not realize the importance of chimneys in extracting smoke and reducing chances of suffocation in the event of fire out break. It was established that although there exists a requirement for approval of building plans, the City Council lacks capacity to verify that construction is carried out according to designs and especially in the informal settlement where development was uncontrolled as illustrated in the picture below.

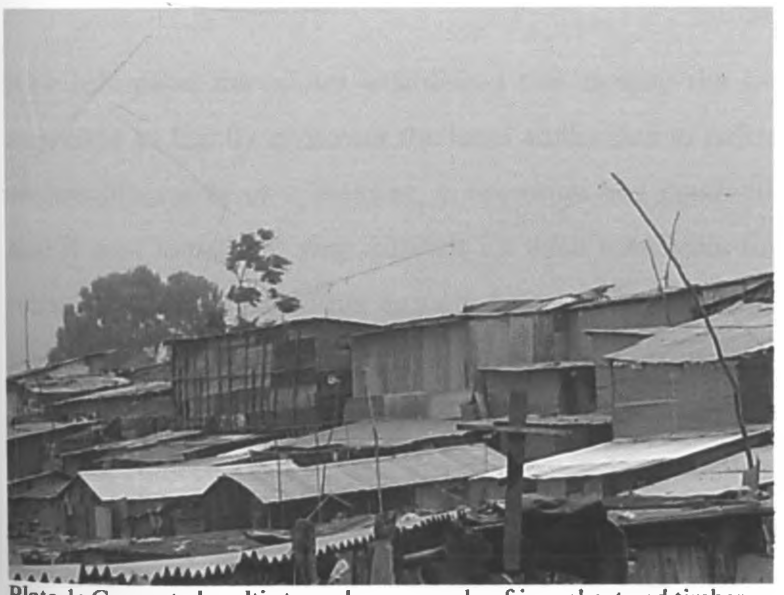


Plate 1: Congested multi storey houses made of iron sheet and timber

It was established that in spite of the past experiences in fire hazards, very little effort to contain fire hazards had been put in. While it may appear plausible to have well documented regulations, training programs and liaison arrangements on paper, lack of

capacity to implement them will most definitely render them useless. In spite of the existing government acts and by laws, the same government has been unable to effectively enforce them and ensure compliance. Training in fire safety at the community and household levels has been neglected, as there is no section of the law that makes it compulsory to acquire such knowledge. Legislation alone is not sufficient in changing attitude and promoting awareness. Liaison arrangement amongst various fire services in the city is not defined for ease of coordination, as such their reaction to emergency is left open for interpretation by the individual organization that owns the services. A national policy on fire safety was still on the drawing board and might take some time before it is finally established and approved for implementation. The policy proposes that there be established an independent body to be known as The Kenya Fire Agency to promote a culture of fire safety in Kenya. To achieve this, the agency will aim to Harmonize and comply with all applicable international policies and common platform directives and conventions on fire safety. The policy also proposes to set out the legal and institutional framework to promote fire safety.

Key informant interviews established that despite the existence of by-laws that were supposed to legally empower the local authorities to enforce/compel building owners to ensure fire safety of a building, cooperation and goodwill from the public was lacking and it was sometimes very difficult for them to enforce fire safety regulations especially when buildings that did not comply belonged to influential people. At times owners of buildings threatened local authority workers with various threats such as having them fired from their jobs if they insisted on having them (building owners) adhere to the building code regulations and therefore in such cases the council workers would choose to give a blind eye to the fact that the buildings did not comply since they did not want to loose their jobs. This highly incapacitates the local authorities and it is one of the major challenges in preventing fires in the informal settlement.

It was also established that the fire brigade was using by-laws that have not been revised since 1968 which were ineffective given that many new developments and technologies have taken place. For instance the hydraulic platform (which is one of their most

advanced equipment) that the fire brigade uses to put out fire in multi-storey buildings can only get upto eighth floor yet we have many multi storey buildings that have more than 24 floors. This means that if a fire occurs in the floors beyond eight floors, the fire brigade would not be able to put it out effectively. Another major challenge was the fact that the number of fire stations can not efficiently cover the population in Nairobi. The international standards on establishing a fire brigade dictate that one fire station should cover a population of 200,000 people. Nairobi has a population of over 3 million people and only three fire stations. The slums account for 30% of Nairobi's population which is about 900,000.Therefore in the slum areas alone we should have three fire stations. The three existing fire stations do not also have sufficient equipment that is necessary to respond to fires. This means that the current fire brigade cannot efficiently respond to fire outbreaks and many are the cases that go unattended to. The following table displays the recommended requirements in establishing a fire brigade versus the available ones.

Table 6: Requirements for establishing a fire station

	Recommended	Available
Total Fire Stations to cover Nairobi	16	3
Fire Engines (water)	32	8
Fire Engines (foam)	32	3
Fire Engine (carbon dioxide)	32	0
Communication facilities		
1) Fixed lines	32	5
2) Mobile phones	32	-
3) VHF Radio	16	1
4) Internet lines	16	-

4.3 Vulnerability to Fire Hazards in the Informal Settlements

The second objective sought to establish the extent to which the violations of guidelines on settlements lead to vulnerability to fire hazards in the informal settlements. The study established that there was a provision for fire safety measures but as we have seen in objective one above but these measures were not observed in the informal settlements leading to vulnerabilities to fire hazards in the informal settlements. This section discusses the various ways that the informal settlements are vulnerable to fires.

4.3.1 Potential Fire Risks

All the households observed had high potential fire risks. This was due to the building materials and methods that were used which were in violation of the Building Code Regulations thus making the residents highly vulnerable to fire hazards. The construction materials used in the slums are highly flammable which range from polythene paper, iron sheet, timber, cardboard and pieces of clothing. The population in the slum is very high and the houses are very congested and there is no space in between them such that when the fire personnel go to put out the fire, they are unable to access the scene of fire. None of the residents had installed the fire safety requirements in their houses and 97% of the houses had grills on their windows which would be an obstruction if it were the only means of escape left should a fire occur. The building code specifies the minimum distance to be maintained between adjacent buildings, construction materials to be used and the minimum time a building should withstand fire. These provisions are made to guarantee a degree of safety against fire for the occupants.

4.3.2 Construction Materials Used in the Slums

The structures in the informal settlements are constructed with highly flammable materials ranging from scrap timber, old felts, cartons and sacks to nylons and clothing for walls. Majority of the structures were made of iron sheet and these were about 62%.Those that were constructed from mud were 21%.About 7% of the houses were made of pieces of carton and polythene paper. Those that were made of timber were 6%.Those that were made of brick were only 4%. Roofs are in most cases made up of second hand corrugated iron sheets or flattened tins which are roughly nailed to gum

rafters and in some cases weighed down with stones .Reeds were also used as roofing materials Still one sees cardboards, rough felt or even sackings, cartons and nylons lying on top of some of the metallic roofs especially where leakages are suspected. Generally, most of the houses at the core of the slum are old and contain a lot of timber which increases the chance of fire outbreak due to their high flammability. One of the interviewees said "...just let a mad man, a drunk or even a careless child throw a lighted matchstick at a building and a large flame will come up within a very short time consuming anything that is capable of burning around it." The picture below displays the poor construction materials used in the informal settlements.

