EVALUATION OF FIRE PREVENTION AND PROTECTION MEASURES IN MARKETS IN THE FEDERAL CAPITAL TERRITORY OF NIGERIA

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PhD/SET/2015/665

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ABSTRACT

Nigeria has been facing the problem of frequent fire outbreaks in market places. This problem has led to the substantial loss of valuable goods, properties and human lives. Hence, it brought a need for the evaluation of fire prevention and protection measures put in market places with the aim of generating additional guidelines to improve the National Fire Safety Code of Nigeria with respect to market design. The population of this research was the seven regional built-up markets in the Federal Capital Territory (FCT) of Nigeria that are under the control of the FCT Markets Management Committee. Thus, Wuse market, Garki model market and Kado market were selected from the research population for study by using purposive sampling method. There are 2,091, 1,430 and 353 sales points in Wuse market, Garki model market and Kado market respectively. Hence, by applying systematic sampling method at every 5^{th} interval, 419, 287 and 71 sales points were studied in Wuse market, Garki model market and Kado market respectively. Consequently, primary research data were generated from the direct observations of the conditions of the three selected markets, and the total number of 777 questionnaires administered to the sales people in the markets. Likewise, they were generated from the discussions with the sales people, and staff of the FCT Markets Operating Bodies such as the Federal Fire Service of Nigeria, National Association of Nigerian Traders and the managing company of the selected markets. Also, interview questions were administered to the FCT Markets Operating Bodies, in order to generate the primary data. Secondary research data were obtained from the reviews of relevant literature on fire outbreaks in markets; other public buildings in and outside Nigeria. Parametric statistical and content analysis techniques were used to analyse the data, and the results of the analyses were accepted via normality test. The results of the research showed that among the changes made by the users that cause the fast spread of fire in the markets is fixing of canopies in between the roofs of two or more buildings as sun shading devices by the sales people. The major factors attributed to the changes made by the users that cause fast spread of fire in the markets are from electricity related issues such as indiscriminate use of personal electricity generators. The design of all the markets against fire outbreaks were poor such that there are some buildings in the markets without front verandahs or corridors for mounting fire extinguishers or other mountable fire protection devices on their inner walls. Moreover, it was revealed that the current 2013 edition of the National Fire Safety Code of Nigeria (NFSCN) is not adequate for Nigeria because it is not well enforced in terms of passive fire prevention and protection measures. Thus, among the generated additional guidelines for designing markets to improve the NFSCN are: all the floors of lock-up shops in markets must be designed to have front verandahs/corridors, in order to reduce the use of canopy roofs as sun shading devices for sit out areas. All the market sites must have main fire resistant generator houses, in order to reduce the indiscriminate use of personal electricity generators. Among the recommendations is that the current 2013 edition of the NFSCN should be reviewed to adequately focus on passive fire prevention and protection measures.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF PLATES

LIST OF APPENDICES

CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Research

Markets are authorised sites and public places where people meet for trade or where goods and services are exchanged for money; they are places where people buy their basic needs in retails and as well as in wholesales (Chabbi-Chemrouk, 2007; Jikun and Scott, 2003; Lipsey, 1963; Ngugi, 2015). In Africa, markets vary in terms of sizes, modes and qualities of constructions, facilities and physical maintenances (Ikelegbe, 2005; Mbisso, 2011). According to Ngugi (2015), uncontrolled market development where sales people build markets at any empty space is as a result of underemployment or unemployment which lead the majority of the urban population to look at markets for honest living. The expansion of markets is inevitable because of the increased needs of sales people and the supporting infrastructure require more spaces for trades.

Trading is among the well-known occupations of people in the informal sector of economy of cities/towns in Nigeria (Ogeah and Omofonmwan, 2013). It is comprised of the sales people and buyers who operate in markets in urban areas. The Federal Capital Territory (FCT) of Nigeria is the study area and according to the Federal Capital Development Authority (FCDA) of Nigeria, different markets for trades were established in the FCT due to its population increase (FCDA, 2016). According to Federal Fire Service of Nigeria (FFSN), National Association of Nigerian Traders (NANT) and other scholars, as more markets are established in Nigeria, different problems arise from their establishments and these include fire outbreaks, stealing, fraud, human congestions, quarrels and disputes, inadequate supply of water and

electricity, inadequate toilet facilities, dilapidated market structures, substandard buildings, and the activities of hawkers and open space traders that do not conform with the standard market operations (Achumba *et al.,* 2013; FFSN, 2016; Gidipoint, 2015; NANT, 2014 and 2016; Olayinka, 2016; Terkula *et al.*, 2016). Among these problems, it has been established over the years that on regular basis, outbreaks of market fires in different parts of the country have been leading to the destruction of substantial goods, properties and human lives (FFSN, 2016; NANT, 2016).

National Fire Protection Association (NFPA) and Science Learning Hub (SLH) defined fire as the process of burning with different visible effects (NFPA, 2016; SLH, 2009). Glossary of Wild Land Fire Terminology (GWLFT) and NFPA further defined it as a chemical process of a very quick oxidation which releases sound, light and heat as products (GWLFT, 2009; NFPA, 2016). Among the destruction agents across the globe is fire (Bond and Van, 1996; Parminter, 2015; Sugita *et al.,* 1997; Willy *et al.*, 2000). In Africa, particularly Nigeria, markets are very prone to the outbreak of fires (Ogeah and Omofonmwan, 2013); therefore, it became important that fire is treated with care specifically in Nigerian markets.

Fire hazards have negative effects on people and societies because of the damaged buildings that result to the removal of businesses and thereby negatively affecting the tax rolls of government. Statistics showed that more than 40 percent of market activities that experienced outbreak of fire did not re-open due to the loss of customers' bases (Stookey, 2010). The country faces the challenges of property and income losses, deaths and injuries at a significant rate as indicated by a recap of 2014 Fire Loss Statistics of United States (Hylton, 2015). Therefore, it became essential that markets

are well prevented and protected from fire outbreaks not just only in United States but also in Africa and particularly in Nigeria.

Prevention and protection measures against fire in building are safety plans to make sure that the fire risks are reduced through appropriate architectural design, the use of fire protection devices and fire drills for building occupants. Scholars suchlike Building Department (BDE) and Whole Building Design Guide (WBDG) established that there is a necessity for safety with respect to fire in building designs (BDE, 2011; Iyaji *et al.,* 2016 and WBDG, 2017). Life Safety Services (LSS) and other scholars stated that safety in buildings with respect to fire can be obtained via passive and active prevention and protection measures against fire (Anderberg, 2011; LSS, 2015; Stuart, 2017). Passive and active prevention and protection measures against fire in buildings assist to reduce fire disasters. Department for International Development (DID) and other scholars revealed that frequent disasters of fire in market places are not just occurrences but they have diverse and devastating consequences (Addai *et al.,* 2016; DID, 2005). Therefore, it became crucial to take steps to reduce them through preventive and protective measures, in order to reduce their further impacts such as loss of goods, properties and human lives (Alhaji, 2014). As a result of this importance, protection/prevention measures against market fires in the territory of Nigerian capital were studied.

1.2 Statement of Research Problem

A good market is supposed to have an adequate protection against the outbreaks of fire, so as to save human lives, properties and goods (Leo, 2014; Oladokun and Emmanuel, 2014). According to the International Fire Code (IFC), protection equipment against

fire are supposed to have a frequent maintenance in good conditions, so that they can be fit for maximum protection (IFC, 2006 and 2012). Hence, Seattle Government (SEG) and a scholar stated that by preparing against fire outbreaks in buildings, properties and lives can be saved (Alhaji, 2014; SEG, 2016). Globally, advancement of technologies in fire safety exist for the facilities of industries and commerce (Menon and Vakil, 2016). However, frequent outbreaks of market fires in Nigeria is a challenge that have resulted to human live losses and the loss of valuable properties and goods. There is no year without fire outbreaks in Nigerian markets (NANT, 2016). For example, between January, 2015 and March, 2016, fire outbreaks in Nigerian markets claimed goods and properties that worth over 5.3 trillion Naira and 600 human lives (FFSN, 2016).

Literature shows that the National Fire Safety Code of Nigeria (NFSCN) lacks well enforcement to effectively reduce the frequent fire outbreaks in Nigerian markets despite the engagement of different building professional bodies in its preparation (NFSCN, 2013). According to acknowledgement page of the NFSCN, Nigerian Institute of Architects, Architects Registration Council of Nigeria, Department of Architectural Services in Nigerian Federal Ministry of Works and Housing, and other bodies of Nigerian building professionals were engaged in the preparation of the 2013 (first) edition of the NFSCN that is currently in use. Yet, it gives little consideration to the use of building design for reducing outbreaks of fire and the spread of fires in buildings (passive prevention and protection measures against fire) in just five pages with fire resistance constructions in only seven pages which are building engineering aspect, and this is a serious weakness.

In addition, the NFSCN was approved in 2013 by the Federal Government of Nigeria (NFSCN, 2013). From the preface page of the 2013 edition of the NFSCN, the Fire Code is subject to review every three years, in order to reduce fire outbreaks and their negative resultant effects in the country. This implies that since the first edition of the NFSCN was approved in 2013, it was supposed to be reviewed in 2016, in order to minimise outbreaks of fire in buildings in the markets and other buildings in the country. However, since 2013 that the NFSCN was approved, no revision has been made on it despite frequent fire outbreaks in Nigerian markets (FFSN, 2016; NANT, 2016). Therefore, it became important to propose additional guidelines for market design against fires by conducting a research on existing markets before the establishment of the 2013 NFSCN with regards to prevention and protection measures against market fires in the FCT of Nigeria from an architectural perspective, so as to improve the NFSCN. These will reduce the frequent loss of human lives, valuable properties and goods. These will also reduce other negative implications of outbreaks of fire in all parts of the country.

1.3 Aim and Objectives of the Study

The aim of this study is to evaluate the fire prevention and protection measures put in market places in the Federal Capital Territory (FCT) of Nigeria, in order to generate additional guidelines to improve the National Fire Safety Code of Nigeria with respect to market design.

The objectives of this study are:

i. To identify the changes made by the users that could cause fast spread of market fires in the FCT of Nigeria.
ii. To examine the passive and active fire prevention and protection measures put in market places in the FCT of Nigeria.
iii. To determine the adequacy of the National Fire Safety Code of Nigeria for fire safety in the design of markets in the FCT of Nigeria.
iv. To propose additional guidelines that can improve market design against fire outbreaks in Nigeria.

1.4 Research Questions

The research questions are:

i. What are the changes made by the users that could cause fast spread of market fires in the FCT of Nigeria?
ii. What passive and active fire prevention and protection measures put in market places in the FCT of Nigeria?
iii. How adequate is the National Fire Safety Code of Nigeria for fire safety in the design of markets in the FCT of Nigeria?
iv. What additional guidelines can be proposed to improve market design against fire outbreaks in Nigeria?

1.5 Scope of the Research

Different researchers have given market classifications on the basis of diverse factors such as time, competition, function, location, legality, transactions, regulation, volume of business, nature of commodity, demand and supply (Gaurav, 2010; Manoj, 2015). Classifications of markets have been grouped into three forms on the basis of location. According to the Food and Agriculture Organisation of the United Nations (FAO) and other scholars, they are built-up or closed market type, open-air market type and street market type (Amiteye, 2015; Bromley, 1998; FAO, 1995).

Likewise, on the basis of location, Ngugi (2015) gave market classifications as street market type and regional market type, in which regional market types are open-air market types and built-up market types. Integrating the immediate market classifications on the basis of location, markets can be grouped into regional open-air market type, regional built-up market type and street market type. In this scenario, regional built-up market type is a type of market in a specific region or location which comprised of diverse business buildings such as restaurants, open stalls, lock-up shops and other market features (Amiteye, 2015; Ngugi, 2015). Hence, the scope of this research was the three regional built-up market type in the territory of Nigerian Capital.

In Nigeria, regional built-up market types are also known as the urban-markets and they are majorly located in the urban places. According to Ogeah and Omofonmwan (2013), Nigerian urban-markets are very prone to outbreaks of fire and the market users suffer the losses severely. Likewise, in Nigeria, regional built-up market types are very

prone to outbreaks of fire and they have resulted to the loss of many human lives; destruction of properties and goods that are valued up to trillions of Nigerian Naira (FFSN, 2016). Since regional built-up market types in Nigeria are very prone to outbreaks of fire, it became necessary that they are studied, in order to find a way to reduce the occurrences of fires. Three regional built-up markets in the FCT of Nigeria were studied; they are Wuse market, Garki model market and Kado market.

1.6 Study Area

The Federal Capital Territory (FCT) of Nigeria was selected as the research area due to the outbreaks of fire that are always occurring in different market places in the area as revealed by Abuja Markets Management Limited (AMML) and the Federal Fire Service of Nigeria (AMML, 2018; FFSN, 2003, 2013, 2014 and 2015). Another rationale for chosen the FCT of Nigeria as the domain of this study is owing to the fact that the management authority of the markets that were studied (AMML) is a more organised management authority of Nigerian markets among others (AMML, 2016; FCDA, 2016). Thus, it became important that markets in the FCT of Nigeria are studied, so that appropriate research data can be gotten from this organised markets management authority in the FCT of Nigeria owing to the fact that the Abuja Municipal Area Council (AMAC) of the FCT of Nigeria where this research was conducted is a purpose-built city among other few cities in Africa and it is the capital city of the country (Murray, 2007; Nnodim, 2011).

Figure 1.1 shows the Nigerian map revealing the FCT location in the central part of Nigeria; it also shows the locations of other states in Nigeria. The capital city of Nigeria is Abuja and it is situated in this territory. Figure 1.2 shows that the FCT of Nigeria has boundaries with Kogi State of Nigeria to its south-west area, Nasarawa State of Nigeria to its south and east area, Kaduna State of Nigeria to its north-east area, and Niger State of Nigeria to its north-west area. According to the National Population Commission of Nigeria (NPCN), FCT of Nigeria has a landmass of 7,753.85 kilometres square (NPCN, 2010). Moreover, Figure 1.2 reveals that the FCT of Nigeria is presently comprised of six local councils which are the Municipal Area Council of Abuja (city of Abuja), Kuje, Kwali, Bwari, Abaji and Gwagwalada.

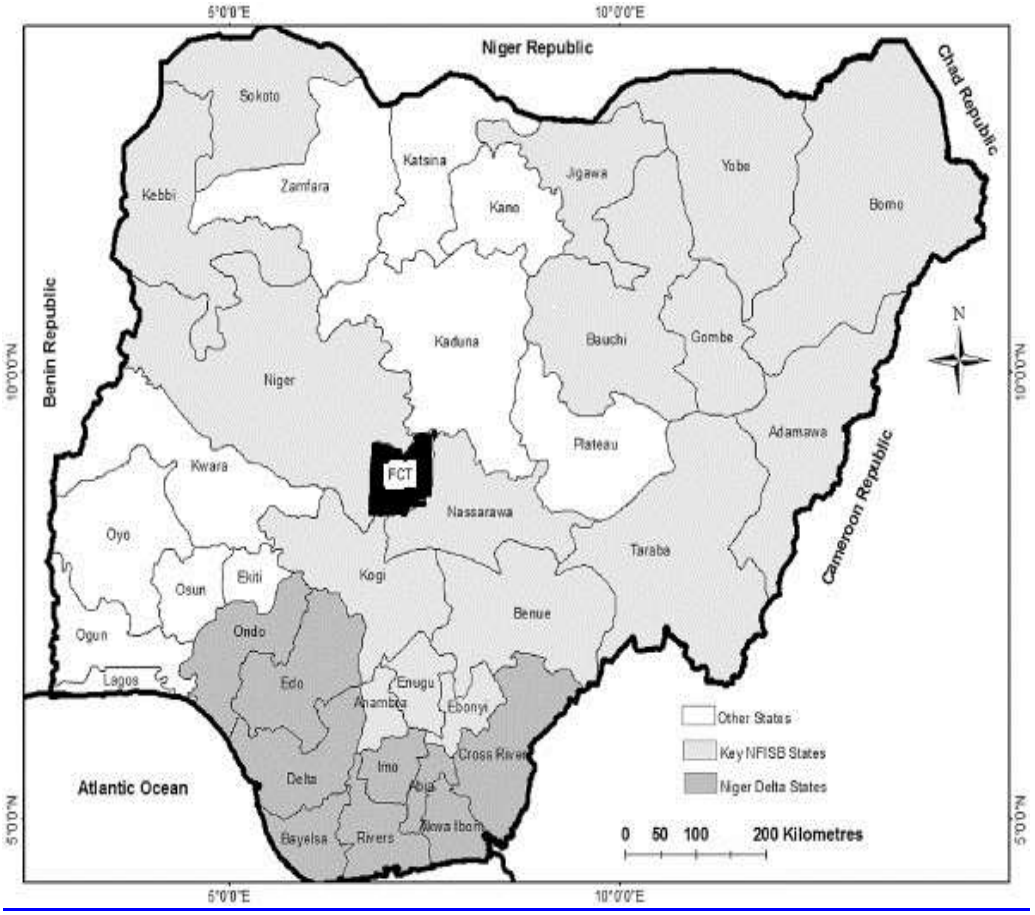

Figure 1.1: Nigeria showing 36 states with FCT highlighted. Source: Research gate, 2016 (https://www.researchgate.net/figure/260672838_fig5_Figure-1-Map-of-Nigeria-showing-the-Nigerian-Frontier-Inland-Sedimentary-Basins-NFISB).

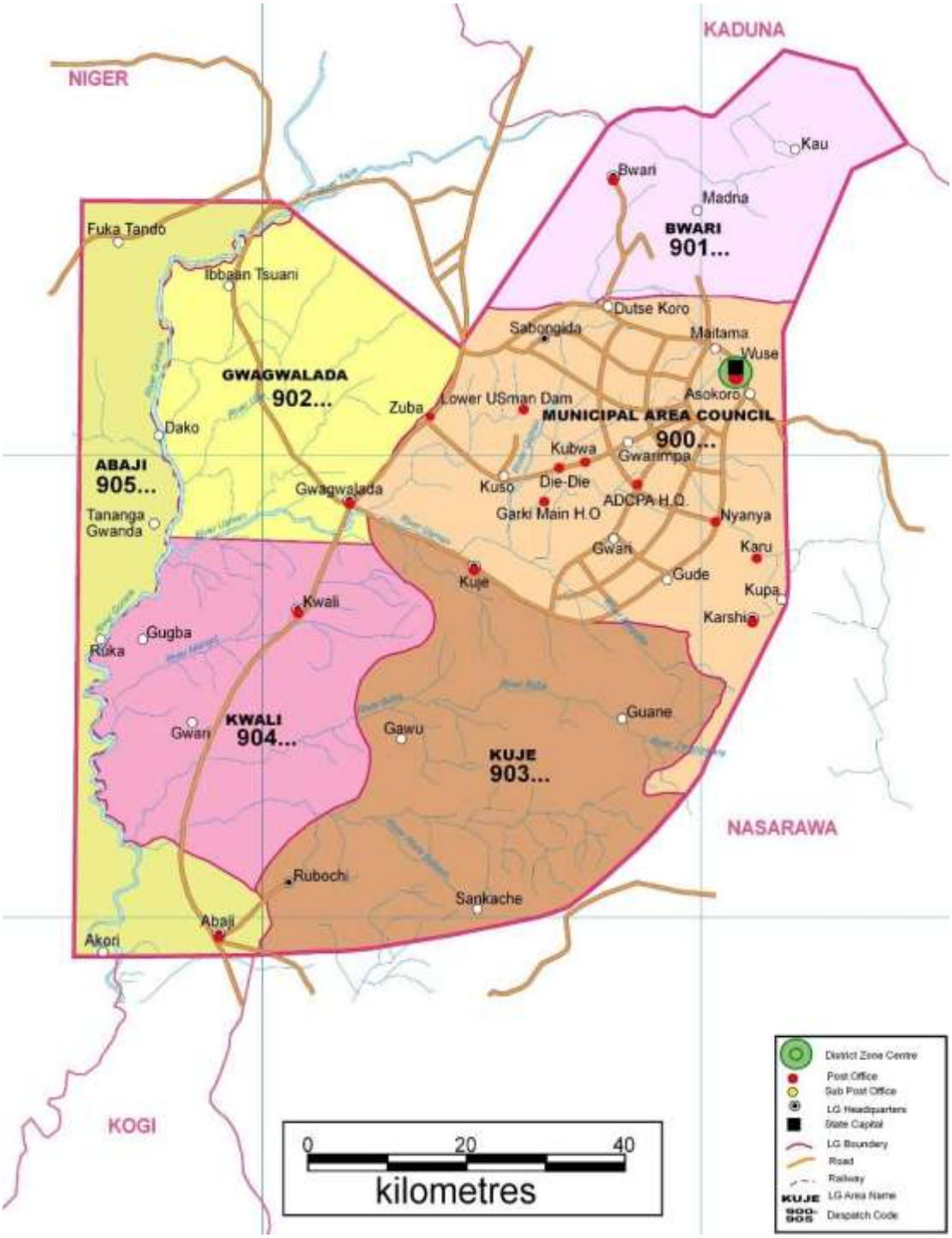

Figure 1.2: Federal Capital Territory of Nigeria. Source: Satellite city google maps, 2016 (http://naijatellit.blogspot.com.ng/2016/01/list-of-6-local-councils-in-abuja.html).

Figure 1.3 reveals the map of Municipal Area Council of Abuja. The three markets that were studied are situated in the Municipal Area Council of Abuja. Wuse market is

situated in the district of Wuse Zone 5 of AMAC; Garki model market is found in the district of Garki in AMAC, and Kado market is found in the district of Gwarimpa in AMAC.

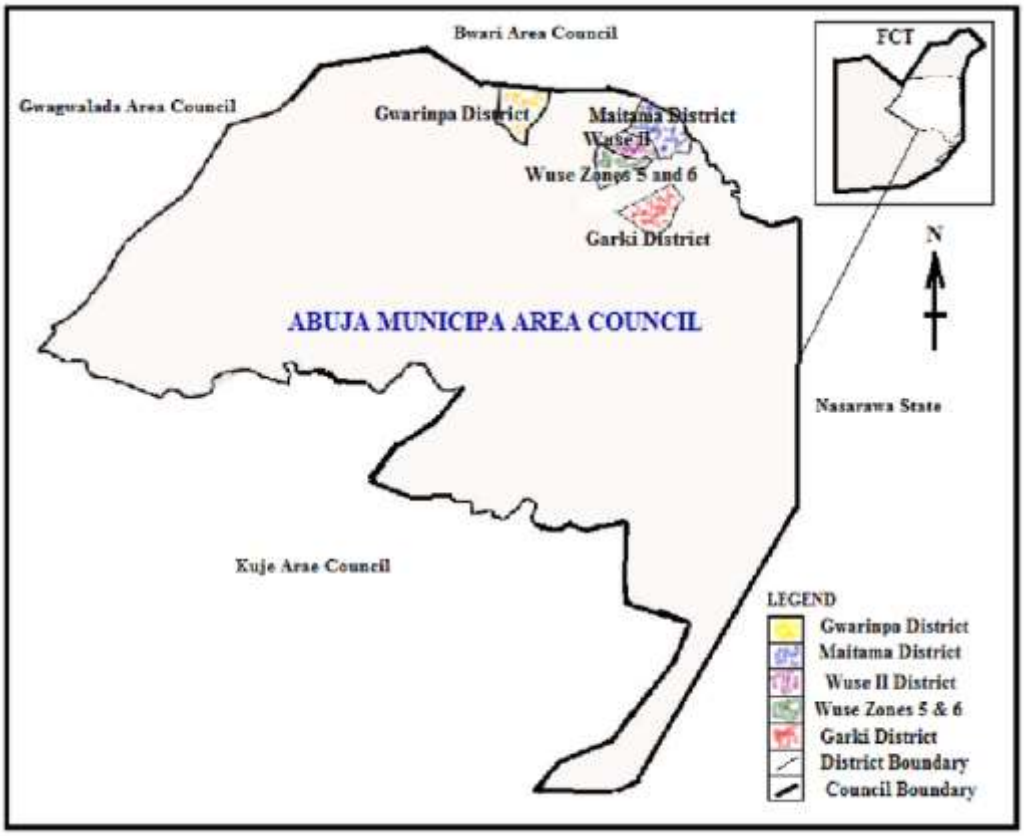

Figure 1.3: Municipal area councils of Abuja in the Federal Capital Territory of Nigerian revealing the research area. Source: Research gate, 2015 (https://www.researchgate.net/publication/276278580_Carbon_Monoxide_Its_ impacts_on_human_health_in_ Abuja_Nigeria).

1.7 Research Justification

Several researches have been conducted on the outbreaks of market fire in Nigeria and diverse associated issues have been revealed. For example, when there are outbreaks of fire in markets in Nigeria, in most cases, the FFSN often arrives late to the places of incidence and usually comes with inadequate firefighting equipment to fight them (Ogeah and Omofonmwan, 2013). This denotes that when there are outbreaks of

market fire in Nigeria, the problem of combatting them exist. Lekan (2015) found out that different renewal schemes in urban areas have been existing, so as to minimise outbreaks of fire in Nigeria and other associated problems by the Nigerian government. These include campaigns of enlightenment, relocation of areas of settlement from markets and impermanent markets closure with high threat of fires. Unfortunately, these interventions only come after fire outbreaks in markets, and in many cases people hardly respond positively to these programmes. It was outlined that it is important to acquire a proactive perspective towards a better management of fire safety to be merged into the general management of the built environment in the country.

Researchers have identified some causes of outbreaks of market fires in Nigeria. It was stated by Mann (2010) that what causes outbreaks of market fires in Nigeria are the use of gas cylinders, stoves, cookers, lighted match, careless disposal of the stubs or ends of cigarette, sparks, illegally connected electricity, unstable electric power and adulterated fuel. Also, Olaiya (2013) found out that outbreaks of fire in Nigerian markets are majorly connected to faults from electricity. Gbenga (2014), pointed out that fire outbreaks are accidents; whether they are viewed from the perspective of human error, situational or environmental factors, they are however preventable in most cases. The researcher further pointed out that about 70% of incidents of fire in Nigerian markets are connected to the faults from electricity. Hence, with this reason, measures for safety should be among the considerations during the stages of both design and construction and not after markets have been built before alternative arrangements will be considered, so as to ensure the safety of people and the entire markets.

Considering outbreaks of fire in Nigerian public buildings in which regional built-up markets are inclusive, Abdulhamid and Ibrahim (2011) revealed that the occurrences of fire outbreaks are more in office places and markets. Abdulwahab *et al.* (2012) found that the causes of outbreaks of fire perculiar to public buildings are spill of chemicals; too much reliance in making use of appliances like electrical power boards, computers, electrical lamps, heaters; other electrical equipment. National Emergency Management Agency (NEMA) reported that in addition to the loss of properties and human lives due to fire outbreaks in public places, the indirect fiscal loses are incalculable due to the resultant unemployment, reduced property values and lost business incomes (NEMA, 2013). It was established that there is no pattern for the occurrence of fire. However, it has been shown that in Nigeria, fire outbreaks in public buildings and the intensity of damages; loses from them are more during the harmattan season which is the period between November of a particular year to March of the following year. The research conducted by Makanjuola *et al.* (2016) revealed that issues of outbreaks of fire in public buildings are connected to accident, arson and carelessness.

From these researches on the fire outbreaks in Nigerian markets made by the above mentioned researchers, different causes and other issues of fires were pointed out and discussed but there is a gap in knowledge. This gap is the lack of study of the weakness of the National Fire Safety Code of Nigeria with respect to passive and active prevention and protection measures against market fires, in order to propose additional guidelines that can minimise fire outbreaks or the spread of fires in Nigerian markets. Therefore, it became vital that this gap is filled through the evaluation of protection/prevention measures against outbreaks of market fires in the Federal Capital Territory (FCT) of Nigeria.

1.8 Benefits of the Research

Benefits of the research are gains or significance of the research (Christopher and Braden, 2013; Fred *et al.,* 2009; Khazragui and Hudson, 2015; Luke, 2015). The architects, Nigerian government, academia; the general public have benefitted from this study.

