AN EVALUATION OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET, KAFANCHAN

BY

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DECLARATION

I declare that the work in the thesis entitled ‘AN EVALUATION OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET, KAFANCHAN’ has been performed by me in the Department ofArchitecture. The information derived from the literature has duly been acknowledged in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at any university.

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CERTIFICATION

This Thesis entitled 'AN EVALUATION OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET' by Daniel Shebanyan DUNIYA meets the regulations governing the awardof the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its'contribution to knowledge and literary presentation.

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ABSTRACT

The occurrence of disasters and emergencies has increased in frequency and intensity in the last decade, especially recent times. Rapid population growth, urbanization and social political issues compounded by ethnic plurality has been resulting in fierce competition for scarce resources leading to deteriorating livelihoods, social marginalization, crime and general insecurity. Traditional markets amongst others experience the manifestations of these which is revealed in the growing rate of fire outbreaks amongst other negative things.

Fire outbreaks in markets has led to a wanton loss of lives and properties worth billions of naira across Nigeria, this ugly sinister isn't mostly due to natural causes but man-made. Eventually Architects during the conceptual design stage had barely paid attention to prevention and control strategies that could minimize fire outbreaks and spread in cases of emergencies.

The aim of this study is to evaluate fire prevention and control strategies in the design of markets in Nigeria. For the evaluation of fire prevention and control strategies in markets case studies were conducted on some selected markets. Data was collected through interview and a checklist was designed and in each of the cases.

The results obtained from the cases studied showed that the markets are not properly zoned with regards to fire. Also, fire prone areas and the non-fire prone areas were not clearly defined and the devices and strategies provided are inadequate. Furthermore the research shows how fire could easily be spread through ducts and voids that have not been careful treated especially through roof spaces.

The findings were considered in the proposal of an ultra-modern market in Kafanchan, the design demonstrated key fire prevention and control strategies that could minimize fire spread and outbreak.

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ABBREVIATIONS AND DEFINITIONS

KASUPDA: Kaduna state urban planning development Authority

NBC: National building code

NEMA: National Emergency Management Agency

NFPA: National Fire Protection Association Standards:

FIRE COMPARTMENT: A subdivision of a building into an isolated unit surrounded by fire walls and floors to inhibit the spread of fire.

FIRE EXTINGUISHER: A portable apparatus for putting out a small fire.

FIRE GRADING: Fire rating, fire-resistance rating; a system of grading materials and components according to the results of laboratory tests carried out to ascertain their fire-resisting properties.

FIRE PREVENTION: Measures taken in a building to reduce the risk of outbreak of fire.

FIRE STOPPING: A thin strip of non-combustible material inserted into joints to prevent the spread of fire through gaps such as joints between components, and where pipes and cables pass through construction

FIRE WALL: A wall or partition in a building designed to prevent the spread of fire between compartments.

SMOKE VENT: An openable or fusible vent, window or hatch opened automatically, manually or by melting in the event of a building fire to allow the release of combustion fumes and smoke to the outside

1.0. CHAPTER ONE: INTRODUCTION

1.1. BACKGROUND OF STUDY

Indeed, the occurrence of disasters and emergencies in Nigeria has increased in frequency and intensity in the last decade and especially in recent times. Rapid population growth and urbanization and social political issues compounded by ethnic plurality has been resulting in fierce competition for scarce resources leading to deteriorating livelihoods, social marginalization, crime and general insecurity (NEMA, 2006).

Fire disasters particularly have become so incessant that they now occur on a daily basis, Even though the risk of fire outbreaks is higher during the dry season, it is very scary the number of fire incidents that has occurred in quick succession across the nation the statistics for the year ended 2012 coming from various states in the federation are equally frightening(Adamu, 2013). In Rivers State, for instance, the government has announced that 73 persons suffered different degrees of injuries and that no fewer than 230 persons lost their lives in 222 fire incidents in the state in 2012 alone(Ogunmosunle, 2013). Another statement from the Oyo State Fire Service Department indicated that about N1bn worth of property were destroyed and a total of 38 people were killed in 607 fire incidents last year. In just the first two weeks of 2013, the department has received 46 distress calls over fire disasters in different parts of the state in which three persons were killed (Ogunmosunle, 2013).

The occurrence of disasters and emergencies in the country has increased in both frequency and intensity due to increase in population. Most times market fire are attributed to shop-owners' carelessness in handling electrical appliances, faulty electric wiring and storage of inflammable substances in unsafe manners(Adamu, 2013). Billions of Naira and human lives have been lost to the inferno with most victims failing to recover financially and

physically afterwards. It is against this background that the NEMA conceived the idea of evolving an insurance scheme for both structures and the individual shops in those markets tagged Market Shop Owners Insurance Scheme in 2009. It worked out affordable insurance cover for patronage of shop owners with insurance firms so that in the event of major fire incidents, victims are guaranteed of immediate, adequate and satisfactory compensation to enable them recover quickly from their losses. It is common knowledge that the best firefighting technique is prevention and the best strategy for recovery is insurance cover.

The 'Not my portion or God forbid' syndrome has also been the bane of developing an attitudinal change framework for achieving a safer society in Nigeria (Shuaib, 2010). Some people, out of sheer ignorance, still harbour the cultural belief that to make provision for the prevention of hazards is to actually invite the occurrence of such misfortune. This is why many of our people do not subscribe to simple fire and safety tips that can keep disasters at bay (Shuaib, 2010).

The issue of safety which once occupied a major place in the programmes and plans of every level of government is now treated with levity. (MaC-Paul, 2013)Within the context of Nigerian laws on safety, the National Fire Safety Code, for instance, seems to have been neglected. The code is a set of rules guiding fire prevention and control in all public buildings in Nigeria. If Nigeria as a nation is desirous of halting the embarrassing trend of preventable fire incidents in the country, it is therefore imperative for the government to strengthen and strictly enforce all existing laws on safety with a view to achieving a safer society. Those who breach the laws must be punished accordingly (Ogunmosunle, 2013).

Kafanchan located at Jema'a local government area of Kaduna State is the third largest city after Zaria. It serves as a commercial call point to places like Kagoro, Madakiya, Zonkwa, Samarun Kataf amongst others. Kafanchan Since inception has never had a well-designed market(Archibong, 2010). Two delineated sites were allocated by the government of Kaduna state for the purpose of economic activities. One of the allocated sites is situated at the Funtswan chiefdom and the other at the very heart of the Jema'a Emirate. The site at the at the Jema'a emirate got fully developed due to the influx of people all round the city, the market developed with scattered temporal structure made of Aluminum and timber. This market was gutted by fire early 2011 (Abaje, 2010). Immediately after the 2011 presidential elections.

1.2. PROBLEM STATEMENT

A market anywhere is a place where buying and selling of goods and service occurs, it is usually a beehive of activities where a large number of people are participants in this activities. In Nigeria traditional markets is a call point for all and sundry for the purpose of business, the markets gives an opportunity for the buyer and seller to interact and bargain on the prices of the goods and services this is in contrast to the shopping mall/centres, super markets amongst others where the prices of goods and services are fixed with any opportunity for the participants in business to bargain. Due to the influx of large number of people as a result of population expansion the markets has become a haven characterised by so many vices amongst these vices are traffic congestion, improper waste disposal, chaotic circulation patterns, these factors combine to constitute considerable risk during fire outbreaks as a result of improper use of the facility.

Fire outbreaks in markets has led to a wanton loss of lives and properties worth billions of naira across the country, this ugly sinister isn't mostly due to natural cause but made. In this study various prevention and control strategies would be investigated and assessment to establish the extent of application, and thereafter a demonstration in the design of a multi-level market in Kafanchan.

1.3. AIM AND OBJECTIVES OF THE STUDY

The aim of this study is to evaluate fire prevention and control strategies in the design of markets in Nigeria. This would be achieved through the following objectives:

i. To identify the fire prevention and control strategies applicable to markets.

ii. To evaluate the extent, to which these strategies have been applied in selected markets in Nigeria, based on the existing standards of Nigeria.

iii. To demonstrate the outcome of the study in the design of market at Kafanchan.

1.4. RESEARCH QUESTIONS

i. What fire prevention and control strategies can be incorporated into markets design in Nigeria?

ii. To what extent has fire prevention and control strategies been applied to markets in Nigeria?

iii. How can the outcome of the study be demonstrated in the design of Market in Kafanchan.

1.5. SCOPE OF STUDY

This thesis dwells on evaluating fire prevention and control strategies in markets. It will further demonstrate how the various design parameters aid in adapting and applying fire

prevention and control strategies in markets design. The research will also cover all the necessary facilities that are related to a market, and also follow the current trends of designing a market.

1.6. JUSTIFICATION OF STUDY

Although there been a designated sites by the Government of Kaduna state for market in Kafanchan that is one at the heart of the Jema'a emirate. Ever since the discovery of Kafanchan there has never been a market designed and constructed to be used by the population of Kafanchan. Markets within that region just sprung up by chance, as a result of population expansion and the need for a conducive environment for commercial activities. The market in Kafanchan in Jema'a local government area of Kaduna was gutted by fire in early 2011. The cause of fire is widely attributed to human factors. The market was never designed, sprung up accidently. The aftermath of the event of the fire out-break was greeted by a decision by the state government of Kaduna to map out a new site for Kafanchan central market so as to cater for the business needs of the populace of Kafanchan and the surrounding environment.

2.0. CHAPTER TWO: LITERATURE REVIEW

2.1. NATURE AND CHARACTER OF FIRE

According to Raalte (2010),fire feeds on air, moisture, and earthy material; as a consequence, it cannot justly be called a ‘simple’ body, or a ‘first’ thing, or a principle. Four things must be present at the same time in order to produce fire:

a. Enough oxygen to sustain combustion,
b. Enough heat to raise the material to its ignition temperature,
c. Some sort of fuel or combustible material, and
d. The chemical, exothermic reaction that is fire

Taking any of these four things out of fire will result to fire been extinguished essentially, fire extinguishers put out fire by taking away one or more elements of the fire triangle/tetrahedron see (Figure 2.1). Fire safety, at its most basic, is based upon the principle of keeping fuel sources and ignition sources separate (Raalte, 2010). Fire is a rapid chemical reaction that releases great quantities of heat. This chemical reaction nearly always involves the oxidation of some fuel (the fuel reacts with). To initiate the chemical reaction an ignition source must heat the fuel to a temperature hot enough to sustain the reaction. The main products of the chemical reaction are smoke and heat. The heat generation would virtually always be sufficient to maintain the high temperatures of the fuel and the oxiditant, thus continuing the reaction (keeping the fire going). Flame is present in most fires and essentially a gaseous zone in which the oxidation of fuel occurs and from light is emitted.

Fuel is a generic term that refers to anything that can burn (for instance many gases, many liquids, paper, wood, cloth, plastics, adhesives, sealants and many other materials too

numerous to catalogue) Nearly always, fuel will be organic in nature: it would be composed of carbon atoms and atoms of other common elements such hydrogen, nitrogen, sulphur and the halogen group (Heerwagen, 2008).

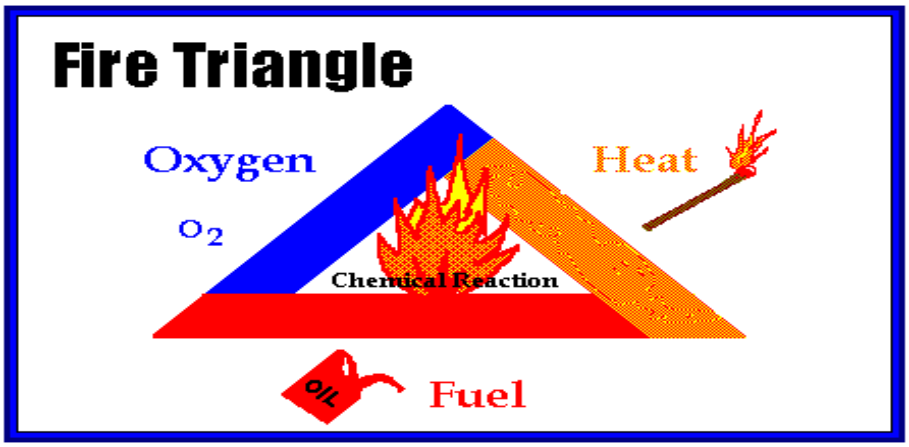


Figure 2.1: Fire triangle.
Source: Kramer (2013).

2.1.2. The combustion process

When self-sustaining combustion occurs, the heat produced would essentially create a feedback condition, which causes the released heat to induced further vaporization of a liquid fuel and/or the production of flammable gases from the solid materials. These vapors or gases then mix with oxygen and burn, spreading the fire beyond its point of origin. The combustion process would thus continue for as long as adequate fuel and oxidants are present and the heat of combustion is maintained.

However one or more of these actions can lead to the extinguishment of the fire. First the fuel is totally consumed by the fire, secondly the oxidant is totally consumed by the fire, and thirdly some means of heat generation by the fire is reduced sufficiently so that the temperature of the reaction falls below self-sustenance. Or fourth the combustion process is inhabited by the addition of some chemical or physical agent that reduces the reaction rate.

These four actions constitute the range for the principal solutions for fighting fire in any building (Heerwagen, 2008).

2.1.2. Phases of fire

According toHeerwagen (2008),there arevarious phases of fire which may not necessarily follow each other sequentially, but they include:

a. Initial or inpatients phase

This is where the temperatures are between 188.7^0C–377.4^0Cit is a phase during which fuel is being ignited by an ignition source. A result of the heated fuel would the production of flammable vapor that could burn in a future fire event. How long this phase could endure depends on a variety of factors for instance: the nature of the fuel- its chemical composition and physical form; the amount of fuel present in the space; the rate with which oxygen flows around the fuel; the speed with which heat from the potential igniter is applied to the fuel and the gaseous mixture of the fuel products and oxygen; the environmental conditions in the vicinity of this pre-combustion.

b. Free burning phase.

This where the temperatures is between 566^0C–1273.5^0C Flaming combustion results when the reaction between the fuel (in vaporous state) and oxygen releases enough heat so that a flame can be maintained. The combustion would be rapid and vigorous. unless confined by its enclosure or limited by the amount of fuel or oxidants, a flaming fire would spread readily to any adjacent unburnt material. Note the spreading action involves the continuing conversions of fuel into vaporous state (that can mix with the atmospheric oxygen). The temperature in the vicinity of the flames would increase as the combustion spreads outwards from its initial location.

c. Smoldering Phase

Fuels burns more slowly and less completely than when combustion with an observable flame occurs. Smoldering would usually happen at 538^0C to 816^0C usually results from smoldering combustion. Whereas temperatures of high as 482^0C are produced with flaming combustion. Smoldering is usually a limited form of combustion. It may lead to complete combustion-flaming-or not, depending on whether the heat generated by the reaction of fuel and oxidants (oxygen) increases sufficiently to sustain complete combustion.

2.1.3. Causes of fire

Heerwagen (2008),opined three main causes of fire, they include:

a. Art of God

This is fires caused due to providence for instance thunder and lighting.

b. Accidental origin

This type of fire maybe caused by faulty electrical appliances, electrical cables, and careless disposal of items that have fire for instance cigarettes among others.

c. Incendiary Origin

This may be due to bush fires, due to cause of irksome bush burning.

Adamu(2013) added;

d. Arson

This is the burning of a building or other property for a criminal or malicious reason.

2.1.4. Products of fire

The combustion of fuel in the presence of oxygen produces smoke and heat(Heerwagen 2008). The levels of heat production are substantial and, when fire events are not

constrained by automatic or human intervention, combustion occurring in an enclosure will produce to flash over. Both smoldering and flame combustion often will yield copious amounts of smoke, thus causing difficulty for occupants as they evacuate the fire ridden building. For those occupants who are unable to escape the fire, the likely results would be injury or even death.

Smoke is a combination of hot gases, particulate matter, aerosols, all of which are produced by the combustion of fuel. The hot gases results from the decomposition of the fuel as it oxidizes. As combustion is rarely complete, unburned or partially burned particles fuel would become suspended in these gases. Similarly fine droplets of liquids, aerosols-will enter into the smoke. The heat energy entrained in the smoke causes it to roil and expand outwardly. If the smoke is not enclosed, it would rise upwards into the sky. if the smoke is enclosed with a building then it would expand to fill the space. For occupants still present in the smoke filled space, the smoke would irritate the eyes and obscure vision because of the suspended particles of matter and aerosols, both of which restrict light transmission through the smoke. The smoke would make breathing difficult, as it affects the lining of the respiratory track and lungs. And, most seriously, the smoke would induce narcosis, in which, first, muscle coordination and ordinary mental function will begin to fail and, soon after, unconsciousness will occur. If an occupant continues to stay in the smoke filled space- the occupant is rendered unable to leave- loss of consciousness -then death would be eminent.

2.2. PARAMETERS FOR FIRE SPREAD

According to Carlsson (1999) the spread of fire from a burning building to an adjoining building can occur in a number of different ways. It has been found that some ways, or a combination of ways, are more common and often more hazardous than others.

2.2.1. Flying brands

Ignition of combustible materials may occur due to flying brands emitted from a building on fire. These brands may travel far distances and protection against this is possible by fitting external surfaces with appropriate fire resistant claddings. Flying brands do not represent a significant hazard by itself with respect to ignition of buildings. They may though act as an igniting source together with radiation, where the volatiles given off by the radiation exposed material may ignite.

2.2.2. Flame contact

It is possible that projected flames from an opening may impinge onto an adjoining building and cause ignition. The projection distance for instance the horizontal extension of the flame from the facade, and the flame length for instance the vertical extension of the flame, are dependent on many factors including geometry and size of the opening as well as wind conditions and mass burning rate.

2.2.3. Convective heat transfer

Convective heat transfer may also result in the ignition of an adjoining building, given that the stream of hot gases hitting the building can be several hundreds of degrees Centigrade. In order for ignition to occur by this phenomenon, the exposed building has to be very close to the fire source.

2.2.4. Radiative heat transfer

Ignition due to radiation is the most common way for fire to spread between buildings and can happen at much greater distances than by direct flame contact and convection. Typical values of radiation where ignition of wood may occur is 33.5 kW/m2 for spontaneous ignition, i.e. ignition in absence of an ignition source, and 12.5 kW/m2 for piloted ignition that is, ignition in presence of an ignition source such as a spark or a brand (Barnett 1988).These values are widely used throughout the world.

2.3. FIRE SAFETY REQUIREMENT

Prazeres(2013) asserts the requirements for fire safety, they include:

1. Provide access and means of egress.
2. Fire detecting operations
3. Limit internal fire spread (linings)
4. Limit internal fire spread (structure)
5. Limit external fire spread

2.3.1. Provide access and means of egress.

Access is classified users:

a. Building users

b. Fire fighters

2.3.1.1. Building users

Building should be designed and constructed so that there are means of escape from the building, accessible to the building users, in case of fire to a place of safety outside the building. The main danger to people in buildings, in early stages of a fire, is the smoke and

noxious gases produced which cause most of the casualties and may also obscure the way to escape routes and exits. The regulations are concerned to:

a. Provide a sufficient number and capacity of escape routes to a place of safety.
b. Protect escape routes from the effects of fire by enclosure, where necessary, and to limit the ingress of smoke.
c. Ensure the escape routes are adequately lit and exits suitably indicated.

The general principle of means of escape is that any person in a building confronted by an outbreak of fire can turn away from it and make a safe escape. The number of escape routes depends on the number of occupants in the room or storey, and the limits on travel distance to the nearest exit depend on the type of occupancy. Where there are more than 50 person one escape routes is acceptable(Neufert and Neufert 2000).

2.3.1.2. Fire fighters

Access is very vital in fire safety this should serve both firefighters and users trapped during emergencies. Access should be designed to accommodate the vehicles and others gadgets of fire firefighters. During fire emergencies means of egress for evacuation is key

Bukowski (2011) asserts that the primary strategy for the safety of building occupants in emergencies (especially fires) is by facilitating their relocation to a safe place. In other than a few institutional occupancies this generally involves the use of stairs as part of a protected means of egress for vertical evacuation. For tall buildings with large populations, providing sufficient stair capacity for simultaneous egress has been considered impractical by code making organizations, so the strategy of phased evacuation has been employed.Components of means of egress include:

A means of egress consists of the following:

a. An exit access (normally a common use corridor leading to the exit), the exit itself (normally a stair), and

b. An exit discharge (normally a door to the outside or into a protected corridor leading to the outside).

c. Egress stairs may incorporate areas of rescue assistance which are part of enlarged landings providing space for people (especially with disabilities) to move out of the flow to rest or await assistance.

d. Egress stairs may also incorporate transfer corridors that are used to shift the vertical alignment of the stair horizontally, to go around equipment or to maintain minimum required stair separation at floors where the building floor area changes (Neufert and Neufert, 2000).

Components of means of egress

Bukowski(2011) gives the following means of egress:

1) Stairs

2) Core arrangement

3) Occupant egress elevators

4) Fire service access elevators

2.3.1.3. Stairs

Stairs are the primary means of vertical travel during fire emergencies and are generally effective and reliable, but with several significant shortcomings. Most building regulations require at least two independent stairs so that a single event cannot block access to both. This independence comes from the location of the stairs remote from each other. In some

locations scissor stairs (two, intertwined stairs in a common shaft) are popular since they minimize the building space required. The disadvantage is that they are not remote and can both be easily compromised by openings in the separating partition. However, when counted as a single stair they provide additional stair capacity in a better configuration than a single, wider stair since there is better access to handrails as people descend. Another shortcoming of stairs in high rise buildings is that standard firefighting procedures involve the designation of one of the stairs as the attack stair, in which the fire hose is extended to permit its advance onto the fire floor.

2.3.1.4. Core arrangement

Most tall buildings are designed with a core area which contains the elevators, stairs, and shafts in which the utilities run vertically through the building. The core usually serves as the building's spine and often plays a significant role in the structural system. Because the core is most often infrastructure and common use space it is less likely to generate revenue for the owner. The designers spend a great effort to "optimize" the core design, meaning to make it as small as possible, maximizing the revenue producing space on each floor. The exit access is generally arranged just outside and surrounding the core, with the stairway doors facing outward and cross corridors providing access to elevator lobbies.

2.3.1.5. Occupant egress elevators

Elevators are the normal means of vertical transport in any building taller than a few stories. However during fires, the safety of elevators can be affected by the fire itself and by water from sprinklers and fire hoses, so the policy worldwide is not to use elevators during fires. Elevators are also taken out of service during earthquakes when the lateral acceleration exceeds a level that might compromise further safe operation.

2.3.1.6. Fire service access elevators

While fire service access elevators are not a part of the means of egress they do have a significant impact on occupant egress in tall buildings. For any building of sufficient height that egress has not completed before the fire service begins to move into position to begin operations, there is a conflict between occupants leaving and firefighters entering resulting from counter flow in the stairs.

2.3.2. Fire detecting operations

Detection systems are placed within a building to sense the presence of some fire products. Once a detector has sensed that fire event is occurring, then the detector will furnish a signal to an alarm device or system, or the detector will emit an aural or visual signal directly to occupants see (Plate 2.2). Thus, the detector may have an alarm capacity as a component, or the detector may be connected electronically to an alarm device or system.



Figure 2.2: Showing fire alarms. A B
Source: Kramer (2013).

2.3.2.1. Types of fire detectors

There two main types of fire detector, they include:

a) Automatic detector

The automatic system operate continuously without human intervention

b) Manual detector

The manual detector works with human intervention, any of the three products of fire could be detected (smoke, heat convected from fire and heat radiated by fire). Essentially the detectors are programmed when some increment of temperature increase per unit time occurs in the vicinity of a detector. Heat detector more commonly used sense either that some elevated air temperature has been reached in a building space or that some incremental increase in the air temperature per unit time has occurred. Thus a fusible -link sprinkler head is basically a heat detector.

2.3.2.2. Smoke Detector and Operation

Smoke detectors on the other hand sense the presence of suspended particulate matter aerosols in the hot gases emitted by a fire.

2.3.2.3. Types of smoke Detector

The two most common smoke detectors are:

a. The ionization chamber

The ionization chamber operates by using a small bit of radioactive material to ionize air molecules in close proximity to the chamber thus making the air electrically conducive. When the smoke particles enters the air space between the air space it disrupts the conductivity of air, and the current flow between the electrodes is inhibited causing the detector to emit a signal see (Figure 2.3).