Plate 2: A house built of sacks, nylons, clothing and polythene paper:

4.3.3 Types of Fuels Used for Cooking and Lighting by Residents

The fuels commonly used by slum residents are paraffin, charcoal, firewood and electricity. The table below displays the percentage and the frequency of respondents using each category of fuel for cooking and lighting.

Table 7: Type of fuel used for cooking and lighting

Fuels	Frequency	Valid Percent
paraffin,electricity,candle	14	12
paraffin and charcoal	38	32
paraffin	19	16
charcoal,firewood,paraffin,candle and electricity	2	2
firewood and paraffin	2	2
cooking gas and electricity, candle	3	3
paraffin, charcoal, candle and electricity	23	20
paraffin, electricity, candle, charcoal and cooking gas	4	3
paraffin, charcoal ,candle and electricity	3	3
charcoal,gas,electricity	1	1
charcoal,firewood,paraffin	6	5
paraffin and Gas	2	2
paraffin,Gas,Electricity	1	1
Total	118	100.0

The use of such fuels in the slum increases the chances of fire outbreaks in the slums given that these fuels are not compatible with the kind of houses they live in which are highly flammable and can hardly withstand even the smallest of fire outbreaks. This greatly contributes to vulnerability to fire hazards in the informal settlements.

Room space in the slum is quite limited and it is not unusual to find a room with upto ten people living in it. For example in a one-roomed house lived two parents six of their children and two grandchildren! It is in these overcrowded rooms where we have all the wooden furniture, clothing, beddings and other household belongings. A small space is left beside the bed to serve the purpose of a kitchen place. An interviewee explaining the kind of energy he uses for cooking said that in his case he makes use of an old paraffin wick stove which sometimes leaks throwing paraffin and flames towards the roof! Given that the walls and the roofs are easily ignitable and the rooms small and highly overcrowded, the bedroom-cum-kitchen use of such rooms increases the chances of fire

outbreak. It should be noted that where the walls are made of timber the inner sides were in most cases found to bear the coats of oil paints which also ignite quite easily if temperature in the rooms happen to rise to their (paints) points of ignition.

Some house holds could also be seen lighting charcoal burners outside their rooms where they have to be left to take advantage of fine wind breezes so as to catch fire quickly. Cooking is normally done in the room but the red hot charcoal burners may catch onto the easily ignitable walls and end up setting a whole lot of structures ablaze.

Mountains of garbage were found spread out carelessly in between the closely spaced rows of buildings. This is as a result of negligence by the authorities concerned, of the refuse collection organizations. In the slum areas there exists a real worrying situation of "every man for himself and God for us all". Every household is responsible for their refuse disposal. The large heaps of garbage are normally accumulated in between the rows of buildings where they are from time to time burnt in an attempt to contain their growth. This burning of the accumulated refuse between easily ignitable structures poses a great risk of fumes escaping from the burning refuse onto the buildings.

4.3.4 Economic Activities Carried out in the Informal Settlements

A conflict was found to exist among the various economic activities in the area such as open air ghetto butcheries, fish friers, kiosks, temporary carpenter stalls, bars and changaa (highly volatile local brew) brewers. Most of the operators of these businesses light their fires in the open, very close to the buildings thus increasing the chances of fire outbreaks. The researcher remembers with a lot of pity her encounter with some young ghetto boys who were playing with fire behind one of the rows of carton and nylon walled buildings. This habit is encouraged mainly by a lot of litter being left lying everywhere especially timber shavings from the carpenter stalls. This exposes the buildings to a great risk if the fire is to escape from the fire lit by fish frier, the food kiosk operator, the butcher, or even from the hands of the careless ghetto kids into the timber shavings which are in direct contact with the easily ignitable walls.

Charcoal dealers were found piling bundles of sacks full of charcoal stacked one upon another in between the rows of ramshackles.If a lighted match or a cigarette butt happens to come into contact with the charcoal, then we expect fire to erupt with a lot of thrift in such a situation, catching onto anything that can burn near it onto anything near it including buildings. The pictures below display bundles of sacks lying in between houses.

Plate 3: Bundles of sacks full of charcoal lying in between houses.

People were also found cooking in the open close to the highly flammable structures thus increasing the chances of fire outbreaks. The following picture displays cooking going on in an open air food kiosk

Plate 4: Cooking going on in an open air food kiosk very adjacent to the highly flammable structures.

4.3.5 Rapid Spread of Flame

Given that the walls and roofs of most buildings in the slums are built of highly flammable materials and also the fact that these buildings are congested and don't have any space between them, if fire occurs at one point in any row, it will tend to spread very rapidly consuming the whole row. Chances of fire spreading to other rows adjacent to the one on fire are quite high.

Most structures in the slums are designed in such a way that if fire occurs in one room it is likely to spread to other rooms adjacent to it even before the household in the next room become aware of it. This is mainly due to lack of the necessary compartmenting effect. These buildings also have room which are excessively ventilated.

This is a poor mode of construction because even a small fire in the room will tend to rapidly grow into a huge one getting out of control given that oxygen supply will not be limited in such a condition. Any uncovered parts of such frames are likely to act as points

of weakness through which flame can escape to other parts of the building with a lot of ease.

4.3.6 Barriers to Quick Escape from Buildings on Fire

The illegal developments in the area have left the whole place filled up with uphazardly placed rows of buildings. No plans whatsoever were followed because development here happened to come before planning. The result of this has been narrow streets which take sudden turns at very short intervals. Come the rainy season and these streets become extremely muddy and slippery making them completely impassable.

The greatest danger occurs where these narrow streets lead to blind alleys acting as death traps. If escapees are trapped at such points then death will be mostly due to panic and not due to direct fire effect as such.

Slum lighting is generally lacking and given that there is likely to be a great crowd of people using the same route at the same time in an endeavor to escape from buildings on fire, it is quite hard for the people to escape from the building at night and at the same time evacuate their dear belongings with ease. In such a situation, most likely to occur are collisions, jams and confusions which may result in panic causing deaths leave alone bodily injuries.

Cart pushers and hawkers tend to make use of every little space left in between buildings during the day for conducting their businesses. Temporary stalls upharzadly erected in the middle of the streets during day time are a very common scene in the area. All these act as obstructions to the escapees in the event of fire.