1.8.1 Benefit for the architects

It is necessary to check buildings, in order to assess their performances, learn and make use of the knowledge acquired to improve in the subsequent maintenance, design and construction of buildings, so as to have a better and desired living environment (Adrian *et al.,* 2010; Ardavan and Ryan, 2015; Hay *et al.,* 2017; Rosi and Behzad, 2017; Zubairu, 2012). In the same scenario with this immediate statement, this research has generated additional solutions for architects in designing buildings, so as to curtail incidences of market fires in Nigeria.

1.8.2 Benefit for the government of Nigeria

This research has created additional guidelines for market design against fire for all the local governments in Nigeria. This is because according to the National Association of Nigerian Traders (NANT) and Nigerian Constitution (NCO), it is the responsibility of the local governments in Nigeria to establish, regulate and maintain all the markets within its area as stated in the Functions of a Local Government Council under the Fourth Schedule in the Nigerian Constitution (NANT, 2016; NCO, 1999). These additional guidelines have improved the NFSCN. In greater dimension, they will help

to reduce fire outbreaks with their negative implications on the lives of people, goods, market buildings; other market properties and the entire economy of Nigeria.

1.8.3 Benefit for the Academia

Feedback and evaluation are very important for continuous improvements in the design of buildings (Faris, 2017; Hay *et al.,* 2017; Mundo-Hernandez *et al.,* 2015; Reza *et al.,* 2016; Zubairu and Olagunju, 2012). In the same scenario with this immediate statement, this research has laid a base for further studies on the evaluation of prevention and protection measures against market fires in Nigeria, so as to have improved design of markets against fire outbreaks in a continuous manner and thereby reducing subsequent negative effects of fire on Nigerian markets.

1.8.4 Benefit for the General Public

Ignorance has been identified as a significant factor that increases the occurrences of fire outbreaks in market buildings (Amoako, 2014; Murage, 2012). Poor awareness of the dangers of fires and their preventions have resulted to different outbreaks of fire in market places. Thus, this research has educated people with regards to the dangers of outbreaks of fire by passing information to them about the diverse inappropriate activities that increase outbreaks of fire and how they can be prevented in Nigerian markets.

1.9 Limitations of the Research

Library of the University of Southern California (LUSC) and other scholars stated that limitations of the research are constraints on the applications to practice and generalisation in research (LUSC, 2017; Marilyn and Jim, 2013; Price and Judy, 2004). The FCDA of Nigeria could not provide the architectural drawings of the three markets that were studied. The replied letter from the Director of Public Buildings of the FCDA and the discussion with him in respect of the request for the architectural drawings of markets revealed that the hard copies of architectural drawings of the markets were lost during the relocation of Department of Public Buildings in the FCDA from its old building to its present new building. Appendix H shows the replied letter of request for the photocopies of the architectural design of Kado market, Wuse market and Garki model market. Also, the markets were designed manually for a very long time when it was not possible to have the soft copies of architectural drawings of the markets. Thus, the research was conducted based on as built design of the markets which were also accepted to be as originally designed.

Other limitations are the issues associated with the sales people in the markets. Some sales people were very busy with their businesses and could not give adequate time for the focus group discussions as expected. Thus, this affected the required information that were gotten from the sales people in the markets via focus group discussions. In addition, there were restrictions by the sales people in providing information to the researcher and research assistants due to security problems in Nigeria; this made some of the respondents in the markets to be careful and conservative in their responses to the interview questions at the time of focus group discussions. This also affected the

required information that was obtained from the focus group discussions with the sales people in the markets.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.2 Structural Transformation of African Markets

Onyango *et al.* (2013) and Ngugi (2015) outlined that in Africa, markets developed as open air market places where people met for business transactions in strategic areas. After some time, markets took diverse forms such as street markets and regional built-up markets. The transformations are as a result of numerous factors which are economic, political, social, urban informality, demographic changes and urban land policies for the countries of Africa that were colonised. They are also as a result of cultural behaviour in humans. Man being a social primate needs the factors such as entertainment, interaction and other activities for companionship. To this end, Kamarudin *et al.* (2015), Ngugi (2015) and Raipat (2016) noted that the market places serve as an avenue for the interaction of people; it is because of the social factors that play areas and eatery joints were carved out in markets, especially if they were not initially provided in any given market.

Many regional, weekly and local market centres developed during the colonial era where European and local goods could be traded. South African History Online (SAHO) and a scholar added that the transformation of markets came to Africa as a result of segregation policy with the advent of colonialism, and this led to overpopulated areas (Ngugi, 2015; SAHO, 2017). Due to too much population, where market expansions could not be achieved, it resulted to encroachment within the markets and also into circulation routes around the markets and thereafter, into informal settlement that sprouted around the markets (Mendelsohn, 2015; Ngugi, 2015).

Encroachment within the markets, especially, the encroachment of wooden structures can increase the spread of fires in markets when there are outbreaks of fires. Plates I, II and III show the structures of regional built-up markets with their over populations in Africa.

Plate I: Typical Nigerian market structure (Wuse market) in Abuja. Source: Abuja markets management limited, 2016 (http://www.abujamarketsmanagement.com/wuse-market/).

Plate II: Typical market structure (Hamali market) in Kumasi, Ghana. Source: Wordpress, 2011 (https://huihanwestafrica.wordpress.com/2011/09/16/ Wednesday-7-september-kumasi-%E2%80%93-ghana/).

Plate III: Typical market structure (Akodessewa fetish market) in Voodoo, Togo. Source: Africa Togo travels, 2013 (http://www.flyingfourchette.com/2013/12/23/lome-togo/).

2.2 Market Classifications

Markets are classified in several ways on the basis of different factors. Based on market regulation, the classes of market can be either open market or closed market. According to Ogeah and Omofonmwan (2013), open-markets are under the class of market in which any vendor or merchant can conduct business transaction without obtaining a permission from merchants to trade in a business area or town. In reverse of the open-markets are closed-markets whereby there is a need for one to first obtain a permission from the market management authority to conduct a trade in a business area or town.

Four different ways to classify markets have been identified by Bromley (1998) and Amiteye (2015). The first is on the basis of location, and the three kinds of market locations were pointed out. They are street markets, open-air markets and closed or built-up markets. Secondly, the other kind of classification could be based on periodicity of operation of markets which implies the market activities in relation to the number of days. The study of Ofori and Asiedu (2013) also agreed with this immediate kind of market classification and on the basis of this, the classes of markets could be every day markets, every week markets and the markets which have operations in not less than six days. Thirdly, the other kind of classes of market could be with respect to the kind of trading goods which could be manufactured goods or foodstuffs, and quantities of trading goods (wholesale or retail). In this regards, market can therefore be classified as market for the sales of foodstuffs, market for the sales of manufactured good, market for the sales of wholesale goods and markets for the sales of retail goods. Lastly, according to Bromley (1998) and Amiteye (2015), market classes could be on

the basis of their sizes (the turnover in the perspective of their physical sizes). Thus, market classes could be markets of large sizes, markets of medium sizes and markets of small sizes.

Additionally, Owusu and Lund (2004); Onyango *et al.* (2013) pointed out that a combination of other factors such as the number of attendants in average which is measured in the perspective of buyers and sellers, capacity of sales which is measured in the perspective of the number of shops of lock-up type and stalls of open type, and the available market facilities are also essential in classifying markets. Moreover, markets can be classified as night markets. Lee *et al.* (2008); Kamaruddin and Bakhtiah (2014); Manoj and Amitabh (2017) defined night markets as street markets that operate at night and they are mainly in suburban or urban areas that generally tend to have more shopping, leisure and eating areas. They are groups of outdoor stalls of temporary type operated by petty sales people where products are displayed for sale. Khalilah (2010) and Mazlan *et al.* (2017) added that night markets are temporary events that normally occur every week at available open spaces and on road sides or parking lots that are closed temporarily to allow for operations. The friendly and relaxed atmosphere of night markets allow the customers to enjoy diverse environments, wide choices of freshly cooked food and fresh vegetables at affordable prices.

Most villages and towns in Nigeria have markets and various markets are different from each other as they are responsible for performing distinct functions and roles. Nigerian markets are made up of street markets, periodicity markets, open-air type of markets, regional built-up type of markets, mixed type of markets, wholesale type of

markets, retail type of markets and night markets. The actual knowledge of market differences is essential to understand markets organisation and relationship (Ofori and Asiedu, 2013); likewise, it could be essential in evaluating prevention and protection measures against outbreaks of fire in market places.

Mostly, markets that are located along the street are known for city areas having spaces that are limited for trade in legally commercial areas which are created by the sales people who do not have opportunity to have spaces for trade in the main market places, or they are actually for the sales people who cannot afford the payment of spaces in markets. Likewise, some sales people take merits of particular locations in strategic manner to start markets that are located along the street that are not formally known; vehicular traffic and pedestrian movement are being obstructed and thus causing all kinds of congestion and bringing problems for urban authorities (Solomon-Ayeh *et al.,* 2011). Based on location, open-air type of markets and regional built-up type of markets have been established to be two majorly and formally known Nigerian markets (Ogeah and Omofonmwan, 2013). Consequently, this study considered the well-known regional built-up markets that are prone to outbreaks of fire in the FCT of Nigeria.

2.3 Importance of Nigerian Markets

The most outstanding livelihood sources for different persons are the market places (Amiteye, 2015). They are places for commerce or business transactions and ways for the accumulation of wealth. Sales people get the source of living from the market

places and they enable them to contribute to the increase of economy and growth of Nigeria in different avenues. Market places create employment and generate local revenue; supply household incomes and support the development of human resource via provision and education of the family relatives or children of the sales people (Baah-Ennumh and Adom-Asamoah, 2012; Owusu and Lund, 2004). Fire safety in markets in Nigeria is thus very crucial for the sales people.

Also, markets are the cultural, social, economic and political institutions because they are meeting grounds where people interact with each other in diverse ways to achieve different goals (Kamarudin *et al.*, 2015; Overa, 2006; Raipat, 2016). They bring ways for different kinds of interaction that result to the forming of the relationships between the sales people; even among the sales people and the market customers. Some relationships exist that could even go beyond the Nigerian markets with good lasting resultant effects. Apart from the sales people, market places employ different auxiliary workers like security men, revenue collectors, truck pushers, porters among others. Lastly, markets in Nigeria provide places for different kinds of exchange of culture because the ethnic backgrounds of sales people are usually heterogeneous. A recap of Nigerian markets is thus very vital, so as to acknowledge the necessity for protection and prevention measures against fire in Nigerian market places.

2.4 Market Planning in Africa

Market planning needs important analysis because markets are multi-functional and multi-purpose especially in Africa (Amiteye, 2015); thus, ways to reduce outbreaks of

fire in African markets, particularly the ones in Nigeria are of paramount importance through appropriate designs. The design of markets are parts of planning of urban areas because they are important parts of cities and towns. The effectiveness of the operation of well designed markets is connected to the effective, availability and efficient functioning of infrastructural facilities like electricity, roads and transportation services.

Morales (2009), Chris (2015) and Waldron (2015) stated that a well-designed market should put into consideration, the needs of all attendants of the market and various sales people and customers alike. Communities and Local Government (CLG), World Health Organisation (WHO) and other scholars additionally stated that adequate access to building site for the fire fighting vehicles must be given to enable fire appliances to properly have a good approach to buildings, and also there should be provision in the design of buildings to enable firefighters to have a very good access to the buildings in case of outbreaks of fire to protect properties and lives of people (CLG, 2011; Neufert and Neufert, 2000; WHO, 2014).

Since markets in Nigeria are prone to fire, it is therefore important that adequate access to them for the vehicles that fight fire must be given in the planning of markets in Nigeria to allow firefighting appliances to approach them. In achieving this, it is also vital to have a very good knowledge of regulatory frameworks of markets in Nigeria. A good understanding of diverse businesses and operations of the sales people is vital for creating regulatory frameworks which respond to the needs of various sales people and customers. Methods of participation are essential for ensuring sustainable market

design proposals and outcomes of strategies, in order to check the negligence of the market buildings (Onyango *et al.,* 2013; Nystrom, 2002).

Some buildings in markets are being neglected of maintenance and in turn have increased trading on the streets and also increased activities of hawking in Africa; this is peculiar to Nigeria (Asiedu and Agyei-Mensah, 2008; Owusu and Lund, 2004; Solomon-Ayeh *et al.,* 2011). Facilities that are for markets in most cities in Africa tend to be old and dilapidated; markets have inefficient structures with inadequate stalls for the sales people (FAO, 2016). In most cases, central markets that were built during the colonial period lacked adequate trading facilities like storage. The most recent facilities for markets that were built at the time of late 1960s and beginning of 1970s have major intention to meet up with the desires of the sales people with respect to the manufactured type of goods. These facilities were particularly planned as buildings of multi-storey; examples can be found in Yaounde, Cotonou, Lome, Douala and Abidjan in response to the limitation of spaces particularly in city capitals (FAO, 2016).

To accommodate farm produce from the sales people, ground floors of multi-storey market buildings were normally designed for that purpose but they were often allocated to the sales people to accommodate the manufactured goods. Particularly in 1980s, apart from a few markets like Ouagadougou market and Niamey market in West Africa that have been given reconstruction, the majority of markets were not efficient and the construction of markets with no regulation on sidewalks and streets had an increment (FAO, 2016). Although there were significant number and different goods that were traded; the major market stalls categorically fell and grouped into four which are the

bare floor, simple tables, stores and roofed stalls with open sides. Open stalls were up to 60% to 80% of the market stalls and the sales people that used such facilities faced acute security problems (FAO, 2016).

Up till 1970s, the sales people were made to be in charge of constructing central market shops and stalls with about 30 percent of the involved works being handled by the market management. Bobo-Dioulasso central market in Burkina Faso in West Africa is the only exception where the management of the market was responsible for about 68% of the construction of the market (FAO, 2016). In recent years, the management of markets gave an important role in market construction/reconstruction, most especially in making sure that the primary requirements for modern designs are met. However, at the beginning, the sales people are usually responsible for the financial implications of the constructions that were executed by the management of markets.

The majority of African markets are directly controlled by the authorities of local governments with the exception of some cases that are special where rehabilitation/construction has been externally funded (FAO, 2016). Local government authorities have duties which are: market regulation, development and maintenance of facilities, collection of taxes and fees; the allocation of stalls and shops. The maintenance of facilities like fire protection devices and other developments that are supposed to be executed by the authorities of local governments appeared to be blocked via the absence of financial/technical resources. The sales people therefore assumed these responsibilities and in most cases, buildings became dilapidated and the market facilities especially fire protection devices and sanitary appliances became non-

functional. Another problem associated with the market facilities in most cities of Africa is the activities of the itinerant. The mobile sales people (itinerant) ranged from 33 percent to 50 percent of the sales people in the extended market centres in 1980s (FAO, 2016). The increase of these sales people brought a considerable challenges regarding sanitation, maintenance and organisation of markets.

2.5 General Design Principles of Markets

According to the Conversation Africa (CAF); Food and Agriculture Organisation of the United Nations (FAO), worldwide overriding rationale in the design of majority of markets is that the most cost-effective solution should be found (CAF, 2016; FAO, 1995). However, there is a need to consider a number of basic elements and principles of building designs when preparing proposals for the infrastructure of markets. These include the uses of space, choice of materials and structures, and impact of climate (wind, temperature and rainfall) on the design of markets.

2.5.1 Uses of space in markets

FAO (1995) and Penner *et al.* (2013) state that globally the uses of space in buildings (markets) vary substantially with the designs and types of function they contain. It is essential to develop more precise description of different spaces (sections) of markets which are:

i. Vegetable and fresh fruit trading areas.
ii. Egg, poultry, fish and meat sales areas.

iii. Areas for selling of spices and grains.

iv. Areas for selling of cooked food.

v. Area for selling of household goods and clothing.

vi. Areas of general circulation (external and internal).

vii. Areas for some of other uses such as public toilets, administration and storage.

According to Food and Agriculture Organisation of the United Nations; National Development Plan (NDP), generally there is a wide difference in the overall number of stalls in markets (FAO, 1995; NDP, 2013). The vegetable and fruit stalls in some markets in urban areas (regional built-up markets) represent a little proportion of the total number of available stalls. The basic problem to resolve in the design of markets is to determine the distribution of spaces for sales with regards to the required numbers and whether there is a need to be accommodated in open air stalls or within the lock-up shops of markets. The needed facilities affordable by the fruit and vegetable sellers for example, will be much simpler than those of the sales people with higher-value goods such as clothing who will invariably demand for the lock-up facilities. In the design of markets against fires, it is important that different spaces for the sales of goods are properly considered in terms of grouping with respect to how the spaces are prone to fires.

Association for Specialist Fire Protection (ASFP); London Fire Brigade (LFB) added that inadequate spaces between buildings can lead to easy fire spreads from buildings to buildings when fires break out in buildings (ASFP, 2004; LFB, 2015). According to

scholars suchlike Building Regulations (BRE), the distance between buildings is truly a crucial factor to consider because it is expected to be the severity of fire which is ascertained via the building fire load (BRE, 2016; Neufert and Neufert, 2000). The buildings in markets are also included in these theories. Therefore, it became very crucial to have adequate spaces between the buildings in Nigerian markets, since they are very prone to fires.

2.5.2 Choice of materials and structures of markets

Building and Construction Authority (BCA) and other scholars stated that the materials for designing buildings against outbreaks of fire should be capable of resisting flame spread on building surfaces (BCA, 2017; Neufert and Neufert, 2000; Quarles, 2013). According to Food and Agriculture Organisation of the United Nations; World Economic Forum (WEF), globally, the construction techniques and choice of building materials for markets involve making a balance of the need for robust and simply maintained structures for the necessity to minimise expenditure as a result of the problem like fire outbreaks, and other problems that should be considered on the choice of building materials (FAO, 1995; WEF, 2014). International Building Code (IBC), Quizlet Incorporation (QIN) and other scholars stated that walls of buildings that are made up of sandcrete blocks can crack under the influence of fire especially when they contain embedded conduits and there is a possibility of fire spread (Dunn, 1996; IBC, 2006; Neufert and Neufert 2000; QIN, 2017). The consideration of how a building project is to be implemented (whether by means of self-help programme or contractor built) and the extent to which standardised building components or materials can be useful is very essential for the construction of market buildings. According to the North

Carolina Building Code (NCBC), there are two categories of building materials which are: combustible materials and non-combustible materials (NCBC, 2011).

Combustible building materials are the building materials that give off flames when they are heated or subjected to fires. According to Zurich Company (ZCO), they are generally plastics and non-fire resistant timbers; other examples can also include chemical coatings, adhesives and rubbers (ZCO, 2015). Scholars like National Fire Academy (NFA) revealed that the combustibility of building materials is a prime factor to consider when designing buildings against fires (NFA, 2000; Sikazwe, 2015; Tan, 2007). Nebosh Fire Certificate (NFC) and other scholars added that the spread of fire from buildings to buildings can be stopped via the qualities of fire resistant of external walls (Chitty, 2015; Neufert and Neufert, 2000; NFC, 2013). Civil Engineering Home (CEH) and other scholars stated that non-fire resistant building materials such as wood can easily burn and increase the rate of spread of fire when there is fire outbreak in buildings (CEH, 2017; Chen *et al.,* 2015; Iwami *et al.,* 2004).

According to ZCO (2015), building combustibility is a measure of impacts that the building materials of a structure have on the spread of fires when it is subjected to fires. Combustible construction can make a fire to rapidly spread through the components or materials of a building which can result in a much larger losses. The building materials with low combustibility should be selected for building construction where risks of fires need to be reduced. If too much combustible materials are used for a building construction, there will be a greater chance of fire accidents and the subsequent injuries or deaths of people when there is any ignition in such building.

In contrast, NCBC (2011) pointed out that non-combustible building materials are the materials that do not start ignition, advocate combustion, burn by the time they are under the influence of heat or fires, and the examples are:

i. Concrete: Portland cement type, gypsum type and the ones that have gravel, cement and sand as aggregates.
ii. Ceramic tiles, concrete block masonry and brick masonry.
iii. Metals except aluminium, magnesium and magnesium alloys. Aluminium is classified as limited-combustible.
iv. Uncoated glass fibres, block glass and sheet glass.

According to Fire Centre (FCE) and other scholars, the examples of roofing sheet that have high fire resistance are: clay roof tiles, concrete roof tiles and profiled metal sheet (FCE, 2017; Fricklas, 2015; Neufert and Neufert 2000). Bricks Industry Association (BIA), Concrete Centre (CCE) and other scholars revealed that the examples of walls of buildings that have high fire resistance are: concrete walls and bricks walls (BIA, 2008; CCE, 2017; Neufert and Neufert 2000). Thus, the use of limited combustibility and non-combustible building materials in the design and construction of regional built-up markets in Nigeria are very vital factors that were considered in this research, since regional built-up markets in Nigeria are prone to fires and they are frequently burning (FFSN, 2016; Ogeah and Omofonmwan, 2013).

According to Health and Safety Executive (HSE) and other scholars, the use of steel in building design is a good practice against fires (Buxton, 2011; HSE, 2010; Merritt and

Ricketts, 2001; Neufert and Neufert, 2000; Wald *et al.,* 2009). The purpose of non-combustible building constructions is to obtain a good degree of fire safety by employing specific building materials that are resistant to fire for the assembling of structural members of buildings (Keays, 2013). According to CEH (2017), fire resistant building materials should not disintegrate or lose their strengths when they are subjected to fires. They should not also catch fires easily and they should not expand due to the influence of heat when they are subjected to fires, in order to avoid the introduction of unnecessary stresses in buildings.

Abiola (2000), Mogbo (2001), Adewuyi and Odesola (2015), and Aliyu *et al.* (2015) stated that the building materials are the important factors that affect the effective performance of Nigerian construction industries. The main contributor to the construction industry is therefore the sector of materials for building for reasons that in construction, building materials are made up of largest impact and usually, they are more than half of the costs of the whole construction (Mogbo, 1999; Okereke, 2003; Oyediran and Odeniyi, 2009; Ugochukwu *et al.,* 2014). According to Stanley *et al.* (2014), two sources of Nigerian building materials are identified; they are building materials that were locally sourced and imported building materials.

2.5.2.1 Local building materials

The local materials for buildings developed majorly on Nigerian raw materials, styles or technologies. Communal processes of building and building materials were closely knitted with cultural values, socio-economic and climatic condition of the country of

Nigeria (Oluyode, 1998; Agboola and Zango, 2014; Ugochukwu *et al.*, 2014). As a result of these, demands to return to the local building materials have been existing and these have made the French Embassy, and the National Commission for Museums and Monuments in Lagos State of Nigeria to establish the Centre for Earth Construction Technology as the efforts to promote the use of technology of earth in achieving a complete/partial substitute for block and flooring works among others (Oladapo and Oni, 2012).

The government of Nigeria also set up the Directorate for Food, Roads and Rural Infrastructure (DFRRI), and Raw Materials Institute to make people to have interest in the utilisation of local building materials to construct buildings. The application of local raw materials to construct roofing sheets in the country were first initiated by DFRRI (Oladapo and Oni, 2012). Likewise, the Nigerian Building and Roads Research Institute (NBRRI) revealed that the responsibilities of developing and researching on the right local materials for buildings to be employed by Nigerian buildings and construction industries, and to ascertain the best economic methods in relation to the effectiveness of their utilisation were given to the Nigerian Building and Roads Research Institute (NBRRI, 2014).

Different local resources are available in Nigeria which can be exploited. These include the products of manufacturing processes (industrial wastes), naturally occurring deposit of raw materials, residues and products of agriculture with little cost and renewal energy sources; technologies that have been established that can be used for the production of local materials with low cost (Okereke, 2003; Oladapo and Oni, 2012).

However, there are important factors observed as the barriers to realisation of full potential of Nigerian local building materials, and among others includes products of poor quality due to non-compliance with minimum standard (Oladapo and Oni, 2012).

Some of the Nigerian local materials for buildings were outlined by Stanley *et al.* (2014). They are: stones (laterite, hardcore, granite/gravel), sand (sharp sand, plaster sand and others), sandcrete blocks and felting materials. Other local building materials are: polyvinyl chloride (PVC) insulated wires, PVC tiles, paints (undercoats, finishing, putty), ordinary Portland cement, glass (fibre, tinted, louvre), metal works, nails (concrete and ordinary), wooden doors (flush and panel doors), metal doors (Iron and bullet proof) and burnt bricks. These local building materials are used for the construction of market buildings and many other types of buildings in Nigeria. Some people now prefer to use burnt bricks to construct market buildings in Nigeria because of the frequent outbreaks of fire in Nigerian markets; a typical example is Kure Ultra-Modern Market, Minna in Nigeria.

2.5.2.2 Imported building materials

Imported materials for buildings are the materials for buildings that their raw materials are sourced within other countries or those that are manufactured within other countries and then brought into Nigeria for building activities (Atolagbe, 2009; Opoko, 2004; Ugochukwu *et al.,* 2014). Capital goods that are imported affect investment directly, and in turn are made up of the motto of the expansion of economy (Egwaikhide, 2000; Sa'ada and Hassan, 2008; Mutreja *et al.,* 2014). The importation of building materials

is not new in Nigeria. Ayeni (1997) noted that about 48% of building materials have been imported by the Nigerian construction industries. Also, Olowookere (1998) noted that the dependence level on importation of materials for buildings is about 78%. Likewise, Owoye (2003) stated that about 60% of building materials in Nigeria have been imported by the construction industries in Nigeria while Alitheia (2010) noted it to be over 70%. Ugochukwu *et al.* (2014) showed that the importation of materials for building is 63% of the total materials for Nigerian buildings.

Importation of materials for buildings has made the cost of housing delivery higher and unaffordable for the poor people in Nigeria (Kayode and Olusegun, 2013). However, importation makes way for globalisation and international or foreign trade with the capacity to bring development, promotes specialization; brings different materials for buildings and the engagement of principles of significant advantages across the globe (Mbamali and Okotie, 2012). Nigeria is still developing with different taste of foreign materials for building that have left the practices of buildings to remain grappled with different inherent problems which range from insufficient managerial/technical knowhow to inadequate equipment, materials and base of capital or finance (Oluwakiyesi, 2011). Adeniyi (1985) and Ugochukwu *et al.* (2014) affirmed a massive importation of building materials and a gradual reduction of materials for Nigerian buildings that are locally manufactured; which increase the gap that exist between export and imports in Nigeria. This has been established by the economists that it is not healthy for an economy of a nation (Oluwakiyesi, 2011).

Innovative products that are import-based in Nigeria are ever increasing demand which have resulted to a decline in the quality of indigenous materials for buildings (Adogbo and Kolo, 2009; Jev and Owei, 2002; Ugochukwu *et al.,* 2014). The dependence of Nigeria on importation of building materials according to Atolagbe (2009) and Ugochukwu *et al.* (2014) was due to inadequate infrastructures, cost of quality, need to achieve economic growth, and increase in oil wealth which tend to make importation of building materials cheaper than domestic production.

Some of the imported building materials that are in use in Nigeria were outlined by Stanley *et al.* (2014). They are: clay tiles, plumbing materials (PVC and galvanised), polyethene sheet, binding wire, steel wire mesh fabric and mild steel reinforcing bars. Other imported building materials are: reinforcement (high tensile), aluminium roofing sheet, sanitary fittings, tiles (wall, floor, glazed, skirting marble), electrical installations, aluminium conductive/cable, light bulbs, fluorescent fittings, light switches and socket outlets. These imported building materials are used for the construction of market buildings and many other types of buildings in Nigeria. Thus, building materials that were used for the construction of the markets in the study domain were checked with respect to their uses against fire outbreaks.

2.5.3 Impact of climate on the design of markets

The structures in places with extreme climatic conditions (intense sunshine, high rainfall and cold weather) are much characterised of Spain, Britain and France (FAO, 1995; Katen, 2015). Globally, to some extent in tropics and arid climates, it is

appropriate to make use of internal open courtyards within the market buildings (Atiyat, 2015; FAO, 1995). This brings a way of improving conditions of comfort in trading environments by achieving cross-ventilation; internal open courtyards can be used as overspill selling spaces, sitting areas, or they can form the parts where people enter the market buildings. In addition, the climate of an area determines the nature of the roof of building.