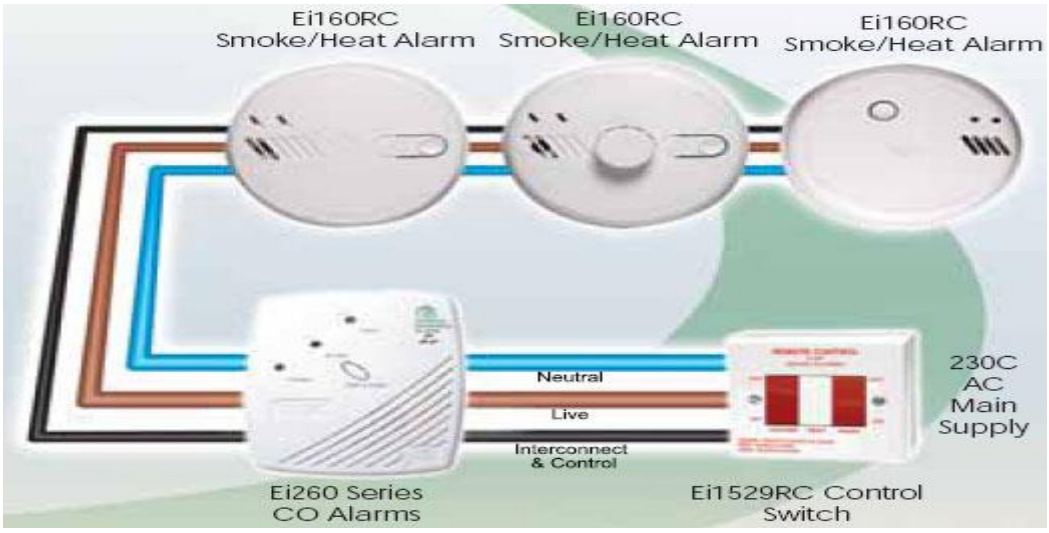


Figure 2.3: Showing the ionization chamber.
Source: Source: Kramer (2013).

b. The photoelectric sensor.

In the photoelectric sensor the beam of light shines across an air space into a photoreceptor. When particles or aerosols impede the light gathering by the receptor, the detector emits a signal (Figure 2.3).

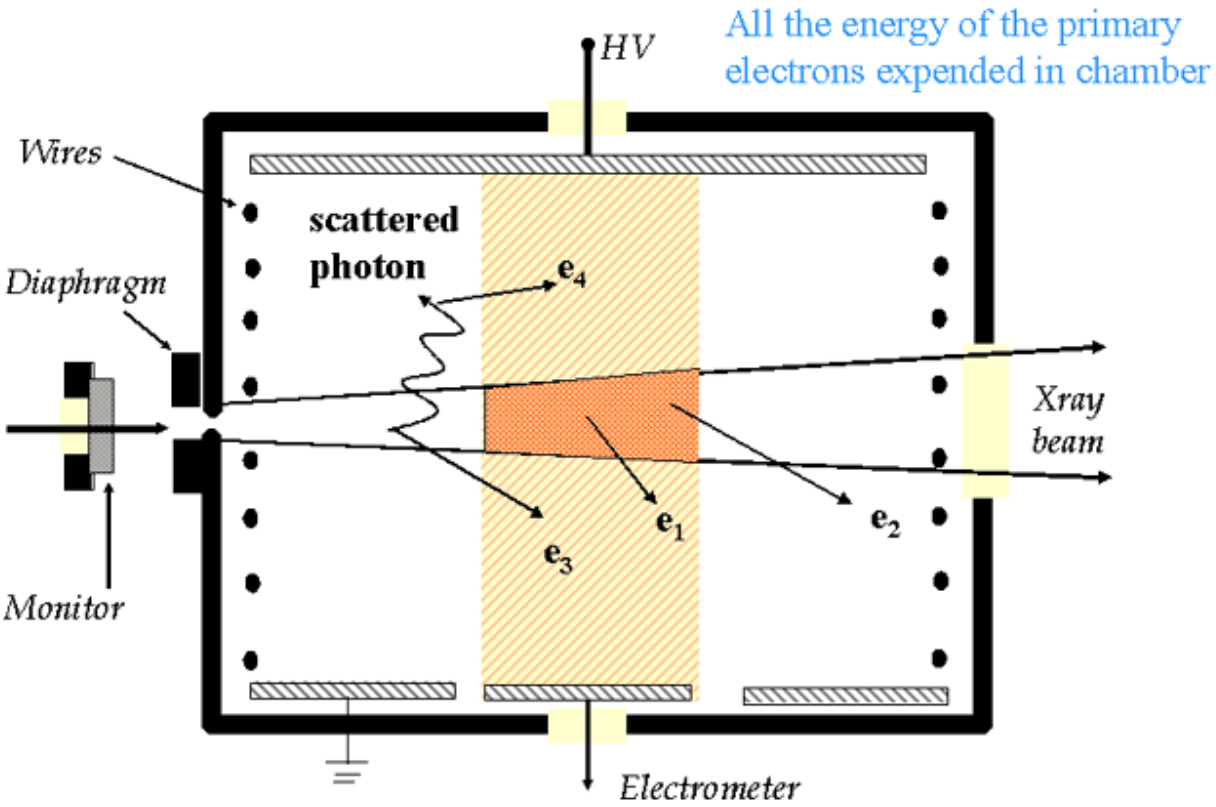


Figure 2.4: Showing the photoelectric sensor.
Source:Kramer (2013).

2.3.2.4. Smoke and venting system

Neufert and Neufert (2000) noted that smoke and venting system comprise one or more of the following element, together with the associated activation and control devices, power supplies and accessories:

a. smoke vents

b. heat vents

c. Mechanical smoke extractors.

Given that they have the task of removing smoke and heat in the event of fire, these contribute to:

a. preventing escape and access routes

b. facilitating of the firefighters

c. The prevention of flash-over, hence retarding or avoiding a full fire.

d. the protection of equipment

e. The reduction of fire damage caused by burning gases and hot ash.

f. Reducing the risk of fire encroaching on structural elements.

The main function of the smoke venting is to promote and maintain smoke free zones in which people and animals can escape from fire. These zones also ensure firefighters are unimpeded by smoke when tackling the fire and give the contents better protection from damage. In addition, smoke vents also contribute to heat venting. The task of heat vent is to conduct away hot burning gases during the development of fire.

The working principle of smoke venting systems lies in the property of hot gases to rise. The Effectiveness of the system depends on:

a. The aerodynamics efficiency of the air venting

b. the effect of wind

c. the size of the air vents

d. the activation of air vents

e. The location of the installation relative to the general arrangement and size of the building.

2.3.3. Limit internal fire spread (structure)

Barley (2000) defines as light transparent components that can be arranged vertically, horizontally or be inclined. They are suitable as fire protection glazing to impede the propagation of fire and smoke according to their resistance period. They do not however, prevent the passage of radiant heat. This type of glazing remains transparent in the event of

fire and it is as effective as glass for fire protection.Building should be designed and constructed so that:

1. Internal firefighting facilities are easily accessible
2. Access to the building is simple
3. Vehicular access is straightforward
4. The provision of fire mains is adequate.

2.3.4. Internal fire spread (linings)

According toCarlsson (1999),fire spreads internally within the linings between build through the following ways:

2.3.4.1. Compartments

To prevent the spread of fire which could trap occupants, and to reduce the chances of fires growing large, it is necessary to sub-divide building into compartments separated by walls and or floors of fire resisting construction. The degree of subdivision into compartments depends on:

a. The use of fire load (contents) of the building
b. The height of the floor of the top storey as a measure of ease of escape and the ability of fire services to be effective
c. The availability of sprinkler systems to be effective which can slow the rate of growth of fire.

2.3.4.2. Concealed spaces

Construction of building component aid in concealing of space against fire spread, door, wall to wall, floor to floor connections for instance should be air tight. As in the case of doors shutters are more appropriate.

(Neufert and Neufert 2000) opines fire protection closures are units comprising:

a. a door, or doors, with associated frames and fixing for the frame.
b. a self-closing device (either a flat spring or door closer with hydraulic damping)
c. a closing sequence regulator (on double doors)
d. Relevant mechanisms required if sliding, roller or vertical lift doors are fitted.
e. a door lock
f. A locking system with release device for closures which, during normal usage, must be held open and closed only in the event of fire.

If a fire takes hold, considerable distortion can occur between the wall and the door, fire protection doors should therefore be considered in conjunction with the method of construction of the wall, to ensure that the combination is effective and permissible.

Smoke and flame may spread through concealed spaces, such as voids above suspended ceilings, roof spaces and enclosed ducts and wall cavities in the construction of a building. To restrict the unseen spread of smoke through such spaces, cavity barriers and stops should be fixed as a tight fitting barrier to the spread of smoke and flames.

2.3.5. Internal fire spread (structure)

As a measure of ability to withstand the effects of fire, the elements of a structure are given notional fire resistance times, in minutes, based on tests. (Neufert and Neufert 2000) opines the typical maximum height is 3.50metres, with a maximum individual pane size of

1.20metres X 2.00metres. There is also the possibility of replacing individual panes of glass with non-loading bearing panels. Elements are tested for the ability to withstand the effect of fire in relation to:

a. Resistance to collapse (load bearing capacity) which applies to loading elements.
b. Resistance to fire penetration (integrity) which applies to fire separating elements.
c. Resistance to the transfer of excessive heat (insulation) which applies to fire separating elements.

2.3.5.1. Fire resistance of steel elements

Neufert and Neufert (2000) opine fire resistance duration of structural steel elements for a prescribed level of fire intensity is dependent on the rate of heat increase and the respective critical temperature of the element.

Urban markets in Nigeria have been characterized with incessant fire out break because of Their crowded nature and the types of building materials used mostly made up of timber And corrugated iron sheets, thus making them more susceptible to fire disaster(Musa, 2007).This problem of fire disaster usually resulted in indelible loss of wealth and properties which need to be addressed through the use of high quality, durable and fire resistance materials as opined by Johnson (1970) in Musa(2007) “it is not the presence of any market system that matters but the structures and function of the system” therefore the overall performance of a market as an efficient and viable socio-economic institution depends on its physical setting which in turns determines the relationship between the various components that do exist therefore, for a market to be effective it must have qualitative structures.

2.3.6. External fire spread

To limit the spread of fire within buildings, limits the to the size of “unprotected areas” of walls and also finishes to roofs, close to boundaries. Fire may spread within a building over the surface of materials covering walls and ceiling. Materials that encourage the spread of fire are discouraged. Limits are set on the use of thermoplastic materials used in roof lights and lighting diffusers.

2.4. FIRE SUPPRESSION MECHANISM

Supression mechanism are triggered into action after detection by the detection opertors in place. Raalte (2010) gives the wet and dry sprinkler systems as the major supression mechanisms.

Wet systems are the simplest and most common type of sprinkler system installation, with relatively few components. The system provides fixed fire protection using piping filled with pressurized water supplied from a dependable source at all times. Water is continually discharged through sprinklers that have activated over or near the fire, thereby minimizing water damage. Closed heat-sensitive automatic sprinklers spaced and located in accordance with recognized installation standards are used to detect fire see (Figure 2.5). upon operation, the sprinklers distribute the water over a specific area to control or extinguish the fire (Vikings, 2008).

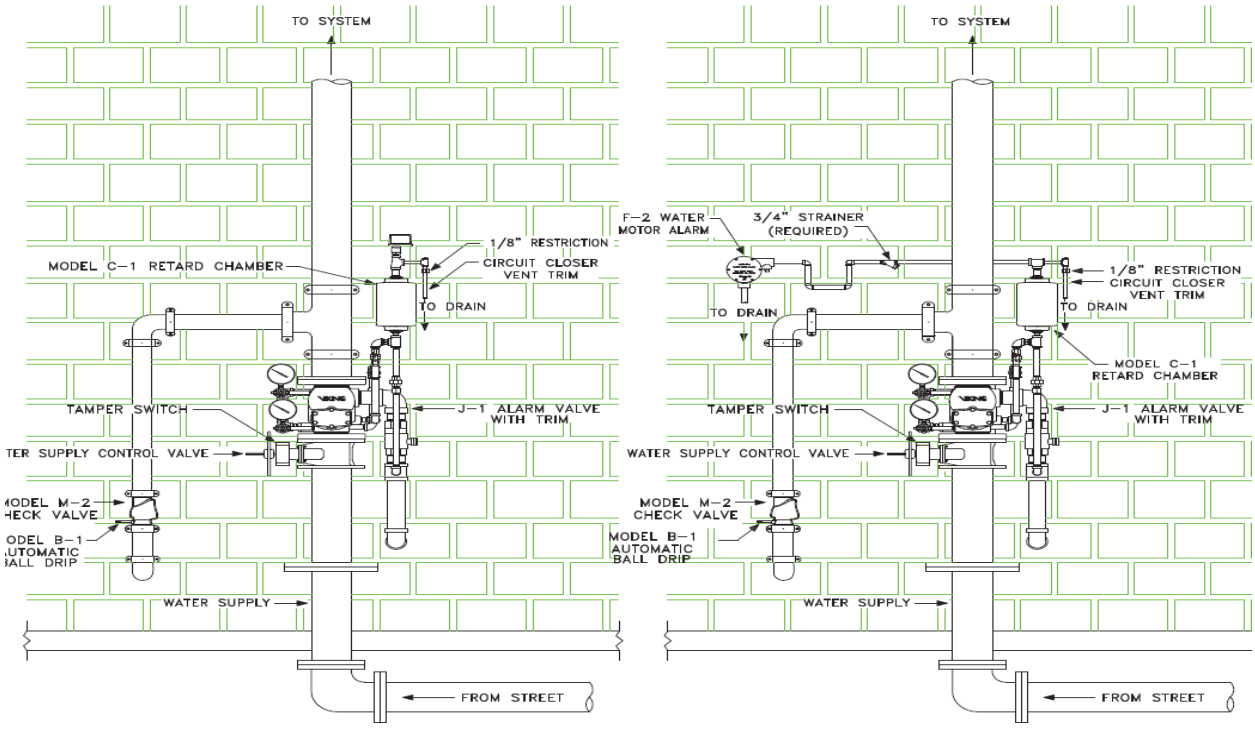


Figure 2.5: Wet sprinker system with arrow indicating water flow.
Source: Vikings (2008).



Plate 2. 1: Three dry pipes on a common header.
Source: Beattie (2012).

2.4.1. Mechanical smoke extractors

Neufert and Neufert (2000) asserts that mechanical extractors perform the same function as smoke vents but used forced ventilation for instance fan to achieve the extraction of smoke. Barry (2004) agrees these smoke are particularly useful where smoke vents or mechanical smoke extractors can, in principle, be used in place of heat vents. Mechanical smoke extractor's should be provided:

a. for single storey building with large areas and volumes
b. For buildings with long escape routes which cannot be kept smoke free for a sufficient period by other means.
c. For building subject to particular regulations, in which special protection is necessary.

d. For housing particularly valuable articles or equipment's, or materials that are susceptible to smoke damage and therefore require extra protection.

2.5. MARKET THEORIES

A Market is any established operating means or exchange for business dealings between buyers and sellers(Encarta, 2009). As opposed to simple selling, a market implies trade that is transacted with some regularity and regulation, and in which a certain amount of competition is involved

The earliest markets in history conducted bartering. After the introduction of money, commercial codes were developed that ultimately led to modern national and international enterprise(Encarta, 2009). As production expanded and became less practical, communications and so-called middlemen came to play an ever growing role in markets. Types of markets include retail, wholesale or distributors', producers', raw material, and stock(Encarta, 2009).

Hodder and Ukwu (1969) inCaleb (2010), defined market as an institutionalised activities occurring at a definite place and involving the meeting of people there at a particular time. Here, the institutionalised activities referred to buying and selling as well as various social, political and economic activities in which the people of a place indulge.

Mabogunje (1964) in Abdulwahab(2010) also defined market from a geographical point of view by referring to market as towns where transactions are carried on in delineated areas occupied periodically by buyers and vendors of retail goods. Here, he tried as much as possible to identify a defined space for occasional buy and selling.

From the economic point of view Chapin (1972) in Musa(2007) asserts markets does not necessarily mean to be a place where buying and selling is done but any point where there

is interaction of demand and supply. What the economics tries to say here is that, buying and selling can take many forms, which include telephone and post.

It is significant that much of the contemporary of interest in markets as plan comes from those social scientists who are primarily concerned with central place studies. At first sight and especially in the light of a frequent lack of corresponding sight, and especially in the light of a frequent lack of correspondence between rural periodic markets and the location size, and hierarchy of settlements, it might seem that central place models or theories have little relevance to market place studies today. One cannot ignore the growing volume of material on markets and central place theory from (china Skunmar, 1969) in (Caleb, 2010). While in Yoruba land and Ibo land Hodder and Ukwu (1969) in Musa(2007) Moreover, as The periodic central -place is a wholly valid concept within the context of modern central place theory.

Gibberd (1959) in Caleb(2010), defines the market as the oldest form of shopping, consist of series of stalls or booth range in row in an open or sometimes a covered space around which the public can circulate, goods are mostly convenience goods and they are arranged in stalls or even on the ground which performs the function of the display window. There is no separation between the shopper and the merchandise so that the former fingers the goods. Sometimes without purposing and bargain the price.

A lively jostle crowd of people characterise the market. The usual arrangement of stalls is to place their end on or in parallel rows. Although circulation is in theory a lineal one, frequent spaces are arranged between the rows so that the shopper can out cross from row to row thereby setting up gyrator movement.

A study(Odeleye (1963) in Musa(2007), was based on markets in Lagos Island, which in all the markets there is none that is worth the name. In addition no one is up to date in the

social and hygienic standard. The word Squalor was used to describe them. His statement still stands, in the sense that the area is now been over populated resulting in congestion and rowdiness of the market.

2.5.1.1. The Functional Role of the Market

Market may be one of the general urban social services whose provision is within the scope of urban management considering the numerous functions it perform in the socio-economic development of towns include:

i. Attracting new investment

ii. Raising production

iii. Increasing income per capita

iv. Creating employment opportunities

v. Increasing living standard of people

vi. Serves as a sources of revenue generation

vii. Boosting image of towns through their pulling effect of people from different parts of the country.

As Johnson (1970) in Musa(2007) argues that any government, be it military, sacerdotal, juridical or democratic will require some economic mechanism for its operation. Today this is found in commercial center's (markets) which serve as magnets for development. But to achieve a functional market there are certain key urban management considerations that need to be put in place, such as:

a. Feasibility of the place as a market i.e. the area must satisfy principles of location.

b. It should be adequate in size.

c. It should be economical to develop i.e. cost effective.

d. It should be accessible.

e. It should be in close proximity to residential and other work areas.

f. It should conform to the surrounding land use.

g. It should have a threshold population to support its operation.

Also the process of market development should be transparent, less bureaucratic and participatory by involving all the relevant stake holders.

2.4.1. Market studies in Nigeria

In order to solve the problem (Odeleye (1963) in Musa(2007),proposeddust bins all over the section of the market. He tried as much as possible to separate the pedestrian and the vehicular traffic by the provision of tool bridge across busy roads. Shoppers were protected from sun and tropical rain by a special design roof covering the whole site with roof lighting design for natural lighting.

Arinze (1976) in Musa(2007), in the study of markets centre in Zaria urban area, identified the hierarchies of the markets and shopping centers in Zaria and their spatial distribution as the problem associated with markets, A proposal for integration of markets and shopping centers, according to her will be a time saving device for shoppers, who commute over space from a shopping centre to a market.

Modi (1999) studied the problem of fire in Kaduna central market.He conceived the solution to the menace of fire in markets in two perspectives; structural and the use of fire detection suppression method.

From the previous studies in Market it is apparent that all the problems tackle are right and have been worrisome issues regarding markets

2.4.2. History and evolution of markets

An account of the history of markets as given by Modi (1999),markets can be traced back from the pre-historic age, when the methods of land cultivation came into existence. This development further led and gave birth to subsistence societies as people came together to live in cluster groups in search of better means of communication and defense against animals, wild man and safe-keeping for their farm produce. People give in exchange according to their needs ina system is called the barter. Communal societies evolved as a result of different subsistent societies merge and interacted to develop and progress. The surplus production of the societies led to increase in level of trading activities and therefore, the beginning of the market. The barter system strengthens until the advent of money as a means of exchange.

Markets have existed in one form or the other as areas in which trading activities were exercised and known as 'Agora' in Greece, and 'Bazaar' in Middle East.

In west Africa, the first market started by the craftsmen, these produced and sold their wares in their homes, by the 10th century. A new breed of enterprising merchants emerges. Their interest was that instead of selling their produce at home individually, they decided to find a large area, which could accommodate their wares.

2.5. Classification of markets

Nkwogu (1988) in Musa (2007), gives three main classifications of markets are group in these classifications are:

1 Functional classification

2Periodic classification

3 Time of operation

2.5.2. Functional classification

Markets are here classified by the function they perform in the distributional chain. Vagale (1974) in Caleb (2010), however identified four functions in Nigeria:

2.5.3. Feeder markets

These types of markets exist in rural areas; they are small periodic markets that supply urban traders with goods for in bigger in urban centers. They act as feeder markets to the bigger markets.

2.5.3.1. Bulking centres (markets)

These markets are where products from various smaller markets recollected and assembled into large quantity for onward transportation to the urban retail or whole market. For instance the Ode-Oba market in Oyo state.

2.5.3.2. Urban whole sale market

This is an intermediary market between the bulking centers and the urban retailers. The products from the bulking markets are broken into smaller components and are distributed to retailers. For instance the Owode market Offa.

2.5.3.3. Urban retail market

Johnson (1975) in Abdulwahab (2010) added that these are consumer markets where households get their daily needs. In these markets, goods are also broken into smaller consumable units for sale.

2.5.4. Periodic classification

Most African towns and societies are not self-sufficient, because they specialized in the production of one thing or the other, thus there is the need for periodic meetings of these towns for the exchange of their various commodities.

Mobogunje(1986) in Musa(2007) classified periodic markets into two

2.5.4.1. Provincial periodic market

The provincial periodic markets are held every fourth day and attended by people living not too far from the market place. This type of market is normally found in small towns and villages and sometimes in urban centers too.

2.5.4.2. Inter-kingdom periodic market

The inter-kingdom periodic markets are held at intervals of eight to sixteen days, and often attract buyers and sellers from far and distances ranging from 50km and above.

However in periodic markets, various types of goods ranging from stuffs, clothes and house hold goods as well as imported materials are sold, they also there are other markets that operates daily.

2.5.5. Time of operation

The operation of markets has taken various forms in the past years. The time of operation varies from one market to another; most of these markets are identified based on the time within which they are operated and on the type of goods sold in them.

2.5.5.1. Morning markets

Morning markets are usually found in the northern Nigeria, situated very close to the traditional defense wall around the town. The operation time is between 6.00am and 12.00 noon daily.

2.5.5.2. Day markets

Day markets on other hand are found in most Nigerian towns. They are more organized and usually operated between 8.00am and 6.00pm daily. Intensive retailing of agricultural goods as well as manufactured goods characterized the activities in this type of market.

2.5.5.3. Day and night

Day and night have been identified in some parts of the country, especially in Ibadan. The time of operation of this market is between 8.am and 9pm. Intensive retailing of agriculture and non-agricultural goods characterized this type of market.

2.5.5.4. Night

Night markets in Nigeria dated back as far as 1825, when Clapperton identified seven Night in katunga (old Oyo empire). The market usually commence around 5pm and ends 11pm daily. The type of commodity sold here calls for the old time of operation. The various commodities sold include, perishable goods such as: Vegetables, meats, fish, cow geese and various cooked items. These types of market are usually located in close contact with the king's palace, thus making it easily accessible to young men and women, meeting for other reasons other than economic. Mabogunje(1964) in Musa(2007), further asserts various other functions such as political and social function are performed in the night market.

2.6. GENERAL PLANNING CONCEPT

De Chira(2004)presents some of the basic planning concepts used in the layout of different markets. They are analyzed with their merits and demerits as follows:

2.6.1. Centralized delivery with one way traffic

i. There is proper separation between light and heavy traffic

ii. There is no proper separation between vehicular and pedestrian traffic.

iii. Pedestrian bridge required.

iv. Better goods delivery and safety

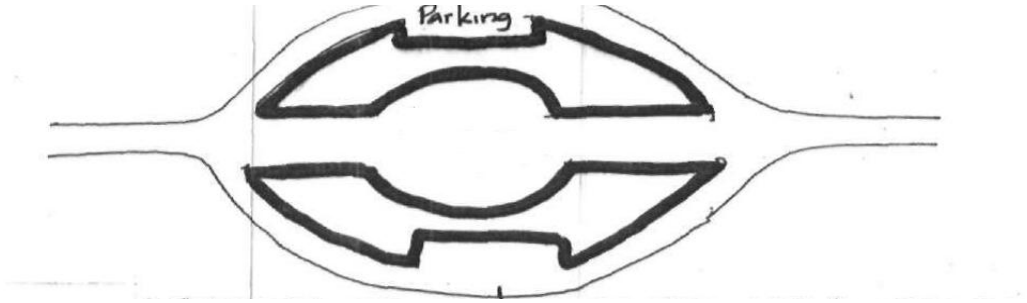


Figure 2.6: Centralized delivery with one way traffic.
Source: Based on (Musa, 2007).