4.4 Capacity of the community and other support systems to respond to fires in the informal settlement

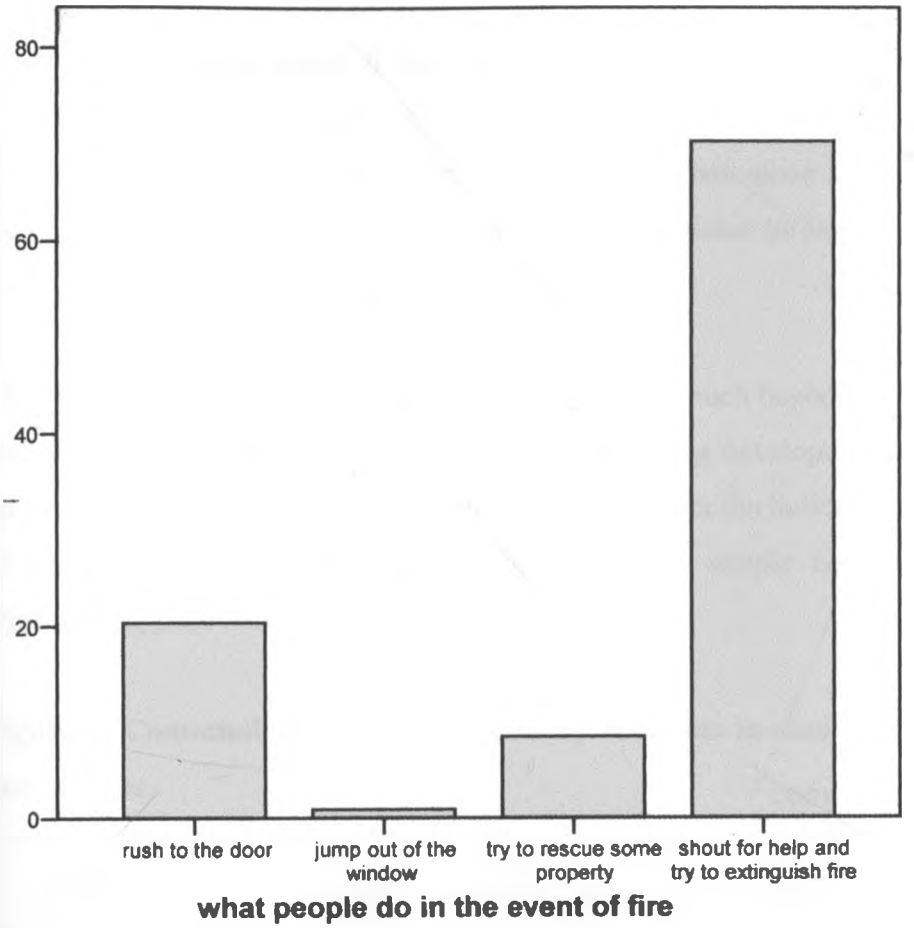
The third objective sought to assess the capacity of the community and other support systems to respond to fires. Capacity building refers to the development, fostering and support of resources and relationships for monitoring, prevention and management of a

phenomenon or phenomena at individual, organizational, inter-organizational and systems level. According to Bethke et.al. (1997) the contemporary view of capacity building goes beyond the conventional perception of training. The central concerns of management should be to manage change, to resolve conflict, to manage institutional pluralism, to enhance coordination, to require a broad and holistic view of capacity development. The definition covers both institutional and community based capacity. One of the requirements in this regard is to recognize that the social whole is more than the sum of its individual components. According to Kausperson (1989), an efficient disaster management strategy is a combination of various sub systems which include accurate detection and early warning arrangements, reliable and diversified information, capability on the potential risk expected, a preparedness strategy indicating actions to be taken on receipt of warning, and an effective communication arrangement to warn potential victims on what action they must take to contain the hazard. This section has analysed the capacity of the community and other support systems to respond to fires in the informal settlements.

4.4.2 Knowledge on what to do in the event of a fire outbreak

When residents were asked whether every member of their households knew what they should do should a fire break out, 93% said they did not know while only 7% were sure that every member of their households knew what to do should a fire breakout. When they were further given choices to pick from to measure their level of knowledge of steps to take in case a fire broke out, 20% of the respondents said they would rush for the door if a fire broke out while 1% of the respondents said they would jump out through the window if a fire broke out. About 9% of the respondents said they would try to rescue property if a fire broke out and the rest 70% said they would shout for help and try to extinguish the fire with available resources. The graph below displays their responses.

Figure 3: Steps taken in case of a fire outbreak



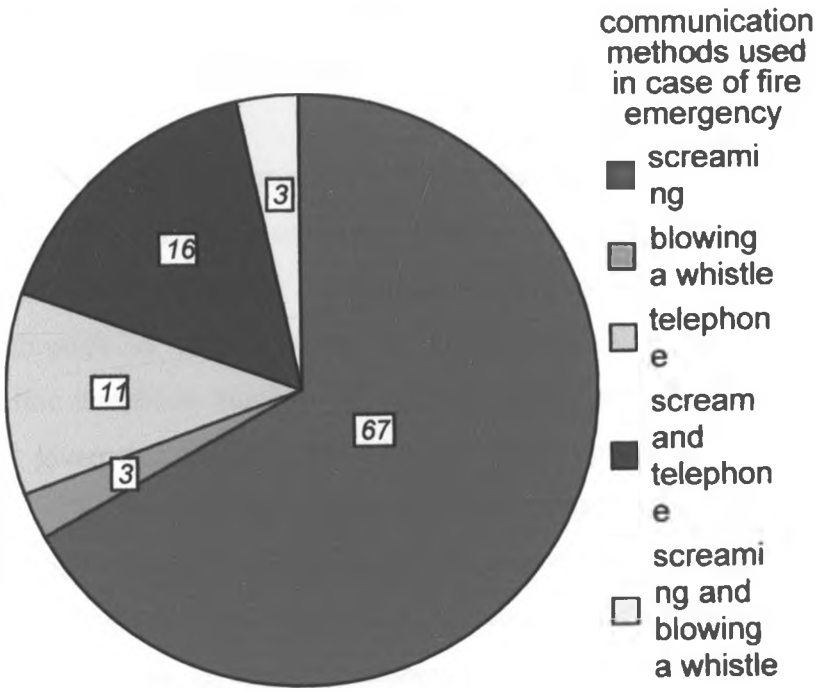
These responses indicate that the capacity of the residents of the informal settlements is completely lacking in terms of knowledge of the steps they should take in the event of a fire outbreak. The conventional rules on how to respond to fires as provided for by KRCS (2002) dictate that the first action one should take in the event of a fire outbreak is shouting for help/raising the alarm, then calling the fire brigade or the police on 999.The rules also dictate that one should warn others from going towards the direction of the fire and that one should never stop for belongings or go back to a building on fire. However we see that the slum residents are always driven by their passion to rescue property first before anything else. This is due to their low income status as they can not imagine loosing their hard earned property to fire and therefore they try rescuing it even if it means risking their lives.

4.4.1 Whether residents have any fire fighting/detection devices installed in their houses

When residents were asked if they had any fire fighting/detection devices installed in their houses all of them said they did not have. One of the fire safety requirements are that a kitchen blanket[7] should be installed in the kitchen since this is where most fires start. The requirements also dictate that a fire extinguisher be installed in the house but none of the residents had even this simple requirement.

Modern fire detecting and alarming systems are quite much beyond the ghetto technology and it seems the authorities concerned with controlling development there forgot to put up fire report centres maybe because they did not expect the buildings there to be capable of catching fire with the currently evident ease or simply because they don't care whatever happens to the slum dwellers.

Figure 4: Communication methods used by residents in case of fire emergencies in percentages



[7] A Kitchen Blanket is installed in the kitchen and it is used for covering a fire once it has started denying it oxygen thus extinguishing it.

According to the findings, 67% of the respondents said they would scream to alert neighbours if a fire broke out. About 16% of the respondents said they would use both screaming and telephoning as a communication method to alert neighbours that a fire has broken out. Those who said they would telephone their neighbours to alert them of a fire break out were 11% while 3% of the respondents said they would only blow a whistle to alert neighbours of a fire outbreak. Another 3% of the respondents said they would scream and blow a whistle if a fire broke out as a way of communicating to their neighbours

4.4.3 Emergency Telephone Numbers

When respondents were asked if they had emergency telephone numbers for the nearest fire service station, 86% said they did not have any emergency number while only 14% of the respondents had emergency telephone numbers for the nearest fire station. This factor really makes residents of informal settlements vulnerable to fire as they wouldn't know what number to call and so when a fire gets out of their hand all that is left for them to do is watch as the fire consumes all their houses and property.