Australian Government (AGO) and other scholars revealed that the roofs of buildings protect buildings from the effect of heat, cold and wind and these depend on the roof structures in terms of the height and other factors (AGO, 2013; Neufert and Neufert, 2000; Taleb, 2014). The above immediate statement means that the roof height of buildings in regional built-up markets can be used to control temperatures (degree of coldness or hotness) within the lock-up shops and other internal built environments. In areas or places that experience intense sunshine and subsequently high temperatures, it is important to make the heights of the roofs to be high, in order to reduce the heat penetration from the sunshine to inside the lock-up shops and other internal built environments in markets. Conversely, the height of the roof of buildings should be made low, in order to increase the heat penetration from the sunshine to inside the lock-up shops and other internal built environments in markets.

Giving a consideration to the impact of climate on the design of regional built-up markets (passive building design measures), temperatures within the built environments in markets can be naturally controlled and by this, conducive trading environments can be achieved. This will in turn reduce the over dependence on making use of the

electrical appliances like fans and air conditioning systems (active building design measures) to control temperatures; the use of electrical appliances may results to fire outbreaks in markets.

2.6 Characteristics of Users of the Market Places

Market places allow regular meetings of buyers and sellers to exchange services and goods which could be locally produced goods or imported goods (Muli, 2007). It is important for people to buy and sell or transact their businesses in markets for the normal progress of life. Adeyinka *et al.* (2016) recognised that women are the predominant traders in markets as trading is a good profession for women because it is so flexible. This makes them popular as they transact businesses for longest number of hours. Some daily markets specialise in the transaction of specific goods while some trade in a wide range (variety) of goods. These characteristics make buyers to patronise them at any time of the day.

According to Felix *et al.* (2014), satisfaction of buyers is central to the existence of any business organisation in line with the concept of marketing. It was further pointed out that the responsibility of determining the need or want of buyers and value of the target markets are factors that should be taking very important. Hence, it is crucial that the value of markets is kept via adequate fire prevention and protection measures among others for the satisfaction of their users. The fact that fire is caused by humans (users) is a logical reason to work on the attitudes of these users, in order to see the effect it will have on reducing fire incidents in the market places in Nigeria

(Ilodiuba *et al.*, 2017). Thus, it became important to check the issues of awareness of market users with regards to the hazardous activities that go on in market places that can lead into fire outbreaks and how can the addressed issues of this awareness be used as tools to reduce market fires in Nigeria?

2.7 Passive Protection and Prevention Measures against Fire in Market Places

Fire Safety and Emergency Guidelines (FSEG) and another scholar stated that fire prevention management is putting into use of disciplined plans to make sure that the fire risks are curtailed (FSEG, 2009; Sordelet, 2014). Fire prevention is made up of activities with the aim of reducing ignition sources; it focuses on fire reduction programmes to the level of educating people against the things that start fires. Fire Safety Programme Index (FSPI) and other scholars stated that passive fire prevention measures are ways in which fire is prevented with maximum possibility via the design of buildings and making use of appropriate building materials (Botma, 2013; FSPI, 2013; Niall, 2005; Park, 2013). Communities and Local Government (CLG), National Fire Protection Association (NFPA) and other scholars revealed that these include the provision of areas or places of refuge, fire escape stairs and doors, and fire training for educating occupants of buildings on protection equipment against fire and ways of exit (CLG, 2008; NFPA, 2016; Norman, 2016; Proulx and Pineau, 1996). In this regard, Seattle Government (SEG) stated that the properties and lives of people can be saved via readiness before the fire incidence (SEG, 2016). They can also be saved through a good management of fire. Thus, it became important that lessons should be learnt from the fire management processes for market design, construction and post-construction.

African markets are very prone to the outbreaks of fire; they are frequently occurring in different places in Nigeria (FFSN, 2016; Ogeah and Omofonmwan, 2013). Therefore, it became necessary that the ways to minimise their occurrences in market places in Nigeria are properly proffered through good management and best practices. Thus, analysing fire risks to determine how best to address fire safety problems which are particularly known for markets are absolutely needed in the design concept of markets in Nigeria. The analysis of risks will show which fires should be addressed by the design where fires may include fires from arson (intentional fires) or accidental fires. It will also show which fires should be addressed by a good prevention management.

2.7.1 Fire safety in market design

There is a necessity to ensure fire safety in planning of buildings; through it, impacts of outbreaks of fire will be minimised (Adler 1999; BDE, 2011; Iyaji *et al.*, 2016; Joseph *et al.*, 1992; WBDG, 2017). Optimum protection and prevention against fire are enhanced with incorporation of fire safety from stages of design to the stages of completion of markets which in turn curtail the risks from fire. To enhance optimum fire safety according to the Nebosh Fire Certificate (NFC) and Ohio Building Code (OBC), fire spread from buildings to buildings can be stopped via the qualities of roofs in terms of fire resistant; they should give a fire barrier and also give resistance to the flame spread on building surface (NFC, 2013; OBC, 2016).

Likewise, according to Neufert and Neufert (2000) and BRE (2016), the spaces between buildings or the spaces between the buildings and boundaries are truly very

important factors to consider as they are severity of the outbreaks of fire that are ascertained via the fire loads of buildings. Hence, fire safety will be enhanced in buildings. Also, to enhance fire safety, California Fire Code (CFC), International Code Council (ICC) and Metropolitan Fire Brigade (MFB) revealed that the buildings or facilities shall be accessible by the firefighting apparatus via avenue of a better access road for the fire apparatus with approved driving surfaces such as concrete, tar and asphalt being able to support the imposed firefighting apparatus load (CFC, 2009; ICC, 2007; MFB, 2014). Thus, it became crucial that fire safety is incorporated into the design of markets, especially in Nigeria, so as to save human lives, properties and goods from being destroyed.

Nigerian Society of Engineers (NSE) affirmed that fire safety in buildings should be taken very important. According to NSE (2016), the design for fire safety or fire prevention and protection should address the following in public buildings of which markets are included:

i. **Dead-end corridor limitations:** The allowed length of dead-end corridors in many occupancies is the maximum distance required to move before getting to the pathway of exit. In occupancies with sprinkler protection that is completely automatic, the maximum length of corridor before reaching exit pathways is 30 metres in storage, most residential, educational, mercantile and some institutional occupancies.

ii. **Evacuation:** This is an orderly movement of people from the zone of danger to the zone of safety in a building. This needs a good design of stairways that will allow easy evacuation from the building. This is on the

bases of the counter flow on stairs in an emergency. There is a need for a counter-flow factor in the design of building, in case of the process whereby the occupants go downstairs during escape and the firefighters go upstairs with their equipment. After 911 disasters in the United States, this factor became important. The width of stairway that used to be a minimum of 1.1 metres is now put at the minimum of 1.4 metres in high-rise buildings. In addition, to enhance directional movement, provisions for self-luminous exit path markings were made because of non stable power supply.

iii. **Means of Egress:** This is unobstructed and a way of moving from a point in any building to any public way that is made up of three distinct and separate parts which are the escape access, escape and escape discharge (an access beginning from a point in the building to the road or street).

iv. **Material specification:** Specification of building materials in relation to fire safety has been neglected by some architects and this is an essential part of building construction. Sometimes, beauty or aesthetic has taken over the concept of safety to the point that fire resistance of materials that will stop the fire spread from compartments to compartments had been given little concern or attention.

2.7.2 During and after the construction of market buildings

Competent fire inspectors should be conducting regular inspections of market construction in line with the specification of building design. According to NSE (2016), activities of post-construction should consider the following in public buildings of which markets are included:

i. Certification for fire safety before occupancy.

ii. Routine inspection of the installation of fire protection devices.

iii. Routine prevention programmes for fires.

iv. Plans of emergency responses.

v. Drills for fire incidents and evacuations.

vi. Yearly re-certifications.

It is important that the immediate activities of post-construction are properly considered so that the fatalities of fires can be reduced in Nigeria and other nations of the globe. In United States of America, fires are fatal with regards to the loss of lives. According to the International Association for the Study of Insurance Economics (IASIE), among the 25 developed countries, the rate of mortality from fires in United States of America ranks eighth (IASIE, 2009). Similarly, the Topical Reports (TRE) stated that in 2007, the fire death rate of United States of America ranks 10th among 24 industrialised nations with 12.4 deaths per a million population; for quite some years, Japan that is a leader in fire safety has been having a slight worsening of fire death rates (TRE, 2011). Likewise, the mortality rate in Nigeria from outbreaks of fire, especially in market places has gotten to an alarming proportion. For example, between January, 2015 and March, 2016, 600 people died as a result of outbreaks of fire in Nigerian market places (FFSN, 2016). This means that 600 persons lost their lives due to outbreaks of fire in Nigerian markets within the space of one year and three months.

United States Consumer Product Safety Commission (USCPSC) revealed that in United States of America fires are also fatal with regards to the loss of properties. The

loss of properties to fires is significantly rated every year in United States of America, and the long term emotional damages to the victims and people that love them cannot be calculated (USCPSC, 2007). Similarly, Haynes (2016) affirmed that in United States of America, the loss of properties to fires is about 14.3 billion dollars in 2015; average loss per structure has not been relatively changed since 1977 till date where it was 14,600 dollars to 20,700 dollars per structure in 2015.

Likewise, valuable properties are frequently lost to the fire outbreaks in Nigeria, especially in markets and the long term emotional damage to the victims and people that love them is incalculable. For example, between January, 2015 and March, 2016, properties that have a valued worth of 5.30 trillion Naira were lost to outbreaks of fire in markets in Nigeria (FFSN, 2016). This means that properties that have a valued worth of 5.30 trillion Naira were lost to outbreaks of fire in Nigerian markets within the space of one year and three months. Therefore, it became crucial that buildings as infrastructure need passive protection and prevention measures against fire especially in Nigerian market places, so as to reduce further loss of human lives; destruction of goods and properties.

2.8 Active Protection Measures against Fire in Market Places

Life Safety Services (LSS), Occupational Safety and Health Administration (OSHA) and other scholars stated that active protection against fire is a way to put an end to the spread of fire by means of the application of fire protection devices (LSS, 2015; OSHA, 2015; Sean *et al.*, 2012). According to World Fire Statistics Bulletin (WFSB),

there is need for serious attention with regards to the avenues to protect people from the dangers of outbreaks of fire (WFSB, 2012). This can be achieved through the installation of appropriate fire protection devices in buildings. Protection devices against fire are the equipment that can be employed to protect buildings as much as possible when there are outbreaks of fire prior to the intervention of the experts of fires or fire brigades. To increase the safety of firefighters and the first people to respond to the fire outbreaks during emergencies, annual fire inspections in markets can be helpful by making sure that the maintenance requirements are met at minimal level. It was outlined specifically that sprinkler, standpipe, fire alarm systems and other fire protection devices should be frequently maintained in an operable condition (Beattie, 2015; IFC, 2006). Appropriate maintenance of fire protection devices ensures that the purpose of their installations is achieved at all times.

Also, the ideas on the use of the installed fire protection devices in buildings are very important in tackling fire emergencies, otherwise their installations will not be useful (Kachenje *et al.*, 2010). According to Action Aid (AAI), Codes and Standards (CAS), Department of Environmental Health and Safety (DEHS); Health and Safety Manual (HSM), fire protection devices that are mostly common are fire extinguishers and fire sprinklers, and the services of firefighters are given in the majority of developed places to put out fires that are difficult to control (AAI, 2006; CAS, 2016; DEHS, 2015; HSM, 2017). These are some of the important measures needed to achieve uptimum building fire safety. Scottish Government (SGO) and a scholar stated that the achievement of safety in terms of fire is enhance by good measure systems at management and physical levels that interact collectively to give a comprehensive fire safety system (Kincaid, 2012; SGO, 2008).

When buildings are designed with a little compliance to fire safety, the control of fire outbreaks will be difficult when they occur and this lead to the losses that could have been avoided at the initial stage (AAI, 2006; White, 2014). Scholars like African Urban Risk Analysis Network (AURAN) stated that as news headlines are captured from the mega-risks such as earthquakes, far more, the lives of people in the cities are lost to the disasters every day and they include fires, poor sanitation and dirty drinking water (AURAN, 2008; Alteneiji, 2015). To reduce these mega-risks such as fires, Makanjuola *et al.* (2016) stated that there are several kinds of firefighting devices for public buildings. Since markets are public buildings, it therefore became vital that at appropriate locations and where it is necessary, various fire protection devices such as emergency lighting system, street fire hydrants, sprinklers, argonite automatic fire suppression equipment (FM200 fire suppression), fire hose reels, fire alarm system, portable fire extinguishers and others are properly installed in market places in Nigeria for the protection against fire outbreaks.

2.8.1 Fire sprinkler system

According to Fireline Corporation (FCO) and Cintas Corporation (CCO), a fire sprinkler is a system that put out fires by the use of water (main extinguishing agent); it is normally made regarding the National Fire Protection Association Standard (FCO, 2015; CCO, 2016). Different types of this system that exist are:

i. Foam water spray sprinkler system.

ii. Deluge foam sprinkler system (water spray type).

iii. Sprinkler system with fixed water spray.

iv. Sprinkler system with pre-action dry pipe.

v. Complete pre-action type of sprinkler system.

vi. Deluge sprinkler system.

vii. Sprinkler system with dry pipe.

viii. Sprinkler system with wet pipe.

Very importantly, sprinklers reduce the effects of smoke and hot gases from fires. However, it has not been observed that sprinklers do improve visibility in smoke during fire outbreaks (Gottuk, 2012; Shields, 1999). Sprinklers are one component of different measures; the team of designers should put into consideration their installation during the construction time (Hamidovic, 2014; SGO, 2008). The fire sprinkler together with other suppression systems are mostly of recent design; significantly, the adoption rate for sprinklers with other fire suppression systems is increasing (SGO, 2008; Solomon, 2016). Scholars such as National Institute of Building Sciences (NIBS) stated that fire sprinkler systems are routinely put into consideration as a component of the design of fire strategy in important projects and it should be known that in smaller premises, economic asset protection or life safety in favour of fire sprinkler could be justified (SGO, 2008; NIBS, 2017).

According to scholars like Department for Communities and Local Government (DCLG), for appropriate justification, a smoke alarm installed in an area will give early alert of a fire and should worn occupants of the challenge and if it is linked to the sprinkler system, there is possibility of putting off fire at the early stage (Ahrens, 2015; DCLG, 2007). Hence, all the people in markets should survive in such a case. This type

of a system would be far more expensive and complex than an ordinary sprinkler system. Plate IV shows a fire sprinkler system.

Plate IV: Fire sprinkler system. Source: Cintas corporation, 2016 (http://www.cintas.com/fire-protection-services/fire-sprinkler-systems.aspx).

2.8.2 Automatic fire suppression equipment

Word Press (WPR) indicated that this type of fire suppression equipment is an automatic fire protection equipment without the application of water extinguishing agent; there is a possibility of the extinguishing agent being released into the fire in a 10 seconds time frame (WPR, 2013). Immediately, the fire will be extinguished by the extinguishing agent. This type of fire protection device is normally used in data and commercial centres, telecommunication and medical facilities.

This type of fire suppression equipment is made to give protection to businesses or homes, and it should be installed to give a safeguard in times of fires. Different types of automatic fire suppression equipment that exist in markets are: the fire suppression system which contains chemical agents or gases and the liquid-based solutions type (WPR, 2013). There are different experienced and qualified companies that specialise in the installation and sales of this fire protection device. However, it is necessary for a research to be conducted to ensure that good services are received by the customers for the best value of money. Plate V shows an automatic fire suppression equipment.

Plate V: Automatic fire suppression equipment. Source: Word press, 2013 (https: //bestfiresuppressionsystems.wordpress.com/).

2.8.3 Street fire hydrants

Street fire hydrants are upward pipes that are normally by the side of the roads or streets which have connections with the main water system of the towns and can supply

water for extinguishing fires (Trevor, 2018). Every fire hydrant is an attachment to the main water line. It upwardly supplies water to put out fires and save goods, properties and lives of people. Fire Services Department (FSD) stated that good standards should not be compromised with regards to street fire hydrant. According to FSD (2003 and 2012), the following standards should be maintained for street fire hydrant system:

i. Any time it is possible, there should be at least two street fire hydrants within the area of buildings that are concerned and they should be fixed not less than 6 metres from the buildings they are supposed to protect.

ii. All the hydrants have to be installed with respect to the main laying practice of the standard of water supplies department.

iii. In cases where minimum standard could not be maintained, the water supply should be augmented by other means, for example, pumps and sump tank. This is dependence on the nature and sizes of the properties to be protected as well as the total available supply.

iv. The minimum output should be capable of delivering not less than 4,000 litres per minute if the outlets of the hydrant are two that are delivering at a time.

v. The pattern of the hydrant shall be of an acceptable standard and it has to be capable of delivering not less than 2,000 litres per minute provided the outlet is only one.

vi. Wherever practicable, 100 metres spacing between fire hydrants should be maintained and staggered on the alternate sides of the road.

vii. The installation of the street hydrant system shall always have its maintenance in an operable condition; a contractor of fire service

installation (a registered one) shall carried out the inspection for at least once in twelve months.

It is important that the above or similar standard should be maintain in Nigerian markets, in order to achieve optimum results intended for the design of street fire hydrants. Plate VI shows a street fire hydrant.

Plate VI: Street fire hydrant. Source: Department of fire services (special administrative region) of the Hong Kong government, 2003 (http://www.hkfsd.gov.hk/ eng/faq_safety.html)].

2.8.4 Fire hose reels

Fire hose reels are positioned in a strategic manner at the building areas, so as to provide a good controlled and accessible water supply for putting out fires. Fire hose reel system is made up of hose reels, pipes, pumps and water supply which is positioned in a building in a strategic manner to make sure that water coverage for

putting out fires are proper (Grundfos, 2016). They are operated and activated manually via a valve opening to enable the flow of water into the hose of the length of about 30 metres. The pressure loss of the system shall give an activation to the pump to ensure a sufficient flow of water and the available pressure to give a minimum value jet of water of about 10 metres away from the nozzle of the hose reel (Grundfos, 2016). Plate VII shows a fire hose reel.

Plate VII: Fire hose reel. Source: Grundfos, 2016 (http://www.grundfos.com /service/encyclopedia-search/fire-hose-reel-systems.html).

3.8.5 Portable fire extinguisher

This type of extinguisher is a fire protection device that contains a special gas or water, foam or powder which is used to extinguish fires (Grainger, 2016). Access Intelligence (AIN) stated that during a modernisation project, one of the more challenging

engineering decisions is to decide whether or not to give a fire protection system that is fixed (AIN, 2016). The selection of the equipment is dependence of certain factors such as the kind of winding insulation, risk tolerance and the size.

According to AIN (2016), portable fire extinguishers must be:

i. Operated by the people who can effectively make use of them.

ii. Inspected and maintained regularly, so that they can always be in good operating condition.

iii. Situated in a place of easy accessibility for urgent applications and in sufficient qualities and sizes to extinguish expected fires.

iv. Of good types for classes of fires that are expected.

v. Approved by a good and known testing laboratory. For example, the extinguishers that are manufactured in United States of America are generally approved by Factory Mutual Insurance Company and listed by Underwriters' Laboratories Incorporation.

The majority of all the fires are small in the incipient stage and can be extinguished quickly if a proper portable fire extinguisher is applied and also, if the person that discovered the fire has the knowledge of how to use it (Grainger, 2016). Therefore, it became crucial that the sales people in market places should know how to use them. Plates VIII, IX and X show different types of portable fire extinguishers.

Plate VIII: Underwriters laboratory (ul) fire extinguisher. Source: grainger, 2016 (https://www.grainger.com/category /fire-extinguishers/fire protection/safety/ecatalog/n-b08).

Plate IX: Wheeled fire extinguisher. Source: Grainger, 2016 (https: //www.grainger.com/content/qt-portable-fire-extinguishers-135).

Plate X: Fire extinguisher alarm. Source: Grainger, 2016 (https://www.grainger.com/content/qt-portable-fire-extinguishers-135).

2.8.6 Emergency lighting system

According to Safelincs Limited (SLI), this type of system is provided for emergency situation in case there will be a stop of light from the main power supply which will lead to a failure of any normal illumination (SLI, 2015). Fire could be the result of the loss of main electricity supply leading to the failure of normal lighting supplies. This may lead to a possible danger to the occupants as a result of sudden darkness. Allbrite Company (ACO) stated that an emergency light is usually needed to work automatically and give light of an adequately high level to enable the affected building occupants to safely exit from the premises of fire outbreak (ACO, 2014). The majority of new buildings are expected to have installed emergency lighting system during constructions; the type of the equipment are specified by the architects with regards to the Building Regulations and requirements of any local authority.

According to SLI (2015), an emergency lighting system is sub-divided into two which are standby system of lighting and emergency escape system of lighting. These are discussed as follows:

i. **Standby system of lighting:** This system of lighting is given to allow normal activities to substantially continue without change. This requirement is legal and it is a facility that may be required depending on the occupancy of the premises and uses.

ii. **Emergency escape system of lighting:** This type of an emergency system of lighting gives light for people to be saved by trying to appropriately remove a potentially dangerous process. It is sub-divided into three which are area lighting system (high risk system), open area lighting system (Anti-panic Lighting system) and escape route lighting system; they are discussed as follows:

   a. **Area lighting system (high risk system):** This kind of escape system of lighting gives light for people to be saved in a situation or serious danger, and to allow proper procedures of shut-down to ensure that the occupants and operators of the premises are saved.

   b. **Open area lighting system (anti-panic lighting system):** It is the type of escape system of lighting for an emergency that is given to curtail panic and to ensure that adequate light exist to enable occupants of a building to get to an area where the route for escape can be known.

   c. **Escape route lighting system:** It is the type of escape system of lighting for an emergency that is given to ensure that ways of exit are effectively known and employed by the occupants of the building in a safely manner.

Since regional built-up markets in Nigeria are prone to fire outbreaks; they can lead to electric power cut. Therefore, it became important that emergency lighting are adequately installed in Nigerian markets, in order to enhance escape of people who are at the risk of fires. Plate XI shows an emergency lighting system.

Plate XI: Emergency lighting system. Source: allbrite company, 2014 (http: //allbrite.ie/emergency-lighting/).

2.8.7 Fire alarm system

According to Welt Limited (WLI), fire alarm system falls into two main categories (WLI, 2013). They are: automatic fire detection device and manual fire alarm device.

i. **Automatic fire detection device:** An automatic fire detection device comprises the detectors of heat and smoke together with alarm sounders and

break glass units joint to a control panel. It has the capacity to raise alarm even though the occupants of the building are present; it gives an early alert of incidents of fires.

ii. **Manual fire alarm device:** This type of device is comprised of alarm sounders and units joint of break glass to a control panel. The operation is only executed if activated by the person that discovered the incident of fire.

The intention of alarm device is to allow the detection a fire at a good beginning, so that the persons that are at the fire risk could be safe either by extinguishing the fire or escaping from the premises of fire, and to as well avoid serious damages of the properties (David and Matthew, 2005; Wilson, 2016). For the purpose of the occupants of buildings to escape from fires without major difficulties, there should be an early alarm operation prior to the route of escape to become logged up with smoke to the level that it will cause the occupants of buildings to face difficulties of finding their ways out of the fire risks. Plate XII shows a fire alarm system.

Plate XII: Fire alarm system. Source: welt limited, 2013 (http://weltuk.com/fire-alarms)].

2.9 Classification of Fires and their Extinguishing Agents

Formerly, the numbers of classes of fires are six but they were reduced to five due to the removal of one of the classes of fires, which is fires from electricity (formerly known as Class E Fires [Based on the standard of the method of classifying fires by the United Kingdom]) because electrical fires can involve in any of the present five classes of fires (Firesure, 2011). However, electrical fires according to scholars suchlike Scottish Qualifications Authority (SQA) include fires from wiring, electrical appliances, electrical transformers and other electrically energised objects in the vicinities of fires with the resultant risk of electrical shocks if an electric current conductive agents are used to control them; they can be extinguished by the use of dry powder and carbon dioxide agents (Firesure, 2011; SQA, 2007).

Classes of fires and their extinguishing agents have been discussed by different researchers and agencies like Fire Equipment Manufacturer's Association (FEMA). According to SQA (2007), Firesure (2011) and FEMA (2017), the following are the highlights of the classes of fires and their extinguishing agents:

i. **Class A fires:** They are class of fires from the materials that are solid and they are usually in organic nature in which burning usually occur and later form glowing embers and leaving of ashes as by-products. Examples of this class of fires are fires from textiles, trash, wood, papers and anything that leaves ashes, and they can be extinguished by the use of water agent. According to the DCLG (2006) and Twumasi (2013), fire is made up of three elements or components (fuel, oxygen and heat) which are known as fire triangle; to extinguish a fire, there is a need to remove one of these components from the fire triangle. In Class A Fires, water agent put out fires by taking away the heat element or component of the triangle of fire.

ii. **Class B fires:** They are class of fires from liquids or liquefiable solids. Examples of this class of fires are fires from paints, petroleum oil and also some waxes that are not cooking oils or fats; they can be extinguished by the use of foam, dry powder and carbon dioxide (CO2) agents. Foam agent takes away the oxygen component of the triangle of fire. Similarly, dry powder agent put out fires by taking away the fuel from the oxygen component of the triangle of fire or via separating the heat component of the triangle of fire. Likewise, carbon dioxide agent put out fires by taking away the oxygen component of the triangle of fire and also removes the heat component of the triangle of fire with a very cold discharge.

iii. **Class C fires:** These are fires from the flammable gases. Examples of this class of fires are fires from natural gas, butane, propane and hydrogen. They can be extinguished by the use of a dry powder agent.

iv. **Class D fires:** These are fires from the combustible metals. Examples of this class of fires are fires from aluminium, sodium, magnesium and potassium. They can be extinguished by the use of a dry powder agent.

v. **Class F or K fires:** These are fires from some cooking ingredients. Examples of this class of fires are fires from greases, cooking oil and fats from animals. The high temperature of fats and oil when on fire extremely exceeds that of other flammable liquids. It implies that the normal fire extinguishing agents should not be used to put such fires under control. This class of fires can be extinguished by the use of wet chemical agent. Wet chemical agent put out fires by taking away the heat component of the triangle of fire; disallows re-ignition via making a barrier inbetween fuel and oxygen components of the triangle of fire.

It was observed from this literature that all fires are not alike; there are various fuels that made diverse kinds of fires and need different types of agents for putting out the fires. Applying the wrong kind of agent for putting out the fire can lead to the severe damage being faced by the user or can make the fire worse (Firesure, 2011). There are bit of fire extinguishing agents that can be used for more than one class of fire and good examples are dry powder and carbon dioxide agents (FEMA, 2017). To make a choice of the use of the right type of fire extinguishing agent to put out a particular class of fire, there is a need for the understanding of the different classes of fires, especially in Nigerian markets where buildings are prone to fires.

2.10 Fire Management Models

Fire management models are avenues to curtail occurrences of outbreaks of fire (Amoako, 2014). Outbreaks of fire can be controlled properly by employing analysis of fire management models. Khan and Abbasi (1995); Twigg *et al.* (2017) pointed out that the analysis of fire management model is a systematic method of identifying and assessing hazards. Khan and Abbasi (2001) and Aven (2016) stressed it to be a process that involves quantitative and qualitative risk determinations, and their social analysis. The effective management of fire safety needs to recognise the main risks in connection with the subject matters and adequately conducting the evaluation of adequacy with regards to the measures required or available in putting away risks. Analysis of risk shows the proneness to the outbreaks of fire and fire spreads; therefore, it determines what measures must be carried out to bring arrangements that are suitable for protecting the properties and people in fire premises, and it should make sure that fire risk is absolutely curtailed to the minimum level as well as minimising the risk of the spread of fires (Buchanan, 2001; Dwomoh, 2015; Oladokun and Ishola, 2010).

Considering the reduction of risk of fire, Oladokun and Ishola (2010) employed analysis of risk for assessing and estimating disaster from the risks of outbreaks of fire for selected business buildings in Lagos and Ibadan of Nigeria. The result of the research showed that analysis of risk model been developed is worthy to be used for analysing the proneness of commercial buildings with regards to fire accident required for strategies development of design control by the regulatory bodies, users of the commercial complexes, companies of insurance, management of estates, and the rest of concerned stake holders in tackling reoccurrences of fire disasters.