2.6.2. Central precinct with peripheral parking

i. Enough parking spaces but not well defined.

ii. Enormous traffic congestion

iii. No proper separation between various traffic

iv. Foot bridge required

v. Good for highly populated centers

vi. No room for horizontal spreading of centres.

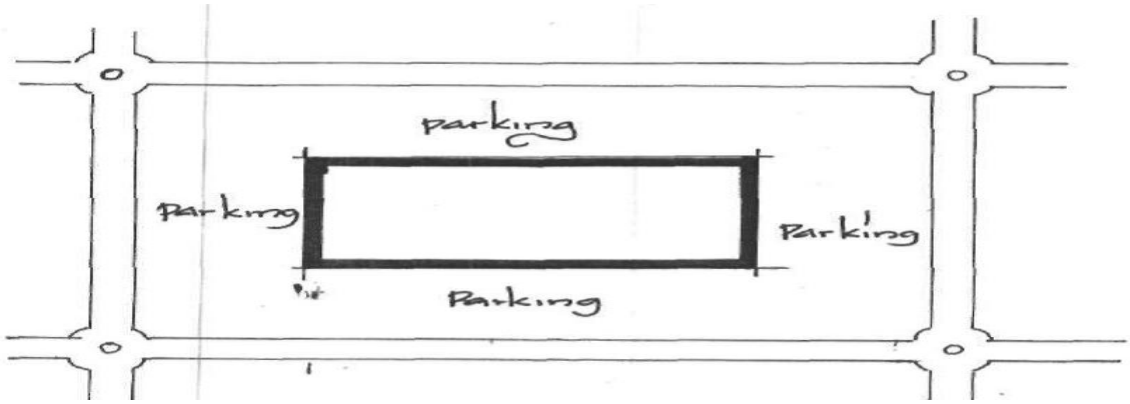


Figure 2.7: Central precinct with peripheral parking.
Source: Based on (Musa, 2007).

2.6.3. Centre with central parking junction

This characterized by:

i. Roadside parking which may result to congestion.

ii. Lack of proper separation between the various traffic.

iii. Pedestrian movement unsafe.

iv. Easy access to service trucks.

v. Site attractiveness is marred with traffic chaos.

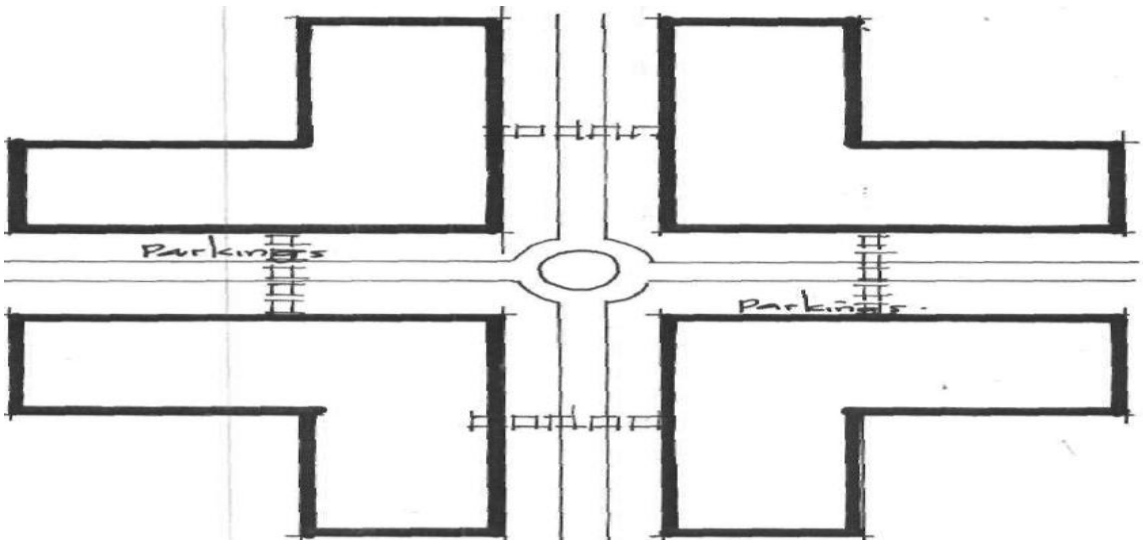


Figure 2. 8: Centre with central parking junction.
Source: Based on (Musa, 2007).

2.6.4. Pedestrain princt with parking enclosed by a ring road

i. Proper separation between pedestrain vehicular traffic.

ii. Vertical expansion of building possible.

iii. No proper separation between light and heavy traffic.

iv. Ttraffic problems at junctions.

v. Limits acessibility to service trucks.

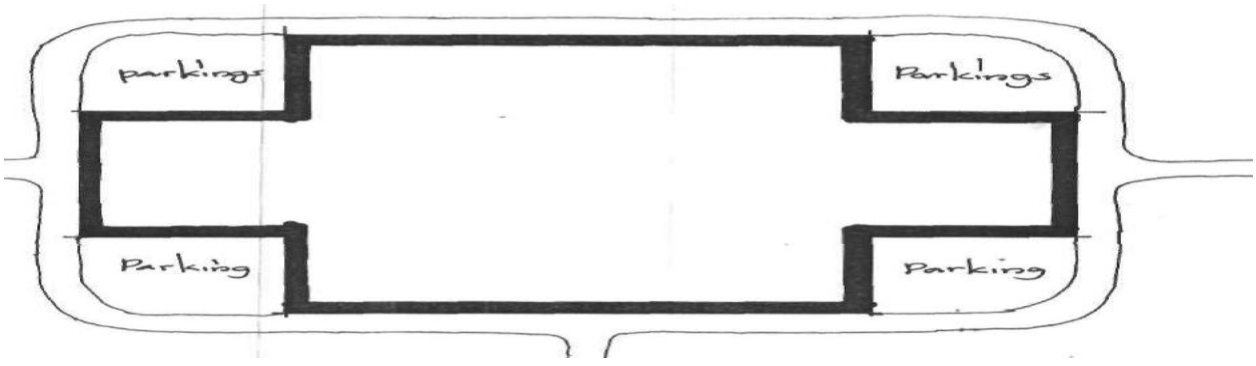


Figure 2 9: Pedestrain princt with parking enclosed by a ring road.
Source: Based on (Musa, 2007).

2.6.5. Pedestrian precinct interlaced by vehicular route

i. Traffic chaos at the various junctions

ii. Pedestrian circulation is very bad.

iii. Poor access for service trucks.

iv. The concept is usually good for low rising centres.

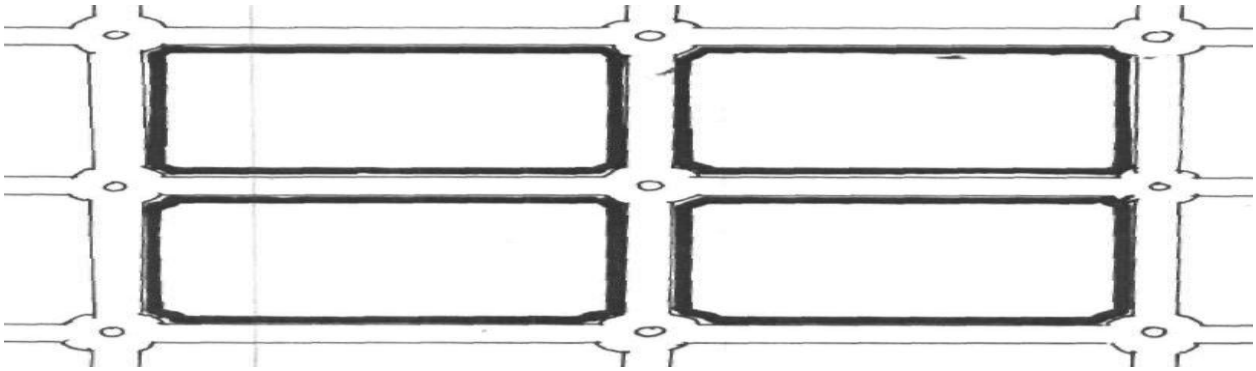


Figure 2 .10: Pedestrian precinct interlaced by vehicular route.
Source: Based on (Musa, 2007).

2.6.6. Pedestrain precinct with enclosed parking

i. A very practical concept.

ii. Easy access to service trucks.

iii. Sound car access to the building.

iv. Too many access points.

v. Good for low rising commercial centres.

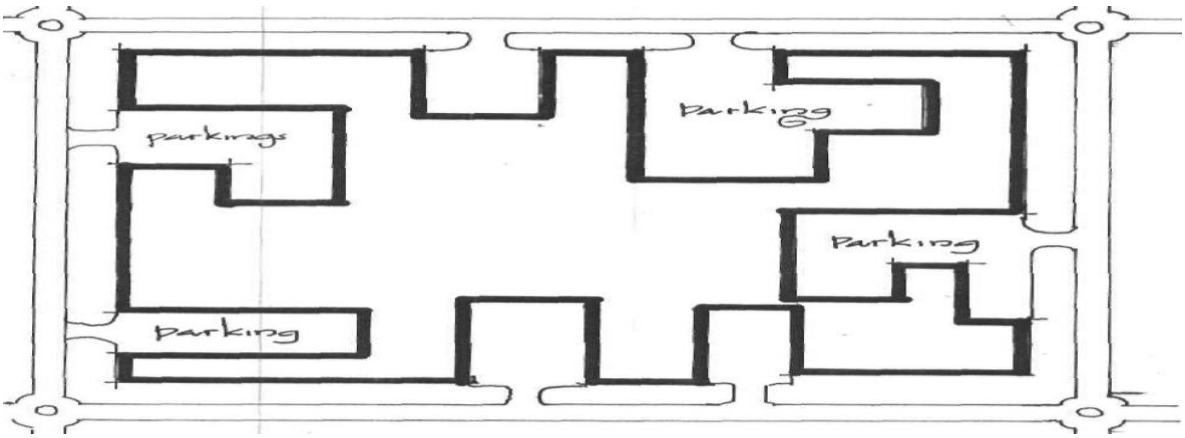


Figure 2 11: Pedestrain precinct with enclosed parking.
Source: Based on (Musa, 2007).

2.6.7. Pedestrianised centres with end parking's

Here the pedestrian precinct is bounded on two ends by parking; this however is characterised by:

i. Possible expansion on the other two ends.

ii. Proper separation of vehicular and pedestrian traffic.

iii. Proper separation of light and heavy traffic.

iv. Problem of servicing the core areas with goods.

v. The concept is suitable for compact, high rise centres.

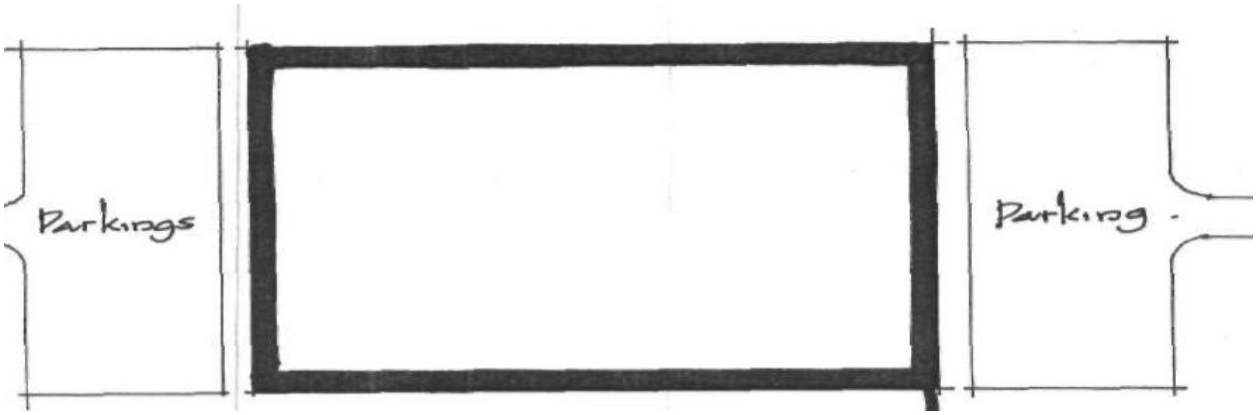


Figure 2 12: Pedestrianized centres with end parking's.
Source: Based on (Musa, 2007).

2.6.8. Precinct with central parking

i. Lack of unity in planning.

ii. Lack of separation between between light and heavy traffic.

iii. Lack of proper separation between vehicular and pedestrain circulation.

iv. Possible central congestion and rowdiness.

v. Less traffic junctions.

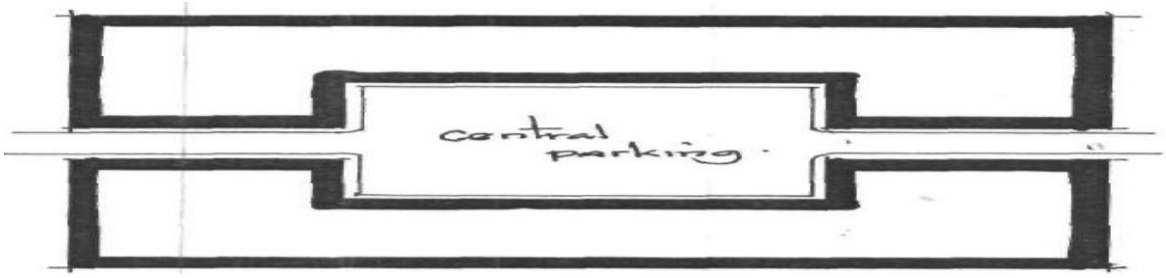


Figure 2 13: Precinct with central parking.
Source: Author's sketch (2013).

Non of the planning concept is good for fire prevention and control, all the planing cocepts have very limited no of accesses and exits. There will be difficulty for fire fighters especially in manuvouring of their vehicles. Most of the planning concepts are two compact

this will further increase the chances of fire spread to adjoining building. For multi level buildings,Centre with central parking junction Figure 2.11 will be most preferred to others. This is because of the efforts made with respect to circulation at various levels.

2.7. THE STANDARDS OF MARKET DESIGN

Different standards have been developed to guide for an effective development of commercial activities ranging from convenience shops through minor and major markets to departmental stores and other commercial establishments such as banks, insurance companies amongst other. Standard in this context is a specification or yard stick by which the qualities required of something may be tested or it may be a required degree or level of something reached by average specimens (Musa, 1999).

Planning standard is one major concept which can provide a common frame of reference for the planners and the researchers as far as planning and analysis of the provision and distribution of public services in Nigerian cities is concerned (Onokerhoraye 1982). For the achievement of efficiency and effectiveness in market, standards are outlined for the percentage of the total area to be allocated to different land uses so as to avoid misuses of landandcongestion, which may eventually reduce rowdiness and further encourage adequate separation of buildings to reduce fire spread in cases of emergencies, the breakdown is shown in the table below:

Table 2. 1:Standard of market land allocation to different land uses

Land Use Area	Percentage of Developed (%)
Shop / Stall	15-20
Organized open space	30-40
Utilities, Services, and Factories	10-15
Circulation and Parking.	15-20
Other uses	10-12

Sources: Vagale (1972) in Musa(2007).

For a market to be effective it should adequately be provided with basic Essential facilities, utilities and services that will make the market function efficiently,these include efficient circulation, adequate parking space, organized refuse collection points, drainage, public, convenience, electricity, water, telephone, police station, administrative block, firefighting, equipment, ware houses for bulk storage, banks, open spaces, motor Park, clinics, restaurants, cold rooms and mosques. All these must be taken into consideration when developing a market(Musa, 2007).

2.8. STANDARDS FOR DESIGN PUBLIC BUILDINGS AGAINST FIRE

Adamu, (2013) opines various design standards have been developed as a guide for the development of public buildings in respect to fire, these standards cuts across fire safety, non-combustible building and fire prevention and control amongst others. Standards here refer to design strategies and specifications by the qualities required for fire prevention and control maybe achieved at a certain degree. The national building code (2006) defines a non-combustible construction as that type of construction in which a degree of fire safety is attained by the use of non-combustible materials for structural members and other building assemblies. It further states The fire-resistive time periods may be reduced by one hour for interior load bearing walls, exterior load bearing and non-load bearing walls, roofs and the beams supporting roofs, provided they do not frame into columns. For the achievement of fire prevention and control that would be specific to markets standards and specifications are outlined in table:

Table 2. 2:Design Specification for fire in public building with users greater than 150

S/N	ITEM	DESCRIPTION
1.	Materials/construction	Materials which are non-combustible as described in the fire safety code. adjacent interior spaces, floor to floor, wall to wall and roof to wall connections by means of 12mm gypsum board or equivalent apply walls, partitions, structural elements, floors, ceilings, roofs, and the exits are constructed and protected with approved non-combustible materials to afford the fire resistance rating specified
2.	Fire detection devices	Where an automatic fire detection system is required by this Code, the plans and specifications shall show the location and number of all sending stations and signals with specifications of the type of construction and operation of the system including all automatic detection devices An automatic fire detection system shall be installed and maintained in full operating condition in the locations described in all building with expected users of greater than 200.
3.	Fire suppression devices	In buildings equipped throughout with an approved automatic fire suppression system, other than buildings, or portions thereof, the area of unprotected openings shall not exceed the tabulated limits for protected openings. Fire hydrants installed on private property shall be located and installed as directed by the fire department. Hydrants shall conform to the standards of the administrative authority of the jurisdiction and the fire department. Hydrants shall not be installed on a water main less than 150mm.
4	Fire spread control strategies	Any means by which fire transfer is from one place to another is reduced.
5	Fire Safety	Easy evacuation of users into safety for the purpose of determining the number of persons for whom exits are to be provided, net floor area shall be the actual occupied area, not including accessory unoccupied areas or thickness of walls Exits are permitted to discharge into a fenced or walled courtyard, provided that not more than two walls of the courtyard are the building walls from which exit ie being made. Enclosed yards or courts shall be of sufficient size to accommodate all occupants, a minimum of 15.0m from the building with a net area of 1.4m2 per person.

Source: (National building code, 2006)

2.8.1. Development and Management Plan

Despite the importance of markets in national development it has been observed that most urban market in Nigeria have been allowed to develop organically without proper planning and where planned are poorly managed (Caleb, 2010). To achieve effectiveness in markets, planning principles and standards for commercial development were developed to guide for an effective development of commercial activities. This standard is a specification or yard stick outline for the percentage of the total area to be allocated to different land uses so as to avoid congestion and misused of land therefore for any market to effective it must have development and management plan that should serve as a guide to the entire project life during and after (Ibraheem 2000).

2.9. SITE SELECTION CRITERIA FOR MARKET

In choosing an appropriate site for a market there are few decisions that are crucial as selecting the site of next development. This decision will affect which tenants will be interested in locating the market, which consumers will frequent the market. In short, the decision will largely determine the success or failure of the project and will determine whether the developer and investors in the project will in fact realize, negative or superior returns on their investments of capital and time (Brubaker, 2004).

On paper, land and space can be treated as relatively homogenous; however in reality every site must be considered and analyzed individually. Even something such as poor access or the inability of the site plan to accommodate the necessary parking requirements can singularly cause the failure of a shopping center investment. The subjective component of retail site selection must certainly be taken into account as time-proven experience as a “gut feeling” will also play a part in the selection process.

According to Brubaker (2004) each community centre tenant expressed obvious concern about the character and desirability of a given site. While many pertinent issues will be discussed each site is unique and will have its own unique attributes which will be of concern or interest to the tenants. Knowledge of the individual tenants' preferences will not only facilitate negotiation and site planning for the developer. But when synthesized contribute significantly to an understanding of critical success factors in the site selection for the community centre as a whole. These factors are as follows:

2.9.1. Visibility

All tenants want to maintain maximum visibility of the store front. In fact about 90% of the typical community centres tenants will want to be located at the end cap.

Community centres developers will need to ensure that each site that is considered will accommodate visibility and signage requirements to ensure that the community center site plan accommodates these needs prior to contacting potential tenants.

2.9.2. Access

Community centres retailers will all want to ensure that shoppers' movements are expedited to and from the centers. To facilitate this, retailers will look for multiple ingress and egress points. Two major intersections with a fully signalized traffic signals leading into the community center is characteristic of the optimal type of ingress/egress retail tenants will desire. Additionally, protected left-turn signals into the center will be greatly valued by all tenants and any site characteristic which will communicate a feeling of security to consumer. Ideally, the center will not only address major through ways, but will also include access to and from any adjacent communities on lesser roads. Other concerns regarding access include curb cuts directly into the site, turns lanes, egress acceleration

lanes and driveway width and length within the site which affects the number of cars which can comfortably enter and exit the site at one time.

2.9.3. Site size and character

The site size and character must be large enough to create the kind of co-tenancy and draw that retailers find so valuable in super community centres. Most category killer tenants want to locate in community centres that are at least 66.67 to 100,000 square metres in size which will allow at least five or six mid-size category killer anchor to co-locate. For most centers a relatively flat site is most desirable, although sometimes mild topography can enhance the site visibility. A rule of thumb for the site slope is that is should typically not exceed5%.

2.9.4. Parking

“I want to see it, and park in front of it” is the way Bill Lehman; most retailers have a general rule of thumb that they will require 4 parking spaces per 33.33 square metres of retail space. This ratio will be somewhat flexible for some tenants and will be strictly defended by others. Stores selling home goods or electronics or other goods which may be bulky and heavy will be especially concern with parking ratios and will want to stay away from typical community centres “parking hogs” such as restaurants, movie theaters and fitness facilities. Community centres tenants who experience large spikes in sales during seasonal periods will also be more concerned with parking and may require a higher parking space/ square feet of gross retail space ratio to accommodate the heavy seasonal demand for parking.

2.9.5. Co-tenancy

Community centres are built to create a draw or pull by uniting and combining the attractive qualities of several retailers in an effort to increase the overall number of consumers which frequent a shopping centre. Most community centers retailers are concerned with being located near others uses such as theater, restaurant, and health clubs which will monopolise the parking needed to ensure that their consumers will be able to park conveniently. Many mid to large size community center retailers will often negotiate a requirement that they be at least 50 to 66.67 metres from these types of use.

2.9.6. Demographics

The population surrounding a center is the most basic source of demand for a community centre. The extent that retailers and developers alike are able to understand this population and act on its findings will be a significant determinant in the success or failure of the community centre. Census data has historically been the primary source of the information,. But today that population data can be gathered more up-to-date information from other sources, and even overlay this information on current census data using GIS and mapping software.

2.9.7. Income

The level of income in a surrounding area is an important variable in evaluating a market as it is directly correlated with the amount of disposed income that the surrounding population possesses and thus the aggregate retail sales volumes that can be anticipated.

2.9.8. Competition

The location of direct competitors will play a key role in the sales projection generated by the implementation of analogue, regression models. Developers will need to map out the locations of retails and their competitors to better understand the retail landscape.

2.9.9. Education

Although income maybe a strong indicator of education, certain retailers will want to look at education alone. Booksellers will be very interested in areas where the education levels of the trade area population are average. Highly educated populations will have different shopping characteristics than populations with lower levels of education and will purchase for instance, significantly more books per capita.

2.9.10. Consumer search behaviour

Some typical community centre tenants will be willing to locate even next door to competitors as long as the trade area of the center is large enough to support both stores. Rather been a question of which store will outperform the other, these stores will both benefit by drawing consumers who value the opportunity to search and compare. This will be especially true of the two stores which offer similar types of goods but whose variety is such that the same item will rarely be found in a competitors store.

3.0.CHAPTER THREE: METHODOLOGY

3.1.AN OVERVIEW OF RESEARCH METHODOLOGY

Research methodology involves the systematic procedures by which the researcher starts from the initial identification of the problem to its final conclusions. The role of the methodology is to carry on the research work in a scientific and valid manner. The method of research provides the tools and techniques by which the research problem is solve (Singh, 2006). There are different types of research, depending on the form of science in question, but the basic and more general classifications mostly applied take the form of descriptive, analytical, applied or fundamental, conceptual and empirical research, or even a combination of one or more of the above stated forms of research (Cone, 1999) in (Oluigbo, 2010).

3.1.1. Qualitative approach

The major factors that contribute to the selection of a particular research method in research project(s) are research purposes and circumstances (Imoisili, 1996) in (Cone, 2010). This type of approach is descriptive, interpretive, naturalistic, and does not primarily focus on numbers (Manuel, 2004). It is that approach that applies subjective assessmentof opinions, behavior, and attitudes. Research in such a situation is a function of theresearcher's impression and insights; it usually uses techniques like in-depthinterviews, focus group interviews, case study, and many other projective andobservatory techniques, depending on the phenomenon under study (Cone, 1999) in Oluigbo(2010).

This study 'Evaluation of fire prevention and control strategies in the design of multi-level market" is geared towards a comparative analysis between the selected markets and the standard for fire prevention and control, through physical observation. And as Patricia

(1993) in (Cone, 2010) suggests that user's perception is also important, a semi-structured interview would be used for the users (shoppers, sellers) and the owners.