Telephone services are the only means by which the slum dwellers can alert the Fire Brigade office in the event of fire outbreak in the slums. At the same time Fire Brigade has not embraced the technology of mobile phones which is the easiest way to communicate through in today's world. In other words the Fire Brigade has only provided land line telephone numbers through which the public can call in case of an emergency and given that landlines have become less popular with the public, booths have been phased out thus making it difficult for the slum residents to contact the Fire Brigade in the event of a fire outbreak since it is very expensive to make cell phone to landline calls. Field findings also established that majority of the slum residents did not even have the Fire Brigade emergency numbers as they did not find it of any use since the fire brigade rarely responded to their distress calls and whenever they did they responded rather late when the fire had already done the harm. One bitter interviewee said "...hakuna haja ya kupigia zima moto simu kwa sababu hawakuji na hata wakikuja

tunawapiga na mawe kwa sababu wanakuja kama wamechelewa na hata hawakuji na maji...hiyo ni kama kutumock..." (There is no use of calling Fire Brigade because they don't even come to put off the fire and even if they respond, we usually stone them since they usually respond late and they don't even come with water...that is like mocking us..."A lot of time may therefore pass before any action is taken to contain the fire .Even upon calling the fire brigade, the caller who is usually at the peak of panic may end up giving the wrong address of the location of the fire. Thus the fire brigade team may arrive in good time but at the wrong destination and the confusion which follows in trying to locate the right location of the fire may end up wasting a lot of time. Equally helpful may be a policeman on patrol in the area who may use their V.H.F (Very High Frequency) radios to alert the fire brigade office of fire outbreak in the slum. But delay is unavoidable given that the alarm may reach the fire brigade office during peak hours which are characterized by serious traffic jams. Thus the fire brigade team ends up wasting more than the estimated 10 minutes travel time between the office and the slum. Generally in most cases a lot of time may pass before any action is taken to contain the fire. The result of this is that a small fire is likely to grow to a big uncontrollable size before the fire brigade team arrives to deal with it. This is the reason why some of the residents said that in most cases of fire, the fire often goes out on its own after burning everything consumable on its way and not due to lack of action of man to combat it.

4.4.4 Water Problems

When the respondents were asked if they had water problems at any time, 60% of them said they had water problems in their area while 40% of the respondents said they did not have water problems. Out of the 60% who said they had water problems, 40% said their water problem was caused by frequent disconnections and the rest 60% said that they had to buy water daily. This means that should a fire break out in their areas, it would be very difficult to get water to extinguish the fire since most people would be unwilling to give their water which they had bought to be used for putting out the fire. Therefore even a fire that would have been contained by the use of water would get out of hand simply because water is a rare resource. The case study below validates this point.

Case Study 1

Akinyi*, a 36 year old mother of four lives in Mukuru Kayaba.In October , 2006 she lost everything that she had to a fire that broke out in their area. This fire started out in a neighbour's house. Efforts to put it out the fire were frustrated by lack of water. In the whole neighbourhood they could not get water and sand was difficult to find in their area. Within a very short time the fire grew in to a big uncontrollable size because of the wind. The next thing she knew, she was running for her life.

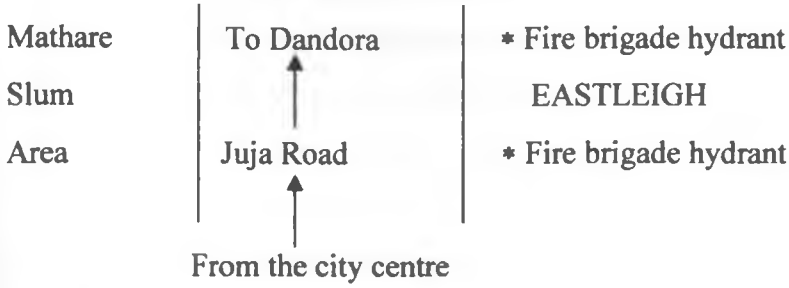
Source: Field Interviews, April 2007

Therefore as we can see that water, which is one of the most efficient agents of fighting fire due to its good cooling effect is generally insufficient in the slum. Most of the residents in the slum buy water on a daily basis and even in areas where they have piped water, they experience frequent disconnections. The study also established that whenever fire occurs in the areas with piped water, residents are fond of breaking the on-the surface water pipes in an attempt to obtain water so that they can combat the fire on their own. This denies water supply to the lower parts of the work pipes such that if fire spreads towards these lower parts there will be no water to combat it and afterwards the pipe may lie unrepaired for weeks resulting in an acute shortage of water for domestic use in the area.

4.4.5 Inadequate Fire Fighting Facilities by the Fire Brigade

The survey found out that fire brigade hydrants have been installed in the slums for use by the fire brigade teams from where they can obtain sufficient water supply at sufficient water supply at the right pressure to combat fire in the slums. The main problem with these hydrants is that some of them were laid on the wrong side of the road. For instance the ones that have been installed on Juja road were laid on the wrong side of the road as shown below.

Figure 5: Fire Brigade hydrants laid on the wrong side of the road



This water hydrant is about 50 metres from the slum. The result of all this is that the fire brigade team is forced to lay long delivery hose across the road to reach the slum and oftenly vehicles run over these hose thus interfering with water flow. Again vehicles may be parked directly above some of the nearest fire brigade hydrants when the fire brigade team arrives. The owners of these vehicles may not be nearby to be asked to move them and so the fire brigade team is forced to look for other hydrants far away. Builders also tend not to be aware of the importance of these fire brigade hydrants and usually build on top of these hydrants or bury them with debris from construction work in the area. These debris need to be cleared first so as for the fire brigade team to reach the hydrants. All these factors lead to time wastage before any action is taken to combat the fire. This factor indicates that organizational and institutional capacity is lacking.Capaity building equips people to work better in their own day -to- day affairs. To do this capacity building must include the elements of human resource development (individual training), organizational development (improving the functioning of groups and organizations), and institutional development (the formalization of group initiatives into social structures with legal and regulatory authority to allow efficient functioning of groups and individuals) Bethke et.al (1997).

4.5 Mitigation and Preparedness Measures put in Place

The fourth objective of this study sought to examine the mitigation and preparedness strategies put in place to combat fires in the informal settlements. By definition, the concept of mitigation includes the capacity to prevent risk of fires for minimizing damages when prevention fails (Nick Hall et al, 2000). As such it must encompass a comprehensive range of activities for detection, issues alerts, as well as clear guidelines

on actions to be taken once fire is reported. Preparedness are measures that are taken in readiness for a disaster which include early warning. This arrangement tends to constitute a system of various interconnected activities that function towards a common objective. In Nairobi, current efforts towards containing fire hazards within the city are varied but seem to be geared more towards response than for mitigation. A successful mitigation strategy derives its strength not only from the commitment by the authorities but also from the degree of individual awareness to prevent fires. In the event that preventive measures fail, the available fire service resources must be activated to stop the fire within the shortest time possible so as to minimize the impact of the threat. This section gives an analysis of the mitigation and preparedness measures put in place to combat fires in the informal settlements.