Two concepts of the modelling approaches of fire are empirical fire behaviour model and physically-based model approaches. The empirical fire behaviour model is initiated based on the number of reasonable observations of fire and project the fire flame size or the rate of spread of fire (Joaquim *et al*., 2010). The physically based model is on the basis of principles of burning and the attempt to quantify the main mechanisms of fire (Amoako, 2014). Hence, conceptual framework adopted in this study is focused on the principle of physically-based model which is protection and prevention measures against fire in market places in the FCT of Nigeria. Reason for this is because it is important to investigate how fire starts in markets, and the principles of burning. Also, to determine the quantity of the basic fire mechanisms, so as to generate appropriate additional guidelines for market designs against fires in Nigeria.

2.11 Fire Risk Assessment

Health and Safety Authority (HSA) and Fire Safety Advice Centre (FSAC) stated that it is important to undertake assessment of fire risks. HSA (2006) and FSAC (2015) suggested the following procedure for undertaking assessment of fire risks:

i. Identify the hazard of fires.
ii. Conduct an assessment of the risks of fire safety.
iii. Prepare a written statement of safety, so as to handle fire risks.

Hence, in identifying the hazard of fires, the fuel and ignition sources that contribute to the ignition and initial fire increment is an essential part of the analysis of the traditional hazards. Scholars such as Healthy Working Lives (HWL) stated that after

the identification and qualification of fire hazards in terms of the likely initiation and the rate of fire spread, it is then needed to identify the fire risks of occupants (DCLG, 2006; FSAC, 2015; HWL, 2016). Scholars suchlike Government of Canada (GOC) stated that the risk of individual is defined as the probability that a person will be affected by unwanted consequence (Ale, 2009; Frantzich, 1997; GOC, 2017). The risk of each resident is determined by the action of a person and physical reaction in time of a fire which in turn determines the dependence on the people to give help to enable the resident to escape from the fire room or building.

Scholars such as Department for Communities and Local Government (DCLG), Health Technical Memorandum (HTM) stated that it is important to classify and identify the dependencies. According to DCLG (2006), HTM (2011) and White (2014), the dependencies have been classified and identified as follows:

i. The residents whose condition and care creates a high dependency on people and where immediate escape from the fire would prove potentially life threatening.
ii. All the residents of the building, apart from the residents defined as very high dependency. This category also comprises residents with the problems of mental health with no regard to their independent mobility.
iii. The movement of the residents of building is not in any way impaired and they are able to physically leave the premises of fires without the help of people. Alternatively, if they experience some movement impairment and they are able to leave with the little help from other people.

Frantzich (1997), Hadjisophocleous and Fu (2004), HSE (2009), and Molen (2010) stated that the societal risk is the consideration of the number of people under the risk of fire of multiple fatality. In this regards, it is not only the probability of unwanted fire event that is considered but the numbers of the people that are subjected to the fire hazard are also considered. Thus, it can be stated that the societal risk is the number of the persons in a specific location multiplied by the individual risk for that location.

2.12 Reduction of Disaster Risk of Fire

According to International Strategy for Disaster Reduction (ISDR) and National Disaster Management Centre (NDMC), the reduction of disaster risk is a concept of a framework of the consideration elements which have the possibilities of reducing the risks of disaster and vulnerabilities in the entire society and thereby curtailing the negative effects of hazards in the perspective of development of sustainability (ISDR, 2004; NDMC, 2014). Making a way to prevent hazards is important to reduce consequences of disasters. Giving consideration to this, it is vital to incorporate fire risk reduction into the components of all the development programmes, policies, strategies and investments for all the levels of government (Goodyear, 2003; Stouffer, 2016). Reduction of fire disaster takes measures to address the reduction of risk that involves social equity and the protection of environment; advance the growth of economy to ensure that the developmental efforts do not give increment to vulnerabilities of hazards (ISDR, 2002; Gachago, 2013).

In all the developmental activities, it is crucial to check and consider the reduction of risk of disaster. Scholars like Red Cross and Red Crescent Societies (RCRCS) stated that in meeting up with the future problems, capacity is thus essential to be created at both community level and national level, in order to have a curtailed and well managed risk (DID, 2005; ISDR, 2005; Pelling and Holloway, 2006; RCRCS, 2011). In considering the high cost of hazards from fire, the approach to reduce risk of fire disaster has resulted to the focus of the conceptual framework of this research which is again physically-based model.

2.13 Vulnerability Factors of Fire

Scholars like United States Agency for International Development (USAID) stated that vulnerabilities are situations that have influence on the capacity of the nations, individuals and communities to stop or reduce and make preparation for hazards responses (Ariyabandu and Wickramasinghe, 2003; USAID, 2011). Vulnerability serves as dependent element, whereas the agent of trigger represents disaster element that is independent. It is ascertained via the amount of resistance, risk, susceptibility and resilience (Cardona *et al.*, 2012; McEntire, 2001).

The risks from fire have different societal implications. Outbreaks of fire in markets negatively affect the societies with enormous damages to economic resources, environment, human lives and giving different treatments to men and women because the vulnerability to the consequences of disasters of fire in markets are more in women due to their activeness and social roles in market trades. This emphasises the necessity

to harmonise gendered perspectives in all the implementations of the measures and policies in the management of disasters like fires (Gachago, 2013; Ginige, *et al*., 2009; ISDR, 2002).

2.14 Fire Outbreaks in Market Places in Nigeria

Outbreaks of fire in Nigerian market places have become a discourse in the country (Oladokun and Emmanuel, 2014). As a result of these, Nigeria has recorded significant losses due to fire outbreaks. The reports from the Federal Fire Service of Nigeria (FFSN) in 2003 to 2016 showed that fire outbreaks are frequently occurring in Nigerian markets. Table 2.1 shows the reports of fire outbreaks in some Nigerian markets. It also shows that the rate at which fires occur in markets is increasing. For example, it reveals that there were three different fire outbreaks in markets within January and February, 2016. Likewise, there were two different fire outbreaks in markets within August and December, 2015. Similarly, it shows that fire outbreaks in markets were at significant rate in 2014 by showing the three different fire outbreaks within March, April and June.

However, it indicates low numbers of outbreaks of fire in markets in 2003 and 2013; these are indications that fire outbreaks increase in Nigerian markets by comparing the numbers of outbreaks of fire in these years and the numbers of outbreaks of fire in 2014, 2015 and 2016. Valuable properties and goods were destroyed in these fire outbreaks. Therefore, the issues of concern are the factors responsible for the frequent outbreaks of fire in Nigerian markets and their control measures in market designs. Plates XIII and XIV reveal the photographs of outbreaks of fire in markets in Nigeria.

Table 2.1: Reports of fire outbreaks in some Nigerian markets.

S/N	Market	Location	Date of Incidents	Year of Reports
1	Wuse Old Market	Wuse, F.C.T, Abuja	January 17, 2003	2003
2	Galadimawa Mini Market	Galadimawa, F.C.T, Abuja	June 23, 2013	2013
3	Garki Model Market	Garki, FCT, Abuja	March 29, 2014	2014
4	Food Stuff Market	Ose Okwuodu, Onitsha, Anambra State	April 13, 2014	2014
5	International Market	Alaba Ojo, Lagos State	June 30, 2014	2014
6	Major Market	Ilesa, Osun State	August 9, 2015	2015
7	Garki Model Market	Garki, F.C.T, Abuja	December 30, 2015	2016
8	Yola Main Market	Yola South, Adamawa State	January 4, 2016	2016
9	*Jakande Market*	*Ikosi-Ketu, Lagos State*	*January 28, 2016*	2016
10	Singer Market	Fagge, Kano, Kano State	February 20, 2016	2016

Source: Federal Fire Service of Nigeria, 2003 - 2016.

Plate XIII: Outbreak of fire at the major market in Ilesa, Osun State of Nigeria. Source: Official facebook website of the FFSN, 2015: https://web.facebook.com/FEDERALFIRESERVICEPRESS/photos?ref =page_internal).

Plate XIV: Fire outbreak at Singer market, Kano, Nigeria. Source: Kano State fire service, 2016 (https://www.newsbreak.ng/tag/ kano-state-fire-service/).

2.15 Factors that Cause Fast Spread of Fire in Market Places

Nwaogu (2015) stated that outbreaks of fire in market places are significantly rated high. Fire outbreak in Nigerian markets is always occurring in different places and the occurrences are significantly rated. Most of them are attributed to the factors such as cookers, electric sparks and storing of adulterated fuel (Nwaogu, 2015). These factors are attributed to the changes made by the users that cause fast spread of fire. It is an established fact that whether from the fire crackers or electrical faults and other ways of outbreaks of fire in markets in Nigeria, properties and human lives that valued millions of Naira worth are always lost in such incidents (FFSN, 2016; NANT, 2016).

It has been stated that fire is one of the greatest servants but the worst master that may not be easily controlled when it becomes an inferno (Agbonkhese *et al.*, 2017; Olaiya, 2013; Paul and John, 2002). Three elements (things) are needed for any fire to begin; they are: ignition source, fuel and oxygen. Fire cannot start if one of the elements is absent. To minimise fire chances according to scholars like Euro Fire Protection (EFP), it is important to take appropriate measures in avoiding the three elements to come together (DCLG, 2006; EFP, 2012). Naturally, by the time the three elements of fire are available which are usually called the triangle of fire, then, fire can occur. Figure 2.1 indicates a triangle of fire. For any fire ignition to begin and be sustained, the availability of oxygen, heat and fuel in their right proportions are required (DCLG, 2006; EFP, 2012). In this case, fuel is a thing that can burn which is been kept in open spaces or buildings in the market and this includes clothing, papers, flammable liquids and interior design features such as furniture, curtains and bedding. During fire

outbreaks, the more fuels in the open spaces, the more severity the resulting fires will be (Ohemeng, 2010).

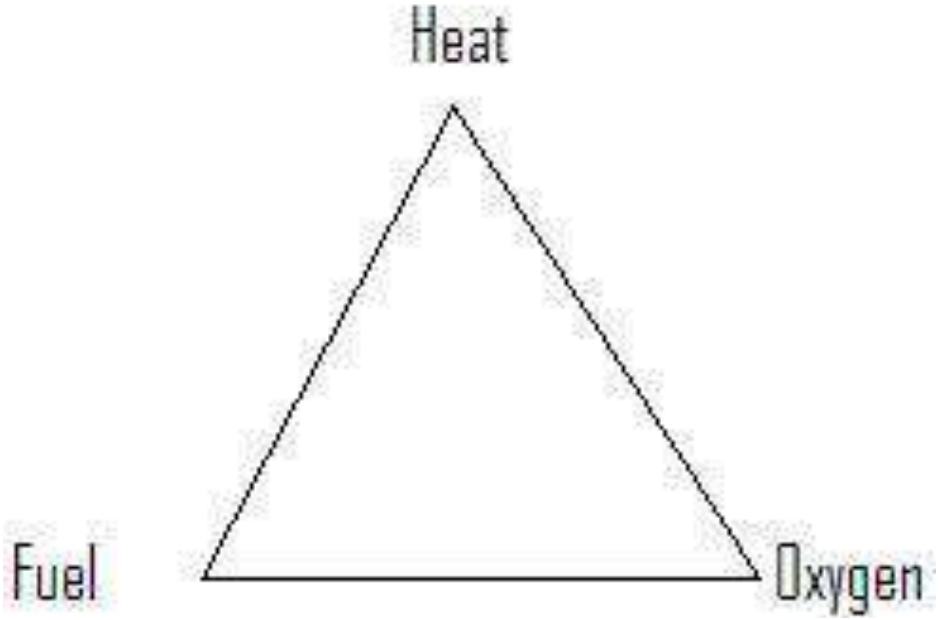

Figure 2.1: Fire triangle. Source: Fire safety advance centre, Alford, United Kingdom, 2015 (http://www.firesafe.org.uk/information-about-the-fire-triangletetrahedron-and-combustion/).

About 48 percent of fires are caused by human activities in British Columbia (Amoako, 2014), and some of the disasters from fire are due to the fluctuation of electric power (Giwa, 2012). Fire outbreaks in buildings are still the main disasters not only in Nigeria but across the globe with different causes, severities and consequences. Pang and Chow (2011) stated that over 80 percent of cases of fire in buildings were linked to wrong actions of building occupants, and these are usually seen in public buildings such as market places. When there are outbreaks of fire in market buildings, there will be serious challenges for the occupants of the buildings as putting out fires is not an easy task to execute.

Alhaji (2014) stated the following common factors which have attribute to the changes made by the users that cause fast spread of fire in market places which should be noted to reduce their challenges:

i. **Heating electronic appliances excessively:** electronic appliance which is wrongly installed having constricted air vents like stereo equipment, computers, television, and radios are under the expectation of heating excessively. It can result to the outbreaks of fires and other similar problems.

ii. **Smoking of cigarettes:** when fires from cigarettes make contact with flammable materials in markets, there are chances for them to set the markets on fires.

iii. **Leakage of gas cylinders:** if leakage of gas cylinder is not rectified on time, it can lead to outbreak of fire. When there is leakage of gas cylinder via the pipe in a market kitchen or other parts of the market in which gas cylinder is used to cook or to execute a similar purpose, a matchstick fire can set up the entire market on fire.

Boateng (2013) posited that tapping from the federal grid illegally, and unstable power due to frequent outages of power; improper electrical fittings are the factors that cause fast spread of fire. According to Anaglatey (2013), increase in the outbreaks of fire in public places such as market places is traceable to overloading of electrical appliances on a fuse, and the intense harmattan that increases the rate at which fire spreads. Anaglatey (2013) continued that old and improper wiring systems are also parts of the factors that could cause fast spread of fire. Likewise, ignorance is a significant factor that could cause fast spread of fire in markets. Poor awareness of fires and the ways

they should be avoided have resulted to different outbreaks of fire in buildings (Murage, 2012; Paschal, 2006).

In addition, arson attributed to the factors that cause fast spread of fire in market places. Fire can be willingly set as a kind of vengeance or protest against government or individuals. In researches and other reports, arsons have been previously discussed (Mann, 2009; Sandstrom, 2015). For example, according to scholars like Australian Institute of Criminology (AIC), it has been reported that actual or potential arson is of substantial rate in Australia (AIC, 2016; FAO, 2006). In Nigeria for instance, some outbreaks of fire in markets were traced to arson in which political reasons were the attributes (Agalga, 2013; Mann, 2014; Paschal, 2006).

According to NANT (2016), the causes of outbreaks of fire in Nigerian market places are associated with carelessness like the forgotten candle lights. Other factors are weak responses to the emergencies of fire by the Federal Fire Service of Nigeria. As a result of these attributed factors and other unknown factors, since 17 years ago, not less than 5.3 trillion Naira worth of goods was estimated by the National Association of Nigerian Traders (NANT) to have been lost to the fire outbreaks in Nigerian markets. Having considered these various factors that cause fast spread of fire, it became important that they are given adequate preventive measures from the architectural point of view, in order to reduce further significant loss of goods in markets.

2.16 Effects of Market Fires on the Environment and Health of People

Fire outbreaks have environmental implication through the release of smoke that causes atmospheric air pollution. According to scholars such as British Columbia Government (BCG), Department of Environmental Protection (DEP), UNEP [United Nations Environment Programme] Collaborating Centre on Energy and Environment (UCCEE) and Union of Concerned Scientists (UCS), air pollution occurs when the air contains odour, dust, smoke and fumes or gases in harmful amount; the smoke contains carbon dioxide (CO_2) which causes acid rain and global warming by depleting the ozone layer as a result of human activities that pumped excessive amount of CO_2 into the atmospheric environment (BCG, 2016; DEP, 2016; George *et al.*, 2013; Jason, 2009; UCCEE, 2006; UCS, 2016). Thus, as market building materials or components are burnt when there are fire outbreaks, chemicals, insecticides, pesticides, fertilizers and other agricultural materials, kerosene, paints, scientific and engineering products and divers products for sales that are made of harmful materials in markets are equally burnt. Consequently, damage has been made to the environment through the release of harmful smoke (containing CO_2) to the atmosphere.

In addition, scholars such as Department of Health (DOH), Manitoba Health, Seniors and Active Living (MHSAL) and National Geographic (NGE) stated that the smoke that is released to the atmospheric environment causes eye diseases by the time it enters the eye; it also causes skin cancer and respiratory diseases such as lung cancer by the time it is inhaled (DEP, 2016; DOH, 2016; Jason, 2009; MHSAL, 2016; Michael, 2016; NGE, 2015). The more sales people in the markets try to save money, goods and properties from being destroyed during the fire outbreaks, the more the smoke that will enter their eyes and touch their skins; also, the more the smoke that will be inhaled by

them. Likewise, people in the nearby buildings to the affected markets are not exempted from inhaling the smoke, if they remain within the nearby areas of the markets during fire outbreaks. Buyers in the markets can equally be affected by the smoke, if they fail to escape from the markets before the excessive release of smoke that generate the increase of congestion of escape routes by the people which will in turn hinder prompt escape.

2.17 Training and Education of Fire Service Personnel in Nigeria

The Federal Fire Service of Nigeria (FFSN) owns a National Fire Academy which is located along Lokoja - Abuja express way in Sheda Kwali in the Federal Capital Territory (FCT) of Nigeria. The academy is headed by a Commandant. According to FFSN (2017), the responsibility of this academy is to train the manpower of middle-level for the Nigerian Fire and Rescue Service Sector. It awards National Diploma and it got the accreditation from the National Board for Technical Education. The following facilities are found in the academy: cafeteria, clinic, gallery, staff quarters, drill ground, hostel accommodation, training props, library, water supply and many other facilities that are under constructions.

Similarly, the FFSN owns a training centre which is located at Clegg Street, Surulere, Lagos State of Nigeria and the responsibility of the centre is for the training of low-level manpower for the Nigerian Fire and Rescue Service Sector (FFSN, 2017). It has been reported on the official twitter website page of the FFSN (2017) that on 7th September, 2015, there was one day workshop/training for the personnel of the FFSN

which is on fire safety in buildings; similarly, the Fire Investigators concluded a two week training workshop on intensive fire investigation on 23rd September, 2015.

Frequent outbreak of fire is a serious problem in Nigerian markets (FFSN, 2016; NANT, 2016). The rate at which market buildings are frequently burning in Nigeria is high which is incomparable to the rate at which other buildings are burning in Nigeria. Thus, there is a serious need on how to specially address frequent fire outbreaks in Nigerian markets, in order to reduce their negative implications. However, there is no report on the official website of the FFSN with regards to the training of personnel on how to effectively train the sales people, in order for them to know how to effectively tackle and reduce fire outbreaks in Nigerian markets. Therefore, it became important that the training and education of Nigerian Fire Service Personnel is taking very serious, most especially with respect to the protection and prevention measures against fire in market places, so as to obtain a proper prevention and mitigation strategises of fires in Nigerian markets.

2.18 Precautions for Fire Safety and Management

Some best practices of the prevention of fire were identified and implemented by the British Fire Service in United Kingdom. Such best practices were classified into eight main categories which are: staffing increment and training on the programmes to prevent fires, identification and analysis of high risk households, making homes a safety places and conducting extensive youth and school programmes (Gakpe and Mahama, 2014; Schaenman, 2007). Other classifications were the direction of

programmes to the elderly population of the high-risk, coordinating local and national campaigns of fire safety, sufficient use of fire stations for the programmes of safety of the community fire and the development of safer consumer products (Gakpe and Mahama, 2014; Schaenman, 2007).

Schaenman (2007); Gakpe and Mahama (2014) further explained that in categorising campaigns of safety for fire, the Fire Service in Britain employed some local radio stations and newspapers in spreading the messages of fire safety. The campaigns were intended to increase smoke alarm ownerships, bring awareness of the problems of fires and change behaviours of fire safety. This enablement to recognise the dangers of fires and to know what actions to take for fire preventions together with what to do in cases of fire outbreaks aid effective safety management of fires. Comolotti (2004) and Twigg *et al.* (2017) stated that preparedness of a fire disaster is on the basis of the knowledge of hazards from fires, the causes of outbreaks of fires and expected impacts on the built and natural environments.

Comolotti (2004) and Twigg *et al.* (2017) further argued that people with the knowledge of disasters from fires will acquire devices for fire protection such as fire extinguishers, smoke detectors and fire blankets to support the activities of the responses. According to the Government of United Kingdom (GUK), the regulations of safety in United Kingdom imposed compulsory trainings for the fire safety on all the employees that are working in the construction areas and other busy areas such as markets (GUK, 2017). These also aid in providing employees with the important

information and developed skills such as the proper behaviours of escape and operation of fire extinguishers.

The safety regulation gives minimum standards of fire safety in buildings. Fire safety is a consideration that has not been taken serious in the development of new buildings (Brian, 2012). This challenge has been expressed by the World Fire Statistics Centre (WFSC) as fire banality. Fire should not be banal in any nation because of its economic and human costs. Across the globe, the yearly toll of deaths from fires is significantly measured high with the people that were injured as a result of fire. The avenues to protect humanities from the dangers of outbreaks of fire are therefore required via appropriate protection and safety measures against fire.

Protection from fire is dependence on the functional activities of occupancies especially in market environments. According to African Adaptation Programme on Climate Change (AAPCC), the principle tends to put fire into consideration as a serious hazard; to give applications in handling the protection or safety of human lives, properties or goods (AAPCC, 2012). Since markets in Nigeria are very prone to outbreaks of fire, it therefore became crucial that adequate fire protection and safety measures are ensured in their designs, in order to minimise further loss of goods, properties and lives of people.

2.19 Prevention of Fire Outbreaks

The Federal Fire Service of Nigeria (FFSN) stated on September 20, 2014 that properties and goods that worth millions of Naira are always destroyed as a result of fire incidences in Nigeria; lives are also lost in the process. Some times, they are not reported but are there thoughts to the causes of fires in markets, shops, office places, homes and other environments of people and the ideal ways to have them reduced? (FFSN, 2014).

According to DCLG (2008), Abubakar (2012), Nixon and Diemler (2012); FFSN (2014), the following are the ways to reduce fire outbreaks in buildings:

i. Electrical appliances should always be put off when no one is making use of them and do not excessively load electrical sockets.
ii. Do not smoke at bed times to avoid the tendency of dozing off which may lead to a possibility to toss butts anywhere while they are half-lit and it is important to always give sturdy and deep ash trays to the smokers.
iii. Do not use phone in the kitchen to avoid the temptation of forgetting the food on the cooking appliances due to discussion on the phone.
iv. When in the filling stations, phones should be off because making and receiving calls in an environment that is highly inflammable such as stations where petrol are sold is very risky. This is because mobile phones emit little charges with the possibility of explosion when petrol is in contact with them.
v. Avoid fueling generators while in use to reduce the possibility of catching fires.

vi. Make sure that house wiring are supervised by certified electrical engineers, and do not fix electrical faults personally when there is no skill to handle such tasks.

vii. Get thunder arresters to safely lead a huge amount of electrical charges away from buildings to the earth, so as to have fire preventions.

viii. Candles should be kept on their stands because candles may fall off and a nearby objects may get burnt which may lead to a serious fire outbreaks in buildings.

ix. It should be ensured that attention should always be given to the cooking pans or pots when they are on fires; it should also be ensured that after cooking, cookers are turned off immediately.

x. Always put off the fire of kerosene lamps before refilling their tanks to avoid outbreaks of fires in case the kerosene is adulterated with petrol.

xi. It should not be forgotten to put off and unplug electrical appliance after making use of them.

xii. Substances that are flammable should not be placed near the sources of heats such as kitchens, stores of kitchens and fire places or furnaces.

xiii. Fire-ignited means such as matches should be kept out of the reach of children.

xiv. Be cautioned when using alternative heating sources; there should be yearly inspection and cleaning of heating units by a relevant reputable professional.

xv. Store ashes of fires in a metal container and ash containers should not be placed on the decks that are made of wood or composite materials.

xvi. Keep screens in front of fireplaces where there are combustible materials; alternatively open flames should be kept away from combustible items such as drapery and furniture.

xvii. When sleeping at night, fire proof doors should be close, so as to avoid fires from spreading through them in case of possible outbreaks of fire.

2.20 Compliance of Fire Safety

Scholars such as Fire Department (FDE) stated the major reason for inspection of compliance with measures for fire safety is to minimise situations that can pose threats to human lives, properties and goods; to assure the building managers and owners of the reduction of future fire hazards (FDE, 2017; Frangiamore, 2009; Hall *et al.*, 2008). Australian Fire and Emergency Services Authorities Council (AFESAC) reported that most fires were discovered to be extinguishable if appropriate protection device is used at the right time (AFESAC, 2014).

As one of the compliance measures with the fire safety of Australia, fire extinguishers are positioned throughout their workplaces. However, Fire and Safety Australia (FSA) stated that most persons are afraid of the extinguishers in times of fire emergencies (FSA, 2013). From the study in Australia with regards to the safety for fire, FSA (2013) indicated the following outlines:

i. Over 90% of people can correctly used fire extinguishers during the second time attempt after attending basic training session of extinguisher (where all participants operated fire extinguishers on a real fire).

ii. The location knowledge and operation of firefighting equipment should be improved by the occupants of buildings via regular training on fire safety.

iii. More confidence should be obtain by the occupants of buildings in complying with procedures for emergency in the workplaces. Hence, there shall be improvement with regards to the kind of emergency actions that are to be taken.

iv. Training for fire safety increases the emergency response actions and knowledge of the occupants of buildings in times of confrontation with a situation of fire emergency.

Giving consideration to FSA (2013) with regards to the approach and outcome of the study, compliance to the safety measures against fire in the study area was thoroughly assessed in terms of the adequacy of firefighting equipment and the levels of the knowledge of their operations.

2.21 Emergency Evacuation

British Standards Institution (BSI), Department of the Environment Heritage and Local Government (DEHLG) and other scholars stated that emergency evacuation is the major or actual concern of safety for fire in the design of building and the system of ways of the escape of people from fire hazards in buildings; it is among the crucial measures of safety for fire (BSI, 2010; DEHLG, 1996; Li and Chow, 2003; Nelson and Mowrer, 2002; Proulx and Pineau, 1996; Purser and Bensilum, 2001). According to Kobes *et al.* (2010), people in a building with a fire incidence have to either be rescued

by other people in their immediate vicinity or depend on themselves in the early stages of a fire. It was further explained that evacuation behaviour is how people behave in time of an escape from fire. The behaviour of people during the first phase of fire in a building in terms of survival is an essential factor. It is defined as the actions that people take with respect to their intentions and perception of conditions; it involved considerations before the execution of actions (Kobes *et al.,* 2010).

2.22 Fire Science

Fire science brought about a deep insight into the mechanism of ignition, growth and spread of fire together with the problems associated with the smoke movement (John, 2012). The consideration of critical stages of fire in a building will give a knowledge of the function of fire science in getting fire safety in buildings. According to United States Fire Administration (USFA) and other scholars, there are different kinds of fires in buildings and the main features that are peculiar to all fires can be observed; all fires exhibit three key critical stages which are: the period of growth, the full time developed stage and the stage of decay (Drysdale, 1994; Frassetto, 2012; USFA, 2008). In most materials, the ignition needs the heat flux (incident type) which leads to the fuel surface temperature to increase (Jaskołowski *et al*, 2014 and Kealy *et al.,* 2003).

Considering the science of building fire behaviours, the ways to get safety for fire can be based on ignition prevention. According to Drysdale (1994), HSE (2014); HSA (2017), the ways to prevent ignition are listed as follows:

i. Use of low-ignitability materials.

ii. Use of fire resistant materials.

iii. Elimination or control of the materials that can be ignited easily.

iv. Elimination or control of the sources of ignition.

However, no approach to the ignition prevention could be effective absolutely; if fire starts, the protection of a second level should protect the occupants of buildings by preventing the exposure of building occupants through different forms of fire protection with the provision for evacuation of the building occupants (Hartzell, 2001; Spadafora, 2012). According to Drysdale (1994) and White (2014), in the scenario of any fire, safety of lives of people depends on the prevention of occupants of buildings from coming close to the smoke and fire by making the occupants of fire room to escape as fast as possible. According to Siemens Company (SCO), in the case of the occupants in the fire room, time is gained to evacuate by the early alert of fire outbreak that is given by the automatic alarm and fire detection system (Drysdale, 1994; SCO, 2014). The containment of smoke and fire in the fire room is gotten by self-closing fire doors and fire resisting construction. Giving consideration to this section, the design of markets should protect the occupants from fire through proper evaluations. However, preventing fire outbreaks from occurring in markets is of paramount importance.