3.1.2. Case studies selection

The cases were purposively selected as suggested by Veal (2006), described as purposive sampling. This suggested that cases are identified for study due to their inherent qualities which were in consonance with the phenomenon under investigation Oluigbo (2010).

The case studies selected for this study were sampled purposely on some primary elements or bases for study, which includes:

i. fire prevention and control strategies

ii. Scope of facilities

iii. Multi-level nature

3.1.2.1.Scope of facilities

A market with adequate coverage of facilities that conforms to the minimum requirements based on standards. Markets most have basic facilities like the connivances, stalls, administrative center, and banks, amongst others. These are some of the basic requirements of a market, and were to a certain degree looked at in selecting the case studies.

3.1.2.2.Fire prevention and control strategies

This is to study the technological trend and level of inclusion of fire prevention and control strategies as a mainstream issue in market design.

3.1.2.3.Multi-level

Markets that have more than one level and with virtually all facilities integrated as a whole structure.

3.1.2.4. Sampled markets

1. Tejuosho market Yaba, Lagos
2. Jos main market Terminus, Jos
3. Garki Ultra-modern market, Abuja
4. Central market Kaduna

3.2. RESEARCH INSTRUMENTS

Two (2) research instruments would be used in conducting this study. These are the structured interview and observation checklists.

The interview schedule see (appendix B) was chosen to obtain opinion of various users within the market are participants in the event(s) around the facility.Checklist see (appendix A) is the standard procedure for evaluation of elements in a facility checklist simplifies accessibility elements to common denomination so that they can easily be quantified (Patricia, 1993) in (Cone, 2010). The checklist was designed to conform to the framework designed by Patricia Falta. The sub-divisions were designed with some items poised as question to be answered. The following forms part of the documentary sources used as guides to prepare the checklist to be used in this study

i. National Building Code(2006 edition). See appendix A

3.3. FIRE PREVENTION AND CONTROL STRATEGIES VARIABLES

The assessment of fire prevention and control strategies is carried out using the following fire prevention and control variables(appendix A) for the assessment table:

3.3.1. Building materials/construction

a. Gypsum

b. Burnt bricks

c. Concrete

d. Steel timber

3.3.2. Fire detection devices

a. Fire alarms

b. smoke detectors

3.3.3. Fire suppression devices

a. Water sprinklers

b. Smoke vents

c. Fire hydrants

d. heat Vents

3.3.4. Fire spread control strategies

a. Fire compartment

b. Fire grading:

c. Fire stopping

d. Fire wall

3.3.5. Fire Safety

a. The exit access,

b. The exit, and

c. The exit discharge

3.4. PROCEDURE FOR DATA COLLECTION

A visual survey would done by looking and identifying what has been achieved in the already existing market with reference to the applying fire prevention and control strategies, this would be done by the use of a digital camera. The survey would involve a range of recording techniques, including physical measurements and observational assessment. On-site measurements of physical features for comparison with current best practice design guidance. The researcher visited the selected markets to complete the assessment checklist table, which involves physical measurement usingadjustable set-square (Rotring Professional DS Art 6441, Rotring in Germany) would be used to measure the angle of the gradient of ramps and steps; it is calibrated from 0-90 degree. Tape measure (calibrated from 1 to 3000 millimetres.), would be used to measure the length and width of the structural parameters surveyed.

For the second research instrument, the interview would be conducted by the researcher to the users (shoppers and traders) and, and the administrators of the markets.

3.5. PROCEDURE FOR DATA ANALYSIS

Tables, charts would be used to assess the existing features based on established minimum requirement for features in and around the building (appendix A for the checklist and appendix BNational Fire safety code for the adapted minimum requirement). Pictures of the existing markets studied would be taken and documented showing the markets facilities and how fire prevention and control strategies were used (if used).

4.0. CHAPTER FOUR: RESULTS AND DISCUSSION OF CASE STUDIES

This chapter reveals Comparative study of some selected markets individually as a single unit, under these headings: Brief introduction, site organization planning and landscape, facilities and service, building material and structure and spatial organization. The findings from conducted assessment of the selected facilities within these cases where also captured. Furthermore data analyses of findings from semi-structured interviewing questionnaires taken with the two groups of respondents. The data collected were coded, tabulated and summarized using descriptive approach, pictures, tables and charts. This chapter presents the analysis along with the findings and ends with discussion of findings.

4.1. CASE STUDY ONE: TEJUSHO MARKET, YABA (TJ)

4.1.1. Brief introduction

The Tejusho market is a 5 storey market high with stalls on all the floors, share facilities like the toilets are situated at every floor according to the need of the floor seePlate: 4.1. Terrazzo and vitrified tiles where situated at strategic grids to accommodate the stalls, administrative area, connivances multi-storey car park. The market is not completely rectangular as some parts of the market are in circularly form, the market structure was designed with an open court in the middle, for ventilation and lightening. A variety of building materials where used, the choice of the building materials used rested heavily on the factor of availability. These building materials used include concrete, steel, timber, glass amongst others.



Plate 4. 1: Entrance to Tejusho Market Yaba, Lagos.
Source: Author's field work (2013).

The Tejusho market was gutted by fire. In the month of October, 2012the Lagos state governments in collaboration with the First bank of Nigeria PLC are currently reconstructing the market. The reconstruction is currently 80% completed see (plate 4.1). Before now the market had no commercial banks and police stationwithin the structure but relied onbanks and police stationsat a close proximity to the market. In the new face of the market, these and many other facilities have been incorporated into the market. Currently all commercial activities are suspended within the market walls and immediate environments whererehabilitation work is in progress, except for a very large number hawkers found outside the periphery of the markets environment outside the fence.

4.1.2. Site planning and landscaping

The Market site experience constraints, majorlydue to facilities in the market being integrated as a whole in a single structure contrary to the conventional and common linear markets. The parking space is multi-storey starting from the basement up to the last floor; this was the maximized space efficiency. As mentioned earlier the market was undergoing rehabilitation thus many landscape features are not in place. There are evidently obvious signs of hard landscape elements interlocking concrete where used all over the market place no green areas also.

4.1.3. Spatial organization

The market is segmented into various sections based on the products obtained in the section. The wet area is zoned separate from the dried area. Rows of stalls of rows are separated by a courtyard located centrally with the stalls on either side (Plate 4.2). The rows have projection of two meters corridors of 2meters wide.

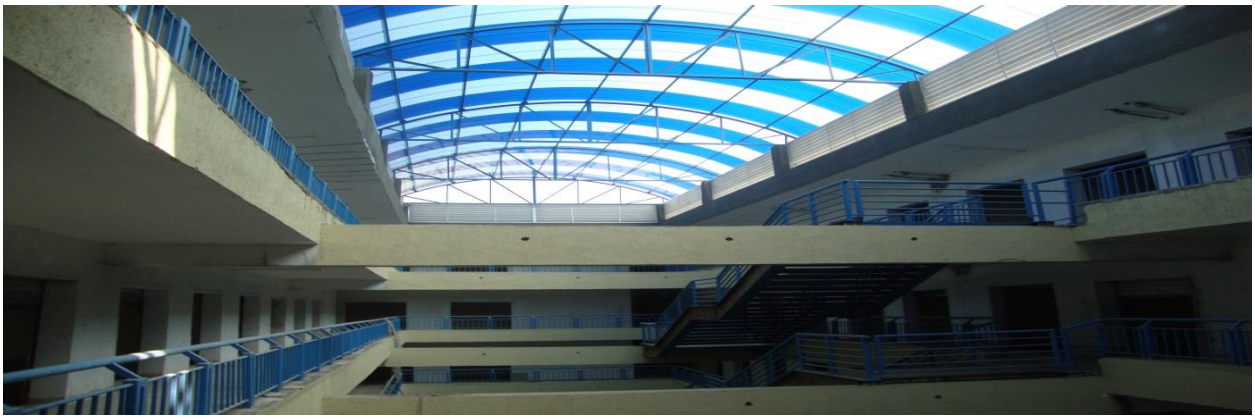


Plate 4. 2: Rows of stalls with a courtyard midway and 2m corridors.
Source: Author's field work (2013).

In the market a courtyard was introduced this is to allow for ventilation and proper lighting. The market administrative area is located just at the periphery to allow access directly from the entrance without necessarily accessing the market proper.



Plate 4. 3: Showing the roof the market structure.
Source: Author's field work (2013).

At the central core which is located right mid-way the entrance there are the elevators linking various floors of the market. The parking in the Market is multi-leveled connected by a ramp to various floors. The parking is multi-storey cars park in between the 6m grid columns. The parking space can accommodate at a time a value of 300 cars (Plate 4.3). The ramps are made such a way as to link the various floors together. User parks at proximity to areas of need in the market **(**Plate 4.7).



Plate 4. 4:Multi-storey parking spaces.
Source: Author's fieldwork (2013).



Plate 4. 5: Ramp linking floors.
Source: Author's fieldwork (2013).

- 8 lifts servicing each floor 12 passengers at a time
- Escalators

Total Number of shops	3848
Total Number of car park spaces	830
Gross floor Area	85,000sqm
Multi- car park	10,000sqm

4.1.3.1.Water

Water supply source for the use of the entire market is through a borehole and water board. The market is provided with an underground tank which serves as the reservoir the water from the underground tank is pumped to the overhead tank which supplies water via natural gravity to various areas of water demand (Plate 4.6)



Plate 4. 6:Showing underground.
Source: Author's fieldwork (2013).



Plate 4. 7: Overhead tank.
Source: Author's fieldwork (2013).

4.2.3. Fire Prevention and control strategy

Fire which forms the major thrust of this study would be look at in depth under the following topics:

1. Fire suppression and detection mechanisms

2. Means of escape, ingress and egress

4.2.3.1. Fire suppression and detection mechanisms

Fire suppression mechanisms are devices put in place to help reduce the action of fire. These devices are made in such a way as to attack major constituents of fire and thus bring it to halt.

Fire hydrants hose points located at appropriate distance where accessibility is possible by fire fighters, which is towards the entrance and the buildings critical points like the parking

in both basements and the upper floorsand ramp linking floors (Plate 4.5)while(Plate 4.8)Shows fire service hydrants hose points and pipes (valves).



Plate 4. 8: Showing fire hydrants, hose point and pipes(valves).
Source: Author's fieldwork (2013).

Wet pipe systems, are appropriate for effective control, the markets appears to get it right, because wet systems are used.

Fire alarms also are situated where they could easily be access by endangered persons, in the case of emergency. As a requirement for this fire device to work appropriately, they should be situated where there will be easy accessibility both for the victims and fire fighter in the case of emergencies. Secondly vehicular access should be emphasized. As to where the fighting gargets can be fixed and the potentials of those device installed in the buildings can be put to use effectively. In the case of this market there appear to be a heavy constraint that hinders all forms of access particularly vehicular. Part of the problem of the market is lack of space and due to population explosion in Lagos state they needed expansion thus

the possible way to achieve this expansion was vertically, which led to so many compromises especially to fire.

4.2.3.2. Means of escape

Building should be designed and constructed so that there are means of escape from the building in case of fire to a place of safety outside the building. The main danger to people in buildings, in early stages of a fire, is the smoke and noxious gases produced which cause most of the casualties and may also obscure the way to escape routes and exits**.** The staircases are made of steel which could easily be dismountable and relocated(Plate 4.9).



Plate 4. 9:Showing a dismountable staircase and lighting.
Source: Author's fieldwork (2013).

Tejuosho markets has staircase found within the courtyard, which tend to cage all point of egress and ingress within fire zones creating serious dangers to victims. there are no dedicated points of escape be it in the form of escalators and elevators which again pose

great danger for fire victims looking for points of escape. These victims may be well trapped should incase of fire becauseBukowski (2011) asserts that the primary strategy for the safety of building occupants in emergencies (especially fires) is by facilitating their relocation to a safe place.

4.2.4. Building materials and structure

In the design of Tejusho market, land was a major constraint, the entire market structure rest upon a structural grid of 6metres X 6metres. The market as an integrated facility is rectangular on concrete beams and columns connections. The roof is made of corrugated aluminum roof sheets to cover the main stalls; the courtyards on the other hand are covered with dampallion PVC sheets which are translucent. This PVC sheet filters solar radiation before getting into the building space to minimize the risk of skin burns from solar heat and again the spaces are lightened.The entire roofing structure are cover with 150mm thickness parapet walls which collects and drain water through drain pipes down to the gutters on the ground. Steel reinforcement rods of various sizes were also used for concreting of columns and beam; clear glasses were employed for windows and glassed areas.. Sky lights were also made provisions for in the roof, this primarily to allow natural lighting in the market long corridors and dark corners. Transparent plastic roof sheets where used to achieve that, they were laid in vaults, from one point to another (Plate 0.1) the façade. The roofs where vented to allow for the evacuation of hot air through the principle of stack effect (Plate 4.7) Water from the roof is drain through roof gutters that was provided. Wide enough to allow access in the case of maintenance (Plate 0.2) shows the roof the market structure.

4.3. CASE STUDY TWO: JOS MAIN MARKET (JM)

4.3.3. Brief introduction

The Jos main market is a storey high with stalls on both the ground and top floor. Mezzanine floors are also situated at strategic grids to accommodate the administration, mosque and some parts of the wet areas of the market. The market was designed by Odeleye International Association in Lagos Nigeria. The initial cost of the project was estimated to be 11 million naira. After development had started for a while, the project came to a halt because of suspension of financial transaction with the union bank. Funding for the project was however, resumed in 1980 and in 1976 contract terms were received and the project cost rose from 11 million to 23 million. This increase of over 100% of the initial cost, was due to austerity measures introduced in Nigeria by the then Shehu Shagari's Administration.



Plate 4. 10: Perspective view of the Jos main Market.
Source: Author's field work (2013).

4.3.4. Site planning and landscape

The rectangular site of the main market is located in the commercial and shopping center of Jos town. It is adjacent to the Jos university teaching hospital (JUTH) and the terminal round about. It is accessible by road from north, west and east bearings by major roads.

The Jos main market was functioning adequately since it was commissioned in 1976 until it was gutted by fire in 2007. Currently all commercial activities within the structure had been relocated elsewhere around the structure. The structure currently is not function as fire had reduced it to an inhabitable state.

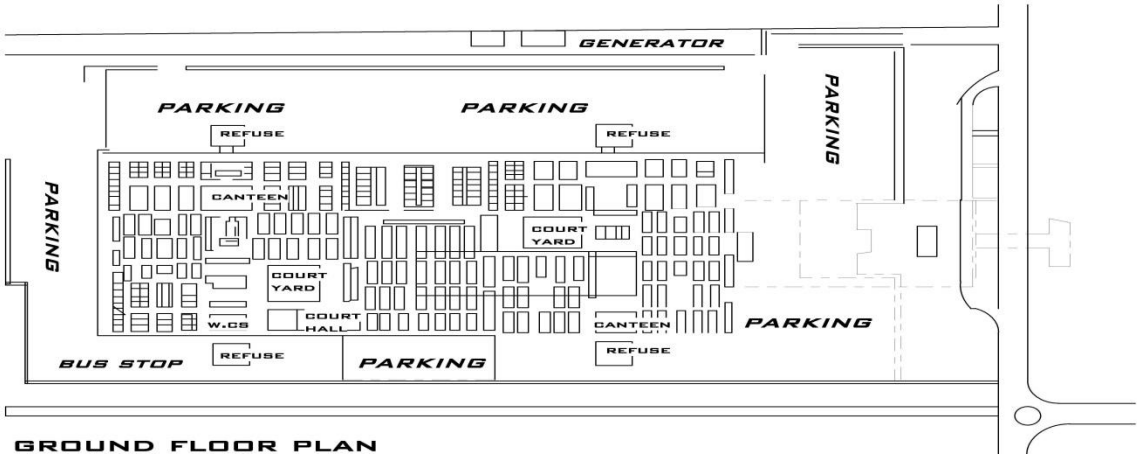
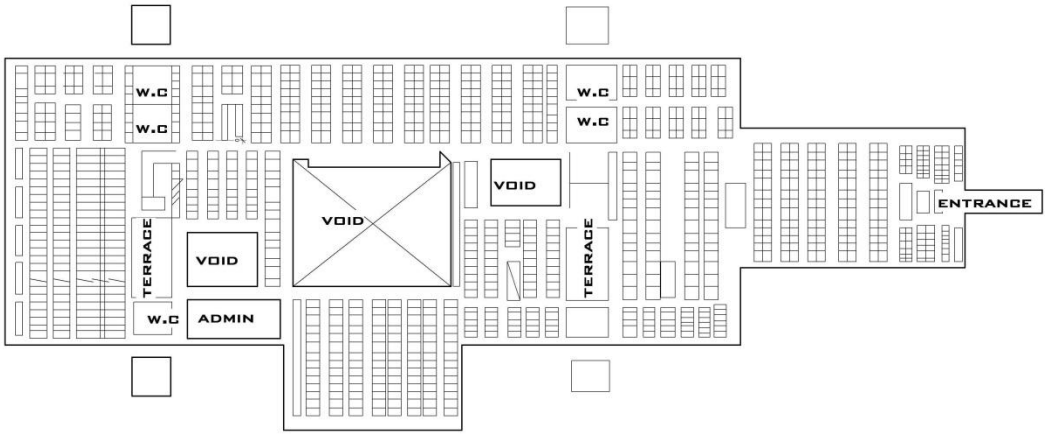


Figure 4. 1: Ground floor plan Jos main market.
Source: Plateau state market Authority (2013).

4.3.5. Spatial organization



FIRST FLOOR LEVEL

Figure 4. 2: Ground floor plan Jos main market.
Source: Plateau state market Authority (2013).

The market was designed in such away the all the facilities are integrated together as a single whole unit functioning together, with the facilities organised around the ground and the first floor. The market structure is divided in into halls named according to the 20 local government's areas of Plateau state. Within the halls are lined the stall each measuring approximately 3metres X 3metres. The entire market structure in laid upon 6m grid structural grid system. Lighting in the market structure is achieved using pockets of courtyards which are at specific point introduced into the market. Where those courtyards exist there is staircase to enhance either coming in or going out of the market structure. The roofs are designed as partial vaults. Orientated to the north so as to capture at the full scale sun light see (Figure 4.2).

This fire service station is located as an integrated facility within the market structure, it is at the market periphery particularly so as to able to be access by the fire fighters should incase there is an emergency situation. Fire safety valves and hose points are located at strategic position so as to combat ragging fires at their incendiary stages.

4.3.6. Services and facilities

4.3.6.1. Waste

In the market there comprise an interesting number of facilities and services that tend to enhance the effective running of the market. The markets drain running/excessive water from the roof through 100mm diameter drain pipes (Figure 4.11).



Plate 4. 11: Underground drainage.
Source: Author's fieldwork (2013).



Plate 4. 12: Refuse collection depot.
Source: Author's fieldwork (2013).

Down to the underground drainages which the bulk of the water is collected centrally, at appropriate points there are refuse collection points, with a collection depot (Figure 4.23).

Centrally located outwards where it can easily facilitate evacuation, the market is supplied water from the Plateau state water board and has borehole to improvise where the water fail, a water tower as seen in (Plate4.13).

4.3.6.2. Water supply



Plate 4. 13: Water tower.
Source: Author's fieldwork (2013).



Plate 4. 14: Generator House.
Source: Author's fieldwork (2013).

Water is pumped up the 30m high tower; this water is distributed throughout the market using natural gravity from this tower. There is underground and overhead water reservoir should incase of water scarcity (Plate4.14).

4.3.6.3. Electricity supply

Electrical power is supplied using the national Grid (PHCN) and using a generator (Plate 4.26) that power this whole market should incase power from the power from the national grid (PHCN) goes out. The generator is located extreme east of the market structure. There appeared to be no alternative power supply aside the two here mentioned.

The market design put into consideration of fire safety measures, particularly in the provision of a fire station just at the south entrance of the market (Plate4.27).

4.3.7. Fire prevention and control strategy



Plate 4. 15: Market fire service station.
Source: Author's fieldwork (2013).

The Jos main market design the compact nature of the internal space especially the stalls and point where fire is being anticipated they have achieved a considerable level of compartmentalisation which could inhibit the wild spread of ragging fire from one space to another. Similarly on the second note the requirement demands that there should be a limit lining that could support fire spread typical markets structure has no need of lining like curtains. Facilities for combating fire where adequately provided (Figure 4.15)

4.3.7.1. Means of escape

Building should be designed and constructed so that there are means of escape from the building in case of fire to a place of safety outside the building. The main danger to people in buildings, in early stages of a fire, is the smoke and noxious gases produced which cause most of the casualties and may also obscure the way to escape routes and exits, the Jos main market poorly responds to this call as there very few number of the escape routes which are in most case not detached from the structure (Plate4.16).



Plate 4. 16: Shows escape staircase made in steel.
Source: Author's fieldwork (2013).

This exposes casualties to further accidents due to smoke which is the principle actor in the case of fire accident. Another critically issue is that the escape stair cases where made of steel and could be dismantled. It is worrisome because since it's incorporated in the structure at high temperature this steel receives and conduct heat which in turn lead to more injury to and victim that seek solace in using the steel staircase as a means of escape. 1650 traditional market mat forms of approximate 3.30metre squareeach 144 meat and fish retail stalls of approximate area of 10metre squareeach with 2406 retail and wholesale stalls of 7.30metre squareaverage area for various items.

4.3.8. Building materials and structure

The choice of materials used for the construction of the market was based on factors such as availability, resistance to fire, most of the materials, with the exception of the roofing and the sun shading devices, are locally available. The materials were chosen to give a modern touch of aesthetics and to blend with the environment and landscape. Dominant

building materials used includes; concrete in the (columns, foundations, beams, slab), glass, steel.



Plate 4. 17: Roof structure.
Source: Author's field work (2013).

The roof carcasses are made with steel and the roof sheet is aluminum see (figure 4.17). The roof was projected outwards about 2m to enhance shading from sun light.

4.4. CASESTUDY THREE: KADUNA CENTRAL MARKET (KC)

4.4.3. Brief introduction

The Kaduna central market covers an area of about 13 hectares of land. The market is made-up of the main market which is surrounded by 3metres high wall, a parking area, commercial Motor Park which was later transferred to Kawo district. Initially this market was built at the cost of N3.19milion in 1975. Ashcroft and Parkman (Nigeria) limited were commissioned to design the market. The market fire outbreak was on Monday 10th November, 1997 at 12:15am. On the 5th January 1998 the remaining part of the market was further razed by fire at 11:55pm see (Plate 4.18).



Plate 4. 18: State of the market after the January 1998 fire outbreak.
Source: KASUPDA(2014).

4.4.4. Site organization and landscaping.

The market is completely laid upon a rectangular grid the whole 13 hectares site was exhausted at a stretch providing stalls/shops of varying sizes, numbering up to 7000.

The whole market was laid at a linear head on arrangement of shops/stalls with a 3om wide walkway cutting across the major axis with secondary walkway of 25m and 10m off setting from this main way(Figure 4.3).