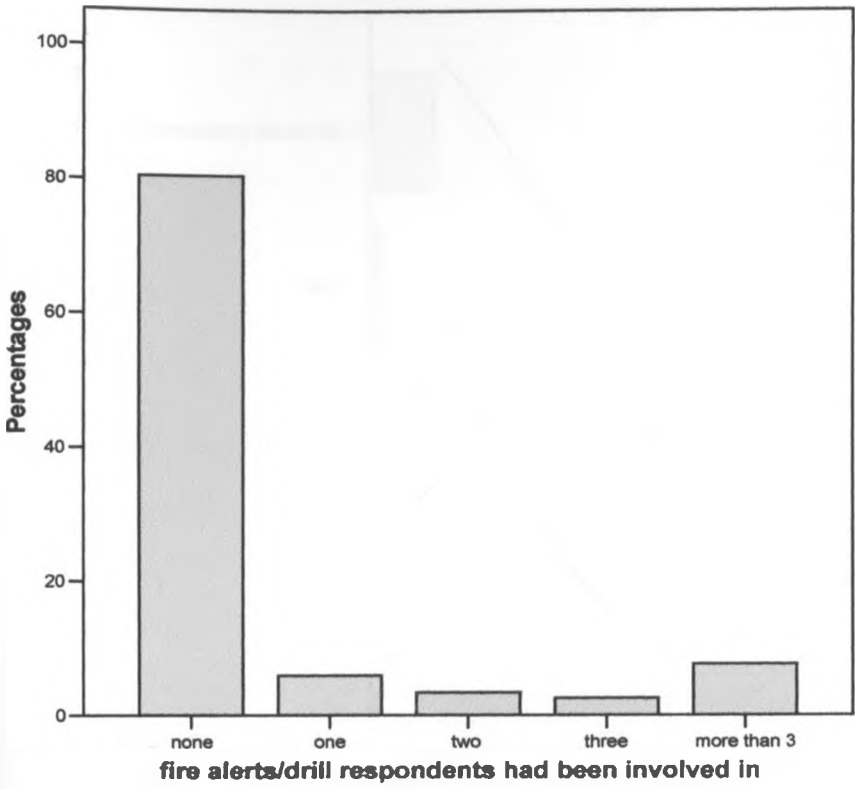
4.5.1 Training in Fire Security

Informal settlements are the shanty areas in the city of Nairobi accommodating more than 30% of the population. Most of the residents are in the lowest income bracket and quite a number are unemployed or small scale traders. The houses in slums are very crowded, in some cases hardly two metres apart and without any road access for a vehicle. The study established that about 95% of the slum dwellers did not consider fire security to be an immediate priority although important. Due to low incomes, fire incidences are considered as mere bad lack for which resources for prevention should not be spared.

4.5.2 Fire Alerts/Drills

When residents were asked if they had been involved in any fire drills, 81% said they had not been involved in any. About 6 % of the respondents said they had been involved in one fire drill while 3% of the respondents said they had been involved in two fire drills. Another 3% said they had been involved in three fire drills while 8% of the respondents said they had been involved in more than three fire drills. The following graph displays their responses.

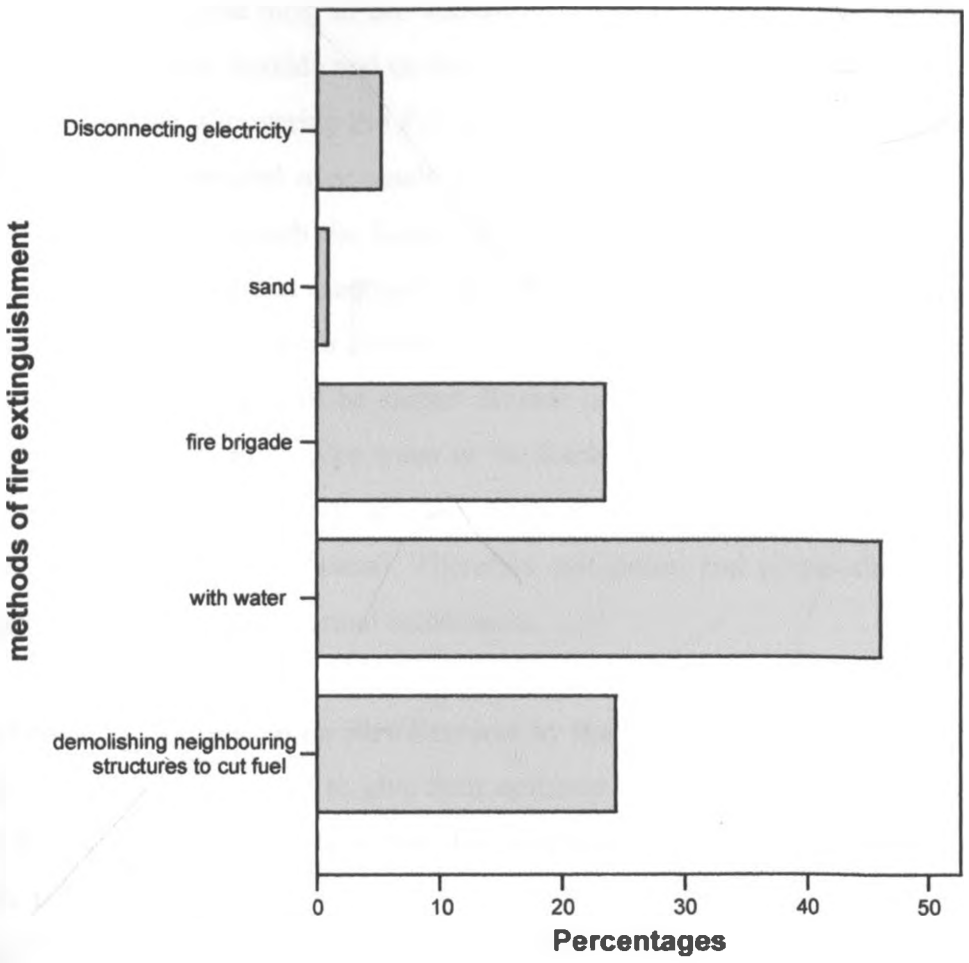
Figure 6: Number of fire drills



4.5.3 The methods that residents use to extinguish the fires

When respondents were asked how they extinguished fires when they occurred in their areas, 24% said that they demolished the neighbouring structures in order to cut fuel. This way the fire did not spread to other areas since the fuel had been cut off. The majority 46% of the respondents said that they used water to extinguish fire. About 24 % said that normally the fire brigade is the one that came to put out fire in their area. Another 1% of the respondents said that they used sand to extinguish fire while 6 % said they extinguished fire by disconnecting electricity since most fires especially during the rainy seasons were caused by electricity. This was because of faulty connections of electricity.