2.23 Application of Fire Science to Life Safety

Emergency escape of people from fire disasters is the aim of fire safety for the design of safe buildings (Charters, 2009; Li and Chow, 2003; Sagun *et al.*, 2013). In an emergency of fire, the occupants of buildings that are not able to escape in time will suffer from such hazard (Gilmore, 2015; Nelson and Mowrer, 2002). The main

principle of building performance-based design in respect of the safety for fire engineering is that the available duration for occupants to escape from buildings should be above the accurate time allowed to evacuate the occupants (BSI, 2001 and 2004; Groner, 2016). The time that is needed for the building occupants to escape when there are fires is called the required safe escape time (BSI, 1999; Health and HSA, 2017).

The projection of the required safe escape time is an integral part of performance-based design of buildings (BSI, 2001; Purser, 2016). This time begins when the occupants of buildings are exposed to the cues of fires and ends when the occupants of buildings begin to move to safe areas that are particularly for emergency exits. The pre-movement process begins with the cue of fire; for instance, a smoke or fire alarm which implies a cue that gives sign that an emergency of fire have occurred and ends at the beginning of movement to the exit (Candy and Chow, 2006; Kuligowski and Hoskins, 2010). According to Purser and Bensilum (2001); Moore and Hrymak (2012), there are two components of pre-movement process which are:

i. **Recognition:** This begins at the stage of alarm or when cues like the presence of too much smoke or heat is detected and finishes with the first response. Some of the occupants of buildings were often found to continue with the activities of pre-alarm. For instance, watching of television, eating, sitting and working.

ii. **Response:** It begins at the first response to the cue recognition or alarm and finishes with movement to the exits. The occupants of buildings execute different activities at this level which are:

    a. Passivity.

b. Firefighting.
c. Alerting other people.
d. Way findings.
e. Preparing and gathering the occupants of building for evacuation (for instance, people that have gone to toilets).
f. Investigation to discover fire source.
g. Stopping equipment such as cooking stoves from working and closing fire doors around the fire rooms or areas.

The actual time over needed by the building occupants to be in a building at the time of outbreak of fire; the time required to evacuate people are dependent of the characteristics of buildings, occupants of buildings and scenarios of the potential fires (BSI, 2001; Kinateder *et al.*, 2015; Sagun *et al.*, 2013). According to Purser and Bensilum (2001), Melly (2010), Moore and Hrymak (2012), in all the occupied enclosures in buildings, the time for evacuation is dependent of different sequential processes and basic additives. This is dependent of the elements such as the training of staff and practice of emergency management; it also depends on the qualities of equipment such as fire alarm to execute a timely and efficient evacuation. According to scholars like Closed-circuit Television (CCTV), fire alarm system is an integral part of fire protection devices for protecting buildings against fires (BSI, 2004 and CCTV, 2017; HSA, 2017). In places of markets, it is important to expect the high number of the sales people that are trained to quickly respond in times of fire alarms.

The occupants of buildings will respond in the events of outbreaks of fires and evacuate, while sometimes, the occupants of buildings will not be able to respond to such events (BSI, 2004; Melly, 2010). According to Sime (1988), Canter (1990), BSI (1999), Charters (2009) and Johansson (2011), the behaviour of occupants of the building during evacuation from fire is dependent on different factors such as the characteristics of the occupants [especially, the familiarity of occupants of the building and its system, the state of alertness of occupants of the building (asleep or awake), and the number of occupants of the building]. It is also dependent on building characteristics (especially, building layout, management system of fire safety of the building, methods for the detection and provision of warnings in the building). Thus, it is vital that all the aspects of these variables should be considered for the design of markets.

2.24 National Fire Safety Code of Nigeria

Different agencies such as Buildings Department (BDE), California Building Standards Commission (CBSC), Environmental Health and Safety (EHS), Office of the Fire Marshal (OFM) and Ontario Ministry of Community Safety and Correctional Services (OMCSCS) have defined fire safety code. It is enforced guidelines or regulations under the fire prevention and protection Act that comprises of a set of minimum standards that give respect to the fire safety around and within the existing facilities and buildings (BDE 2011; CBSC, 2016; EHS, 2015; OFM, 2012; OMCSCS, 2016). These enforced guidelines improve the safety of lives of the people together with the protection of goods and properties by giving a fire hazard management, comprehensive and integrated approach to the regulation of fire safety. British Psychological Society

(BPS); Council of Architecture (COA); Facilities and Operations (FAOP) and New Horizons Resources Foundation (NHRF) explained that a guideline is a procedure or information that direct a person on how the building design or other things should be done by giving advice and examples of information on the type of action that should be taken in a specific circumstance (BPS, 2016; COA, 2015; FAOP, 2017; NHRF, 2006). As a result of the challenges of outbreaks of fire in Nigeria, guidelines for building design were enforced to become the National Fire Safety Code of Nigeria (NFSCN).

During the weekly meeting of the executive council of the Federal Government of Nigeria on 4th September, 2013, the drafted National Fire Safety Code was given an endorsement to be implemented across the country (FFSN, 2013). From the preface page of the NFSCN (2013), the code came to existence as a result of Nigerian cities that continue to increase in size without appropriate provisions for safety infrastructure, and building designs were given approvals without appropriate consideration for requirements of safety, and markets were constructed with no conformity with standards of safety. Moreover, the NFSCN is subject to review every three years. This implies that since the first edition of the drafted fire code was approved in 2013 by the Nigerian Government, it is supposed to have been reviewed in 2016, in order to curtail the outbreaks of fire in Nigerian buildings. However, since 2013 till date, no revision has been made on it despite frequent outbreaks of fire in markets in Nigeria.

From the acknowledgement page of the NFSCN (2013), Controller General of the FFSN and Directors of the Fire Services met severally with the Chief Town Planners

from all the Nigerian states including the Federal Capital Territory (FCT) of Nigeria, and the representatives of the Federal Ministry of Works and Housing as well as pertinent professional bodies to come up with a drafted NFSCN in March, 2009. It was presented as a memorandum to the National Council on Fire at its first meeting that was held in Abuja between 28th and 30th October, 2009 before the final date of endorsement. Also, according to the acknowledgement page of the NFSCN (2013), without any reservation, the efforts of the following personalities and professional bodies in Nigeria were duly acknowledged for contributing to the success of the Fire Code:

i. Honourable Minister of Interior.
ii. Permanent Secretary of the Ministry of Interior.
iii. Director General of the National Emergency Management.
iv. State Commissioners and Permanent Secretaries of the Ministries where the Fire Services reside in the respective States.
v. Director of Architectural Services of the Federal Ministry of Works and Housing.
vi. Director of Building and Engineering Services of the Federal Ministry of Works and Housing.
vii. Representatives of the following professional bodies:
    a. Nigerian Institute of Architects.
    b. Architects Registration Council of Nigeria.
    c. Nigerian Institute of Quantity Surveyors.
    d. Nigerian Society of Engineers.
    e. Council of Engineering Regulations in Nigeria.
    f. Fire Protection Association of Nigeria.

viii. Other individuals that gave contribution to the success of the NFSCN.

The NFSCN is made up of ten parts with regards to the issues relating to fires in buildings. According to Course Hero (CHE), Community Medicine (CME) and other scholars, the size of a measurement scale can be taken based on the magnitude (size, extent or importance) where numbers (the identity) have an inherent order from the least to highest and they are usually represented on scale in ascending or descending order; for example, from the 1st, 2nd, 3rd to the least (CHE, 2021; CME, 2013; Formplus, 2019; Lee, 2007; Mishra *et al.*, 2018). In this case, ten parts of the NFSCN are ranked from first to tenth positions according to the importance of each parts.

The different parts of code are: Part I (Purpose, Scope and Application) with tenth position, Part II (Administration and Enforcement) with nineth position, Part III (Offences and Penalties) with eighth position, Part IV (Classification of Buildings) with sixth position, Part V (Types of Construction) with fourth position, Part VI (Access, Means of Escape and Exit Ways) with first position, Part VII (Fire Walls and Fire Resistance Constructions) with third position, Part VIII (Fire Suppression Systems) with fifth position, Part IX (Electrical Installation in Building and Attendant Fire Hazards) with second position and Part X (Miscellaneous) with seventh position. Table 2.2 shows the arrangement of the parts of National Fire Safety Code of Nigeria.

Table 2.2: Arrangement of the Parts of National Fire Safety Code of Nigeria.

S/N	Section	Function	Rank
1	Part I	Purpose, Scope and Application	Tenth
2	Part II	Administration and Enforcement	Nineth
3	Part III	Offences and Penalties	Eighth
4	Part IV	Classification of Buildings	Sixth
5	Part V	Types of Construction	Fourth
6	Part VI	Access, Means of Escape and Exit Ways	First
7	Part VII	Fire Walls and Fire Resistance Constructions	Third
8	Part VIII	Fire Suppression Systems	Fifth
9	Part IX	Electrical Installation in Building and Attendant Fire Hazards	*Second*
10	Part X	Miscellaneous	Seventh

Source: National Fire Safety Code of Nigeria (2013).

2.24.1 Part I: Purpose, scope and application

Part I of the National Fire Safety Code of Nigeria (NFSCN) is made up of three sections. It comprises of the purpose, scope and application of the code.

2.24.1.1 Purpose of the code

According to section 1, the reason for having the NFSCN is to prescribe minimum standards needed for the establishment of a reasonable fire level and safety of life. Prescription of minimum standards needed for the protection of property from the hazards that result from explosion, fire and dangerous conditions also inclusive.

2.24.1.2 Scope of the code

From section 2, the scope of the code includes:

i. The installation, maintenance, design and operation of system, devices and equipment to control, mitigate, stop and put out fire, explosions or other hazards of life safety.
ii. Emergency planning/preparedness that include the proper evacuation of premises or building occupants in case of explosion of fire; hazardous, biological or chemical material release or incident, natural disasater or other emergencies.
iii. The manufacturing, use, handling, storage, sales and transportation of combustible and hazardous materials.
iv. The control, mitigation and prevention of hazards for the emergency responders and fire-fighters in time of emergency operations.
v. The maintenance and operation of any fire protection system.
vi. Inspection of systems, equipment, buildings, processes; other fire and life safety related matters.

vii. Reviewing of building plans and specifications for hazardous materials, processes, water supplies, means of egress, access, fire protection system, life safety and other related matters that include existing occupancies; conditions, alterations or addition of new buildings, design and construction of new buildings.

viii. Investigation of hazardous materials, explosions, fires and other related emergency incidents.

ix. Access requirements for the Fire Services operations.

x. Life safety education and fire awareness campaign to the general public.

xi. Handling of building fixtures, finishes and other combustible materials that aid the spread of fire and smoke production.

xii. Handling, processing, use, storage and transportation of flammable solids, liquids, gases and hazardous materials.

xiii. Hazards control in combustible wastes.

xiv. Control and regulation of special events that include public places, shows, outdoor events, and other permanent occupancies.

xv. Control of emergency of fire, related operations; the conditions that affect the safety of firefighters.

2.24.1.3 Application of the code

According to subsection 1 of section 3, the code provision should be applied without restriction, unless specifically exempted by the appropriate fire authority. Subsection 2 of section 3 shows that the code made provision for the fire prevention and protection measures. Subsection 3 of section 3 indicates that the provisions of the design and

installation of the code which are protection measures against fire shall be applied to the facilities that were established before the commencement of the code. Also, they shall be applied to the facilities that will be established after the commencement of the code. Subsection 4 of section 3 states that the maintenance and operational provisions of the code which are fire preventive measures that include certification and permit requirements shall be applied to the facilities, uses, conditions, operations and occupancies that will arise after or on the code effective date. Also, they should be applied to the facilities, uses, conditions, operations and occupancies established prior to the code effective.

2.24.2 Part II: Administration and enforcement

Part II of the NFSCN contains different sections. Among the sections are authority to administer development permits, fire investigations, enforcement assistance, deligation of authority, authority at fire and other emergency scenes. Other sections are interference with the fire fighters, fire safety design approval and annual certificate, unlawful acts and permit for place of assembly, plans of evacuation, safety for fire and notification of emergency, and the existing buildings.

2.24.2.1 Authority to administer development permits

According to subsection 1 of section 4, the appropriate authority for granting development permits shall be the planning authority at different levels of government with such professional responsibility and expertise for enforcing and interpreting the

code, and permit shall only be granted after the appropriate Fire Service has appraised and approved all the applications and drawings with respect to the code provisions. Subsection 2 of section 4 indicates that appropriate authority should review, receive, and if satisfied shall give approval for the permit and certificate applications; design installation documents and other necessary approvals for a permit under the code.

2.24.2.2 Fire investigations

From section 5, the appropriate authority may find out the circumstances, origin/cause of any hazard of fire within its jurisdiction. Other safety hazards of life may also be found out by the appropriate authority within its jurisdiction.

2.24.2.3 Enforcement assistance

Section 6 states that if necessary, the appropriate fire authority shall seek the assistance of Police in the enforcement of the NFSCN. The assistance of other law enforcement agencies shall also be sought by the appropriate fire authority in the enforcement of the code.

2.24.2.4 Delegation of authority

Section 7 indicates that if necessary, the appropriate fire authority may give or delegate powers to other competent institutions for the enforcement of the NFSCN. Powers may

also be given or delegated to other competent institutions for the administration of the code.

2.24.2.5 Authority at fire and other emergency scenes

According to subsection 1 of section 8, the firefighter in control at the fire scene or other emergencies, and also involved in property or life protection, or any related part, should have power to give direction to such operation as it is expedient and necessary to control or extinguish any fire, perform any operation of rescue, find out the availability of reported or suspected leakages in gas, outbreak of fire and other hazardous situations or conditions, or remove other measures or actions required for effective performance at such scene.

Subsection 2 of section 8 shows that in the exercise of such authorities in subsection 1 of section 8, the fire service officer may bound people, marine vessels, object and vehicle from coming to the scene and may take away or cause to be removed from the scene, vessels, objects or vehicles that can intervere with the Fire Service operation. Subsection 3 of section 8 reveals that firefighter in control at the fire scene or other emergencies may position guards, barricades, ropes or any other obstruction across alleys, streets, places or private properties in such operation vicinity, in order to stop accidents or interference with the efforts of the fire fighters to control/manage such situation.

2.24.2.6 Interference with fire fighters

From section 9, it shall be contrary to the law in case of obstructing, interfering or hampering firefighters in carrying out inspections with regards to the National Fire Safety Code of Nigeria (NFSCN). It shall also be contrary to the law in case of obstructing, interfering or hampering firefighters in issuing notices/orders or otherwise enforcing the provisions of the code.

2.24.2.7 Fire safety design approval and annual certificate

According to subsection 1 of section 10, permit for fire safety design should be gotten from the office of Fire Service prior to the approval of the development plan and commencement of construction in accordance with the guidelines in the NFSCN. Subsection 2 of section 10 states that on completion and prior to the use of the developments, fire safety certificates shall be collected and thereafter, the Fire Service shall be involved in regular inspection of fire safety and issue certificates of fire safety annually.

2.24.2.8 Unlawful acts and permit for place of assembly

From section 14, it will become unlawful to handle, manufacture, use, store, transport or sell a combustible or hazardous material, and execute an operation or maintain a facility in which a permit is needed pursuant to the provision of the NFSCN with no such permit. Section 29 reveals that permit may also be needed to operate or maintain an assembly place.

2.24.2.9 Fire safety and evacuation plans

According to section 37, emergency action plans, plans of fire safety and evacuation should be approved by the Fire Service. Section 40 states that the owner of any premise shall make an emergency action plan, fire safety and evacuation plans to be organised for such premise in a prescribed manner via the approving authority which shall be reviewed or amended periodically.

2.24.2.10 Emergency notification

From section 38, any occupant, owner or anybody who has known a fire incident, explosion or other emergencies should report such emergencies to the Fire Service immediately. In addition, nobody should take actions or issue directives to delay or stop the reporting of emergencies such as fire to the Fire Service.

2.24.2.11 Existing buildings

From subsection 1 of section 41, the preparation of an emergency action plan, fire safety and evacuation plan shall consist of an operational requirement in any existing building. Subsection 2 of section 41 indicates that the owners of buildings or occupancies that are not needed to have evacuation and fire safety plan before the effective date of the code should have 12 months from such effective date to organise and submit such plan. Subsection 3 of section 41 reveals that owners of buildings or occupancies that have approved plans of emergency action and plans of fire safety on the code effective date should not be needed to file or organise new plans within 12

months period. However, the available plans shall be maintained in accordance with the regulation requirements, applicable laws and rules to such plans before the Fire Code effective date and such amended or additional requirements as may be accepted after the NFSCN effective date.

2.24.3 Part III: Offences and penalties

Part III of the NFSCN contains different sections. Among the sections are criminal liability, tampering with fire protection system and appliances, violation of Code by the developer, owner or occupier, and no smoking order.

2.24.3.1 Criminal liability

According to subsection 1 of section 54, where people are burnt by the explosion of materials of which the sales is not allowed by the NFSCN or that have not received approval pursuant to provisions of the code, and death ensues as a result of the explosion of material; in addition to other penalties given by the regulation or law, rule, the people found guilty of selling such material commits an offence. Thus, the people should on conviction be liable to a minimum fine of one million Naira or fourteen years imprisonment. Subsection 2 of section 54 indicates that in the case of a bodily injury as a result of the explosion of material, the person with injury shall maintain damage actions against the person violating the code provisions.

2.24.3.2 Tampering with fire protection system and appliances

From subsection 1 of section 55, it should be unlawful for people to obscure, deface, take away or otherwise render inoperable or tamper with fire protection equipment such as portable fire extinguisher, fire detection/alarm equipment, fire hydrant and other fire protection equipment. Subsection 2 of section 55 indicates that any body who violates the requirements of subsection 1 of section 55 has committed an offence and should be liable on conviction to a minimum fine of 100,000 Naira or imprisonment for two years or both.

2.24.3.3 Violation of code by the developer, owner or occupier

According to section 56, any occupier, owner or developer of a structure or building who contravenes the provisions of the NFSCN either by failure to provide for fire safety in the structure or building and obtain a fire safety certificate before occupying the building; collect safety permit prior to commencement of the building has committed an offence. Such occupier, owner or developer of a structure or building should be liable on conviction to a minimum fine of 500,000 Naira or imprisonment for three years or both.

2.24.3.4 No smoking order

From subsection 2 of section 57, it will become unlawful to smoke:

i. In areas that smoking is banned as indicated in the code.

ii. In any premise, structure, building or any part thereof where explosives, combustible or flammable materials are used, handled, stored, manufactured or transported.

iii. On board in any lighter, ferry, barge, ship, car float and other similar equipment.

Subsection 3 of section 57 shows that it shall be unlawful to discard/place, or allowed to be discarded of smoking paraphernalia or material such as cigarette, cigar and lighted pipe where it can cause the ignition of combustible waste or material or otherwise allow a fire that is not wanted. Subsection 4 of section 57 reveals that in factory that smoking is allowed, a good non-combustable receptacles or ash-tray should be given at the right locations. Subsection 5 of section 57 indicates that any person that go contrary to section 57 has committed an offence and should be liable on conviction to a minimum fine of 100,000 Naira or imprisonment for two years or both.

2.24.4 Part IV: Classification of buildings

The NFSCN is applicable to different classes of buildings in Nigeria such as assembly buildings in section 60 of which markets are inclusive. Other classes of buildings under the application of the code are business buildings in section 61, factory and industrial buildings in section 62, high hazard buildings in section 63, institutional buildings in section 64, mercantile buildings in section 65, residential buildings in section 66, storage buildings in section 67, structures employed for the storage of materials that are

combustible in section 68, mixed use buildings in section 69, high rise buildings in section 70 and other unspecified buildings in section 71.

2.24.5 Part V: Types of construction

In Part V of the National Fire Safety Code of Nigeria (NFSCN), building constructions are grouped into five types. They are type A which is known as fire resistant construction, type B which is known as non-combustible construction, type C which is known as exterior masonry wall construction, type D which is known as mud wall construction and type E which is known as combustible construction.

2.24.5.1 Type A: Fire resistant construction

According to section 72, the structures and buildings of fire resisting construction in which their exit ways, ceilings, roofs, floors, structural elements, partitions and walls are built and protected with materials that are fire resistant are to achieve the relevant fire resistance ratings of structural elements. The fire resistance ratings should be in minutes or hours.

2.24.5.2 Type B: Non-combustible construction

From section 73, the structures and buildings of non-combustible construction with exit ways, ceilings, roofs, floors, structural elements, partitions and walls are to meet up

with the requirements for fire resistance rating. The fire resistance rating should be in minutes or hours.

2.24.5.3 Type C: Exterior masonry wall construction

Section 74 states that the structures or buildings of outside masonry wall construction that their outside, party and fire walls are built of masonry and other materials are to have the needed fire resistance rating. Also, they are to have recommended properties of the structures.

2.24.5.4 Type D: Mud wall construction

Section 75 indicates that the structures and buildings of interior/exterior walls and partitions which are constructed of terrapise, adobe and laterite shall be subjected to fire resistance investigations. Those that are constructed of the combination of other earthen materials shall also be subjected to fire resistance investigations.

2.24.5.5 Type E: Combustible construction

Section 76 reveals that the structures or buildings of combustible construction in which the roofs, ceilings, floors, partitions, exterior walls and structural elements are constructed partly or wholly of joist assemblies and wood stud with a minimum dimension of 50 millimetres or of other materials that are combustible shall have fire stopping to all horizontal and vertical draft openings. The structural opening elements

should get the needed fire resistance ratings that are specified in the resistance ratings of fire of elements of structures in minutes or in hours.

2.24.6 Part VI: Access, means of escape and exit ways

Part VI of the NFSCN contains different sections. Among the sections are access and site planning, means of escape in low rise buildings, doors leading to emergency stair cases, obstruction of escape route, opening in rooms, and the air-conditioned buildings or structures.

2.24.6.1 Access and site planning

According to subsection 1 of section 77, each building on the site shall have a maintainable access for the Fire Service equipment via means of a private roadway, open space or street. Subsection 2 of section 77 indicates that where access to a building is provided by means of an open space or a private roadway, the location and design of such access should be approved by appropriate authority of fire, and taking the following features into consideration.

i. Connection with the public thoroughfares.
ii. The estate roads.
iii. The radius of curvature.
iv. Overhead clearance of the access road shall be minimum of 4.5 metres and minimum of 6.0 metres wide.

v. The parking arrangement for vehicles should ensure that there shall be no parking of vehicle against fire hydrants or fire lanes.

vi. Location of the Fire Service connections.

vii. Weight of the firefighting equipment.

viii. Location of the fire hydrants at 100 metres intervals.

2.24.6.2 Means of escape in low rise buildings

From subsection 1 of section 79, any storey building of four floors and below shall have at least one emergency staircase apart from the normal one in use and such a staircase shall be within fire resisting walls of two hours rating. The emergency staircase should always be maintained and clear of obstruction. Subsection 2 of section 79 shows that the building shall be equipped with suitable firefighting equipment with respect to the recommendation of the Fire Service. Subsection 3 of section 79 reveals that an exit that faces the street through a single protected staircase in the absent of fire protection lobbies should be permitted only in a house that is not more than three floors in height or nine metres above the ground level.

2.24.6.3 Doors leading to emergency stair cases

According to section 83, all the doors leading to the emergency stairways shall be constructed to resist fire for one hour. They shall also be constructed to be smoke-stop and self-closing.

2.24.6.4 Obstruction of escape route

Subsection 1 of section 85 indicates that escape route serving the buildings that are occupied shall be maintained and free from all obstructions. Subsection 2 of section 85 shows that where equipment is provided to service such escape route, such equipment should be maintained in a good working condition. Alternatively, measures should be taking in accordance with the provisions of subsection 1 of section 85.

2.24.6.5 Opening in rooms

Section 86 reveals that every kitchen and habitable room shall have atleast two openings which could be window or door on the interior wall(s). These two openings must be at least 1.0 metre apart.

2.24.6.6 Air-conditioned buildings or structures

According to subsection 1 of section 88, the storey buildings with no outside window openings which are airconditioned or ventilated artificially, the stairway element of the required exit ways shall be allocated, in order to be accessible for the Fire Service either through the access openings specified. Subsection 2 of 88 shows that the exhaust vents or ducts of air conditioning systems shall not discharge into elevator enclosures or stairways. In addition, the corridors that serve as exit-way access should not be employed as the return exhaust from the spaces of air conditioned except the passageways have approved smoke detectors by the Fire Service. Subsection 3 of section 88 indicates that in all the centrally air conditioning buildings or structures of

several floors, shutters which are either automatically or manually controlled shall be provided on each floor to check the spread of fire, smoke or heat from the adjacent floors. Subsection 4 of section 88 reveals that air conditioning unit of any floor should be able to cut off automatically when there is fire.

2.24.7 Part VII: Fire walls and fire resistance constructions

The part VII of the NFSCN contains different sections. Among the sections are fire walls and party walls, fire doors, multiple doors fire walls, fire windows and shutters, smoke or gases, fire separation walls, roof construction, and fire stopping.

2.24.7.1 Fire walls and party walls

According to subsection 1 of section 94, walls should have adequate stability of structure under the conditions of fire and they shall be constructed of solid/hollow blocks, mansory units or planks. Also, they can be built of reinforced concrete or any other approved materials that are not combustible and the form of materials of required strength with four hours fire resistant rating. Subsection 2 of section 94 indicates that when the wall is constructed of solid masonry, the thickness of wall should be in accordance to the requirements of accepted engineering practice standards. Except the buildings that are more than 6.0 metres in height that are used for moderate hazard storage, any part of masonry wall that is not plastered shall not be less than 450 millimetres thick.

Subsection 3 of section 94 shows that when wall is constructed of reinforced concrete, the wall thickness should not be less than 225 millimetres for the uppermost or portion thereof to be measured from the wall top. Subsection 4 of section 94 reveals that a wall of 299 millimetres thick or less should not be used for socketed or chases for insertion of members of the structure. Subsection 5 of section 94 indicates that when combustible members are framed into hollow walls, the full wall thickness not less than 100 millimetres below, above and between the members of the structure shall be protected with non-combustible materials approved for fire-stopping. Subsection 6 of section 94 points out that the walls of hollow masonry units including brick-faced hollow masonry wall shall have a minimum total thickness of 100 millimetres greater than required in solid masonry.

2.24.7.2 Fire doors

From subsection 1 of section 99, materials or assemblies of component materials that meet the requirements of test of the fire resistance standard shall be used to construct approved fire doors, unless otherwise specifically provided. Subsection 2 of section 99 indicates that the labelled protective assemblies such as factory manufactured assemble units that meet the applicable standard and the requirements of section 99 shall be approved for use.

2.24.7.3 Multiple doors fire walls

Subsection 1 of section 100 shows that the two doors of which each of them has a fire resistance rating of one and half hours that are installed on opposite sides of equal opening should be assumed equivalent in the rating of fire resistance of 180 minutes of the two doors. Subsection 3 of section 100 indicates that the panels of wired glass may be allowed in fire doors as set in section 100. Subsection 4 of section 100 reveals that except as may be otherwise given for the openings in fire separation walls and fire walls, the rest of fire doors should be self-closing and they should be closed when the building is occupied or any building part. Subsection 5 of section 100 shows that fire doors should be constructed to swing towards escape direction.

2.24.7.4 Fire windows and shutters

According to subsection 1 of section 101, approved assemblies of fire shutters and windows should be resistant to fire. Subsection 2 of section 101 states that insulating materials shall be used to protect all metal mullions that are more than the height of 3.6 metres to afford an equal resistance rating of fire as needed for the construction of wall that the protective is situated. Subsection 4 of section 101 shows that by the time fire shutters of rolling type are employed for windows, they should have an approval counter balance construction which can be opened from outside.

2.24.7.5 Smoke or gases

From section 104, interior finished materials that release gases or smoke which is toxic or denser than the one giving off by paper or wood that are not treated under the comparable exposure to flame should not be allowed in buildings. Also, those that are not treated under the comparable exposure to heat should not be allowed in buildings.