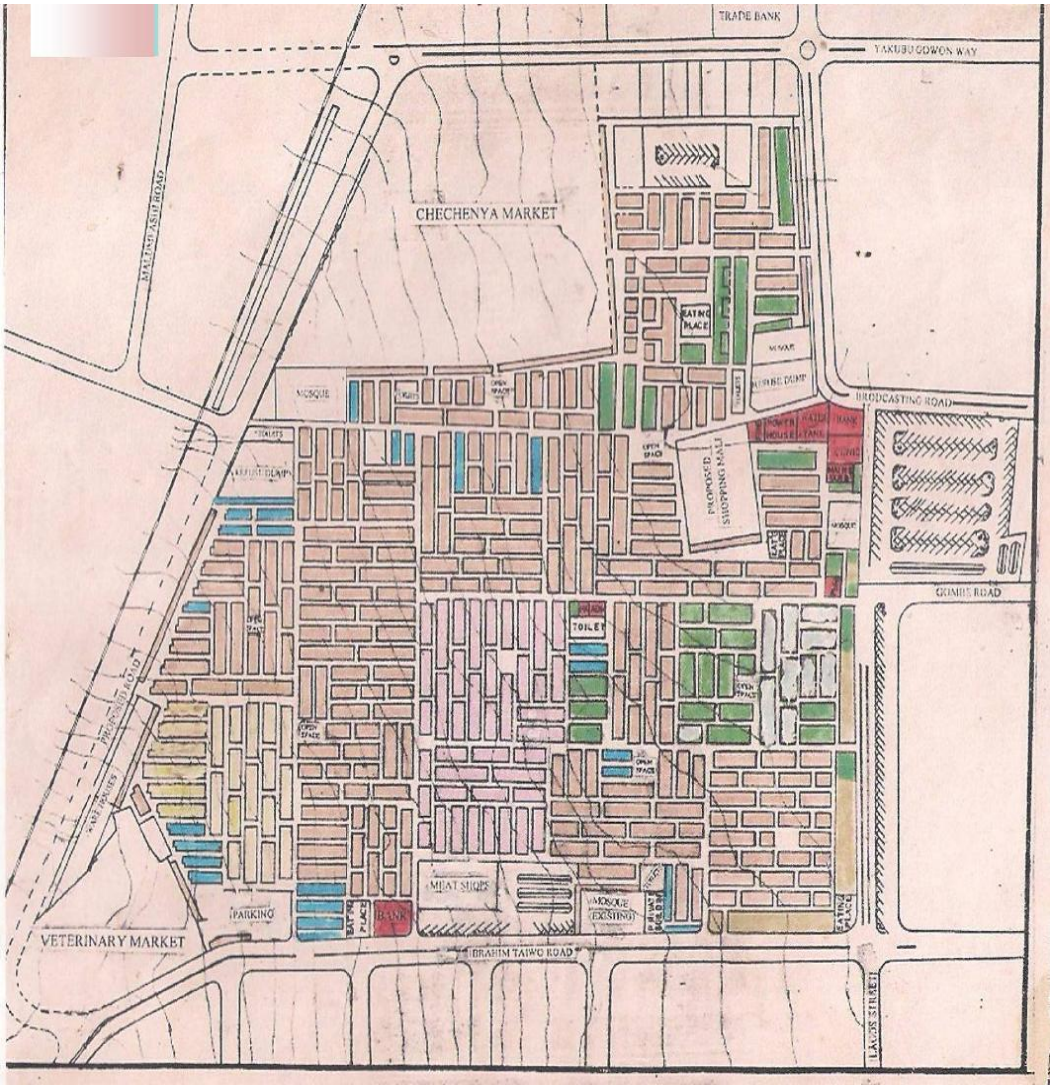


Figure 4. 3:Site plan Kaduna central market.
Source: KASUPDA (2014).

4.4.5. Spatial organization.

The Kaduna central market was design in units of separate blocks, aligned with several shops/stalls facing into the streets (Plate 4.19). This organization isn't adequate for firefighting due to poor accessibility.



Plate 4. 19: Arrangement of stalls/shops at the Central market.
Source: Author's fieldwork (2013).

4.4.6. Facilities and Services

Facilities here mean those supporting physical building or structures that serve the market users in one way or another. They include Banks, post office, restaurants, administration, fire station, toilets, parking spaces and mosques, telephone stands, administrative offices, police station, magistrate court and cinema.

Utility service includes: water supply, electricity, refuse receptacle and mechanical services are existing; however the provision of tap water is very poor, there was not storage tanks. This makes it very difficult for firefighter as the markets completely has no form of fire detectors, fighter fighting gargets. The refuse collections and disposal system are completely poor, thus leading to congestion and improper waste disposal (Plate 4.20).



Plate 4. 20: State of the market as a result of improper waste collection and disposal.
Source: Author's fieldwork (2013).

4.4.7. Fire Prevention and control strategy

Fire which forms the major thrust of this study would be look at in depth under the following topics:

1.Fire suppression and detection mechanisms

2.Means of escape, ingress and egress

4.4.7.1. Fire suppression and detection mechanisms

Fire suppression mechanisms are devices put in place to help reduce the action of fire. These devices are made in such a way as to attack major constituents of fire and thus bring it to halt. This however is Kaduna central market wasn't provided at all.

4.4.7.2. Means of escape

The means for escape is provided but not as in the multi-level markets where there is escape staircase here the market as a whole was design as a low rise with several egresses and ingresses which makes it easy for quick evacuation and easy for the maneuvering of fire fighters and their vehicles.

4.4.8. Building materials and structure.

In the Kaduna central market the commonly used building materials are concrete, steel, timber and some traces of glass. Of these materials concrete was more pronounced especially in the construction of stall no additional care was given to the construction as regards firefight, prevention or control.

4.5. CASESTUDY FOUR: GARKI ULTRA MODERN MARKET (GM)

4.5.3. Brief introduction

Garki Ultra-Modern Market is a collaboration of Abuja Investment and Property Development Company (AIPDC) a subsidiary of Federal Capital Development Authority (FCDA) and Urban Shelter Limited whereby Urban Shelter is to develop the market on a Build-Operate-and Transfer basis.



Plate 4. 21:Front view showing "park and shop" arrangement of stalls.
Source: Author's fieldwork (2013).

The market which remains the biggest and most centralized has about 2400 shops and stalls of various sizes in addition to other facilities such as Clinic, Banking Facility, Cold Room, Restaurant, Fire station, Police station etc. Garki II Ultra-Modern Market covers an area of 12.3 Hectares of land situated in Garki 11 District, Off Ahmadu Bello Way and right in the heart of the Federal Capital Territory, adjacent to the Standard Trust Bank Plc. and adjoins

old Garki Model market. The development of the market commenced in January 2005 and is due for completion in 18 months. The project is expected to cost about N 3.5 Billion and is being financed by First Bank of Nigeria PLC.

4.5.4. Site organization and landscaping

The access to the market is through two major roads and proposed Highway all of which are fitted with well-designed gates and gate houses. There are ample parking spaces with over 1200 lots.



Figure 4. 4: Site image Garki ultra-modern market
Source: (Google earth, 2015)

The entire market premises are well drained and landscaped, with drainages and pedestrian walkways and adorned eighth beautiful trees, flowers, shrubs and grasses to provide natural atmosphere. Essential consideration was made for the maneuvering of firefighters see (Figure 4.4).

4.5.5. Spatial organization

The shops' name is derived from the shape of the building. It consists of 156 closed shop units of 16 square metres each located within the courtyard space.



Plate 4. 22: Arrangement of stalls.
Source: Author's fieldwork (2014).

The block covers an area of 3,880 Sqm. As in the other 2 large blocks, there are also two well-located large ramps and stair ways giving easy access to the upper floor. The ground floor has various access ways. This provides very good advantage during fire emergencies, it's would further necessitate easy and quick evacuation.Facilities services available are Police post. Fire service, Parking spaces, Facility Management, Security, Transformer, Boreholes, Pipe borne water. Admin block.



Plate 4. 23: Cubicles at the Garki ultra-modern market.
Source: Author's fieldwork (2014).

Open stalls 4m^2 size (496 Units), Closed shops 9m^2 size (988 Units) and 16m^2 size (172 Units) total (1.160 Units), Duplex shops 98m^2 size (64Units), Warehouses 36m^2 size (24 Units), Clinic 215m^2 size (1 Unit), Banking Halls 285m^2 size (2 Units), Restaurant 170m^2 size (8 Units), Cold room 15m^2 size (40 Units), Chicken stall 108 Large, Meat shops 64 tables.

4.5.5.1. Fire suppression and detection mechanisms

There is at a distance of 16 meters located fire hydrants, which is a major fire suppression system see (figure 4.24).



Plate 4. 24: Market side view
Source: Authors fieldwork, 2014

Fire detection devices are not seen but there is a provision for fire alarms at a distance of 30m intervals.

4.5.5.2. Means of escape

In the garki-ultra modern market, there is a provision for escape staircase at 15 meters interval which is about the required distance for location of escape staircase from the national building code. The market is at a junction with roads at every side of the building. There are numerous ingresses and egresses which makes it easy for evacuation and for fighter's fighters during emergencies.

4.5.6. Building materials and structure

The dominant building material used is burnt brick which is fire resistant owing to the fact that it is a product of fire that is in it process of manufacture. Other building materials used includes steel, aluminum, concrete, bitumen at this at minimal quantities. This material do poorly in the face of fire compared to the burnt brick which is used dominantly. The whole market is suspended on a frame structure, of a regular grid of 3metres X4meters.

4.6. ASSESSING FIRE SAFETY STRATEGIES IN THE MARKETS

Considering the nature of the data and scope of the study, data collected was analysed using simple descriptive statistical techniques that is, simple analysis showing percentages andpresented in tabular form and charts.

Table 4.1 below shows the fire strategy measures of four markets. The table shows that GM with 31.1% has the highest number of fire strategy measures in terms of quality, this is however below standard. After the GM then followed JM with 26.7%, KC 22.2% and TJ 20% as the least which are all below standards. This therefore implies that amongst the four markets only GM can be considered to have an up to standard fire strategy measures. This also means that in case of fire outbreak in the markets, GM will be expected to have fewer casualties.

Table 4. 1: Fire exit strategy measures.

Case study	Exit access	Exit	Exit discharge	Total(%)	
TJ	4	3	2	9	20
KC	4	3	3	10	22.2
GM	5	5	4	14	31.1
JM	3	4	5	12	26.7

Source: Author's Field survey (2014).

Table 4.2 presents the findings of this research on fire suppression strategies available in the four selected markets.TJ has the highest number of suppression strategies which mean it has the best strategies compared to GM with B, JM with D and KC with B. This implies that TJ has better fire suppression strategies more than other three markets.

Table 4. 2:Fire suppression strategies

S/N Study	Case	Water sprinkler	Smoke vent	Fire hydrants	total score (%)	Evaluation
1	TJ	4	4	5	13	A
2	KC	-	-	3	3	B
3	GM	3	3	5	11	C
4	JM	-	2	4	6	D
Total				**33**		

Source: Author's Field survey (2014).

Table 4.3 presents the findings of the research on fire spread control strategies. The fire spread control strategy has to do with those strategies that helps curtail or reduce the spread of fire in a case of fire outbreak. Out of the four selected markets, GM and JM have better strategies with 31% each while TJ and KC have 25.9% and 12.1% respectively which mean a low standard fire spread control strategy.

Table 4.1: Fire spread control strategies

S/N	Case study	Fire compartment	Fire grading	Fire stopping	Fire wall	Total score	Evaluation (%)
1	TJ	4	4	4	3	15	25.9
2	KC	2	2	2	1	7	12.1
3	GM	5	4	4	5	18	31
4	JM	5	5	441831			
Total					**58**	**100**	

Source: Author's Field survey(2014).

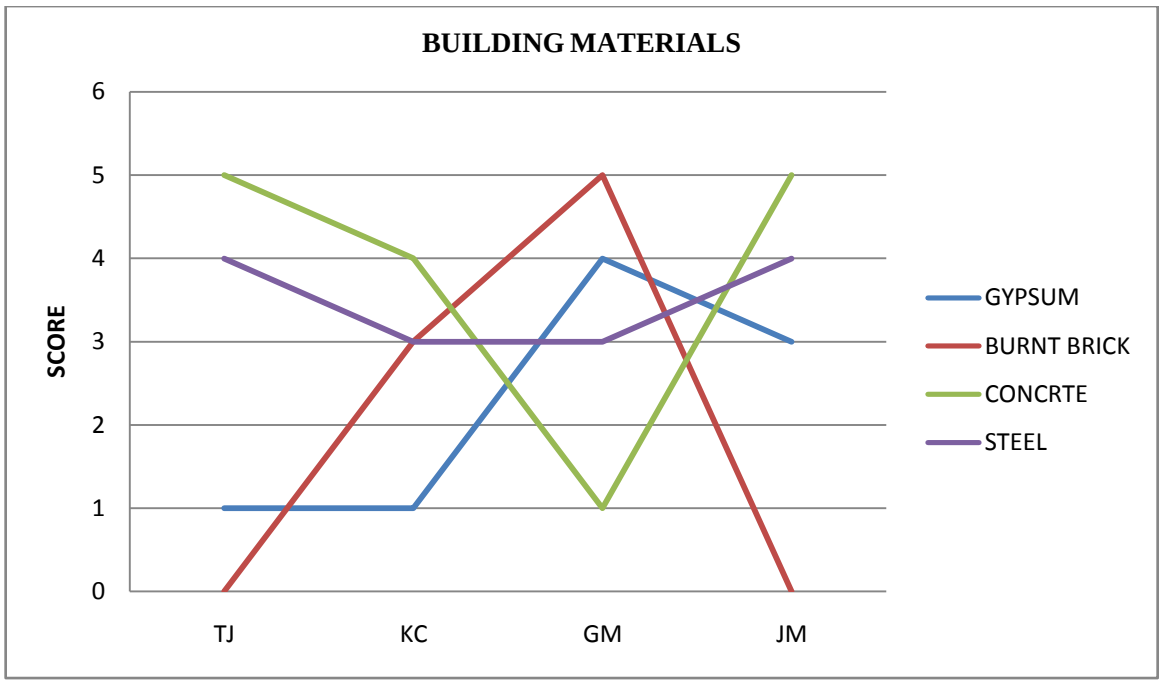


Table 4. 3: Building materials/construction
Source: Author's Field survey (2014).

Table 4.4 shows fire control strategies by the type of building materials used in the construction of the markets. This is because the type of material used in a building to a large extend determines the intensity of havoc caused by fire accident or outbreak. The

In table 4.4 TJ shows no use of gypsum and KC demonstrates very low application of the fire resistant material gypsum. GM with a score of 4 shows an optimum level of application with JM with an average score. This implies the case study JM and GM would perform better where TJ and KC would actually fail.

TJ and JM were completely without the application of burnt brick which is highly resistant material to fire. While the other hand GM has a very high level of application of burnt brick and KC show an average level of use of this building material thus where others may perform poor in case of fire emergency GM would be better.

Concrete with an optimum resistivity to fire was more used in TJ and JM while for GM there was an insignificant level of use of concrete and KC showed and average use of concrete.

Table 4.5 prevents the results of the findings of the research with respect to fire detection strategies. The table shows that TJ and GM with 36% each have more fire detectors than JM and KC that has 20% and 8% respectively. This implies that TJ and GM tends to have more possibilities of preventing serious fire havoc in case of fire incidence in the selected markets simply because such incidence could easily be detected from onset in the TJ and GM than in JM and KC.

Table 4. 4: Fire detection strategies

S/N	Case study	Fire alarms	Smoke detectors	Total	Evaluation (%)
1	TJ	5	4	9	36
2	KC	2	-	2	8
3	GM	5	4	9	36
4	JM	3	2	5	20
5				**25**	**100**

Source: Author's Field survey(2014).

Key

100 – 80: Adequate (A)

79 – 60: Fairly Adequate (FA)

59 – 40: Poor(P)

39 – 0: Inadequate (I)

The results from the conducted interview were collected and arranged under these headings:

Table 4. 5:Showing Assessment of the selected markets

S/No	Markets	Safety Strategies (%)	Suppression strategies (%)	Spread and control (%)	Building materials/ construction	Detection strategies (%)
1	TJ	20.0 (IA)	39.4 (IA)	25.9 (PA)	20.0 (PA)	36.0 (IA)
2	KC	22.2 (IA)	9.1 (IA)	12.1 (PA)	24.4 (PA)	8.00 (FA)
3	GM	31.1 (IA)	33.3 (IA)	31.0 (PA)	28.9 (PA)	36.0
5.	JM	26.1 (IA)	18.2 (IA)	31.0 (PA)	26.7 (PA)	20.0 (IA)

Source: Author's Field Work(2014)

4.6.1 Knowledge of fire (control and prevention) strategies/devices.

Virtually all of respondents are conversant with these strategies, most were able to say a few that is ranging from fire extinguishers, fire hydrants, escape stair cases, fire alarms/detectors. Others took extra miles to mention technicalities as separation of fire zones from fire free zones.

From the list of strategies identified and conversant with by the respondents fire extinguishers have the highest tally with 36%, following distantly by fire alarms with 24%,

fire hydrants with 20%, escape staircases 10%, smoke vents 4%, smoke detectors 4% and others strategies 2%.

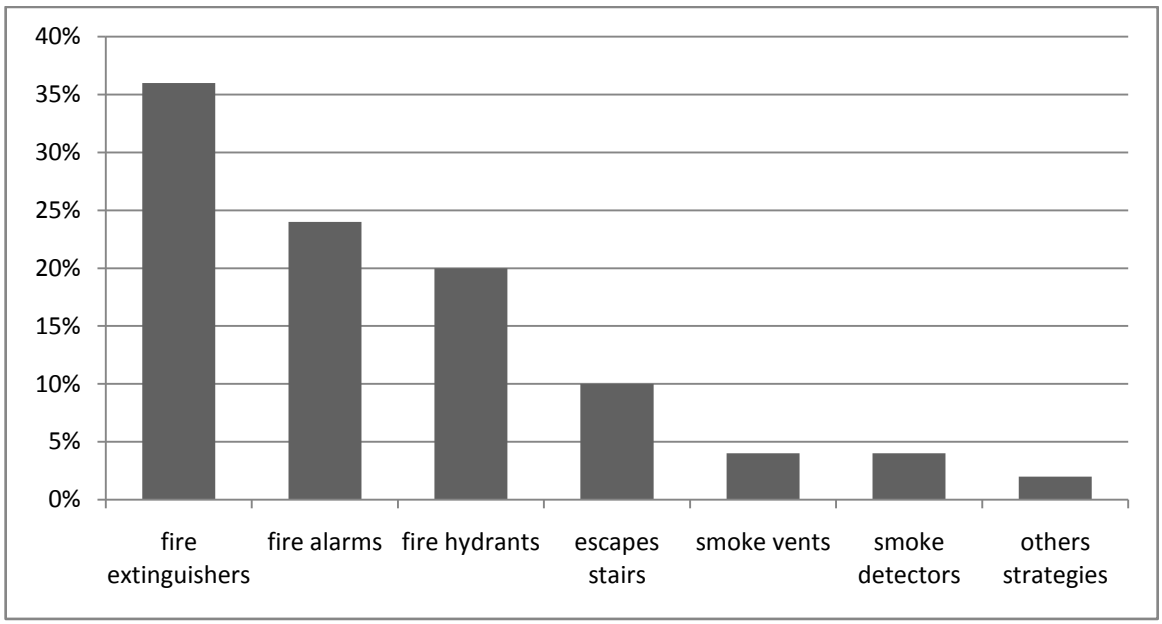


Figure 4. 5: Showing Knowledge level of respondents on fire control and prevention strategies/devices.
Source: Author's Field Work (2014).

4.6.2. Opinion of respondents on Adequacy of fire control and prevention strategies/devices

The following was obtained when respondents were asked about the adequacy of the fire prevention and control devices, out the 12 respondents interviewed 7 said its very inadequate, 3 fair adequate, 2 remained neutral with no response.

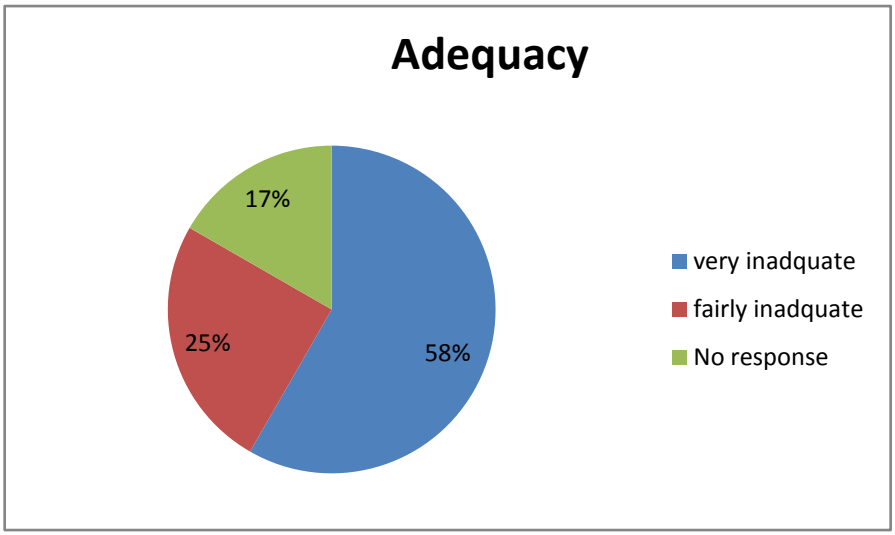


Figure 4. 6:A bar chart showing Opinion of respondents on Adequacy of fire control and prevention strategies/devices.
Source: Author's Field Work (2014).

4.6.3. Experience of respondents to fire outbreak when in use of the facility

Of all the 12 respondents interviewed only 1 had experience fire outbreak in a market, the respondent characterized his feelings as panic and confusion and at the time wasn't conscious of any from control or prevention strategies. The rest never have any experience.

4.6.4. Recommendations from respondents

Most respondents suggested various ways of improving fire prevention and control strategies with market facilities these recommendations are;

a. Government, markets operators should improve and create more awareness on the need for conscious attitude towards the use of some of the strategies and device in case of fire disasters.

b. Firefighters should be well funded and equipped to enhance fight fire.

c. Designers of markets should incorporate fire prevention and control strategies in their design within the reach of endangered user.

d. Positive attitude towards the use of market facilities.

4.7. DEVELOPING A FRAMEWORK FOR FIRE SAFETY DESIGN IN MARKETS

In (Figure 4.7) the framework for fire safety design in markets shows in increasing order (0 - 5) the fire outbreak potential of major components of a market. Circulation (0) is with the lowest potential of fire followed by services (1), administration (2), communal facilities, and shops (3), Restaurants (4) and Power (5) has the highest fire outbreak potential. Component with high fire outbreak potential are segregated away from the others with minimal potentials.

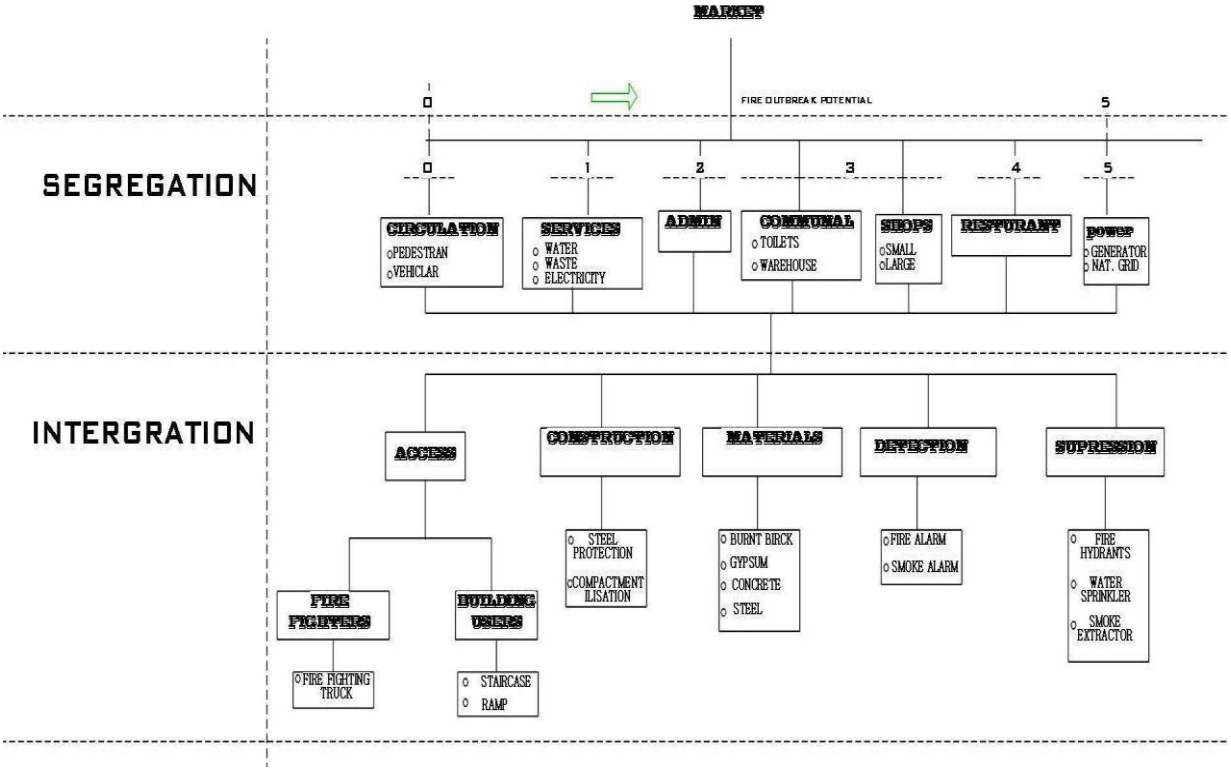


Figure 4. 7:Fire safety design framework for markets
Source: Authors fieldwork

4.8. CONCLUSION

From the analysis carried out on the markets namely Tejuosho market, Jos main market, Garki ultra-modern market, and Central market Kaduna. It was discovered that Tejuosho market had some level of treatment for fire suppression and detection strategies from the devices in place while the rest did very poorly in that respect.

Zoning was poorly done,areas very susceptible to fire are not clearly separated from areas that are not, and this is evident in all the markets studied.In all the markets studied except for Garki Ultra-modern Market all others have been victims of fire outbreaks, electrical faults are been speculated to be the cause of the fire outbreak and since the sources of power are at a close range to susceptible areas the fire outbreak is very pronounced.