Figure 7: Methods of fire extinguishment



From the above responses we see that water is the most popular method of extinguishing fires in the informal settlements. However this method is not effective as not all types of fires are extinguished by water and as a matter of fact only fires that involve solid materials such as wood, paper, cardboard and iron sheet are supposed to be extinguished with water. The study established that there were various causes of the fires that occurred in the slums ranging from those that were caused by electricity, liquids such as petrol, paraffin and changaa (highly volatile illicit brew),and fires that were caused by gaseous substances such as cooking gas. The respondents did not always know the causes of these fires but they used water to extinguish them regardless of their class. This can be extremely dangerous and at times it may only worsen the fire situation for instance when the fire is caused by a liquid. As Watt (1986) notes care should be taken in choosing the

appropriate agent for attacking different types of fire: In liquid fires, water will prove to be ineffective because most of the volatile liquids such as petrol float on water. In such cases foams, carbon dioxide and or inert powder are the most appropriate agents because these are capable of covering the fire and suppressing it by denying it oxygen supply. A bucket of sand if poured over small liquid fires will also prove to be effective because sand will normally absorb the liquid or cover the fire completely given that it is non combustible. In very hot electrical apparatus fires, water or foam is likely to cause damage to materials or even electrocute someone since water conducts electricity. The appropriate agents here will be carbon dioxide or inert powders both of which are non-conductors of electricity unlike water or the foam. However, as we had earlier noted due to low incomes, fire incidents are considered as mere bad lack for which resources for prevention should not be spared. Therefore mitigation and preparedness strategies are generally lacking in the informal settlements.

4.5.4 Resident's Opinion on Fire Services by the Nairobi Fire Brigade

When residents were asked to give their opinions on the services offered by the Nairobi Fire Brigade, 87% of the respondents felt that Nairobi Fire Brigade was inadequate while 13% said that the fire brigade was adequate. Most of them blamed fire brigade for the losses they incurred from fires because they felt that if the brigade was fast to respond to the fires, the losses would be minimized.

4.6 Probable Causes of Fire in the Slums

It should be noted that it is not an easy task to establish the exact cause of most fires in structures. The difficulty arises because fire destroys most of the evidence, the careless man does not like to admit his carelessness, the arsonist will not reveal his crime and witnesses are rarely present at the moment a fire outbreak occurs.

From this it follows that any attempt to establish the exact cause of a fire outbreak, whether by a policeman, a fireman or any other specialist in investigative exercise is highly prone to errors. As a result, most existing fire statistics should be regarded with some suspicion.

Interviews conducted with the residents of the slums and fire brigade officers showed that fire outbreaks may arise from any o f the following causes:-

Improper installation of electricity:-In cases of improper connections of electricity fire usually occur especially during the rainy season because the naked wires catch water thus causing fire.Nb/ Electric fire is so dangerous and very hard to put off. Residents attempt putting out this fire with water which causes even further damage because electricity combined with water can electrocute someone. Residents even testified that on occasions people have been electrocuted in their own houses when they are sleeping or leaning on the walls where these wires pass. If the walls which are usually made of iron sheets even by chance touch these naked electric wires they conduct electricity and if someone happens to be leaning on such a wall he/she can get electrocuted.

Domestic Violence: - Residents said that a couple fighting was a very common thing in the slums and during such fights a partner may and on occasions have burnt houses in anger.

Stove explosions:-Some people are so careless so as to add paraffin to a stove when it is still on and this can cause the stove to explode causing a fire. There are also people who use petrol instead of paraffin and this causes stove to explode causing a fire at the same time endangering the resident's lives since petrol is a very volatile substance. Stove explosions can also be caused by other factors like leakages of paraffin from the stove etc.

Paraffin lamps: - Paraffin lamps are commonly used in the slums and some of the residents don't know how to handle the lamps carefully thus contributing to fire outbreaks in the slums which usually catch on to their highly flammable houses spreading very quickly onto the neighbouring structures. For instance some people after pouring paraffin they forget to cover the opening and when they are lighting the lamp, fire can escape for instance if blown by the wind and catch the paraffin inside the lamp causing

the lamp to explode resulting to huge fires. Some residents also use lamps that are leaking and this too catches fire very easily.

Tin lamps:-These are also very popular in the slums and have on many occasions been the causes of fires in the slums. Commonly known as "Koroboi", "Nyitira Njare" (hold for me while I make the bed), many people usually forget to put them off when they are sleeping and given that there is usually no space between the bed and lampstand, one may accidentally knock off the lamp and its flame may catch on the mattress or on any other flammable material thus causing a fire outbreak which is highly fuelled by the paraffin from the lamp. A cat or a child can also accidentally knock off the lamp thus starting a fire.

Candles: - Interviewees in the slum testified that candles have on many occasions been the cause of fires in the slums. This may be because of mishandling just like the tin lamp.

Children playing with fire:-Children left unattended can be a starter of fire for instance in cases where they are playing with matches. For instance during the field study the researcher came across children who were playing with fire next to some rubbish that was burning next to some structures. The researcher recalls sadly how the children would carry a piece of burning paper and try to make with it another fire. This is very dangerous as the flame from the fire they were carrying can escape and catch and ignite the neighbouring structures which are highly flammable because of the material that they are constructed of (Iron sheet and timber).

Charcoal burners (Jikos):-These are also a common cause of fires in the slums. Embers from the charcoal can escape from the jiko (and given that people leave their jikos in a windy place so as to light easily, this often happens) and catch on any flammable material near it thus causing a fire.

Cigarettes: - This is another source of fire in the slums. Cigarette smokers drop off cigarette butts without putting them off and whenever they catch on anything flammable, they cause a fire outbreak.

Changaa: - Residents brew changaa (illicit brew) in their congested houses which is a highly flammable substance and it can explode causing a fire to start.

Arson: - Interviewees said that at times fire has been started by arsonists who burn their houses for one reason or the other. For instance an interviewee told the researcher that when landlords want them to vacate from the houses so that they can develop their plots or sell them to some private developers, they usually hire goons to start a fire. Another resident from Mukuru Kayaba said that they suspected that the last fire in the area was part of a government plan to remove them to make way for new roads. "It has asked us to leave for sometime now but people have refused", said Otieno*.Another interviewee said that when thieves want to steal they set houses on fire so that when residents start removing their things outside they can easily steal in the commotion. Also some tenants burn their houses when they don't want to pay rent or when the rent is increased.

Drunkenness: - Drunkards have also on occasion started fires. When a drunkard attempts to cook in that state he or she can easily start a fire. An interviewee told the researcher that there was a fire that was started by a drunkard who dozed off when he was still smoking and the fire from the cigarette caught on the mattress and after a while the house was on fire. He was rescued by neighbours badly injured and he only survived because the fire happened during the day when everyone was outside going on about their business and therefore noticed the fire coming from his house. Otherwise had it been during the night when everybody was asleep, it would not have been easy to save him and the fire would have spread to the neighbouring structures.

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*Not his real name

Carelessness and Negligence:-For instance if there is a power blackout some people forget to switch off their electrical appliances such as heaters and iron boxes and they leave the house and when the electricity comes back on the appliances burn the whole place. Risky cooking methods also contribute highly to fire outbreaks. Many residents of the informal settlements use kerosene that is mixed with petrol for cooking and for lighting. This is so because this is usually sold off at cheaper prices in comparison with pure kerosene. The residents may or may not be aware o f the dangers that can result from using such kind of fuels and those who are aware of the dangers are simply pressed by their needs/poverty to use such kind of fuels. This may and has caused stoves and lamp explosions which lead to fires and sometimes death (Usually such kind of fuels are sold illegally).