2.24.7.6 Fire separation walls

Section 110 reveals that the panel of wired glass (vision type) may be employed in fire doors of 60 minutes or 90 minutes fire resistance rating which is intended to be used in the fire separation walls. However, its glass panel thicknesses should not be above 0.625 millimetre square.

2.24.7.7 Roof construction

From subsection 1 of section 112, non-combustible materials or assemblies of non-combustible materials shall be used to protect roof construction to afford the fire resistance rating required. Subsection 2 of 112 indicates that in any building, when every part of the structural frame work of the roofs is 6.0 metres or more over the immediate floor below it, all the protection against fire of members of the structure may be ignored which include truss protections and the protection of heavy timber members, roof framing and decking in accordance with the necessary provision which may be employed for such members with no protection in single floor buildings. Subsection 3 of section 112 indicates that the horizontal or sloping roofs where the omission of

protection against fire from the roof trusses, decking and roof framing is allowed, the roof coverings should be built of materials that are not combustible of the needed strength without a specified resistance rating of fire in buildings and it should not exceed four floors or 12 metres in height.

2.24.7.8 Fire stopping

According to subsection 1 of section 113, the design and construction of fire-stopping shall close the draft openings and form the barriers of fire against fire spread between the floors of buildings and in all the opened spaces of the structures therein which include the locations as follows:

i. Partition and floor framing.
ii. The subdivision of attic spaces.
iii. Pipe, duct and flue opening.
iv. Floor sleeper spaces.
v. Open spaces behind acoustical and over finishes.
vi. Ceiling spaces.
vii. Non-combustible walls.

Subsection 2 of section 113 states that the approved materials that are not combustible should be part of all the materials of fire stopping which will be securely fastened in place. Subsection 3 of section 113 shows that the fire-stops of double thickness of 25 millimetres wooden fillets with broken lap joist or of 50 millimetres wooden fillets installed with tight joists should be allowed in wooden

framing opened spaces. Subsection 4 of section 113 indicates that the fire-stopping should not be covered or concealed from seen until approved and inspected by the appropriate Fire Service.

2.24.8 Part VIII: Fire suppression systems

Part VIII of the National Fire Safety Code of Nigeria (NFSCN) contains different sections. Among the sections are fire suppressions, foam extinguishing systems, carbon dioxide extinguishing systems, water sprinkler systems, rising mains (dry or wet), and water spray fixed systems.

2.24.8.1 Fire suppressions

According to subsection 1 of section 118, in buildings or structures or portion thereof that the areas are more than 500 square metres or when they are more than one storey in height, fire suppression systems should be maintained and installed in good operating conditions. Subsection 2 of section 118 indicates that fire suppression systems should be maintained and installed in structures or buildings of residential uses group when they are more than four floors or 12 metres in height. Subsection 3 of section 118 shows that fire suppression systems should be maintained and installed in every cellar or basement of all the buildings where no provision is made for at least two square metres of opening.

Subsection 5 of section 118 states that fire suppression systems should be maintained and installed in the shops or spray painting rooms where dipping, brushing, painting and mixing are regularly conducted using flammable materials. Subsection 6 of section 118 indicates that fire suppression systems should be maintained and installed in areas or rooms that are used for laundry collection, trash, incineration or similar use. Subsection 7 of section 118 shows that fire suppression system should be maintained and installed in boiler rooms, furnance rooms and rooms for similar uses. In special use structure or building areas, fire alarm system of an automatic type may have its installation in lieu of a suppression system of fire where they are approved by the appropriate Fire Service, provided that all the parking structures and owner or occupier houses shall be exempted.

2.24.8.2 Water sprinkler systems

From subsection 3 of section 120, the details plans and specifications of water sprinkler system supplied shall include the calculations and information on the spacing or arrangement of the sprinkler with discharge requirements, water supply and source; such information shall include identification of the apparatus and devices used. Subsection 4 of section 120 indicates that unless otherwise provided, water sprinkler systems should be actuated automatically. Subsection 5 of section 120 shows that every water sprinkler system shall be connected to the approved visual or audible alarm devices and it should be in approved location, provided that the attachments and alarms should not be needed in a restricted area sprinkler system. Subsection 6 of section 120 points out that at least one additional visual or audible alarm equipment should have its installation within the building, and subsection 8 of section 120 shows that wet riser

system should have a separate main from the sprinkler system but in each floor, it should be provided with landing valves.

2.24.8.3 Water spray fixed systems

According to subsection 2 of section 122, the detail of water spray fixed equipment being supplied with the specifications and plans should include the identification of devices and apparatus used. Subsection 3 of section 122 indicates that the water spray extinquishing system should be actuated type automatically with supplementary auxiliary facility of manual tripping.

2.24.8.4 Foam extinguishing systems

From subsection 2 of section 123, the detail of foam extinguishing systems supplied along with the specifications and plans should include the whole computations revealing pressure drop in all the calculations on liquid lines, system piping, friction losses and a detailed layout of the fire hazard be protected. Subsection 3 of section 123 states that the characteristics of hydraulic of foam makers and foam proportioners should be supplied via the manufacturer to the Fire Service as ascertained via tests, including the range of conditions of operation needed for the purpose of installation, in order to allow the sufficiency determination of hydraulics with regards to the proposal for protection against fire.

Subsection 4 of section 123 indicates that foam extinguishing systems shall actuate automatically with auxiliary tripping facility of manual type as supplement. Subsection 5 of section 123 shows that all the piping, apart from the one that handle expanded foam should be faced with 120 minutes hydrostatic test for pressure at thirteen bars or three bars in excess of the maximum pressures, man-power requirements, consumption rate of the foam producing materials, foam quality, actual discharge capacity and other operating characteristics.

2.24.8.5 Carbon dioxide extinguishing systems

According to subsection 2 of section 124, the detail on the carbon dioxide extinguishing systems given with the specifications and plans should have the information of the amount of carbon dioxide; the flow rate and location of nozzles having equivalent orifice area. Subsection 3 of section 124 shows that the information of the carbon dioxide extinguishing systems shall be submitted in respect of the function and location of detection equipment, electrical circuitry, auxiliary devices and operating devices if employed. The information should properly show the devices and apparatus employed; explanation should be properly given in respect of any special features. Subsection 4 of section 124 indicates that carbon dioxide extinguishing device should be automatically actuated with the supplementary auxiliary facility of manual tripping.

Subsection 5 of section 124 states that any carbon dioxide extinguishing system proposed for where there is possibility that people may be trapped in, warning signs,

breathing apparatus and discharge alarms should be given to make sure that there is prompt evacuation of people and to stop entry into such atmosphere; also to give means for appropriate rescue of the people that are trapped. Subsection 7 of section 124 shows that except the cylinder valves in muilti-cylinder high pressure systems, operational test should be carried out on all the parts of carbon dioxide extinguishing systems.

2.24.8.6 Rising mains (dry or wet)

From subsection 1 of section 126, all the structures and buildings shall be equipped with rising mains. Subsection 2 of section 126 indicates that regardless of the height of buildings of all types of assembly use groups with the load of occupancy of over 300, rising mains should have its installation. Subsection 3 of section 126 states that the rising mains should have its installation in buildings of four floors when they are for factory and industry, business, mercantile or moderate hazard storage that are more than 280 square metres in area per floor. They shall also be installed when such buildings are for residential, institutional, assembly, hotels or any use group that are more than 930 square metres in area per floor. Subsection 4 of section 126 shows that the rising mains shall be installed in building that is more than four floors irrespective of the area per floor.

Subsection 5 of section 126 indicates that the rising mains shall extend from the lowest part of the building to the height of 1.5 metres above the finished floor of the top-most and other fire extinction devices of automatic type should be installed with respect to the approval of Fire Service. Subsection 7 of section 126 states that the rising mains

may serve as water sprinkler device riser(s) in buildings that needed to have devices or buildings that have devices, and a control valve should be installed in each rising mains or sprinkler system to allow the system to remain operational. Subsection 10 of section 126 shows that the rising mains of 150 millimetres size or 100 millimetres size should be able to discharge a minimum of 48 litres per second or 15.2 litres per second respectively where more than one rising mains are required with a residual pressure of at least 448.2 newton/metres square at the highest outlet of each rising main. Subsection 11 of section 126 indicates that at all times, the rising mains shall be maintained in full operating conditions.

2.24.9 Part IX: Electrical installation in building and attendant fire hazards

Part IX of the NFSCN contains different sections. Among the sections are power supply, electrical fittings for explosives atmosphere, lighting fittings for high risk locations, power supply into all types of building, and the disconnection of power from the fire affected floors.

2.24.9.1 Power supply

According to subsection 1 of section 129, the power supply to power protection installation shall be from the maintained power supply such as uninterrupted power supply system which shall have alternative power supply that can be started within a maximum of one minute after the removal of public power supply, since fire detection systems provide signals that trigger up alarms for quick evacuation, intervention of

firefighters and automatic actuation of automatic firefighting mechanism. Subsection 2 of section 129 shows that the system for power backup shall be monitored to be ready at all times for recharging the battery sources that take over from public power supply.

Subsection 3 of section 129 indicates that an alternative power generation shall be used to charge the battery where a direct battery source is the supply power of the fire protection system before it is allowed to go flat in the event of unusually long delay of public power supply returning to the system. Alternatively, the requirements for the total battery power of the fire protection system shall be the product in ampere hour of the current consumption multiplied by the period (hours) expected to wait for the main public power supply (for example, three days or 72 hours). Subsection 4 of section 129 states that there shall be maintainable public power supply to all fire protection system and they shall have redundancy built into the design, in order to ensure availability of power for sensing and monitoring for every 24 hours.

2.24.9.2 Electrical fittings for explosives atmosphere

From subsection 1 of section 134, in paint factories, oil refineries, gun powder factories and other explosive atmosphere where an abnormal evaporation of solvent or an escape of gas around electrical spark could cause an explosion which could destroy machine and human life, all items of the electrical fittings used in such enclosure shall comply with stringent and strict international regulations for protection in explosive atmosphere. Such items of the electrical fittings could be emergency lightings, bulkhead lights, inspection lamps, tubular fluorescent lighting, fluorescent or

combination lamp, control panel, switch with fuse, control cabinets, combined socket with fuse and switch, power outlets and junction boxes. Subsection 2 of section 134 indicates that before the materials can be installed, approved laboratory tests shall be obtained with the purchase of materials.

2.24.9.3 Lighting fittings for high risk locations

According to subsection 1 of section 135, the rooms or points/areas in the rooms where flammable materials could come very close to the electrical installation and equipment of high temperature to present fire hazard shall be provided with protected sealed luminaries that have the flame retardant materials. Subsection 3 of section 135 states that where mechanical damages are expected, lamps and mounting parts of luminaries must be adequately protected by sufficient wire guards or protective glass cover, study protective screens and solid cover plates. Subsection 5 of section 135 shows that luminaries for use in explosive atmosphere shall be provided in all the installations that are meant to house explosive materials such as industrial premises or armouries that are exposed to the explosive harzards.

Subsection 6 of section 135 states that when the luminary is in the open position, it shall be disconnected on all the terminals by a flame proof interlock switch and the degree of protection shall comply with the ignition temperature group and explosion class. Subsection 8 of section 135 indicates that the lighting power unit shall be installed or assembled inside the luminaries; hermetically sealed and the storage battery cells necessary for the cylindrical containers of the luminaries shall be gas-light.

Subsection 9 of section 135 shows that the certificate of fire proof specifications to manufacture should be required from the manufacturers or his agent and submitted to the Fire Service for information.

2.24.9.4 Power supply into all types of building

From subsection 1 of section 136, situations that are connected with the electrical power supply into all types of buildings which can cause electrical fire shall not be permitted, especially in the case of unauthorised extension or installation which can lead to overheating of cables resulting in insulation breakdown and eventually a short circuit between two wires. Also, it shall not be permitted in the case of loosely fixed power supply cables into the terminals which lead to the local overheating such as the public supply meters or junction boxes and their connections to the distribution systems of the premises of the consumers.

Subsection 2 of section 136 states that the mode of materials installation of the electrical equipment of building applications shall be in compliance with the laws guiding electrical installations. Subsection 3 of section 136 indicates that there shall be no alterations to the conditions for application of power supply, unless a special written permission has been obtained ftom the Director of Electrical Inspectorate Services. Subsection 4 of section 136 shows that in applying the NFSCN to the new or existing buildings, the aspects affecting necessary alteration to the electrical installations shall comform with the requirements of the ministry responding for power.

2.24.9.5 Disconnection of power from the fire affected floors

According to subsection 1 of section 138, automatic fire detection system within a building shall cut off power supply to fire affected floor. Subsection 2 of section 138 shows that the power to the security systems shall be maintained and the wiring to such security systems shall be fire proof cables which shall include their installation accessories. Subsection 3 of section 138 states that in order to limit the spread of electric arcs or fires beyond the equipment compartments, all types of breakers or on-load isolators used for all indoor applications shall have protections.

Subsection 4 of section 138 indicates that in case of electric power explosion, all indoor power equipment for rooms shall have two swing doors in opposite direction for ease of escape of the operators. Subsection 5 of section 138 shows that in case of any type of internal faults or electrical rupture, they shall not be oil cooled materials where power transformers and high voltage switchgears are employed for indoor application but they shall have highly dry, none toxic, fire suppressor materials, and instant disconnection of all the indoor electrical power equipment shall be provided.

2.24.10 Part X: Miscellaneous

Part X of the National Fire Safety Code of Nigeria (NFSCN) contains different sections. Among the sections are extractor fans, lift of the fire man, buildings or structures of economic, historical or sentimental nature, maintenance procedure,

flammable and explosive locations, warning sign, lightening protection, and the omnibus penalty for non-complying with the provisions of the NFSCN.

2.24.10.1 Extractor fans

According to subsection 1 of section 140, floor extractor fans that are connected to the pipe work of smoke extraction system shall be capable of handling hot air and they shall discharge directly into a vertical duct which should be joined all through to the roof top of the building. From subsection 2 of section 140, in order to reduce the possibility of fire hazards, only busbar trunking rising through vertical shafts that delivers the floor electrical power requirements shall be acceptable.

2.24.10.2 Lift of the fire man

Section 141 shows that where there are different lifts in building, one of them shall me made the lift of the fireman. The power supply to such lift must be from the maintained uninterruptible supply system.

2.24.10.3 Buildings or structures of economic, historical or sentimental nature

From section 142, buildings or parts of buildings that are made for housing power, computer and other valuable historical or sentimental nature, shall be protected on a 24 hour basis by the use of appropriate automatic fire extinguishing device. The automatic fire extinguishing device should be given with time delay that would permit

intervention of personnel during the day and adjustable for instant action for night or unattended operations. It shall also be maintainable or monitorable for readiness to activate, and be approved by the Fire Service.

2.24.10.4 Maintenance procedure

According to subsection 1 of section 143, all the buildings shall have a register of fire protection systems, equipment and in-built power. Subsection 3 of section 143 states that at least once in a year, there shall be periodic checking of the fire protection system by the Fire Service and public power supply authority. These authorities shall have the responsibility to check on any violations that are likely to render a building vulnerable to fire outbreak.

2.24.10.5 Flammable and explosive locations

According to subsection 2 of section 144, where ducts or trunking, circuits and cables pass through the floors, ceilings or wall partitions, the surrounding hole should be made good with fire resisting material such as cement to the full wall thickness, space and floor by which smoke and fire might spread. Subsection 3 of section 144 indicates that where conduits or conductors and cables are installed in trunkings or shafts, ducts and channels that pass through the floors, walls, partition or ceiling, proper internal fire resisting barrier should be provided to stop the fire spread.

2.24.10.6 Warning sign

From section 145, where explosive or flammable duct, liquids, vapours or gases are expected, or where materials that can explode are stored or handled, adequate warning signs such as “NO SMOKING” should be conspicuously shown. The lettering of warning signs shall be bold and 100 millimetres high; they shall be red on white background.

2.24.10.7 Lightening protection

From subsection 1 of section 146, all the buildings that are more than four floors shall be protected against fire that arises from lightening. Thus, an arrester should have its installation over the building such that the building will be within the protected zone of the arrester. Subsection 2 of section 146 indicates that lightening arrester system shall be terminated to an earthing system that is different from that of the building through a copper tape and the earthing impedance shall not be greater than one ohm.

2.24.10.8 Omnibus penalty for the failure to comply with the provisions of the code

From section 147, any body who is not complying with the provisions of NFSCN has committed an offence. Where no penalty is provided in the Fire Code, the person is liable to a fine of ten thousand Naira or imprisonment for about six months or both on conviction with regards to the offence.

2.25 Summary of the National Fire Safety Code of Nigeria

According to the 2013 (first) edition of the National Fire Safety Code of Nigeria (NFSCN), it was seen that the Architects Registration Council of Nigeria, Nigerian Institute of Architects, Department of Architectural Services of the Federal Ministry of Works and Housing, and other Building Professional bodies were engaged in the preparation of the NFSCN. Yet, there are only five pages on the use of building design to reduce outbreaks of fire and the spread of fires in buildings (passive prevention and protection measures against fire). There are seven pages on fire resistance constructions which are building engineering aspect; this is a serious weakness that led to this evaluation of protection and prevention measures against market fires in the Federal Capital Territory of Nigeria, so as to generate additional guidelines that can improve the design of markets against fires.

The 2013 (first) edition of the NFSCN emphasises more on the active protection measures against fire in buildings. They are very important in buildings in case of fire emergencies but there is a need to also properly and adequately consider passive prevention and protection measures against fire in buildings. Thus, in generating additional guidelines for market design against fires, active fire protection measures were still considered but more emphasis was given to the passive prevention and protection measures against fire in buildings, so as to acquire more efficient enforced guidelines for the design of Nigerian markets against fires.

In addition, the NFSCN is subject to review every three years to reduce fire outbreaks and their negative resultant effects in the country. However, since 2013 that the fire code was approved, no revision has been made on it. As a result of this, the need to conduct proper research on the Nigerian market fires to improve the NFSCN became absolutely unavoidable owing to the frequent fire outbreaks in Nigeria with their significant resultant loss of valuable goods, properties and lives of people.

2.26 National Building Code of Nigeria

Scholars suchlike Penn State University Library (PSUL) stated that building code is a gathering of statutory requirements such as ordinances, regulations and laws agreed by the legislative authority of a government that is engaged in making sure that the adequacy of healthy conditions or physical structures of buildings is attained (Benge, 2001; Mayor, 2019; PSUL, 2019). According to Bureau of Indian Standards (BIS) and scholars, it ensures that the durability and quality of construction materials for buildings are predictable with minimum standards; the main reason of having a national building code is to propose or regulate new building constructions (BIS, 2016; Peter *et al.* 2012).

According to the preface page of 2006 National Building Code of Nigeria (NBCN), the Defunct National Council of Works and Housing gave a directive in 1987 that Nigeria should have a building code (NBCN, 2006). This is as a result of diverse issues in Nigeria such as lack of planning in cities and towns, building collapses, outbreaks of fires and other disasters, abuse of the built environment, substandard building designs,

engagement of quacks, use of materials and products that were not tested, and absence of maintenance culture. All the stakeholders in the building industry were called for contribution. After then, in 1989 the Defunct Federal Ministry of Works and Housing held a training at Badagry in Lagos State of Nigeria.

In 1990, another training was still held in Ijebu-Ode in Ogun State of Nigeria, in order to fine tune the drafted National Building Code of Nigeria. In 1991, the drafted code was given an approval by the then National Council on Housing. However, the drafted code was not given approval by the then Federal Executive Council, in order to be used in the country, hence the drafted code was represented to the second National Council on Housing and Urban Development in PortHarcourt, Rivers State of Nigeria in 2005. The Council gave a directive that it should be circulated widely to all the stakeholders for contribution, in order to have a building code that is acceptable. Consequently, the drafted National Building Code of Nigeria was approved on 2nd August, 2006 by the National Council on Housing and Urban Development.

The National Building Code of Nigeria is made up of four parts with different sections in each part (NBCN, 2006). Part I of the building code is administration part, while part II of the code is technical (professionals) part and part III is enforcement part, whereas, part IV is schedules and references. The technical part of the code was employed because it is the only part of the code that relates to protection and prevention measures against fire in buildings. It is comprised of nine sections which are sections 4 to 12. Section 4 is classification of building designs, while section 5 is classification of

building constructions and section 6 is requirements for environmental and general buildings, whereas, section 7 is requirements for architectural designs. Section 8 is requirements for civil/structural/geo-technical designs, while section 9 is requirements for service engineering designs and section 10 is requirements for building materials and components, whereas, section 11 is requirements for building constructions; section 12 is requirements for post-construction.

From all these sections, only sections 5, 6, 7 and 12 were employed because protection and prevention measures against fire in buildings were critically discussed in those sections, and this indicates the serious weekness of the code. Hence, roofs, floors and walls of buildings, means of egress, fire resistive buildings, openings in walls, stair construction, exterior stairways and fire escape, fire resistance walls, area separation walls, fire warning systems, sprinkler and standpipe systems, maintenance of fire protection systems, and threads for fire protection systems were considered. Some of these immediate issues mentioned are similar to the issues that were discussed in the National Fire Safety Code of Nigeria. Thus, it was ensured that no part of the discussions in the National Building Code of Nigeria are repeated in the generation of additional guidelines for market designs against the outbreaks of fire in Nigeria.

2.26.1 Roofs, floors and walls of buildings

From subsection 5.2.5 of the code, components in walls, floors and roofs that can burn are allowed by the National Building Code of Nigeria to be used for the trim materials and interior finish, light transmitting plastics, fire resistant treated wood, roof covering

materials, sound and thermal insulation, heavy timber and partitions according to the regulation of the code. Otherwise, those elements shall be completely resistant to fire.

2.26.2 Fire resistive buildings

According to subsection 5.3.1.1 of the code, elements of the structures of fire resistive buildings shall comprise of masonry, concrete, iron or steel. Fixed partitions and walls should comprise of fire resistant construction, exception of the permanent partitions that are non-load bearing type of 60 minutes or 120 minutes fire resistive construction that are not among the shaft enclosure, may have treated fire resistant wood in the assembly.

2.26.3 Openings in walls

Subsection 5.5.5.2 of the code revealed that all exterior wall openings shall have a protection from the assembly of fire. They should have a 45 minutes rating of fire protection by the time they are not up to 6.0 metres from the centre line of a public way or adjacent line of the property.

2.26.4 Stair construction

Subsection 5.3.5 of the code showed that reinforced concrete, iron or steel shall be used for the construction of stairs and platform of stairs with risers and thread of steel, iron

or concrete. Combustible materials that are hard such as tile, marble and bricks should be employed for the finish of such risers and threads.

2.26.5 Exterior stairways and fire escape

According to subsection 6.3.4.2 of the code, required elements of means of egress shall not have projection to exceed 1.2 metres beyond the face of the outer walls. Those elements could be fire escapes, tower balcony of smoke proof type and external stairways.

2.26.6 Means of egress

Subsection 7.2.28.8 of the code revealed that all structures that are temporal such as membrane and tent structures shall meet up with the requirements of egress means and the escape route travel should have a maximum length of 30 metres. From subsection 7.3.1.1, the conditions of means of egress should control the plan, arrangement and construction of building elements needed to give a reasonably egress means in safer manner from all the erected buildings and also from future alterations of buildings.

2.26.7 Fire resistance walls

From subsection 7.1.1.4.2 of the code, external walls shall have opening protection and fire resistant; the distance measurement should be taken at right angle to the line of property. Any projection beyond external wall shall not have an extension beyond

one-third of the distance away from the external wall to the property line, and it should not have an extension beyond one-third of the distance from the outside wall to a vertical plane (assumed) situated in a place of fire resistant protection of openings initially needed as a result of location on the property. Also, any projection beyond external wall shall not have an extension beyond when the external wall openings are needed to have a protection as a result of the distance from the line of property and the summation of area of that kind of openings should not be above 50% of the entire area of wall in every storey.

2.26.8 Area separation walls

According to subsection 7.1.1.5.5 of the code, any part of building demarcation via one or more area separation walls should be taken as an individual building. Area separation walls should have a construction that is not less than two hours resistant rating in all types of structures. The overall width of openings in area separation walls should not be more than 25% of the length of wall in every storey. Each opening should have a protection with an assembly of fire that have 180 minutes rating of fire protection in 240 minutes resistant walls; one and half rating of fire protection in 120 minutes fire resistant walls. Area separation walls should go beyond outside edges of the horizontal projecting components like architectural projections, canopies, overhang of roofs, and balconies.

2.26.9 Fire warning systems

Subsection 7.1.14.7.3 of the code showed that all dwelling units and guest rooms in a lodging house or hotel used for the purpose of sleeping should be provided with smoke detectors. Ceiling or wall shall be used as where the smoke detectors shall be mounted at a point situated centrally on the area or corridor that gives access to rooms used for the purpose of sleeping. The detector of smoke should be centrally situated on hotel sleeping room ceiling or main room ceiling in an efficiency hotel suites, hotel sleeping room or dwelling unit. The detector should be situated at the ceiling centre above staircase directly where rooms for sleeping are at the upper floor. From subsection 7.1.14.4, all kinds of smoke detectors shall be situated based on the approved instructions of the manufacturer. The detector should give alarms in the room for guest or dwelling unit by the time they are actuated.

2.26.10 Sprinkler and standpipe systems

Subsection 7.1.14.7.6 of the code revealed that automatic standpipe should have its installation in buildings when it is required. Also, sprinkler system should have its installation in buildings when it is required.

2.26.11 Maintenance of fire protection systems

According to subsection 12.2.1.3 of the code, the tenant or owner of structure or building shall have the responsibility of maintenance and care of each fire protection, in order to make sure that the welfare and safety of the occupants of buildings are

achieved. Subsequent to the disconnection of fire protection systems or otherwise rendered unserviceable, the fire department must be notified.

2.26.12 Threads for fire protection systems

All the provided threads for the connection of fire department to fire hose connections shall have a uniformity to the ones used by the local fire department. The fire hose connections could be yard hydrants, standpipe systems and sprinkler systems.

2.27 Summary of the National Building Code of Nigeria

Part II of the National Building Code of Nigeria is the technical part of the code; it was employed because it is the only part of the code that is related to the protection and prevention measures against fire in buildings. The issues discussed in the National Building Code of Nigeria with respect to protection and prevention measures against fire in buildings are similar to the issues discussed in the National Fire Safety Code of Nigeria. In addition, it was discovered that the issues discussed in the National Building Code of Nigeria are not satisfactory with respect to protection and prevention measures against fire in buildings. This is because passive protection and prevention measures against fire in buildings were not intensively/extensively discussed, and this is a serious weekness of the code. However, active protection measures against fire were extensively discussed in the code but the code still lacks intensive discussions with respect to active protection measures against fire.

The weekness of the National Fire Safety Code of Nigeria in consideration with the weekness of the National Building Code of Nigeria have led to this evaluation of protection and prevention measures against fire in market places in the Federal Capital Territory of Nigeria, so as to generate additional guidelines that can improve the design of markets against fires. Thus, it was ensured that no part of the discussions in the National Building Code of Nigeria are repeated in the generation of additional guidelines for market designs against the outbreaks of fire in Nigeria.

2.28 Recent Studies on Fire Outbreaks in Markets

Kachenje *et al.* (2010), undertook a research work on assessing urban fire risk in markets in the central part of the business district of Dar es Salaam, Tanzania and evaluated risk of fire with regards to public awareness on the use of protection devices against fire and preparedness in the incidence of outbreaks of fire. The study revealed high risk of fire disasters in most market buildings in the study domain, as most of the users of buildings in the markets do not know how to make use of protection devices against fire, and almost half of the users do not have information about the available escape means in the event of outbreak of fire. Also, only few of the market building users have been trained in the last five years. It was suggested that the rescue and department of fire should speed up programmes of awareness particularly in buildings in the markets, and other public buildings regarding the use and functioning of protection equipment against fire and escape means to make sure that there is building safety. Also, training for the users of market building should be carried out regularly. In addition, the owners of market buildings were directed to start maintenance and service

programmes on the use of firefighting devices and to make sure that the schedule of inspection is regular.