5.0. CHAPTER FIVE: SITE

5.1 AREA OF STUDY

The site is in Kafanchan located at 9.58333 (latitude in decimal degrees), 8.3 (longitude in decimal degrees). The average elevation of Kafanchan, Nigeria is 733 metres. In Jema'a local government area of Kaduna State, in north-central, Nigeria (Figure 5.1). It is the location of a junction station of the Nigerian Railway Corporation (NRC) and it sits on the line connecting Port Harcourt, Enugu, Kafanchan, Kuru, Bauchi, and finally Maiduguri. Kafanchan is dominated with the Kaninkon people known as Nikyop and with minor the Fanstuwm people in minority.

The local government is bounded in the east by Kagoro in Kaura Local goernement, in the north by Zonkwa and unguwar Rimi districk of Zongon-Kataf Local Government area, in the west by Jaba Local government area and the south by Nassarawa state and the South-esat Sanga local government area respectively (Abaje, 2009)see (figure 5.1).

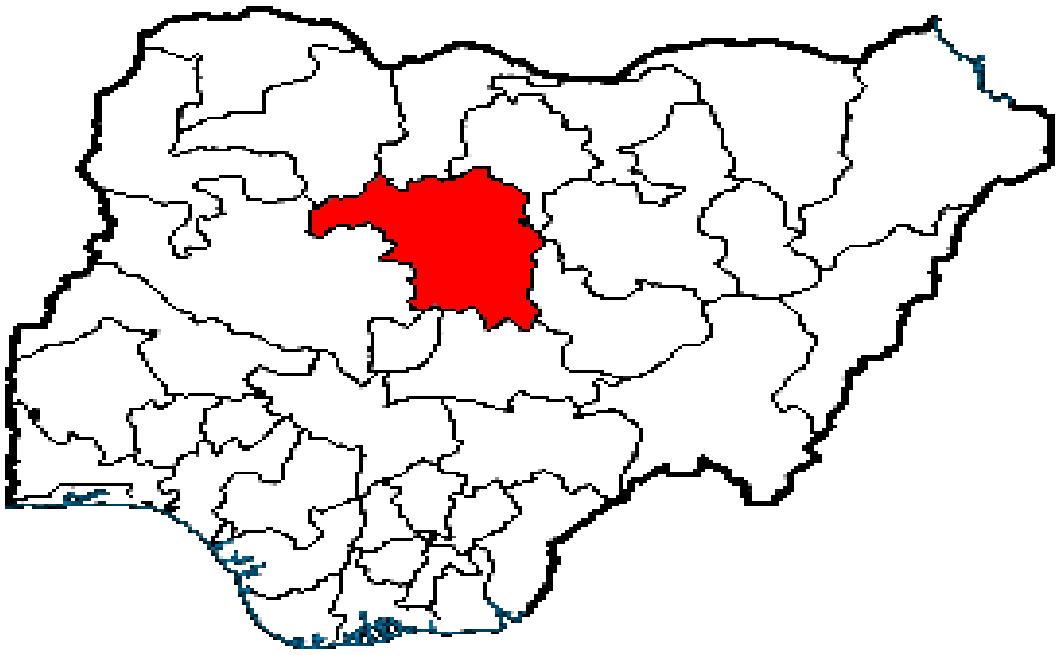


Figure 5. 1: Map showing location of Kaduna state in Nigeria.
Source: Abaje (2009).

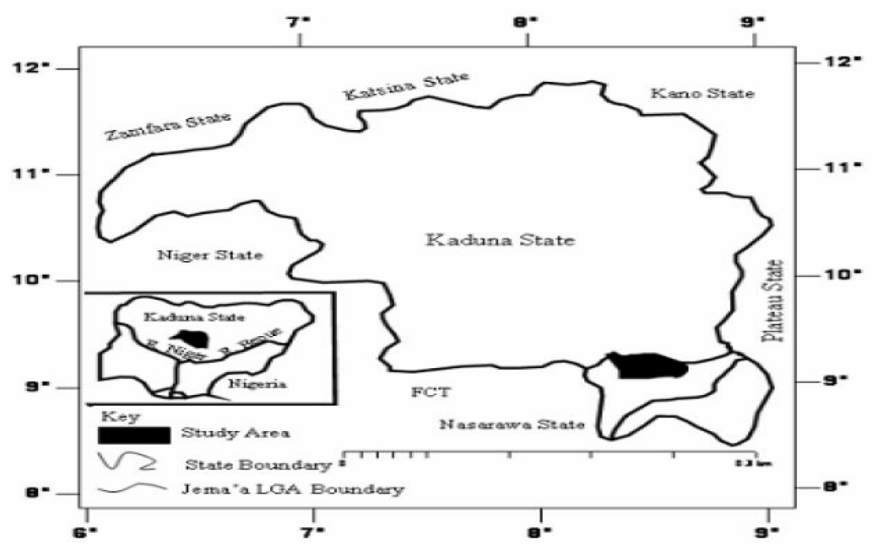


Figure5.2: Location of Kafanhan in Kaduna state. Source: Abaje (2009).

5.2. DEMOGRAPHY OF KAFANCHAN

(Archibong, 2010) Asserts Kafanchan had an estimated population of 183,092. Population by 2012 it has risen to 223,790. it is estimated that the town grew at a natural growth rate of 2.75% per annum however projecting from this population the population in 2014 would be 223,900 as shown in figure 5.2 (The World Gazetteer, 2013).

Table 5. 1: Projected profile table

Year	1990	1995	2000	2005	2010
Assumed annual growth Rate	2.75%	2.75%	2.75%	2.75%	2.75%
Projected population by By end of phase	108,800	123,500	138,200	159,300	205, 150

SOURCE: KASUPDA, (2011).

5.3. Site selection

(Brubaker, 2004)Suggests site for market development is Selected based on the following criteria;

a. Visibility

b. Access
c. Site size and co-tenancy
d. Demographics
e. Income
f. Competition
g. Education
h. Consumer search behaviour

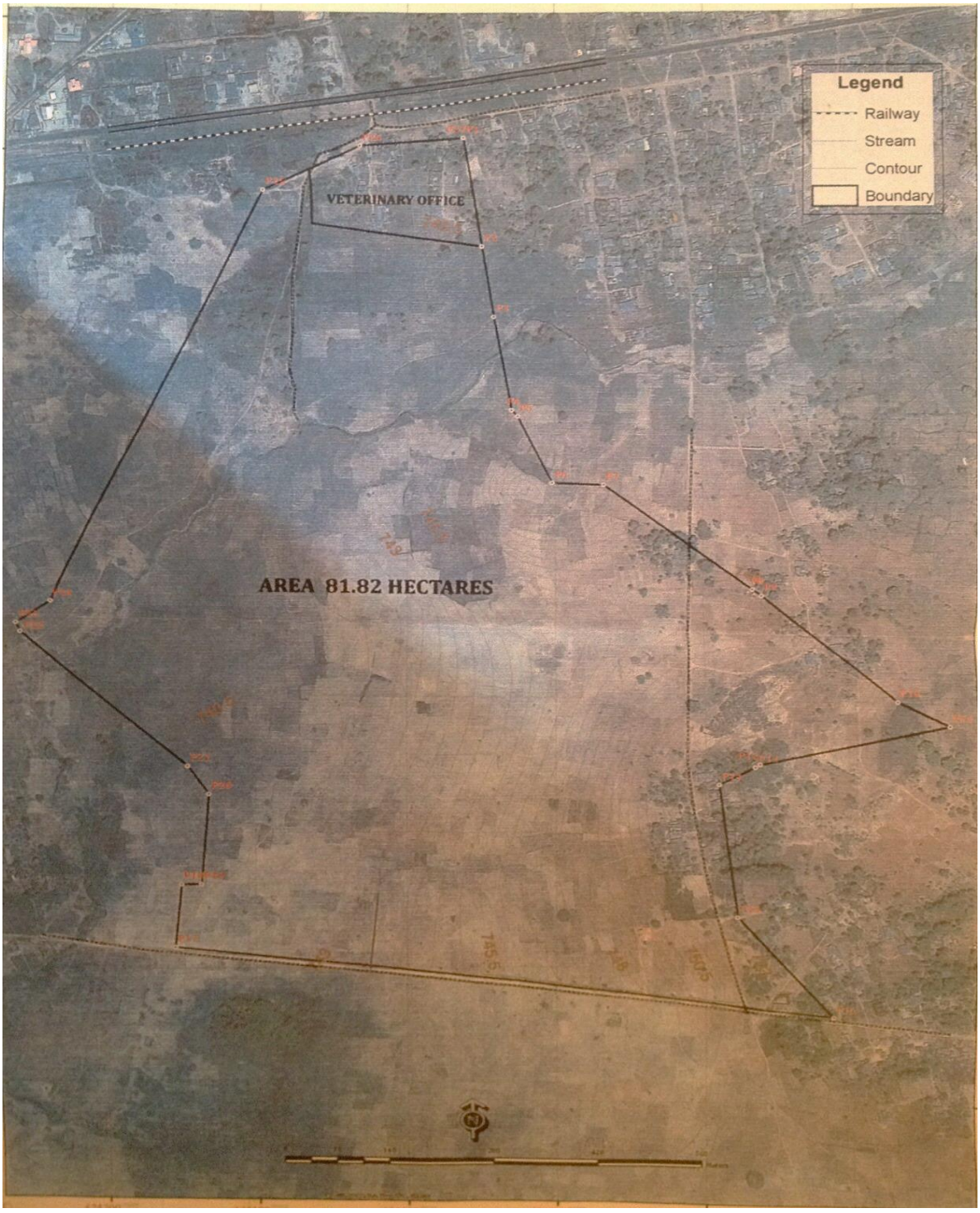


Figure 5. 3: Showing digital mapping site A.
Source: KASUPDA (2011).

Table 5. 2: showing site selection for site A

	CRITERIA	SCALE	REMARKS
3.	Visibility	5	There a clear visibility to site from various standpoint
4.	Access	5	The site can be access from the north or south direction of the site. An untarred road cut into the site. And also a railway line right adjacent the site.
3.	Site size and character	5	The site is very large about 81 hectares and located at a high density area.
4.	Parking	5	Very large spaces for parking: this due to the size of the site
5.	Co-tenancy	3	Facilities close to the site are sparse; only a few that may not show necessarily make any attraction to the market.
6.	Demographics'	4	High populated area.
7.	Income	3	Relatively fair income area composed main of civil servants that are railway workers.
8.	Competition	4	All sites have the tendency to be competitive: this is due to their location at the heart of the city.
9.	Consumer search behavior	4	Same for both sites.
10.	Education	4	This is largely dependent on income; this however reflected same as in income criteria.
TOTAL		**42**	**Site A possess the best possible features for location a market in Kafanchan.**

Weighing scale: Excellent 5, Very good 4, Good 3, Fair 2, Poor 1.
Source: Author's fieldwork (2014).

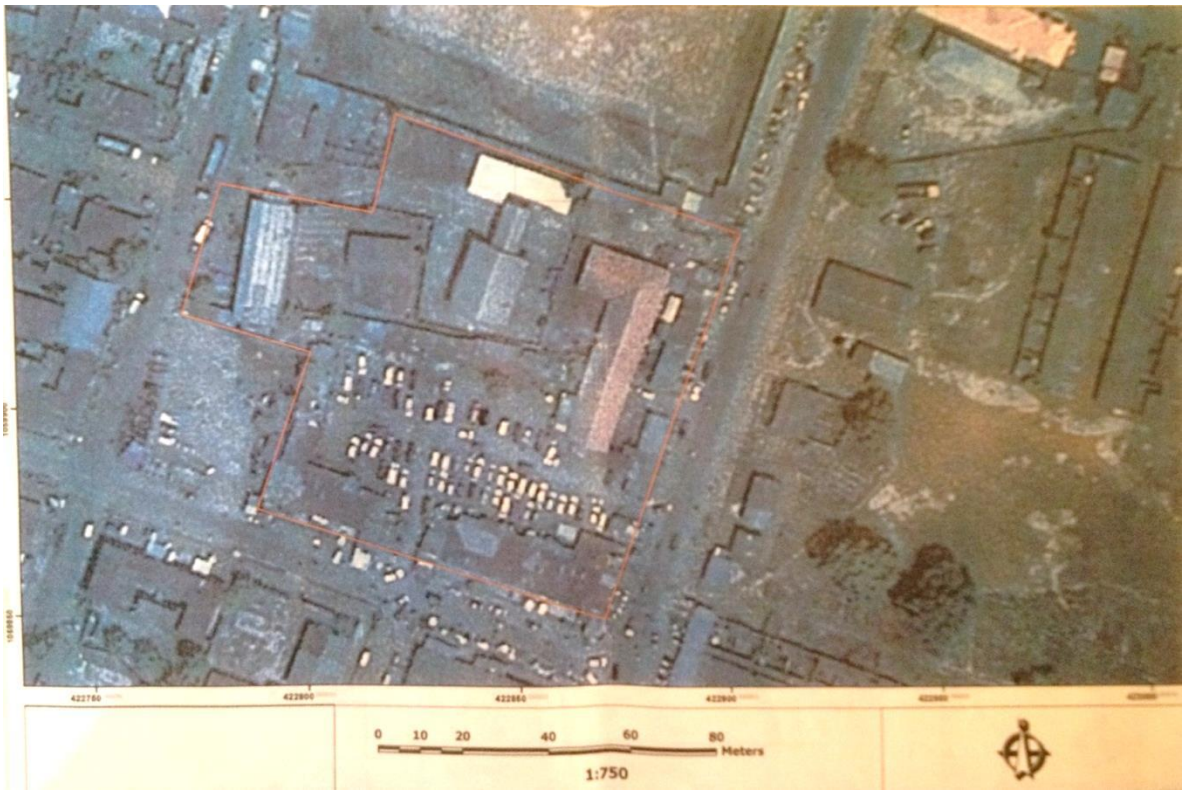


Figure 5. 4: Showing digital mapping site B.
Source: KASUPDA (2011).

Table 5. 3: Showing site selection for site B

CRITERIA	SCALE	REMARKS
1. Visibility	4	There a clear visibility to site from various standpoint
2. Access	2	The site can be access from the only north or south direction of the site.
3. Site size and character	2	The site is small about 3 hectares and located at a high density area.
4. Parking	2	Very large spaces for parking: this due to the size of the site
5. Co-tenancy	5	Facilities close to the site are many; comprising of banks.
6. Demographics'	5	High populated area.
7. Income	3	Same as site A relatively fair income area composed main of civil servants that are railway workers.
8. Competition	4	All sites have the tendency to be competitive: this is due to their location

			at the heart of the city.
9.	Consumer search behavior	4	Same for both sites.
10.	Education	4	This is largely dependent on income; this however reflected same as in income criteria.
TOTAL		**35**	**Site B possess the best possible features for location a market in Kafanchan.**

Weighing scale: Excellent 5, Very good 4, Good 3, Fair 2, Poor 1.
Source: Author's fieldwork (2014).

5.4. SITE ANALYSIS

The factors that are analyzed in a site are:

5.4.3. Climate

Kafacnchan experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cool to hot dry and humid to wet. These two seasons reflect the influences of tropical continental and equatorial maritime air masses which sweep over the entire country However, in Kafanchan, the seasonality is pronounced with the cool to hot dry season being longer, than the rainy season. See (figure0.1) The pattern of rainfall in northern Kaduna (Kafanchan inclusive) is highly variable in spatial and temporal dimensions with inter-annual variability of between 15 and 20% (Abaje et'al, 2010). Again, the spatial and temporal distribution of the rain varies, decreasing from an average of about 1530mm in Kafanchan-Kagoro areas in the Southeast to about 1015mm in lkara-Makarfi districts in the northeast. High storm intensities (ranging from 60mm hr1 to 99mm hr1) plus the nature of surface run off build up the good network of medium sized river systems Kaduna State experiences a typical tropical continental climate with distinct seasonal regimes, oscillating between cool to hot dry and humid to wet see (figure 5:6). These two

seasons reflect the influences of tropical continental and equatorial maritime air masses which sweep over the entire country.

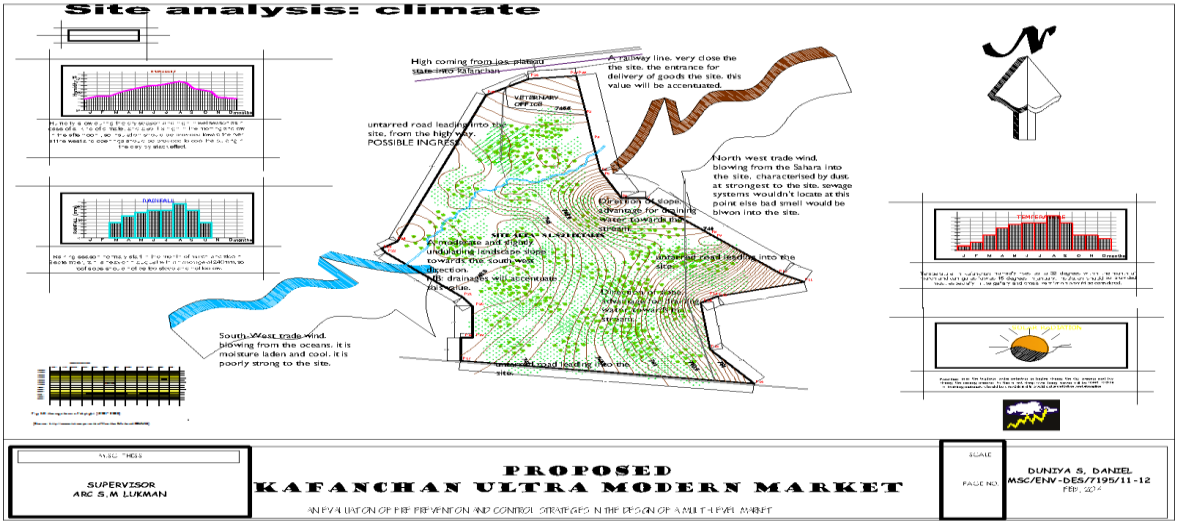


Figure 5. 5: Showing the site analysis (climate).
Source: Author's sketch (2014).

5.4.4. Topography and Geology

The bedrock geology is predominantly metamorphic rocks of the Nigerian Basement Complex consisting of biotitic gneisses and older granites see (Figure 5.8).In the southeastern corner, younger granites and batholiths are evident.

Deep chemical weathering and fluvial erosion, influenced by the bioclimatic nature of the environment, have developed the characteristic high undulating plains with subdued interfluves (Mortimore, 1970). In some places, the interfluves are capped by high grade lateritic ironstone.

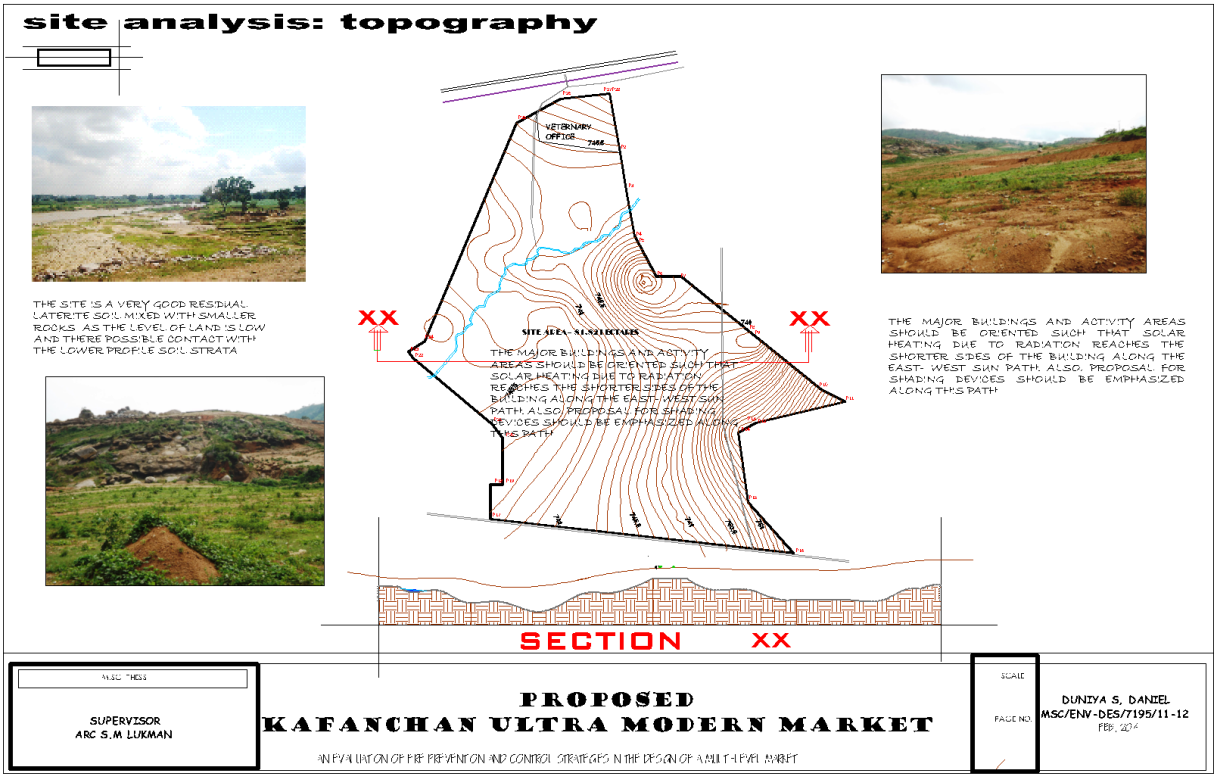


Figure 5. 6: Showing site analysis (topography).
Source: Author's sketch (2014).

5.4.5. Soil and vegetation

Generally, the soils and vegetation are typical reddish brown to red yellow tropical ferruginous soils and savannah grassland with scattered trees and woody shrubs. The soils in the upland areas are rich in red clay and sand but poor in organic matter see (Figure 5.9).

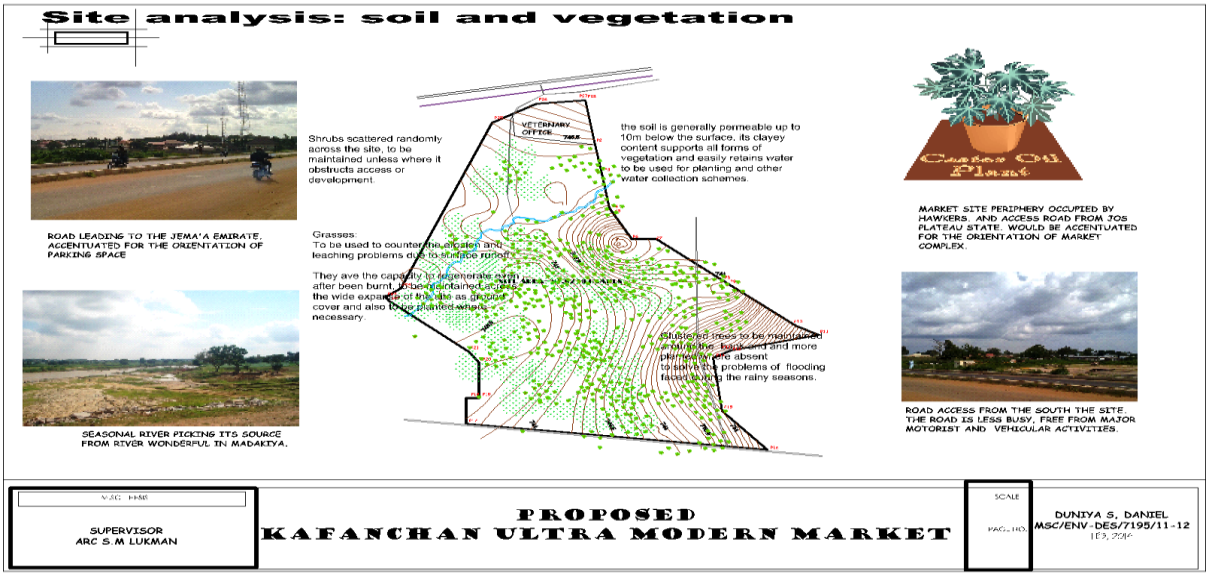


Figure 5. 7: Showing site analysis (soil and vegetation).
Source: Author's sketch (2014).

5.4.6. Site zoning

The site is zoned into A, B, C, and D various advantages particular to the site were accentuated and categories under appropriate zones base on certain design consideration. Zone A is the peripherals of the site parking spaces, gates house, and entrances are possible items that could be located at this point. Zone B just below westwards is the damp area where the stream flows through certain advantages like drainage, treatment of sewagearea, amongst others where to be located there. While C and D far below could be good for warehouses, stalls, cubicles amongst others see (Figure 5.10).