Flammable building materials :-The highly flammable materials that are used in the slums and which do not confirm to the building code regulations are such a big contributing factor to the fire outbreaks because they can hardly withstand fire no matter how small it is.

Congestion of houses:-This is highly to blame for the spread of fire to other structures causing as many as a thousand houses to get burnt.

Burning of rubbish next to the house:- This has on occasions caused fire in the slum because flames of fire can escape from the burning rubbish and aided by the wind catch on to the houses.

Ghosts:-Some residents claimed that fires in the area were started by ghosts. When pressed further to explain one said "sasa tuseme kama hii nyumba haijakuwa na mtu kwa wiki moja halafu tuone ikichomeka na hakuna mtu ameingia na tumesimama tu hapa nje, si hiyo ni "ghost" (Lets say that this house has been vacant for a week and we are standing here outside and suddenly we see a fire and we never saw anyone entering that house because the padlock is still locked, that must be a ghost that has started the fire).They claimed they had seen this happening several times.

5.0 CHAPTER FIVE: SUMMARY AND RECOMMENDATIONS

5.1 Summary of the findings

5.1.1 Factors Contributing to Fire Outbreaks in the Informal Settlements

There were various reasons that were given by the residents of the informal settlements and the key informants from both Nairobi Fire Brigade and the Kenya Red Cross Society as the contributing factors to the fire outbreaks in the slums. They included stove explosions, electric faults, burning rubbish, charcoal burner igniting flammable materials, cigarettes, candles, arson, sparks from welding machines, children playing with fire and volatile liquid catching fire.

5.1.2 The Challenges in Preventing and Fighting Structural Fires in Nairobi's Informal Settlements

The study established that there were various challenges that were faced when it came to preventing fighting structural fires in Nairobi's informal settlements. These included the lack of a fire policy and a fire act that would give guidelines to the fire personnel on how to go about responding and fighting structural fires in the informal settlements. The fire act would also empower fire personnel in enforcing fire regulations in the informal settlements. It was also established that other fire services outside the control of the city council are available but still the Nairobi City Council Fire Brigade is expected to effectively manage all cases of fire incidences within its area of jurisdiction and beyond. It is however affected by lack of adequate resources to cover the whole city. The station which was established in 1912 has realized very little expansion (it has only opened two branches in 95 years) to cope with the demand for improved services.87% of the respondents expressed their dissatisfaction with the fire services. Another challenge that was faced by the local authorities in preventing and fighting structural fires in the slums was the up hazard upcoming of new structures without the knowledge of the local authorities. These uncontrolled developments are very difficult to keep track of and enforce the fire safety requirements. Lack of access to slum areas hampers effective employment of fire tenders whenever they report to assist in controlling the fires. This is also a very major challenge that faces the fire personnel whenever they go to put out fires

in the slums. Another challenge that is faced by the fire personnel is lack of water hydrants near the scene of fire either because they were removed or covered with debris by constructors. This slows down the process of responding to the fire since the fire personnel is forced to go for long distances to look for water and by the time they do so the damage is already done. The other challenge is hostility from the slum residents. This instills fear in the fire personnel and they may be unwilling they may be unwilling to respond to fires in some areas since they are scared about their own security. Other factors that were identified to contribute to challenges in preventing and fighting structural fires in the informal settlements were inadequate fire detecting, alarming and fighting facilities. There is also lack of cooperation and goodwill from the public.

5.1.3 Strategies of curbing fire outbreaks in the informal settlement

Some of the strategies that have been put in place to aid in curbing the rising number of fire outbreaks include holding workshops and trainings on fire prevention and response in the informal settlements. Kenya Red Cross Society in collaboration with Nairobi Fire Brigade has started a project on workshops and trainings on Fire Prevention and Response in the informal settlements. This project was still running and by the time of the study they had trained two groups from Mukuru, Kayaba and Mariguini slums on fire prevention and response. They had also trained some residents in Kibera. The fire brigade is also training the Red Cross Action team who will be responding to fire disasters in the slums. They educate and advice the public that they should inspect kerosene stoves before cooking to ensure that all wicks are in place as this causes fires because air could pass through the space that the wicks should have occupied and this can cause fire to occur or stove explosions. They also advice the public to practice safe cooking methods to avoid fire outbreaks. They are also advising the slum residents on the measures to take in the event of a fire outbreak. The Nairobi fire brigade has also opened up two more new stations and has also acquired some new modern trucks to help it to respond to the many cases of fire more efficiently. The Nairobi fire brigade is also installing fire hydrants throughout the city. There is also more in service training of firemen to always add on their skills on fighting fires. Access roads have also been built in some slum areas to

enable fire engines to get access. The government has also embarked on a slum upgrading project where by houses are being built of less flammable materials.

5.2 Recommendations

The findings from this study make the following recommendations that will help in preventing and managing fire hazards in the informal settlements:-

1. With the recognition that the growing problems of loss of life and property from fire as a matter of grave national concern and that this problem is particularly acute in the informal settlements where an increasing proportion of the population residents, it is recommended to the government to establish a commission to undertake a thorough study and investigation of this problem with a view to the formulation of recommendations whereby the nation can reduce the destruction of life and property caused by fire in its cities, towns and suburbs.
2. The Nairobi Fire Brigade and key stakeholders should hold seminars/workshops/trainings on fire prevention and response in the informal settlements. The Public also needs to be synthesized on the importance of not building on road reserves and on top of water hydrants as this only hinders/slows down any response/intervention by the Nairobi Fire Brigade. The public should be synthesized on the importance of giving way to fire engines on the road to enable them arrive at the scene of fire promptly. The community members in collaboration with key stakeholders should have fire committees whereby they address issues concerning fire outbreaks and their environment. The government should start an equipped fire training school. The youth in every slum should be trained as fire fighters by the Fire Brigade so that they can be putting off fires in their areas for better effectiveness. This will increase firefighting manpower. The fire brigade should conduct more fire drills in the slums to test the preparedness of residents in the slums on fire. The community should be trained to be volunteers rather than being employed by the fire brigade. This will increase manpower for fire fighting. The community should be synthesized on the importance and meaning of an emergency:-That is they should be synthesized on the importance

of calling the fire brigade immediately a fire has started and not after it has done a lot of damage. They should also be synthesized of not placing fake calls to the fire brigade and claiming there is a fire only for the fire brigade to arrive and find it was a hoax. This may make the fire brigade to stop responding to fires in a particular area even when there is a real fire because they might not be in a position to establish whether the distress call was genuine or not.

3. More fire stations (ideally one station per every 200,000 people in an area according to the international standards) should be opened up as our city has expanded rapidly. This will go along with buying of more fire engines and modern fire equipment and training of more manpower. Nairobi fire brigade should also place fire points at strategic areas in the slums in order to enhance a quick response to fire outbreaks. The fire brigade should always have water tender that is fully equipped on standby in every constituency in case of a fire outbreak. The local authorities should install water points and fire extinguishers in slums and residents should be trained on how to operate them so that in the event of a fire in the slum, they can be able to put off the fire on their own without the fire brigade.
4. The fire brigade should invest in helicopters that can be used to extinguish fires in those areas that are inaccessible by their trucks.