Ogajo (2013), conducted a research on the influence of disasters of fire on preparedness and reduction in Kenya business premises and used markets in the Kisumu central business district as the study area. It was outlined that the outbreaks of fires have occurred frequently in different market buildings leading to the loss of lives of people and destruction of goods and properties; hence raising questions about the building occupants safety. The study evaluated the levels of preparedness among the occupants in buildings and local authorities in case of outbreaks of fires. The most important findings are: most of the market buildings lack enough fire protection devices; most of the local authorities and occupiers of market buildings are not ready to tackle emergencies of fire. It was recommended that the education of all the stakeholders will play an important role to improve fire safety; the property managers or owners should engage experts of fires to inspect fire safety and fire protection infrastructure; to also enhance the measures of fire programmes and safety.

Leo (2014), performed a research on the Kumasi central market in Ghana. The research assessed the awareness of fire insurance, in order to strategise towards better protection against outbreaks of fires in markets. The causes of outbreaks of fire in the market were identified; discovery showed that most of the sales people in the market do not have the knowledge of fire insurance. It was recommended that fire service should be organising regular seminars on the prevention and causes of fire outbreaks in markets, so that the carefulness of the sales people about their actions and consequences should be

increased in market places. It was also recommended that special security force that has the understanding of techniques of combating fire should be assigned to the markets, in order to protect them at night since the majority of the outbreaks of fire occur in the night.

Oladokun and Emmanuel (2014), undertook a study on urban market fire disasters management in Nigeria and used south-west of Ibadan as the study area. It was stated that the frequent disasters of fire in crowded markets in urban places and business structures have become the main challenge to the Nigerian planners in urban places; it is necessary for tools and logical approach to predict policy performances and schemes of potential intervention. Also, there is a need to make sure that the deployed scheme resources gain the best impact as much as possible. Different fire outbreaks in markets and their implications were highlighted. From the study, intervention strategy plans were proffered which state that: for assets with high value, the level of the reduction of risk will justify extra facilities; a campaign of enlightenment should be targeted to improve the culture of safety of people.

Kikwasi (2015), conducted a research work on awareness of the measures of fire safety for staff and users of shopping malls. The study area covers quality centre and Mlimani city in Dar es Salaam, Tanzania. Findings indicate that the shopping malls do not have adequate fire prevention measures. Most of the users and staff responded that they understand measures of fire safety but they have a poor knowledge of them as unveiled when evaluating them on different installations and equipment such as fire hose reels, drenchers, portable extinguishers of fire and sprinklers. The conclusion of the research

is that the awareness of measures of fire safety by the staff and users of the shopping malls is rather low. The recommendation showed that the training of users of shopping malls and seminars for their staff for fire safety along with the instructions such as posters for the staff and users should be the primary focus of the owners of shopping malls and responsible authorities.

Samuel (2015), assessed the impacts of fire in markets with regards to the performance of loans and savings organisations in Ghana: using First Allied Savings and Loans Limited. The study revealed that each occurrence of fire outbreak had negative impacts on the affected sales people and the performance of banks, especially loans and savings organisations that have market loan customers. It also revealed that outbreaks of fire in markets have become the cause of loan default among others and account for 15% of all the causes of loan defaults. It further revealed that 50% of the sales people still have huge outstanding loan amounts that they are struggling to pay due to outbreaks of fire in markets. To curtail the effects of outbreaks of fire in the market, it was suggested that Ghana central government must financially empower the Ghana National Fire Service with more firefighting equipment and vehicles. It was also suggested that the Ghana government should reconstruct all the old markets and equip all such markets with fire hydrants. Likewise, the Ghana National Fire Service must on regular basis educate the sales people on fire safety measures.

Kofi *et al.* (2016) undertook a research work on fire safety preparedness in markets in central area of Kumasi business district of Ghana. The result of the research indicated that there is limited preparedness for fire safety in the midst of occupants of market

buildings in the central business district of Kumasi. It was recommended that the issues pertaining the fire emergency shelters, enforcement of policies of fire safety, and public education on safety of fire should be addressed, so as to ensure that outbreak of fires are controlled in markets in the central business district of the town.

Ntim (2018) conducted a research work on mitigating the effects of fire outbreaks on the socio-economic lives of women in the metropolis of Kumasi in Ghana: the role of micro insurance institutions. The result showed that 99% of the market women have no microinsurance, while one percent of them have microinsurance. It further showed that the difficulty to assess claims is one of the major reasons most of the market women do not have microinsurance. In contrary to the popular opinion about the informal section savings, the study revealed that the market women save in the informal section to revamp their businesses in case of fire outbreaks in markets. It was recommended that the microinsurance institutions need to educate the public, in order to boost patronage. It was also recommended that the government must introduce legislation to encourage the informal sector to have microinsurance.

In all these researches on the outbreaks of fire in market places, it was observed that some causes of outbreaks of fire and other important related issues were identified with some recommendations to reduce outbreaks of fire in markets. However, the guidelines for market design against fires have not been addressed; thus, it is a research gap. Owing to this research gap, the study generated additional guidelines for designing markets against fires by considering active and passive protection/prevention measures against fire in more empirical details. Thus, the empirical framework of this research is:

Probability of Fire = Human Technical Factors + Nature of Materials + Prevention and Suppression. Consequently, the Result of Fire Outbreak = the Measure of Impacts of a Fire Event (Amoako, 2014). In this case, Impacts = Biological Impacts + Environmental Impacts + Economic Impacts + Social Impacts.

2.29 Summary

Nigerian markets have enormous importance; they are the main sources of living or survival for different people; they are areas for transaction of economies or business activities and ways to accumulate wealth. Markets also assist to contribute to the employment and local revenue generation, provide incomes for households and support the development of human resources. Hence, by putting into consideration the importance of Nigerian markets, frequent outbreaks of fire in market places is absolutely not necessary. Thus, evaluating protection and prevention measures against outbreaks of fire in Nigerian markets is very crucial.

The National Fire Safety Code of Nigeria gives little consideration to the use of building design to reduce outbreaks of fire and spread of fires in buildings (passive prevention and protection measures against fire). Likewise, other literature on the outbreaks of fire in Nigerian markets and other Nigerian public buildings, concentrated on some of the causes of outbreaks of fire and other important related issues without adequate emphasis on the protection and prevention measures against outbreaks of fire with regards to building designs; this is a research gap. Thus, this research has filled

that gap in knowledge by proposing additional guidelines for Nigerian market design against outbreaks of fire.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Design of the Research

A cross sectional research design deals with the collection of data to make inferences about a population at a point in time without experimental procedure; the aim is to explain a population of a research or a subgroup within the research population with regards to an outcome or a group of risk factors (Eugene and Christine, 2015; Lavrakas, 2008; Levin, 2006; Roundy, 2016). A cross-sectional design was adopted for this research because the nature of the subject matter addressed requires real life situations at a point in time without experimental procedure, and this allowed inferences of statistics to be carried out on the research population and allowed generalisation of discoveries to the situation of real life.

3.2 Research Philosophy and Method

According to James and Qatar (2012), Bracken (2014) and Dieronitou (2014), in research paradigm, ontological assumptions have concerns with constitutes of reality in such a way that researchers are required to consider the perceptions of the reality of things and the real workability of things. In contrary, epistemological assumptions have concerns with ways of creating, acquiring and communicating knowledge. Thus, the philosophical point of view of this research focused on the ontological assumptions owing to the fact that the nature of this research requires reality of situations. In line with the ontological assumptions, the research utilised descriptive survey method, in order to give a detailed description of the characteristics of research population or

phenomenon that is being studied (Nassaji, 2015; Salaria, 2012); quantitative and qualitative research data were generated.

3.3 Population of the Research

This research population was all the regional built-up market places that are within the care of the FCT Markets Management Committee of the Federal Capital Development Authority (FCDA) of Nigeria. According to FCDA (2016), there exist 15 neighbourhood centres, shopping complexes and regional built-up market places that are within the care of Markets Management Committee of the FCT; they are:

i. Neighbourhood centre in Area 1.
ii. Neighbourhood centre in Areas 2.
iii. Neighbourhood centre in Areas 3.
iv. Shopping complex in Area 7.
v. Shopping complex and neighbourhood centre in Zone 3.
vi. Shopping complex in Zone A of Apo legislative quarters.
vii. Shopping complex in Zone D of Apo legislative quarters.
viii. Shopping complex in Zone E of Apo legislative quarters.
ix. Farmers market in Maitama.
x. Building material and regional market in Dei-dei.
xi. Kado market.
xii. Gudu market.
xiii. Nyanya informal market.
xiv. Garki model market.
xv. Wuse market.

Seven market places are regional built-up market places out of the above immediate listed 15 market places, and the other eight market places are street market places. Since this research population was the regional built-up market places within the care of the Markets Management Committee of the FCT of Nigeria, the seven regional built-up markets were considered as the total research population, in order to obtain the sample size. The regional built-up markets that were considered are:

i. Farmers market in Maitama.

ii. Building material and regional market in Dei-dei.

iii. Kado market.

iv. Gudu market.

v. Nyanya informal market.

vi. Garki model market.

vii. Wuse market.

3.4 Size of the Sample and Method of Sampling

Sampling is a way of taking decisions on how to choose a sample and how to also determine the size (McLafferty, 2010; Mugo, 2002; Singh and Masuku, 2014). It involves sampling procedures which are the right steps to be taken to arrive at appropriate sample size. According to Lund Research Limited (LRL), purposive method of sampling is a sampling method which is known as subjective, selective and judgmental sampling due to the qualities the informants possess and usually, the samples being investigated are quite small with phenomenon of interest especially when compared with the probability sampling techniques (Etikan *et al.,* 2016; LRL, 2012; Palinkas *et al.,* 2015; Tongco, 2007). The seven regional built-up market

places that are within the care of Markets Management Committee of FCT of Nigeria are few in numbers to permit the application of purposive sampling method. Thus, by employing it, three markets were chosen for this study because they are situated in the municipal area council of Abuja in the FCT of Nigeria which is the capital city of the country and according to Abuja Markets Management Limited (AMML) and Federal Fire Service of Nigeria (FFSN), they were cases of frequent fire outbreaks in markets in the area (AMML, 2018; FFSN, 2003, 2013, 2014 and 2015; Murray, 2007; Nnodim, 2011). The chosen markets are: Wuse market, Garki model market and Kado market.

In a study, 20% size of the sample of a research population is a good suggested size of the sample (Hill, 1998; Isaac and Michael, 1981; Prashant and Supriya, 2010; Ruger, 2009; Smith, 1983; Steve, 2011; Suresh and Chandrashekara, 2012) because according to scholars such as Creative Research System (CRS), FluidSurveys Team (FST); Statistical and Technical Team (STT), the larger the size of the sample, the more confidence it is for the answers of the research questions to really reflect the population of research (CRS, 2012; FST, 2014; Gigi, 2017; Jeovany *et al.*, 2014; Liz, 2016; Nick *et al.*, 2009; STT, 2011; Sunday, 2015). Giving consideration to this above immediate statement, the three regional built-up market places that were purposively chosen are more than 20% of the population of research; this in turn has made the sample size to be acceptable for use.

The choice of sample size is also on the basis of the fact that in 2002, 2003 and 2015, there were major outbreaks of fire in Wuse market according to National Association of Nigerian Traders (NANT) and FFSN (FFSN, 2003; NANT, 2016). Likewise, in 2015,

there was major outbreak of fire in Garki model market (FFSN, 2016) but there is absence of formal information on Kado market with regards to any major fire outbreak yet because among the markets that were studied, it is the market that was recently established and upgraded. Kado market started as a place for the sales of fish in 1994 and after its operation for some years, it was upgraded to food market place (AMML, 2016).

Thus, it became vital to evaluate the passive and active prevention and protection measures against fire in these two market places with the experiences of major outbreaks of fire in addition to this recent upgraded market without the experience of any major outbreaks of fire yet (based on the non-availability of formal reports on major fire outbreaks in Kado market as at 2017 when the field work of this research was made). As a result of this evaluation, the architects and other affected building professionals, Nigerian government, academia and the general public will concurrently learn from the ones with the experiences of major outbreaks of fire along with the recent upgraded market without the experience of any major outbreak of fire yet. Also, the lesson from the markets that were studied will help to propose appropriate additional guidelines for market designs against fires.

3.5 Units of Analysis

The primary or major units of analysis for this study are the systematically selected lock-up shops and open stalls with their supporting facilities at every 5^{th} interval in the research domain. The rest of primary units are randomly selected internal roads, car

parking spaces and auxiliary buildings with their supporting facilities in the markets. Moreover, the existence and number of the available firefighting equipment like fire alarm systems such as heat, flame and smoke detectors; emergency lighting, sprinkler and automatic fire suppression devices, street fire hydrants, fire hose reels, portable fire extinguishers and other extinguishing systems for fire in the study area were verified with regards to the numbers of existing market shops. Also, the time intervals of their inspection and maintenance services were considered. Additionally, the respondent numbers that have the knowledge of how to make use of firefighting devices and the number of respondents that do not know how to make use firefighting equipments in the markets were related. Similarly, the availabilities of signage and their compliances by the market users were ascertained.

The means of exits in the markets when there are outbreaks of fire and the means by which firefighters (Nigerian Fire Service) can gain access into the study area were ascertained. Also, the activities of market users that can cause the fast spread of fires, and the market design against fires with respect to the use of materials for buildings as well as the market structure styles were ascertained in the area where the study was made. Finally, the avenues to reduce outbreaks of fire in the markets were ascertained from the relevant authorities. The secondary units or the participants (relevant authorities) that followed the concept of this research include FCT Markets Operating Bodies such as FFSN in the FCT of Nigeria, AMML, and the National Association of Nigerian Traders (NANT) of the FCT of Nigeria.

3.6 Reasons for Conducting Research in the Federal Capital Territory of Nigeria

The reason for conducting this research in the Federal Capital Territory (FCT) of Nigeria is due to the frequent outbreaks of market fires in the territory. For instance, the data from the FFSN (2003, 2013, 2014 and 2015) revealed that outbreaks of fire occurred in Wuse old market in the FCT of Nigeria (January 17, 2003); similarly, there were outbreaks of fire in Galadimawa mini market in the FCT of Nigeria (June 23, 2013) and Garki model market in the Nigerian FCT (March 29, 2014 and December 30, 2015). In addition, on January 31, 2018, there was outbreak of fire in Garki model market in the FCT of Nigeria (AMML, 2018). These are just few reports of the outbreaks of market fires in the Nigerian FCT.

All these outbreaks of fire in markets occurred in the municipal area council of Abuja of the FCT of Nigeria; there were destructions of valuable goods and properties in the incidents. Therefore, it became important that Wuse market, Garki model market and Kado market are studied with respect to fire outbreaks, since they are situated in the municipal area council of Abuja, so as to generate proper additional guidelines to improve the design of markets against the outbreaks of fire in Nigeria. Plate XV shows a picture of fire outbreaks in Garki model market of Nigerian FCT.

Plate XV: Outbreak of fire in Garki model market. Source: FFSN, 2014 (https://www.informationng.com/ tag/federal-fire-service).

In addition, the management authority of the markets that are within the care of Markets Management Committee of the FCT is Abuja Markets Management Limited in the FCT of Nigeria; it is one of the more organised market management authorities in Nigeria (AMML, 2016; FCDA, 2016). Therefore, it became important that markets in the FCT of Nigeria are studied, so that appropriate research data can be gotten from this organised markets management authority in the FCT of Nigeria. Hence, the research data will result to appropriate analyses to yield good results or findings for the proposed additional guidelines for designing markets against fire in Nigeria. This is also owing to the fact that the municipal area council of Abuja of the Nigerian FCT where the research was conducted is a purpose-built city among other few ones in Africa and it is as well the Nigerian capital city (Murray, 2007; Nnodim, 2011).

3.7 Description of the Federal Capital Territory of Nigeria

The capital city of Nigeria is Abuja in the Federal Capital Territory (FCT) of Nigeria. Since the study area is situated in the municipal area council of Abuja of the Nigerian FCT, therefore, it is important to describe the climate, vegetation and topography of the FCT of Nigeria.

3.7.1 Climate of the Federal Capital Territory of Nigeria

The rate at which fire spreads when there is fire outbreak in market places depends on a particular climate of a place in terms of raining or hammattan seasons; based on the intensity of the winds (Anaglatey, 2013). The climate of the FCT of Nigeria is the tropical, humid and hot type (Agbelade, *et al.,* 2017; Hassan and Okobia, 2008). Its main elements have regimes that are different from climates of the northern and southern parts of Nigeria (AbdulKadir *et al.*, 2015; Adakayi, 2000; Hassan and Adakayi, 2003; Hassan, 2008; Mabogunje, 1977). Climate Data (CDA) stated that Abuja (FCT) has average annual normal temperature of 25.7 °C (CDA, 2018) and according to Norwegian Meteorological Institute (NMI) it has a range of minimum temperatures of 19.3°C to 34.7°C in December and the range of maximum temperatures of 24.5°C to 37.1°C in March (NMI, 2018).

According to World Data (WDA), the climate of the FCT is significantly warm but has a very few humid and tropical months; the best periods to travel to the FCT is from the month of November to the end of the year and all through to April of the next year due to the lesser rain falls (WDA, 2016). Africa Legislative Summit (ALS) stated that the

relative humidity in Niger-Benue trough and the high temperatures in that area have resulted to heating effect in the FCT of Nigeria but the increment of elevation in north east direction curtail such heat in the Nigerian FCT (ALS, 2013).

According to Abuja City Guide (ACG), the time of harmattan is short in the FCT of Nigeria which comes with the trade wind of the north east and the major features of dryness, haze of dust and severe cold (ACG, 2016). World Weather and Climate Information (WWCI) stated that averagely, December is the sunniest month and there is a lowest amount of sunshine in August in the FCT of Nigeria (WWCI, 2016). According to Time and Date (TDA), in the FCT of Nigeria, the sun rises at about 6:45am and sets at about 06:21pm Nigerian time (TDA, 2016). It means that the sun shines for more than 11 hours every day under normal weather condition.

3.7.2 Vegetation of the Federal Capital Territory of Nigeria

The nature of vegetation perculiar to the Federal Capital Territory (FCT) of Nigeria is not uniform and its shrub savannah vegetation dominates the northern area of the FCT of Nigeria (Adakayi, 2000; Ishaya *et al.,* 2014). The southern part of the FCT is dominated by the gallery vegetation and foothills in most areas of the mountains (Balogun, 2001; Ishaya *et al.,* 2014). The vegetation is known for deciduous trees that are scattered among grasses. However, there are forest in some of the areas of the FCT of Nigeria because they have not suffered too much deforestation (Mallo and Mgbanyi, 2013).

According to Abuja Global Sharpers Community (AGSC), in the Gwagwa plains, patches of rain forest occur particularly in rugged towards the south-east area of the FCT of Nigeria, and gullied train to the southern part of the territory (AGSC, 2016). They approximately comprised 7.4% of the whole vegetation mass and hence present in Gwagwa plains, particularly in rugged towards the south-east; the gullied terrain to the southern part of the FCT of Nigeria (Martins, 2014). These places of the FCT made part of the mature vegetation in the country. The richness of tropical rain forests of the south, north and middle belt savannah grassland are all put together to make the soils of the Nigerian FCT rich for practices of agriculture (Jenkwe and Chup, 2016). Therefore, it became important to have market designs against the outbreaks of fire in the FCT of Nigeria where farmers can be selling their farm produce.

3.7.3 Topography of the Federal Capital Territory of Nigeria

The terrain of the Federal Capital Territory (FCT) of Nigeria is undulated and the high altitude acts as an influence of modulation that makes the entire weather to be pleasant almost at all times (FCDA, 2016). Scholars like Abuja Galleria (AGA) stated that the natural endowments of FCT such as its isolated highlands, rolling hills and other endearing features make it a bliss (AGA, 2015; Nasiru, 2009). Thus, the blissful nature of the FCT of Nigeria as a result of an undulating terrain and the high altitude that always make the weather clement in turn enhance a conducive trading environment, because blissfulness affects a positive thought which could be business thought. This implies that the need for the market designs against the outbreaks of fire is of paramount importance in the FCT of Nigeria for the purpose of its conducive trading environment.

According to Martins (2014), the lowest level of elevation in the FCT is within south-west of the territory where the river Guraja flood plain is approximately at an elevation of 10 metres beyond the level of the sea. From this particular area, the land irregularly rises to the northern, north western and eastern areas of the territory. The territory has its highest part in the northwest with different peaks above 760 metres beyond the level of the sea (Aliyu *et al.,* 2016; Umeokafor, 2011; Zubairu and Folorunsho, 2014). According to Mallo and Mgbanyi (2013), hills occur either by formed long ranges or as clusters in the territory. The most important of these hills are the Wuna range in north vicinity of Gwagwalada, northwest range of Idon-kasa vicinity in Kuje, Bwari-Aso range in northeast vicinity, Guarfata range in southwest vicinity of Suleja of Niger State of Nigeria and Gawa range in northeast vicinity (Martins, 2014). Scholars such as Study Mode Research (SMR) and World Bank Document (WBD) further explained that in other places of the territory, there are different roundish isolated hills within the main hills which are the extensive plains, and the most essential are the Rubochi plains and Gwagwa plains (Martins, 2014; SMR, 2013; WBD, 2016).

3.8 Abuja Markets Management Limited

Abuja Markets Management Limited (AMML) is the company that presently manages some market places in the Nigerian Federal Capital Territory (FCT) and FCT nearby market places situated in Nasarawa State of Nigeria (AMML, 2016). In 2005, the authority to manage the neighbourhood centres, shopping complexes and regional built-up market places that are within the care of the markets management committee of the FCT in the Federal Capital Development Authority (FCDA) of Nigeria was given to AMML; in February 2005, the company officially started managing the

markets (FCDA, 2016). The study locations being managed by AMML are Wuse market, Garki model market and Kado market.

3.8.1 Wuse market

From the data AMML (2016) retrieved from the Nigerian FCDA, Wuse market started in the beginning of 1980 as the initial market that was built by the FCDA and it was under the control of the former markets management committee in the FCDA during that period. Owing to the rapid FCT population increase and high demand of people for shops due to waste of time in building other markets, indiscriminate shop attachments started coming up in the market in 1990s and taking over walk ways, parking lots and other common areas; this resulted to the environment of market to be congested, hazardous and inclement to users. On 14th February, 2005, the management of Wuse market was taken over by Abuja Markets Management Limited (AMML). More than 15,000 number of containers were taken away from the market with the presence of 1,365 lock-up shops by the time of AMML clean-up exercise and sanitisation.

From AMML (2016), the market has two parts which are informal and formal parts. The formal part comprises of the New Blocks (Section C) which is made up of 220 lock-up shops, and the Old Blocks (Section A and Section B) which is made up of 1,365 shops (lock-up type). Furthermore, there are 12 stores, 40 cold rooms, 48 warehouses and 120 retail shops in the 220 shops (lock-up type) in the New Blocks. The informal part which is the part for different open stalls is made up of 500 trading spaces. A police post and one administrative block are available in the market. The

market has five detached toilets and bathrooms, and six detached restaurants. Other features in the market include:

i. Boundary fence.

ii. Generator for the area of the cold rooms.

iii. Fire protection devices.

iv. Traffic system and car parking spaces.

v. Network of roads.

Figure 3.1 reveals the street map of Wuse district showing Wuse market as situated along the street of Herbert Macaulay at old Wuse (off Premium Times, Wuse 1), while figure 3.2 reveals the Global Positioning System (GPS) map on longitude 9.0685139 and latitude 7.4648436 at Block 5, Suite 14 of Wuse market with its adjoining environment. Figure 3.3 reveals the cropped GPS map of Wuse market. The market is situated in the municipal area council of Abuja of the FCT of Nigeria.

Figure 3.1: Wuse market. Source: Pinterest map data, 2018 (https://www.pinterest.com/pin/293930313162114274/).

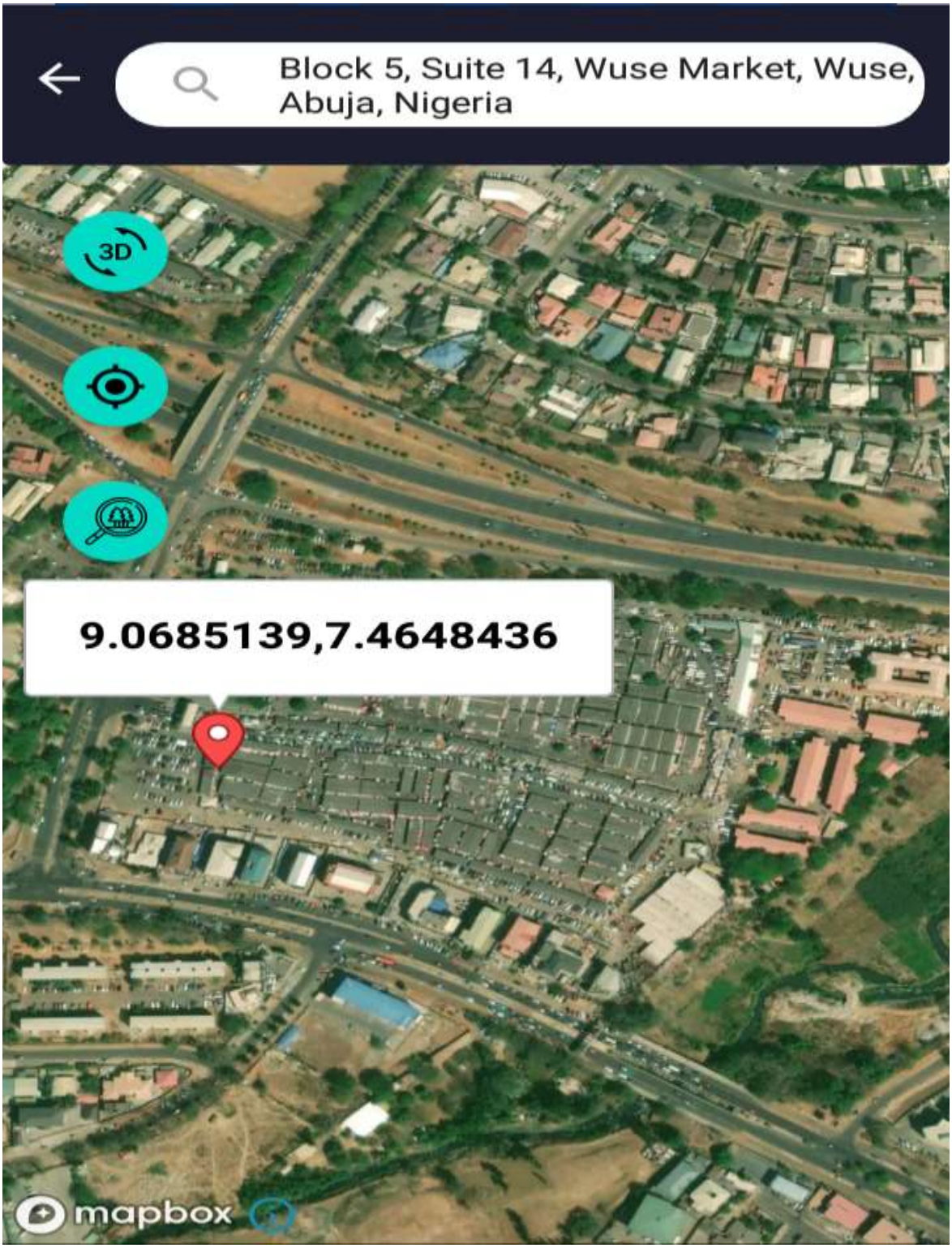

Figure 3.2: Global Positioning System map of Wuse market with its adjoining environment. Source: United States Space Force (2021).

Figure 3.3: Cropped Global Positioning System map of Wuse market. Source: United States Space Force (2021).

Figure 3.4 shows a typical ground floor plan of the lock-up shops in Wuse market, while Plate XVI shows the overcrowded nature of the lock-up shops with non-fire resistant aluminium roofing sheets as sun shading device for corridor in Wuse market.

Figure 3.4: Typical ground floor plan of the lock-up shops in Wuse market. Source: Field work (2017).