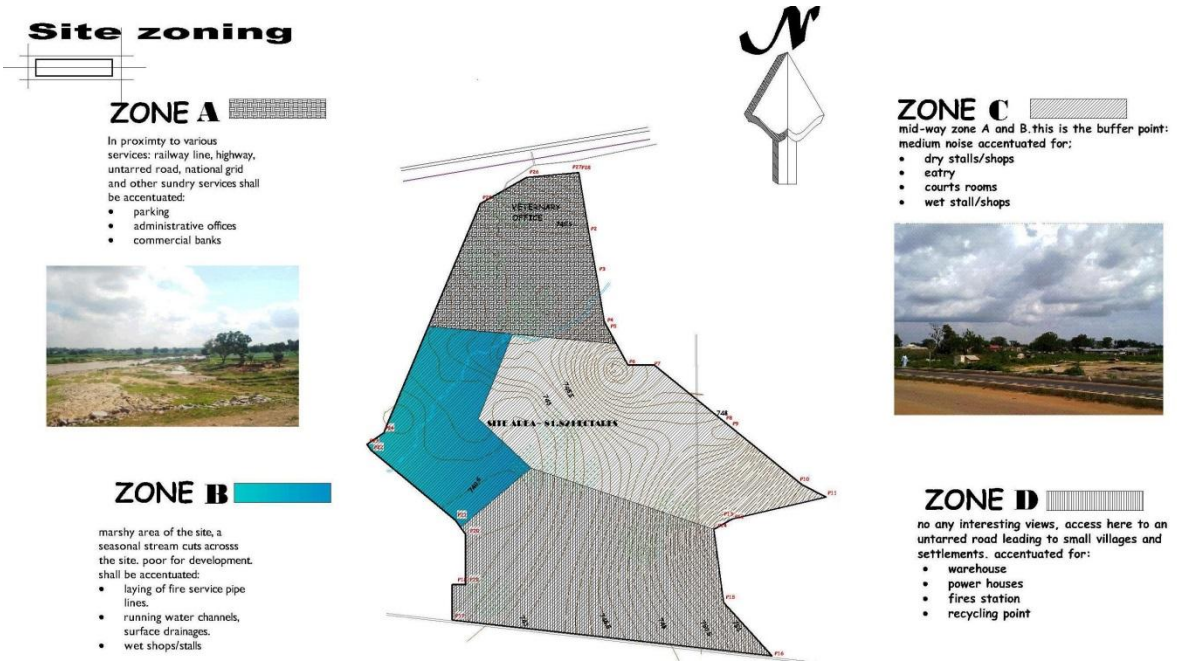


Figure 5. 8: Showing site analysis (zoning).
Source: Author's sketch (2014).

5.4.7. Views and noise

The major origin of noise is from the primary access road, the railway lines. Trees are to be planted close to these sources to buffer this effect see (Figure 5.11). In planning, distance should be created between the major market facilities and this region with proper site zoning analysis. The best view of the site is at the highest point on the site that is north-east of the site, the view

of the major road leading to Kagoro.

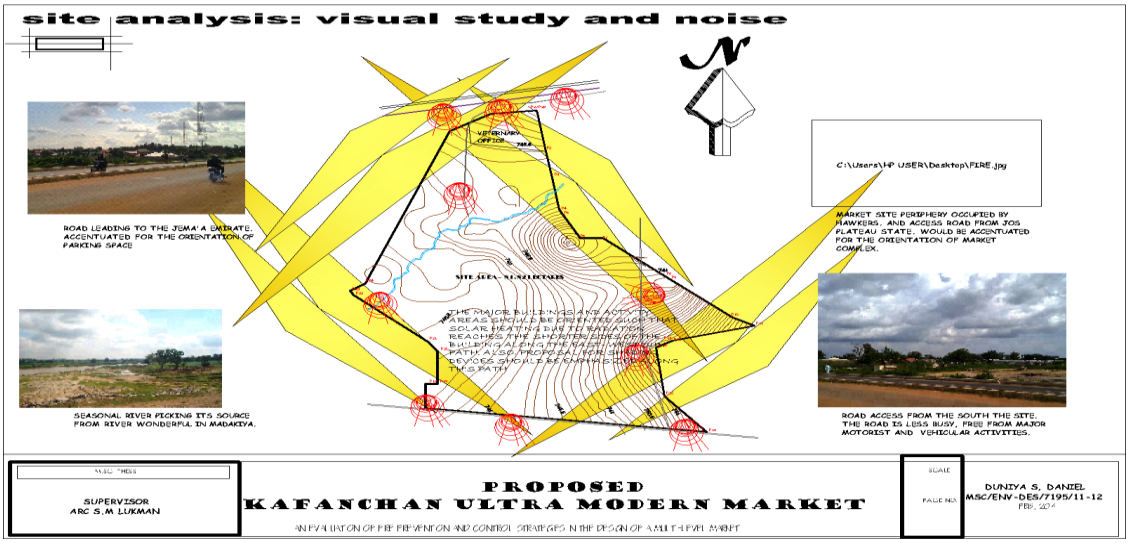


Figure 5. 9: Showing site analysis (Visual and Noise).
Source: Author's sketch (2014).

5.4.8. Human Physical factors

5.4.8.1. Access road;

The main access road runs beside the boundary of the site. It is tarred and

Undulating and there is also an untarred road cutting into the site. All major structures are to be oriented towards the main-road unless where disadvantageous.

5.4.8.2. Ingress and Egress;

The best possible point is abreast the main road. This is because it is the lowest point on the side and due to proximity to the railway line that links Kafanchan and the rest of Nigeria.

5.4.8.3. Local construction;

Materials include thatch, timber, mud, and stone. The only reflection to be applied in the design of the facility will be the in-diginuity of the form. A multi-level market involves a lot of technical highlights that may not warrant the use of indigenous materials, except for burnt bricks, to a limited extent.

5.4.8.4. Settlement;

The veterinary hospital is just at the entrance of the site, while residential and commercial outpost are scattered at the fore of the market and including banks and filling station.

5.4.8.5. Railway line:

The railway line connecting Port Harcourt, Enugu, Kafanchan, Kuru, Bauchi, and finally Maiduguri adjacent the site parallel to the major road.

6.0.CHAPTER SIX: DESIGN REPORT

6.1. DESIGN BRIEF

This provides a description of the various spaces and their relationship, such that it explains the key components of the research that is fire prevention and control strategies. Furthermore, this in detail demonstrates the outcome of the research in the design of a multi-market.

A Market here refers to any established operating means or exchange for business dealings between buyers and sellers. As opposed to simple selling, a market implies trade that is transacted with some regularity and regulation, and in which a certain amount of competition is involved. Thus a market could be said to be collection of shops or stalls: a number of small independently operated shops or stalls, housed in the same building and sometimes all selling the same type of goods.

The design proposal by the Kaduna state Government is, to design an ultra-modern market of 2640 stalls to be located at Kafanchan at Funshown chiefdom close to the railway terminus where easy delivery of goods and services would easily be achieved and further increase economic activities of the region and thus Kaduna state.

The market is design consciously to prevent and control emergency fire out break and to curtail the deteriorating effect of the infrastructure as a result of other negative factors militating against market facilities for instance Waste management systems, circulation patterns both vehicular and pedestrian amongst others.

Apart from providing stall/shops it would also provide a conducive atmosphere for both the buyers and sellers of goods and services to carry out their respective business under protection from adverse weather condition this complete negates the conventional ideology of designing traditional open markets in this part of the globe. Furthermore hawkers

phenomena which is a born of contention in contemporary traditional open markets shall be look into as the whole lot and their needs shall also be catered for.

The Kafanchan Ultra-modern market proposed in this thesis would have the following facilities; administrative block, shops/stalls (large and small), fire service, police station, cubicles (perishable/wet market), restaurants, commercial banks, courts, warehouses and organized convinces.

6.1.1. Administration

The administrative arm, of this building would be located at the 1st floor alongside the commercial banks for easy access by the customers. The staff strength of this market shall comprise:

6.1.2.1. Administrative

i. 1 Market manager
ii. 2 market officers
iii. 4 market inspectors
iv. 3 Tax masters
v. 4 clerks

6.1.2.2. Police

i. 1 inspector
ii. 4 coprals

6.1.2.3. Fire service

i. 4 drivers
ii. 4 Technicians

iii. 2 officers

6.1.2.4. Courts

i. 2 clerk

ii. 2 attorney

iii. 2 Court attendants

6.1.2.5. Restaurants

i. 4 Chef

ii. 4 others

6.1.2.6. Commercial bank

i. 1 manager

ii. 2 ICT

iii. 2 Cashiers

iv. 2 security

6.1.3. Description of spaces

6.1.3.1. Restaurants, courts rooms and commercial banks

The restaurants are 2 numbers each to cater for 30 persons on the ground floor, it was design to accommodate a dining area, a kitchen, store and cold room while the court rooms have two offices alongside the chamber it is located first floor.

Commercial banks are located first floor for visibility on approaching the market complex from the outside or inside. It consists of a banking hall, an ICT office, a managerial office and counters within the banking hall. There are two commercial banks within the complex.

6.1.3.2. Warehouses and convinces

The warehouses are all a single floor sited away from the market complex on either sides but not without adequate access to convey goods in and out of the complex. Most importantly they are sited away to check congestion as a result of vehicular conflict between large vehicles and small vehicles and then pedestrian. Service roads were provided for delivery of goods. The conveniences are provided to accommodate toileting facilities like wash hand basins and W.Cs each floor has it toilets. Each floor was design to have 10 W.Cs and 5 wash hand basins.

6.1.3.3. Fire service and police station

This is located at the ground floor provisions were made for two station vehicles, with offices and a maintenance room and a store at the side. The fire service station is located right at the entrance to the market complex where hence it can; from there fire fighting vehicles can easily go through various sections of the market in cases of emergences. In addition a police station is located close to the fire service station which can accommodate 4 inmates that is male and female section clearly defined. The police post was necessary to curtail and respond to all criminal activities within the market environment.

Table 6. 1: Showing schedule of stall/shops/cubicles/stands.

S/N	Stalls	quantity
1	Large stalls	600
2	Small stalls	1350
3	Cubicles	500
4	Plots for auctioning	100
Total		**2550**

Source: Author's fieldwork (2014).

The smaller stalls measuring 3metres by 3metres are located either sides from the ground to the second floor, while the larger stalls measuring 6metres by 6metres are also located either side from ground floor to first floor all this stalls are clearly defined. The second floor shall cater for fancy goods; this is to enable display, while the first floor shall be for textiles, shoes, provision and other sundry goods. The ground floor includes all goods that may require the use of heavy machines or they themselves (goods) are heavy.

The cubicles shall accommodate all perishable and wet goods all under one roof. This is to completely separate them from other section that do not use water or could easily be ruined by water for the primary purpose of hygiene. This separation also enables adequate control and management of liquid waste envisaged to be generated by this portion of the market, through effective drainage systems. This section of the market is very large and the need to house the users is a primary concern this inform the choice of the structure. This entire vicinity is roof with a membrane held aloof by cables in tension suspension by a rib, a lattice steel truss system connected to the A-pylons at the two ends. The cables at the ends are held firmly by heavy abutments see (Figure 6.1).

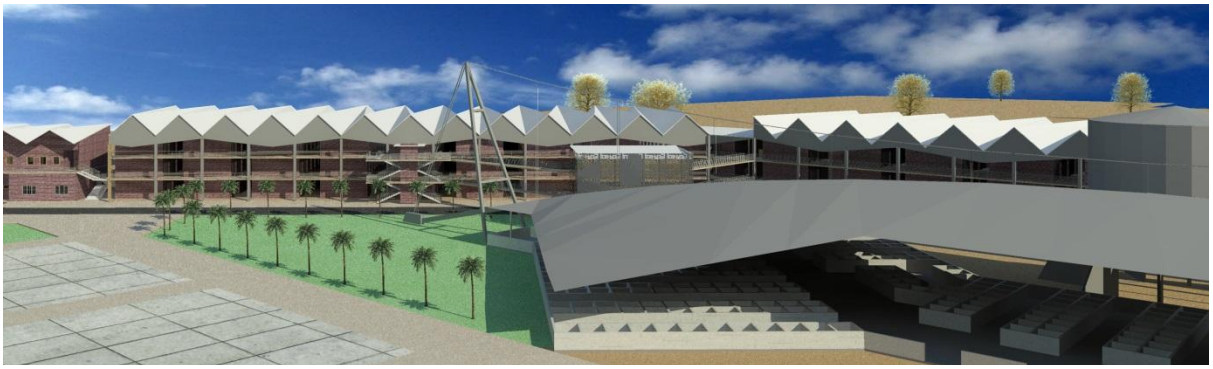


Figure 6. 1: Showing the A-pylons suspending the cables to houses the cubicles/perishable market.
Source: Author's sketch (2014).

Dedicated plots where made for promotions by corporate organisations, government agency and individuals, they are centrally located. These allocated plots shall be used for auctioning, and showing casing of new products or servicing. Display is of essence here hence the reason for the choice of location. This shall hold on specific day(s) of the week where temporal structures could be mounted to accommodate their stands could be raise for this purposes.

6.2 MARKET PLANNING AND DESIGN

The site was planned in such a way as to give all users equal opportunity to interact that is all facilities are located around a central area to carry all and sundry along. Vehicular traffic were located about the peripherals of the market at proximity to various units to further emphasis surveillance by users over their vehicles while shopping to enable them have a sense security over their properties see (Figure 6.2). Pedestrian ways further stretches from the parking's to the markets central core leading users to different units around the market.

Most importantly the adoption of a common area for communal facilities with various accesses is to emphasis ingress for firefighters which was a major setback in all the cases

studied. This is importantly because fires maybe be predicted at most where or when it can surface.

Facilities like the administrative offices, police station, Restaurant, clinics and fire service station are located at the peripherals for easy access for everyone, all this facilities are close to the parking spaces.

Beyond these points is the market proper which has a central core with facilities like the cubicles as hawkers point, warehouses, are refuse collection point scattered at considerable distances. Radially about this facilities are the stalls/shops which are however mixed with the larger and small stalls see (Figure 6.3). At each block of each floor there are convinces at their ends.

More consideration is giving to landscape with hedges, trees, grasses, fountains, this is done symmetrically, linearly and sometimes orbit about a point this is to give the market a taste of pleasure targeted at the users so that they feel at ease even when shopping this contrary to the feeling in most markets studied where users feel very uneasy shopping in markets.

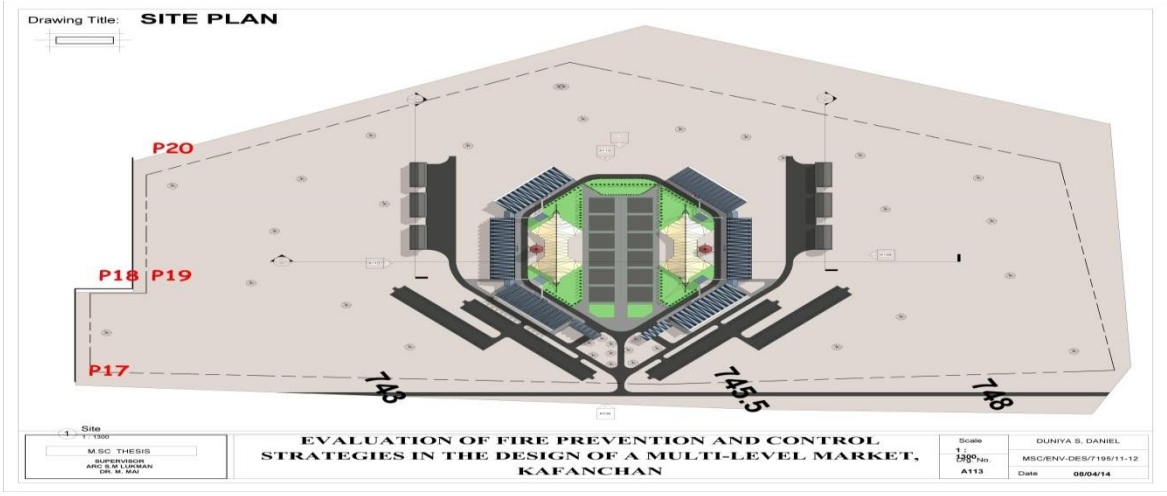


Figure 6. 2: Showing the site plan.
Source: Author's sketch (2014).

6.1.4. Spatial Organization

At the entrance of the market, users are greeted by communal facilities namely: Restaurants, clinic, administrative offices, fire service station, police station, commercial banks etcetera. These facilities are related together with a parking space which extends to the core of the markets proper.

The stalls are arranged linearly around a central core, with access stair case midway the blocks detached from the main building.

This staircases where designed to emphasis the need for the staircases to service as escapes and access/exit staircase in the case of emergency. It is open so as to eradicate the action of smoke during escape. At the far ends are located convinces at every floor of every block. The stalls are mixed that is larger and small stores.

The warehouses are centrally at different points so as to serve different sections of the markets efficiently, based on their different call of need. For instance a warehouse dedicated for a cold and wet sections of the market it follows in that manner. These warehouses are provided with north lighting for the inside to be lighted naturally. This north light where oriented in a way as to harness from the sun it rays.

6.2. DESIGN CONCEPT

The general idea behind this design is culled from the phenomenon of a “ripple effect” this phenomenon could be viewedin several ways across various disciplines of life ranging from sociology, economics, computer science, and physics amongst others see (Figure 6.6).



Figure 6. 3: Showing ripple effect.
Source: Twinkle (2014).

The literal definition to this phenomenon is: A ripple effect is a situation where, like the ever expanding ripple across water when an object is dropped into it an effect from an initial state can be followed outwards incrementally. In other words the repercussion of an event or situation experience far beyond its immediate location.

This effect by extension is the idea translated into the design of the propose market, from the established definitions of the concept of rippling effect. The proposed market is imaged as a small interference in a small community (Kafanchan) that would enhance co-existance and in the long run increase economic activities not only in kafanchan but in Kaduna state in general.

6.2.2. Concept formulation

The concept here is represented with a hexagon split into two symmetrical halves in such a way that a central area is created. The ends of each sides of the hexagon appears to spread

outwards incrementally which represents the slow movement of effects of the proposed market towards infinity, every little increase picks its source from the smalls form in the middle see (Figure 6.7).

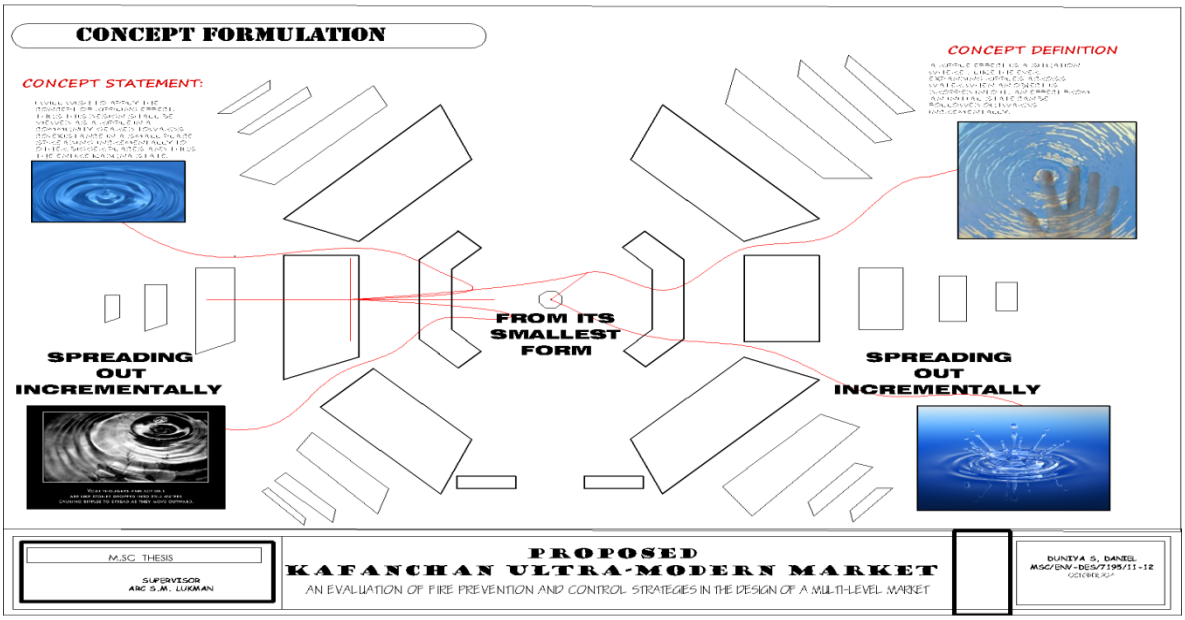


Figure 6. 4: Concept formulation.
Source: Author's Sketch (2014).

6.3. FIRE PREVENTION AND CONTROL STRATEGIES AS REFLECTED IN THE DESIGN OF A MARKET

When designing a market building for fire prevention and control the following keys things must be put into consideration:

6.3.2. Construction technique

The connections that are floor to floor, wall to floor amongst others were treated with gypsum which is a high resistant material couple with the folded plate roof. The entire idea is to prevent fire and smoke spread through any of the mention parts, this fires and smoke

are confined within a particular room for a period of time until the intervention of the fire fighters or until a complete evacuation of the building has been achieved.

6.3.3. Zoning

Zoning is another critical point, it was applied critically. Firstly the wet areas where clearly defined from the dried areas. (Figure 6.8). Demonstrates a typical use of folded plate roof to prevent fire transfer from one room to another. Fire prone areas are clearly defined from lesser fire prone areas this to avoid a collateral damage should incase of fire emergency. Building was clearly defined with a setback of at least 12metres to avoid the hazard of back drift.



Figure 6. 5: Showing a 3D section across the shops.
Source: Author's sketch (2014).

6.3.4. Building materials

The building material used is burnt brick this is due to it high resistance and endurance under fire, since it is already a product of fire. This material can withstand fire better than most materials at high temperatures. Folded plate was used principally as a roof style the

material used for the folded plate is concrete with a thickness of 100milimetres see (Figure 6.9).



Figure 6. 6: Showing the predominant building materials used.
Source: Author's sketch (2014).

6.3.5. Material and Structure.

Predominantly both indigenous and modern building materials were used in the construction of the building. The main building material used is hydra form adobe blocks with a supporting System of concrete beams and columns. Steel has been used as the major roof truss Element on the complex buildings. Adobe blocks where chosen for the construction of this building due to its positive behavior in fire, where concrete and steel would poorly the material would be just ok for construction aimed at combating fire.

The roof type is folded plate which a monolithic roof made of mass concrete, for the stall/shops which has the advantages of confining fire at one space without spread into other compartments. This roof structure need no roof trusses which may favor fire spread. Furthermore folded plate has the advantage of rigidity and strength and could span through larger distances, yet standing the test of time.

The choice of roofs was due to the fact that the research exposes no possible fires from this point owing to the kind of goods sold. Secondly to celebrate the design in terms of aesthetics and advance in technology and for landscape elements like benches and so on. Translucent material is used for the done and Low Emissivity glazing for the windows which reduce the amount of heat penetrating into the building and stone tiles on the elevation to prevent heat absorption.

6.3.6. Circulation

Accesses for fire fighters has to be very free see (figure 6:10). This to increase and aid fire fighter and rescue to any part of the building.

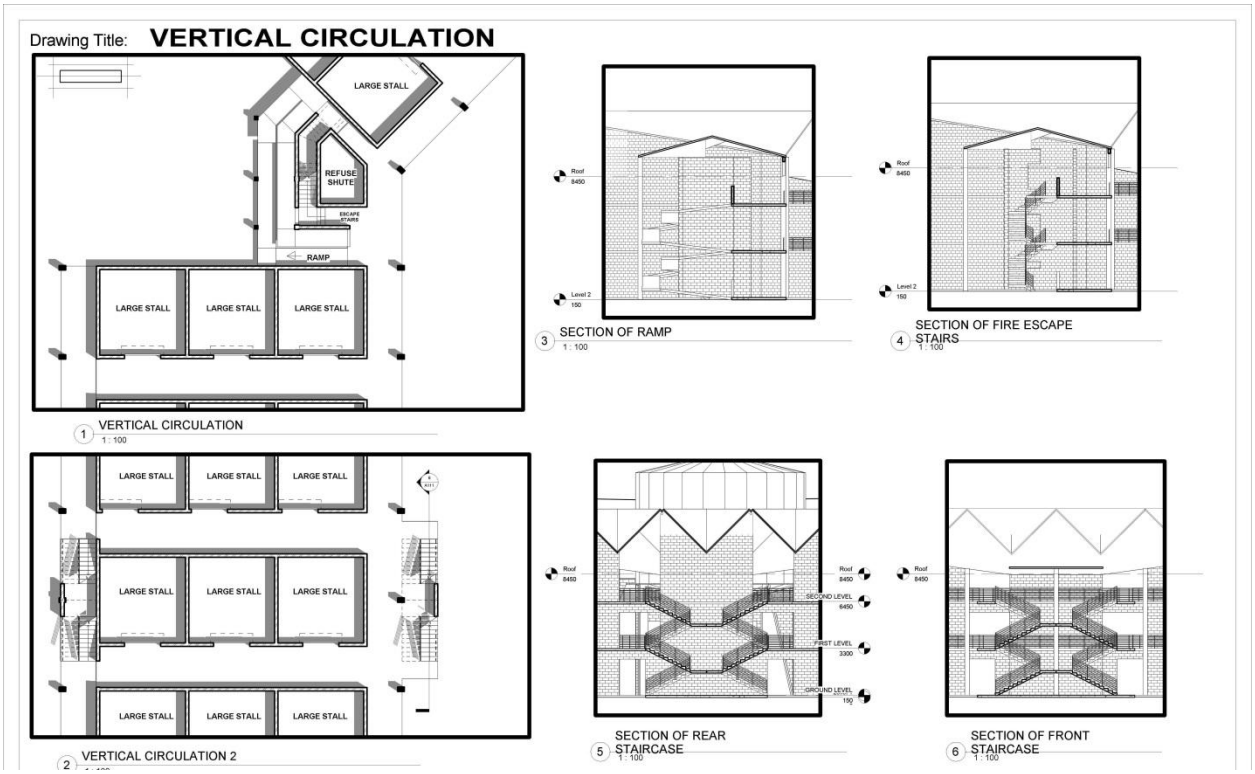


Figure 6. 7: Showing the plans and section of vertical circulation means.
Source: Author's sketch (2014).