5. Fire Brigade should be made an independent organization or a parastatal-currently it falls under the Local Government which already has got eight other sub sections. Therefore it should be made a ministry on its own because it takes time before funds are released to it because there are priorities in all the other sections. This will ensure the decentralization of the fire service hence avoiding bureaucracies which are one of the causes of delays in fire response.
6. A National Policy on Fire Prevention and Management and a fire act should be put in place. The city council adoptive by-laws should also be reviewed and updated to match up to the current technology and developments.

7. Fire brigade should be given security whenever they are responding to fires because at times they are reluctant to respond to fires in certain areas because of hostility from the community.

8. Slums should be upgraded by the government and made of permanent structures with electricity to avoid the usage of fuels like paraffin, candles and charcoal which are more conducive for fire outbreaks. The roads in the slums should also be upgraded by leaving enough space for the fire brigade to be able to access whenever they report to put out the fires. Plot owners should insure their houses against fire to ensure that residents are compensated for their losses in the event of fire outbreaks.
9. There should be enforcement of regulations regarding illegal vendors of kerosene who sell to residents kerosene mixed with petrol. The local authorities should also inspect building plans to ensure that buildings in the slums adhere to the building codes and regulations.
10. Regulations governing against illegal installations of electricity should be enforced by Kenya Power and Lighting Company and it should be ensure that installations are done properly. The concerned authorities should try and solve the problem of illegal connections of electricity since electricity is such a major cause of fires in the slums.

11. There government should build water tanks (boreholes/reservoirs) in the informal settlements to ensure there is always enough water that can extinguish a fire should one arise.
12. There should be co-operation from stakeholders and the public in general. This will increase the effectiveness of the local authorities in enforcing the fire safety requirements.

5.3 Areas for Further Research

This study has addressed the challenges in fighting and preventing structural fires in Nairobi's informal settlements.

Further research should be undertaken in ways in which fires can be effectively prevented through technological advances, construction techniques and improved inspection procedures.

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APPENDIX 1

Questionnaire to Residents of Informal Settlements

My name is Anne Lily Wanjiru Kamau.I am carrying out a study on the challenges in Preventing and Fighting Structural fires in Nairobi's Informal Settlements. This in is Partial fulfillment of a Master of Arts (M.A) degree in Disaster Management at the University of Nairobi. I am kindly requesting you to assist by completing this questionnaire. Your cooperation will be highly appreciated. Any information given will be treated in confidence.

Section A

1. Respondent's Name

(Optional).....

.....

2. Sex: ( ) Male ( ) Female

3. Age group:
   - 15-25 Yrs ( )
   - 26-35 Yrs ( )
   - 36-45 Yrs ( )
   - 46-55 Yrs ( )
   - Over 56 Yrs ( )

4. Education level:
   - Primary level ( )
   - Secondary level ( )
   - University level ( )
   - Not been to school ( )

5. Position in the household:
   - Father ( )
   - Mother ( )
   - Son ( )

Daughter ( )

Others (specify) ( )

6. Are you gainfully employed? Yes ( ) No ( )

If yes specify occupation

.....

Section B

7. How long have you lived here?

.....

8. What fuels do you use for cooking and lighting?

.....

.....

.....

9. Do you have any fire fighting/detection devices installed in your house? If yes specify.....

.....

10. Does every member of the household know what to do in case of fire?

.....

11. What communication methods do you use in case of an emergency?

.....

.....

12. Do you have emergency telephone numbers for the nearest fire service station? Yes ( ) No ( )

13. What would you do in the event of a fire? Tick the answer.

a.) Rush for the door ( )

b.) Jump out of the window ( )

c.) Try to rescue some property ( )

d.) Shout for help and try to extinguish the fire with the available resources ( )

14. How far is the nearest source of help that you can rely on?

.....

.....

15. Do you have water problem at anytime? Yes ( ) No ( )

If yes explain.

.....

.....

16. Do you have any potential high-fire risk? Yes ( ) No ( )

If yes

explain.....

.....

17. How many fire alerts/drills have you been involved in?

.....

.....

18. About how many fire incidents have you experienced in this area for last 3 years (Say from 2004)

.....

.....

.....

a.) How was the fire extinguished?

.....

.....

.....

b.) What was the estimated loss?

.....

.....

c.)Was there any injury or death?

.....

.....

19. In your opinion what are the principle causes of the fire in this area?

.....

.....

.....

20. How do you rate the present Nairobi Fire Brigade in responding to fire outbreaks?

a.) Inadequate ( )

b.) Adequate. ( )

21. Give your suggestions on how to improve the delivery of fire services to people in your community by the Nairobi Fire Brigade.

.....

.....

.....

.....

Thank You

APPENDIX 2

Interview Guide for Fire Officers

My name is Anne Lily Wanjiru Kamau.I am carrying out a study on the challenges in Preventing and Fighting Structural fires in Nairobi's Informal Settlements. This is in Partial fulfillment of a Master of Arts (M.A) degree in Disaster Management at the University of Nairobi. I am kindly requesting you to assist by completing this questionnaire. Your cooperation will be highly appreciated. Any information given will be treated in confidence.

1. Do you inspect the plans for buildings to ensure that they comply with fire safety requirements?
2. What are these requirements?

   a.) .....

   b.) .....

   c.) .....

   d.) .....

3. Do you conduct regular inspection of buildings to ascertain their fire safety?

4. Are you legally empowered to enforce/compel building owners to ensure fire safety of a building?

5. How often are inspections carried out in a year?

6. Are fire drills compulsory? If yes state how they are conducted.

7. How many should ideally be conducted per year?

8. How many do you evaluate each year?

9. How cooperative are building owners in assisting you in your job?

10(a) From your Knowledge, does the Nairobi Fire Brigade charge fees for fire services?

Yes ( ) No ( )

(b) If yes, explain who is directly responsible in:

(i)Collection of Revenue

(ii)Management of Revenue

(c) If no, how are the services here serviced?

11. In the event that some are not able to afford how does the provider deal with them?

12. What are some of the complaints raised by the public concerning your services?

13. How has the Nairobi Fire Brigade management been effective in solving these complaints?

14. What are some of the strategies or preventive measures that have been put in place to help curb the rising cases of fire disasters in the informal settlements?

15. What are the specific problems that you face in enforcing fire safety regulations?

16. What other recommendations would you suggest that can improve the management of fire emergencies?

Thank You

APPENDIX 3

Interview Guide for Kenya Red Cross Society Disaster Preparedness and Response Officers

My name is Anne Lily Wanjiru Kamau.I am carrying out a study on the challenges in Preventing and Fighting Structural fires in Nairobi's Informal Settlements. This is in Partial fulfillment of a Master of Arts (M.A) degree in Disaster Management at the University of Nairobi. I am kindly requesting you to assist by completing this questionnaire. Your cooperation will be highly appreciated. Any information given will be treated in confidence.

1. Have you responded to any fire disasters in the informal settlements in the last three years? (Yes) (No)

   If yes how many?

3. How were these fires extinguished?

4. Was there any death or injury in any of those informal settlements?

5. What was the estimated loss?

6. How did you learn about the fire outbreak?

7. What do you suppose are the major causes of fires in the informal settlements?

8. What are some of the challenges you encounter when you are responding to fire disasters in the informal settlements?

9. What do you think should be done to help curb fire disasters in the informal settlements?

10. What arrangements does your organization have for promoting fire safety in the informal settlements?

Thank You