Circulations, both vertical and horizontal see (Figure 6.10), was accounted for through staircases at gentle slope with ramps for those who are physically challenged and the

transportation of goods via wheel barrows and trowlers these vertical circulators are located at varying points in the market complex.

6.4. BUILDING SERVICES

These include Electricity, Water, and Drainage, Communication System and firefighting devices / mechanism without these the level of activity in the complex would not exist.

6.4.2. Communication system

Communication is very important in such public buildings all parts of the center will be connected to an intercom system routed to the main communication centre, located in the main building.

6.4.3. Power Supply

The main source of power supply is the Power Holding Company of Nigeria which is going to be supplemented by photovoltaic solar panels mounted on all the building units .Also an alternative power supply will be provided by a generator for emergency cases.

6.4.4. Water supply

Stream Water was tapped to supply sprinklers on site and a borehole would supply water to the market this water would be used for all the services of the in the market.

6.4.5. Sewage Disposal

Septic tanks and soak away pits would be used the sewage collection chamber will be equipped with treatment plants to prevent contamination of the environment.

7.0. CHAPTER SEVEN

SUMMARY OF FINDINGS AND CONCLUSIONS AND RECOMMENDATIONS

7.1.SUMMARY OF FINDINGS

Fire which is amongst the worrisome problems of markets forms the main thrust of this study. This research work however, is geared towards evaluating fire prevention and control strategies in some selected markets. Emphasis is on multi-level markets, this is necessary because previous works by architects has laid so much emphasis on markets that are a single level not putting into cognizance some vital aspects like vertical and horizontal fire spread and control. Efforts towards this fire spread by designers in general had been slim because they tend to lay emphasis on economy and other sundry factors thereby compromising the others vital areas that have to do with fire spread, control and prevention.

Review of relevant literature in Nigeria and other countries shows the significance of contemporary markets in transforming a city and further discussing the new trends and typologies that shapes market design.

Findings from writings, interviews and works of prominent sound architects and theorists aided in culminating a set of principles on which fire prevention and control has been ordered, from these principles, theme peculiar to all of them such as Safety strategies, Suppression strategies, Spread and control, Building materials/construction and detection strategies have been extracted.

Case studies were conducted and analysed as single units based on the following headings: Brief introduction, site organization planning and landscape, facilities and service, building material and structure and spatial organization. Data obtained through a checklist ran where

used, coded and scored which were expressed in percentages in tables, charts and graphs. This was to assess the level of conformity of these markets in respect to matters addressed by the study.

Interviews were conducted at the various places under study for the buyers, sellers, administrator and designers and opinions where suggested and recommendations based on their own perceptions of the problem studied. The different response where grouped under sub-headings and a percentage of the total respondents that fall under those sub-headings were expressed in percentages which enabled the results be presented in charts.

Generalizations were made in respect to fire prevention and control strategies and a site was located. The site was analysed based on its peculiarities. The advantages of the site were accentuated to the benefit of the proposed facility. The location of the facility is strategic to produced visual display of goods, economy, recognition and appreciation.

It is anticipated that the creation of a market building will transform the city, foster economic activities in Kafanchan and by extension Kaduna State and the facility will assist in the in fostering the desired unity which is most devoid in that area as most people of different tribes, race and creed would converge for the purpose of business.

7.2. RECOMMENDATIONS

a. Government, markets operators should improve and create more awareness on the need for conscious attitude towards the use of some of the strategies and device in case of fire disasters.

b. Firefighters should be well funded and equipped to enhance fight fire with both technical know-how and equipment so as to effectively arrest fire emergencies.

c. Designers of markets should incorporate fire control and prevention strategies in their design and they should ensure it is within the reach of endangered user.

d. Positive attitude towards the use of market facilities, that's indiscriminate disposal of waste, remains of burning cigarettes should be within designated areas. To prevent fire from springing up from unsuspected areas.

e. Agency saddled with the responsibility of enforcement of laws should be at the hem of affairs in persecuting all defaulters so as to maintain sanity within and around the market facility.

7.3. CONCLUSIONS

From the analysis carried out on the markets namely Tejuosho market, Jos main market, Garki ultra-modern market, and Central market Kaduna. It was discovered that Tejuosho market had some level of treatment for fire suppression and detection strategies from the devices in place. The planning is however a massive for failure especially for tejuosho market largely owing to the fact that there was very poor response to fire-fighters and their gadget. In addition selection of the building materials used was deficient as far as fire is concerned. While the Garki Ultra-modern market had a very significant treatment especially in the area of building materials used and fire safety too was a bit responded to. The other two case studies had no significant treatment for fire.

The research has further demonstrated critical definition of spaces and their function is key to fire prevention and control, that is goods that are highly inflammable should be clearly separated from areas where the goods does not really support fire. That is wets areas and dry areas for instance.

Furthermore the research shows how fire could easily be spread through ducts and voids that have not been careful treated especially through roof spaces thus brings to the fore how careful selection of roof style could go a long way in slowing down fire spread at least till the coming of fire-fighters.

The study emphatically reveals how electrical faults has to a large extend been attributed to causes of fire in virtually all the cases studied, mostly this aspect of building a market is compromised as the research revealed that its largely due to sub-standard use of this materials to maximize profit and minimize cost by the investors and contractors.

Construction methods and building material was also revealed by the research to be a factor to militating against fire with respect to both prevention and control treatment of critical points with fire resistant material like gypsum, areas like the floor to floor, wall to floor, wall to roof connections and also the doors and windows should also be fire resistant. This may not be to stop the action of fire completely both to a large extend slow it rate of reaction until a large number of ushers are evacuated to safety.

7.4. CONTRIBUTION TO KNOWLEDGE

There are there major contributions to knowledge they are;

1. Segregation (zoning) of areas that are susceptible to fire from places that are less susceptible. See Design framework for fire safety in market in page 90.
2. An integration of mechanical suppression systems into the design of markets is required. This can be achieved by providing fire hydrants at 30meters interval each.
3. Provision for ducts, wall to wall, floor to wall, and wall to roof connections are to be made air tight and also fire retardants material such as gypsum plasters and paints should be used, to stop the spread of smoke.

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APPENDIX A

AN EVALUATON OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET: KAFANCHAN ULTRA-MODERN MARKET

CHECKLIST

Under the following headings:

1. Building materials/construction
2. fire detection devices
3. fire suppression devices
4. Fire spread control strategies
5. Fire Safety

CHECKLIST ASSESSMENT TABLE OF FIRE PREVENTION AND CONTROL STRATEGIES

S/NO	PREVENTION AND CONTROL DEVICES/STRATEGIES	SCORING				
		5	4	3	2	1
1.	**Building materials/construction**					
a.	Gypsum					
b.	Burnt bricks					
c.	Concrete					
d.	Steel					
2.	**fire detection devices**					
f.	Fire alarms					
g.	smoke detectors					

3. Fire suppression strategies					
a. Water sprinklers					
b. Smoke vents					
c. Fire hydrants					
4. Fire spread control strategies					
a. Fire compartment					
b. Fire grading					
c. Fire stopping					
d. Fire wall					
5. Fire Safety					
a. The exit access,					
b. The exit, and					
c. The exit discharge					

APPENDIX B

AN EVALUATON OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET: KAFANCHAN ULTRA-MODERN MARKET

INTERVIEW (SHOPPERS)

SECTION B (INTERVIEW)

1. Are you familiar with any fire control and prevention device(s) or strategy?
2. How do you think the following fire devices help control fire in the case of emergencies?
    a) Fire extinguishers
    b) Fire hydrants
    c) Smoke and heat vents
    d) Fire alarms
    e) Smoke alarms
    f) Water sprinklers
3. How in your opinion would you describe the adequacy of the devices/strategies in markets?
4. Have you been any case of fire emergency in a market before?
5. What are some of the challenges you encountered in putting to use the fire prevention and control devices/strategies available?
6. In your opinion suggest way of preventing fire emergencies in a market

AN EVALUATON OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET: KAFANCHAN ULTRA-MODERN MARKET

INTERVIEW (ARCHITECTS)

1. Have familiar are you with the fire prevention and control strategies?
2. Do you make provision for these strategies/devices in your designs?
3. Evaluate the current use of fire prevention and control strategies in markets in Nigeria (multi-level markets inclusive)?
4. What challenges do you face in employing these strategies in your design?
5. What suggestions do you have for improving fire control and prevention in market design in Nigeria?

AN EVALUATON OF FIRE PREVENTION AND CONTROL STRATEGIES IN THE DESIGN OF A MULTI-LEVEL MARKET: KAFANCHAN ULTRA-MODERN MARKET

INTERVIEW (ADMINISTRATORS)

1. Are you familiar with the fire control and prevention devices/strategy in markets?
2. As a market administrator how do you ensure effective use of this device in the case of emergency?
3. Have you have any cause to use these devices in this Market before?
4. What are some of the challenges you had during the emergency?
5. What suggestions do you have for improving the effective use of these devices should incase of and emergency?

APPENDIX C

SUMMARY OF FACILITIES PROVIDED FOR YABA MARKET, LAGOS.

Table 4.1 showing facilities in Basement floor Level.

Facility Present (sqm)	Capacity	Area
Car Parking	580 Cars	
Refuse handling and sewage treatment area	-	
Truck Loading and off-loading area	-	
Commercial Banks	3	
Police post	1	
Conveniences	15	

Source: Lagos Market Development (2013)

Table 4.2 showing facilities in ground floor Level

Facility Present		Capacity
Area(sqm)		
Klamp stalls	1556	
Locked up shops	46	9sqm
Commercial Banks premises	3	

Source: Lagos Market Development (2013)

Table 4.3 showing facilities in 1st floor Level

Facility Present (sqm)	Capacity	Area
Locked up shops 9sqm		482
Locked up shops 12sqm		44
Locked up shops 19sqm		164
Clinic	1	
Commercial Bank	3	

Source: Lagos Market Development (2013)

Table 4.4 showing facilities in Second floor Level

Facility Present Area(sqm)			Capacity
Locked up shops 9sqm	**A**		**550**
Locked up shops 19sqm	B		210
Locked up shops 19sqm	C		210
Eatry and cold rooms		4	
Larger 142sqm			shops

Source: Lagos Market Development (2013)

Table 4.4 showing facilities in Second floor Level

Locked up shops 9sqm			**550**
Locked up shops 19sqm			210
Eatry and cold rooms		4	
Larger 142sqm			Shops

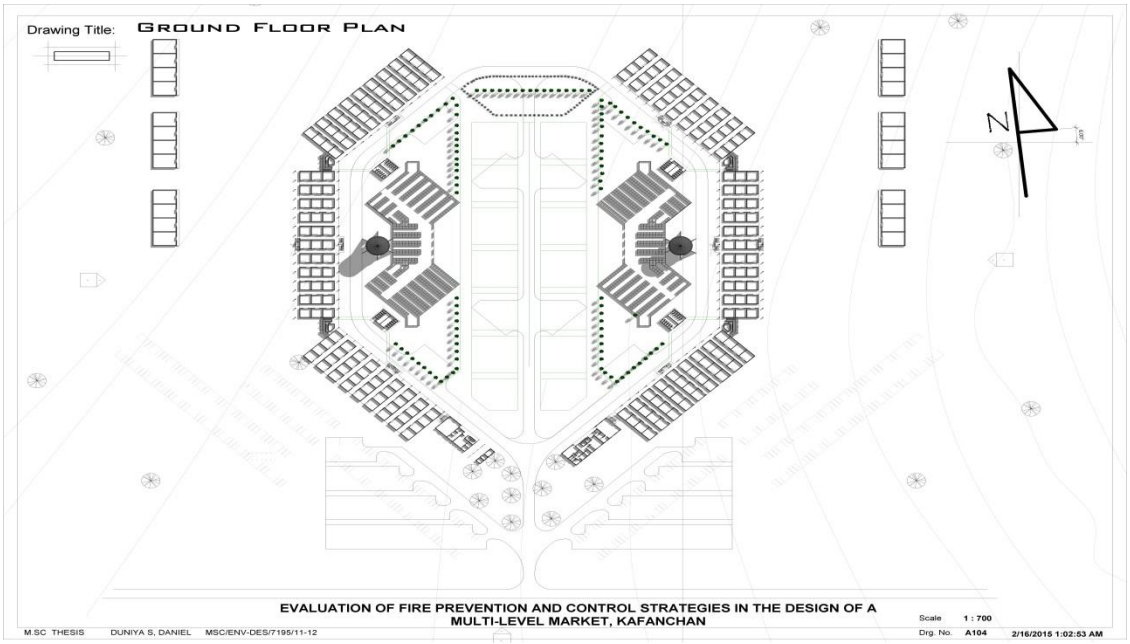
Source: Lagos Market Development (2013)

Table 4.6 showing facilities in Fourth floor level

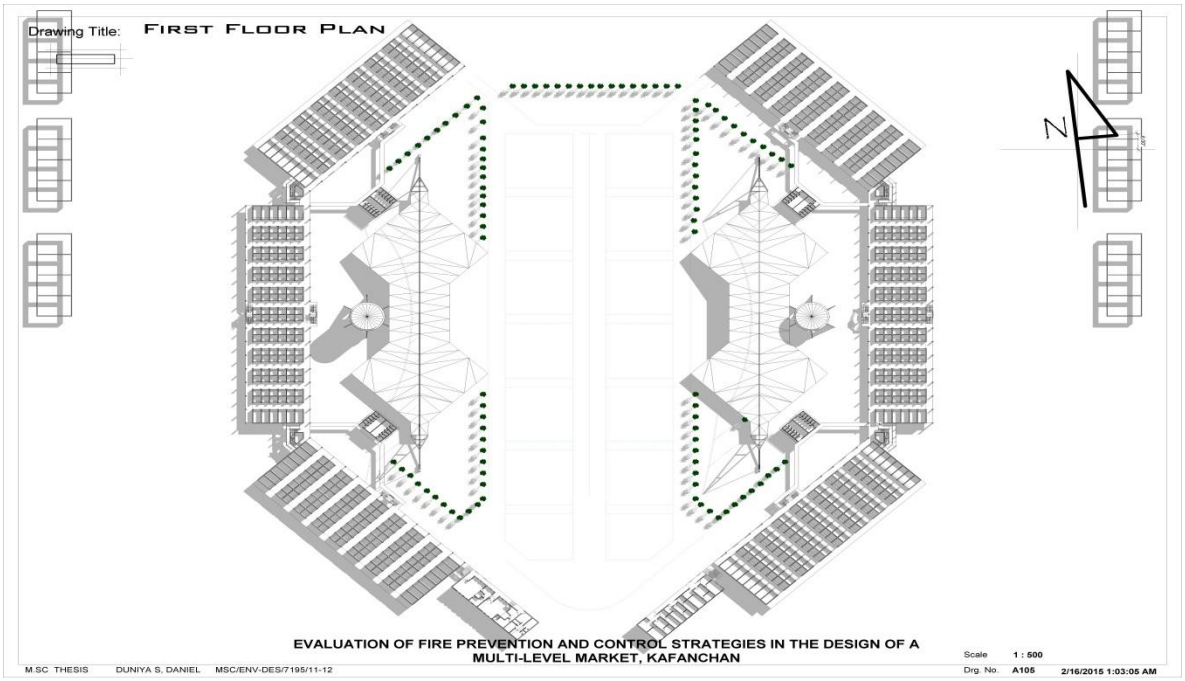
Facility Present Area(sqm)			Capacity
Locked up shops 9sqm			588
Locked up shops 19sqm			214
Locked up shops 26sqm			6
Eatry 142sqm	and	Larger	shops

Source: Lagos Market Development (2013)

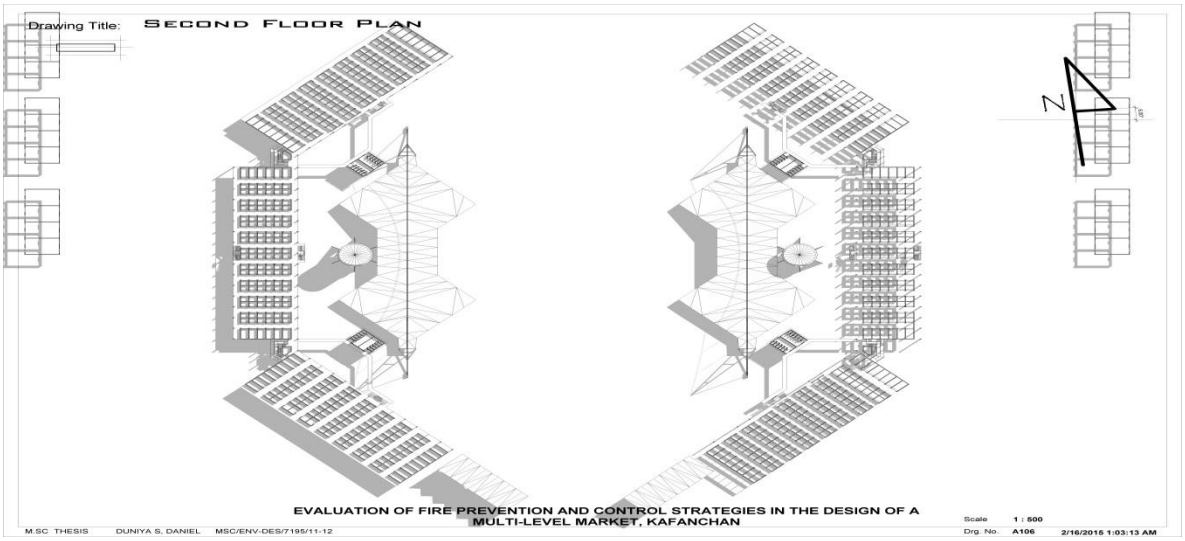
APPENDIX D



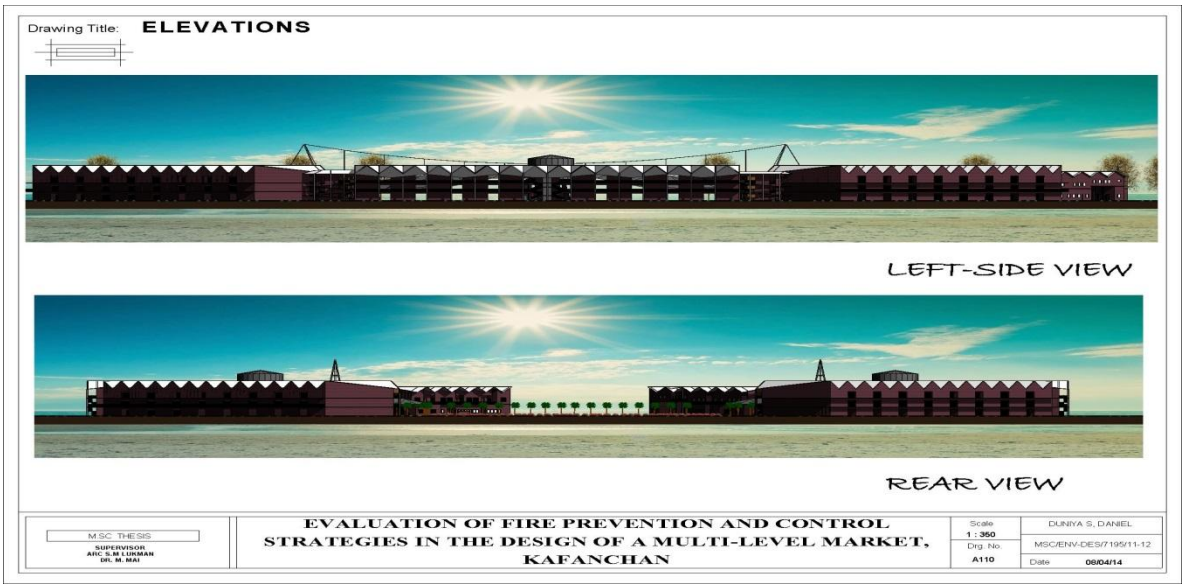
Ground floor plan



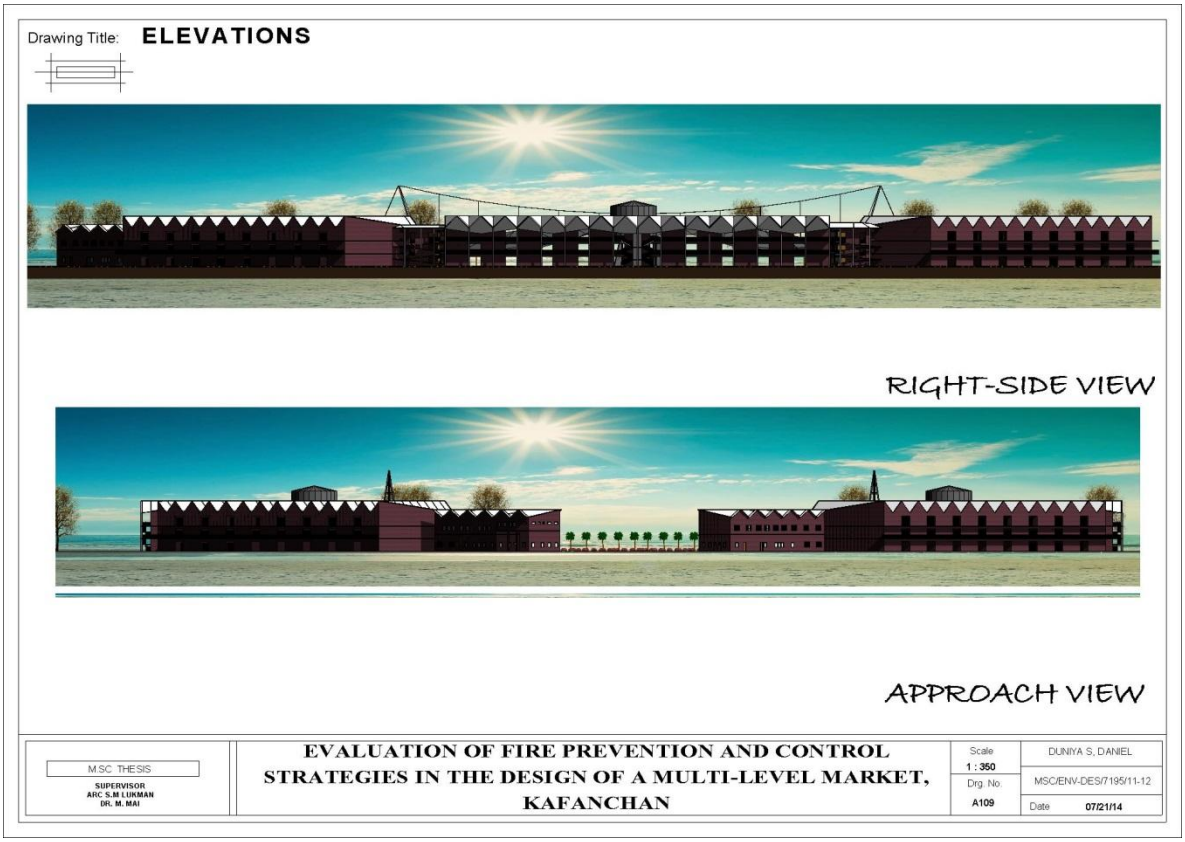
First floor plan



Second floor plan



Left – side elevation and rear elevation respectively



Right-side and Approach elevations respectively



3D perspective of the entire proposed kafanchan market