Plate XVI: Overcrowded nature of lock-up shops with non-fire resistant aluminium roofing sheets as sun shading device for corridor in Wuse market. Source: Abuja markets management limited, 2016 (http://www.abujamarketsmanagement.com/wuse-market/).

3.8.2 Garki model market

From the data AMML (2016) retrieved from the Nigerian FCDA, in 1995, the development of Garki model market started by a company which is known as Aso Timdoz Investment Limited. The company is made up of Investment and Properties Development Company of Abuja, and Timdoz Engineering Limited that came under the arrangement of a public-private partnership. The original concept of the market is purely lock-up shops. In 1998, Major General Mamman Kontagora commissioned the market and in 2003, its open stall constructions started as a result of the demolition of Monday and Bakassi markets in the FCT of Nigeria that led to the relocation of some sales people in the markets that were demolished to Garki model market in 2004.

From AMML (2016), in 2006, the occupancy statutory right that was in control of Aso Timdoz Investment Limited was revoked with regards to the market. This was as a result of the suggestions of the enquiry commissions into the separation of landed properties of the Federal government that was constituted in 2000. In August, 2006, the occupancy statutory right with regards to the market place was transferred to Abuja Markets Management Limited (AMML) at the end of the revocation. On 18th August, 2006, the management of the market was officially taken over by AMML, and on 23rd of August, 2006, a meeting with all the market stakeholders was held with AMML. The available market facilities are:

i. 558 number of stalls (open type).
ii. 872 number of shops (lock-up type).
iii. An office for administration.
iv. Spaces (open type) allocated for informal business activities.
v. A police post.
vi. Two opened parks for cars.
vii. Three toilets.

Figure 3.5 reveals the street map of Garki district showing Garki model market as situated along Samuel Ladoke Akintola Boulevard (off Karaye Street), while figure 3.6 reveals the GPS map on longitude 9.0218231 and latitude 7.4913503 at Block C9, Shop 33 of Garki model market with its adjoining environment. Figure 3.7 reveals the cropped GPS map of Garki model market. The market is located in the central part of municipal area council of Abuja of the FCT of Nigeria.

Figure 3.5: Garki model market. Source: Satellite google map data, 2016 (https://www.google.com/maps/@9.0220938,7.4905048,452m/data=!3m1!1e3).

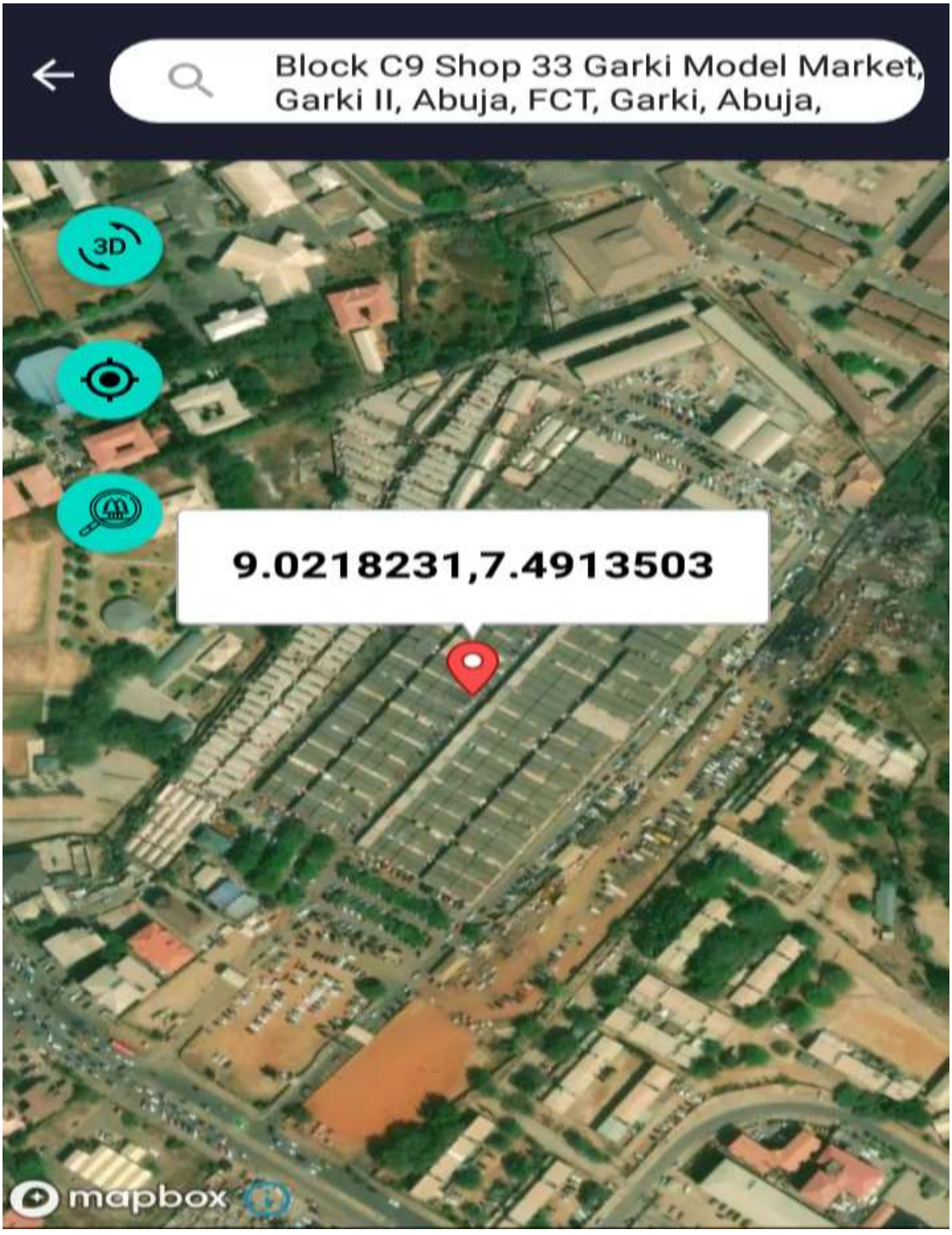

Figure 3.6: Global Positioning System map of Garki model market with its adjoining environment. Source: United States Space Force (2021).

Figure 3.7: Cropped Global Positioning System map of Garki model market.
Source: United States Space Force (2021).

Figure 3.8 shows a typical ground floor plan of the lock-up shops in Garki model market, while Plate XVII shows the over crowded nature of the lock-up shops with traffic congestion in the market.

Figure 3.8: Typical ground floor plan of the lock-up shops in Garki model market.
Source: Field work (2017).

Plate XVII: Over crowded nature of the lock-up shops in Garki model market.
Source: AMML, 2016 (http://www.abujamarketsmanagement.com/garki-market/).

3.8.3 Kado market

From the data AMML (2016) retrieved from the Nigerian FCDA, in 1994, the then FCT Honourable Minister in Nigeria gave an approval to establish the then fish market in Kado district of the Federal Capital Territory (FCT) to prevent epidemics and diseases that were coming up as a result of the uncoordinated sales of fishes in an unhygienic environment and conditions by the junction and side of the roads. The fish market as formerly known was then changed to a food market due to upgrade in a later time. Abuja Investment Company Limited was initially managing the market but the market management was later transferred to Abuja Markets Management Limited (AMML) by the Federal Capital Development Authority (FCDA). Presently, AMML is managing the market.

From AMML (2016), the land size of Kado market is 2.0 hectres and the location is in the Gwarimpa District. It comprises of the following features:

i. 237 number of lock-up shops.

ii. 86 number of open stalls.

iii. 25 number of cold rooms/ware houses.

iv. A space for bank.

v. Three number of restaurants.

vi. A centre for telecommunication.

vii. A clinic.

viii. Two number of toilet buildings.

ix. One number of police post.

x. One administrative block.

xi. An exit gate.

Figure 3.9 reveals the street map of Gwarimpa district showing Kado market as situated in Kado along Jabi - Karimo road (off Public Works Quarters, and Jabi Reservoir), while figure 3.10 reveals Global Positioning System (GPS) map on longitude 9.0669335 and latitude 7.4005808 at shop LS 45 of Kado market with its adjoining environment. Figure 3.11 reveals the cropped GPS map of Kado market. The market is situated in municipal area council of Abuja of the FCT of Nigeria.

Figure 3.9: Kado market. Source: Google earth map (2016).

Figure 3.10: Global Positioning System map of Kado market with its adjoining environment. Source: United States Space Force (2021).

Figure 3.11: Cropped Global Positioning System map of Kado market. Source: United States Space Force (2021).

Figure 3.12 shows a typical ground floor plan of the lock-up shops in Kado market, while Plate XVIII shows the over crowded nature of the lock-up shops (food stuff section) with indiscriminate use of non-fire resistant aluminium roofing sheets as sun shading device for corridor; umbrella stands and tarpaulin in front of shops in Kado market.

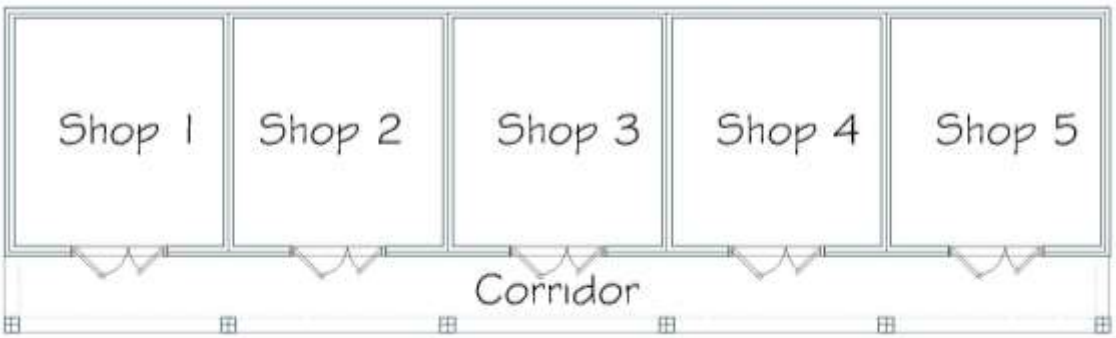

Figure 3.12: Typical ground floor plan of the lock-up shops in Kado market. Source: Field work (2017).

Plate XVIII: Over crowded nature of Kado market lock-up shops with non-fire resistant aluminium roofing sheets as sun shading device for corridor. Source: Abuja markets management limited, 2016 (http://www.abujamarketsmanagement.com/kado-market/).

3.9 Instruments for Data Collection

Instruments for data collection of this study namely as questionnaires, interview questions, focus group discussions, observations, cameras, training of research assistants, ethics and triangulation. They were critically considered as follows.

3.9.1 Questionnaires

The three regional built-up markets were evaluated with respect to their passive and active prevention and protection measures against fire by the use of questionnaires. They were distributed to the sales people via the use of systematic method of sampling at every 5th interval of sales point in each of the market studied.

3.9.2 Interview questions

Interviews were used in some cases to fill the questionnaires for the illiterate sales people that were unable to read and write in the study domain, in order to ensure sufficiency of information from the sales people. Likewise, interview questions were given to the Markets Operating Bodies in the Federal Capital Territory (FCT) of Nigeria such as AMML, NANT and FFSN, in order to get information with respect to their attitudes, preparedness, resilience, beliefs and practices on vulnerability of fire. These research instruments were used to obtain information from the officers of the FCT Markets Operating Bodies that are properly informed with the related issues to the management of outbreaks of fire in markets. They were administered to these officers via the Head of each Markets Operating Body, so that their officers can interact at the management board meetings for generalised research answers.

3.9.3 Focus group discussions

Focus group size involves the determination of a perfect number of participants that will be engaged in a research, so as to get the information related to the research (Sargeant, 2012). According to Masadeh (2012) and Morgan *et al.* (2002), in totality,

the minimum standard number of the participants in focus group for a research is 10 to 12. It was further explained that the main benefits of employing focus group method in a study is obtained in lesser groups that are comprised of five or four number of participants.

Hence, regard was given to this immediate above statement relating to the discussions in focus group; they were organised for different sales people in the markets by employing random method of sampling which according to scholars like Humans of Data (HOD), it is a sampling technique where each member of the research population has an equal chance of being chosen as a subject and the whole process of sampling is carried out in a single step with each subject chosen independently of the other members of the research population (Etikan and Bala, 2017; HOD, 2017; Taherdoost, 2016). In this study, a focus group discussion that was comprised of five sales persons was organised in Wuse market, Garki model market and Kado market. Likewise, a one time group discussion was organised for some of the staff of the relevant organisations to this research such as the staff of the Federal Fire Service of Nigeria (FFSN) in the FCT, National Association of Nigerian Traders (NANT) in the FCT, and the market managing company. It was organised in the office of these organisations, so as to get information which related to protection and prevention measures against market fire.

3.9.4 Observations

Observation is giving a careful attention to the matter of study or phenomenon, and in some cases, it is getting engaged with daily activities connected to the research

(Urquhart, 2015; Watson and Till, 2010). Laurier (2010) and Tichapondwa (2013) also explained that it is involving with unfamiliar and familiar issues of concern and hence needs patience and carefulness. Thus, observation schedule was employed and the current condition of the markets with regards to the changes made by the users that cause the fast fire spread; the factors attributed to the changes made by the users that cause the fast spread of fire were observed. Passive and active prevention and protection measures against market fires were also observed

Observations have helped the researcher and research assistants to get direct information regarding the availability of protection and prevention measures against fire and how people comply with them in the markets. Thus, the availability of fire protection devices, spacing of fire protection devices, availability of fire signs and notices, adequacy of fire signs and notices, and the sizes of the markets with regards to their available facilities were critically observed. Similarly, the activities in the open stalls and lock-up shops which can cause fire outbreaks, conversion of the open stalls and lock-up shops to similar or other uses which can lead to fire outbreaks, demarcation of the lock-up shops and open stalls for other uses which can lead to the fast spread of fire were critically observed. Likewise, the accessibility of the firefighting vehicles into the market places in the event of outbreaks of fire, ways of exit in case of outbreaks of fire, building materials that were used for the construction of the markets against fire outbreaks, and the pattern of design of the markets against fire outbreaks were critically observed.

3.9.5 Cameras

According to scholars like Society of Photo-Optical Instrumentation Engineers Professional (SPIEP), cameras are optical instruments used to capture images (Arzaman and Nordin, 2018; SPIEP, 2017). There are important strengths in the use of cameras for observational research. According to Wilbert (2010), Michael (2011) and Winton (2016), cameras or photography help researchers to overcome the typically fleeting nature of observation and allow for reflection, coding and the use of situation for illustration. In addition, they can also be used for the purpose of analysis of environments as they can be qualitative by aiming for naturalistic, descriptive and rich data; they can also be used to quantitatively measure circumstances and events. Owing to the descriptive survey nature of this research, the use of cameras was employed to gather research data by the researchers and research assistants which enable the generation of adequate photographs of the real life situation of the markets that were studied.

3.9.6 Training of research assistants

Three architects and two building engineers were trained as research assistants to aid in collection of data in the markets, so as to maximise the research data. They were supervised to make sure that their assistance was accurately accomplished. The research assistants were first of all taken through the objectives and rationale of the research. Then, they were trained on how to identify their respondents and how to collect data of the research in all the three markets but they were not engaged in getting the data of the research from the Federal Capital Territory (FCT) Market Operating Bodies.

The researcher / research assistants were involved in the distribution of questionnaires and also asked questions and then recorded the responses from respondents in the time of focus group discussions. In addition, the research assistants and researcher observed to get direct information on the related issues to the factors that cause the fast spread of fire in the markets and their prevention and protection measures.

3.9.7 Ethical considerations

The personalities of research assistants and that of researcher were made known to the management of the markets and other respondents; the reasons behind the research were also made known to them, and permission was obtained from the management of the markets prior to commencement of the research. Additionally, the confidentiality of the respondents was ensured as it was written in the research instruments administered to them, so as to ensure the free mind of the respondents to give a proper cooperation and to also answer questions; demand for the clarification regarding the research questions.

3.9.8 Triangulation

Triangulation serves as the process or technique of cross checking results of a research from two or more sources to validate claims (Bryman, 2012; Carter *et al.,* 2014). The data of this research were produced from diverse informants and sources with different backgrounds. Since, interview questions, discussions in focus group, questionnaires and observation schedule were combined in getting the research data, hence, cross checking these data from diverse informants and sources to determine their validities and

consistencies were considered very important. In this case, visual and calculation methods were employed to validate the research claims. The total number of research instruments were checked to ensure that they are up to the target number originally designed for the research in conjuction with the data collected before the data were analysed.

3.10 Pilot Study

Department for Business Innovation and Skills (DBIS) and other scholars stated that the minimum size of the research instruments of a pilot study should be 10% of the total size of the research instruments of the proposed full study (Connelly, 2008; DBIS, 2012; Glenn *et al.*, 2003; Hertzog, 2008; Naing *et al.*, 2006; Osama and Issa, 2015; Ravi, 2017; Simon, 2011). In addition, Brancato *et al.* (2006), Nasrin and Trisha (2009), Anthony *et al.*, (2014), Joao *et al.* (2014) and Yue (2016) stated that the reliability and validity of the instruments of research indicate that the research instruments appear to be appropriate for the purpose of the study.

To increase the level of the reliability and validity of the instruments of research employed, 15% of the total size of instruments of the research were tested in the study area but in the case of the interview questions given to the FCT Markets Operating Bodies such as the market managing company, National Association of Nigerian Traders (NANT), and the Federal Fire Service of Nigeria, only a copy was administered to their staff since the total number of the interview questions administered to their management boards in a full scale study was one copy. Likewise, a onetime discussion was carried out with the staff of each Market Operating Body in

FCT during the pilot study. Brief observations of all the markets was also made during the pilot study.

The indicated errors from the pilot study in terms of the structure and connectivity of the contents of all the research instruments with regards to the research questions; the readability and clarity of the language used were corrected, so as to ensure the optimum goals of the instruments of research of the full scale study. Moreover, the contributions from the Markets Operating Bodies in FCT were added to the contents of research instruments of the full scale study to also ensure their optimum goals.

3.11 Research Data

Two types of research data were collected for the purpose of this study. They are primary and secondary data as discussed below.

3.11.1 Primary research data

Primary data of this research were collected from the sales people in Wuse market, Garki model market and Kado market through appropriate sampling procedures. Likewise, they were collected from some organisations (Markets Operating Bodies) such as the FFSN, NANT and managing company of the markets that were studied (Abuja Markets Management Limited [AMML]). Table 3.1 shows the distribution of sampling procedures and sizes in markets and organisations.

Table 3.1: Distribution of sampling procedures and sizes in markets and organisations.

S/N	Market/Organisation	Number of Sales Points / Offices	Sampling Size
1	Wuse Market	2,091 Sales Points	419 Questionnaires for the Sales People
2	Garki Model Market	1,430 Sales Points	287 Questionnaires for the Sales People
3	Kado Market	353 Sales Points	71 Questionnaires for the Sales People
4	FFSN	Only National Headquarters Office	Interview Questions of One Set for the Management Board
5	NANT	Only National Headquarters Office	Interview Questions of One Set for the Management Board
6	Abuja Markets Management Limited	1 Office in each Market	Interview Questions of One Set for the Management Board

Source: Field work (2017).

3.11.1.1 Sampling procedures with regards to the primary data from sales people in Wuse market

From the company that manages Wuse market (AMML, 2016), the old block of the market is made up of 1,365 shops (lock-up type) and the market new block is made up 220 lock-up shops. Therefore, the market has an overall number of 1,585 shops (lock-up type). Additionally, the maket has a total number of six restaurants in detached form and 500 open stalls. Thus, by adding the total number of shops (lock-up type), restaurants and stalls (open type) in the market, it mathematically means that 2,091 trading points exist in this market.

According to Lund Research Limited (LRL), Specific Measurable and Achievable Relevant and Time-bond Methodology (SMARTM) and other scholars, systematic method of sampling is on the basis of units selection at a certain predetermined interval which is generally known as the interval of sampling in which the members of the research population are listed in some kind of rosters and then, at every M^{th} (for example, 20^{th}), a component is chosen for a research purpose and it is normally used for a large population size of a research (Investopedia, 2016; LRL, 2012; Simon and Goes, 2012; SMARTM, 2012). Considering this immediate statement, systematic method of sampling was adopted because of the large size of this market and questionnaires were distributed to the sales people. This means that one questionnaire was given to a sales person in the 1^{st} chosen sales point and the distribution of questionnaires continued at the intervals of 5^{th} sales points throughout the whole exercise in this market, bearing in mind that one questionnaire is only for one particular sales point. Hence, by doing this with regards to 2,091 existing market sales points, it mathematically implies that a total of 419 sales points were studied in this market.

This size of the sample is acceptable because the 419 total number of sales points that was selected to distribute the questionnaires are slightly more than 20% of the overall number of market trading points (Hill, 1998; Isaac and Michael, 1981; Prashant and Supriya, 2010; Ruger, 2009; Smith, 1983; Steve, 2011; Suresh and Chandrashekara, 2012). In addition and with regards to Creative Research System (CRS), FluidSurveys Team (FST), Statistical and Technical Team (STT) and other scholars, the choice of size of this sample is on the basis of fact that the more the size of research sample, the more confidence it is for the answers of research question to really display the

population of research (CRS, 2012; FST, 2014; Gigi, 2017; Jeovany *et al.*, 2014; Liz, 2016; Nick *et al.*, 2009; STT, 2011; Sunday, 2015).

3.11.1.2 Sampling procedures with regards to the primary data from sales people in Garki model market

From the company that manages Garki model market (AMML, 2016), there are total number of 558 open stalls and 872 lock-up shops in Garki model market. Thus, by adding the total number of open stalls and lock-up shops in the market, it mathematically means that a total number of 1,430 trading points exist in the market. Similarly, systematic method of sampling was adopted because of the large size of the market and questionnaires were distributed to the sales people. This means that one questionnaire was given to a sales person in the 1^{st} chosen sales point and the distribution of the questionnaires continued at the intervals of 5^{th} sales points throughout the whole exercise in this market, bearing in mind that one questionnaire is only for one particular sales point. Hence, by doing this with regards to 1,430 existing sales points in the market, it mathematically implies that 287 sales points were studied in this market.

This size of the sample is acceptable because the 287 total number of the sales points that was selected to distribute the questionnaires are slightly more than 20% of the overall number of sales points in the market (Hill, 1998; Isaac and Michael, 1981; Prashant and Supriya, 2010; Ruger, 2009; Smith, 1983; Steve, 2011; Suresh and Chandrashekara, 2012). Also, the choice of size of this sample is on the basis of fact

that the more the size of research sample, the more confidence it is for the answer of research question to really display the population of research (CRS, 2012; FST, 2014; Gigi, 2017; Jeovany *et al.*, 2014; Liz, 2016; Nick *et al.*, 2009; STT, 2011; Sunday, 2015).

3.11.1.3 Sampling procedures with regards to the primary data from sales people in Kado market

From the company that manages Kado market (AMML, 2016), Kado market is made up of a total number of 86 open stalls, 25 ware houses/ cold rooms, 237 lock-up shops, one clinic, three restaurants and one centre for telecommunication. Thus, by adding the total number of open stalls, ware houses/ cold rooms, lock-up shops, clinic, restaurants and centre for telecommunication in the market, it mathematically means that a total number of 353 trading points exist in the market. Likewise, systematic method of sampling was adopted in this market and questionnaires were distributed to the sales people. This means that one questionnaire was given to a sales person in the 1st chosen sales point and the distribution of the questionnaires continued at the intervals of 5th sales points throughout the whole exercise in this market, bearing in mind that one questionnaire is only for one particular sales point. Hence, by doing this with regards to the existing 353 sales points in the market, it mathematically implies that 71 sales points were studied in this market.

This size of the sample is acceptable because the 71 total number of the sales points that was selected to distribute the questionnaires are slightly more than 20% of the

overall number of market trading points (Hill, 1998; Isaac and Michael, 1981; Prashant and Supriya, 2010; Ruger, 2009; Smith, 1983; Steve, 2011; Suresh and Chandrashekara, 2012). Moreover, the choice of size of this sample is on the basis of fact that the more the size of research sample, the more confidence it is for the answer of research question to really display the population of research (CRS, 2012; FST, 2014; Gigi, 2017; Jeovany *et al.,* 2014; Liz, 2016; Nick *et al.,* 2009; STT, 2011; Sunday, 2015).

3.11.1.4 Sampling procedures with regards to the primary data from some organisations in the Federal Capital Territory of Nigeria

Interview questions were given to both government organisations and private organisations (Markets Operating Bodies) that are significant to this study. The private organisations in this research are the market managing company and the National Association of Nigerian Traders (NANT) of the Federal Capital Territory (FCT) of Nigeria. The only government organisation in this research is the Federal Fire Service of Nigeria (FFSN) in the FCT of Nigeria. One set of interview question was given to every concerned organisation via their Heads for the meetings of the management board to be organised with respect to them, so that the management board members of every concerned organisation can interact with each other to give generalised research answers.

3.11.2 Secondary research data

Secondary data of this research were acquired from the recap of Nigerian fire safety code; other important literature with regards to the outbreaks of market fires and other public buildings in and outside Nigeria. The reason for reviewing literature from the past fire outbreaks in public buildings is because markets are also public buildings for business transactions (Chabbi-Chemrouk, 2007; Jikun and Scott, 2003; Lipsey, 1963; Ngugi, 2015). In details, the secondary data were acquired from theses, lecture notes, journals, reports, seminar papers, annals, textbooks, features, guides, archive and other academic articles; data bases of institutions.

Most importantly, they were obtained from the past reports of the FFSN, NANT, and the market managing company that were studied. In addition, internet was employed to get information from different websites with regards to the previous outbreaks of fire in market places and other public buildings in and outside Nigeria, so that the causes of such fires can be known, and to also know the factors that cause the fast spread of fire, and other related issues in such buildings. The lessons from the reviews of the literature were applied at different stages of this research.

3.12 Data Analysis

Scholar like Survey Monkey (SMO) stated that statistics give different tools and techniques to analyse the data and interpret the results of analysis (Dillard, 2015; Howard, 2018; McCluskey and Lalkhen, 2007; Peersman, 2014; Penn and Berridge, 2010; SMO, 2018). Parametric statistical technique and content analysis technique were

employed for data analyses, owing to the quantitative and qualitative nature of this research from diverse observations, and several categories of respondents such as the sales people in the markets and FCT Markets Operating Bodies.

According to Minitab Blog (MBL) and other researchers, parametric statistical analysis technique is used for a large sample size that is up to 30 and above; the basic idea is that there is a set of fixed parameters that determine a probability or normal distribution (Andrew, 2005; Bruckers and Molenberghs, 2011; Chan, 2003; Courtney, 2018; MBL, 2015; Nick, 2017). Hence, by using percentage parameter owing to the large size of this research sample, the data collected from traders via questionnaire with regards to objectives one and two were subjected to parametric statistical analysis technique to justify the quantitative aspect of the research. The 2016 version of the Micro-soft Excel, and Statistical Package for the Social Sciences (SPSS) of 23 version are the software engaged in coding and analysing them, and tables were used to present the data.

Library Guides (LGU) and other scholars stated that content analysis technique is the type of research whereby data are categorised in themes or sub-themes, in order to systematically allow for comparison, and it is mostly employed in qualitative research for testing theoretical issues, so as to enhance the understanding of data (Bengtsson, 2016; Hawkins, 2013; Joram, 2013; LGU, 2018; Satu and Helvi, 2007; Spyros, 2015; White and Marsh, 2006). Hence, the data collected from the respondents via interview questions, discussions, and observations with regards to the objectives three and four specifically, were subjected to content analysis technique to justify the

substantial qualitative aspect of the research. The other data collected from the respondents via the same research instruments with regards to other aspects of the other objectives of the research were also subjected to content analysis technique. The data obtained from the exercises of observation, and respondents were presented via the use of photographs and tables.

According to Open Anesthesia (OAN), Statistics and Data Sciences (SDS) and University of Cincinnati Business Analytics (UCBA), normality tests are employed to determine if the sets of data are well-modeled based on the assumption that the data follow a normal and appropriate distribution; they can be achieved through visual, calculation or numerical, plot or graphical methods (Baghban *et al.,* 2013; Fitrianto and Chin, 2016; Ghasemi and Zahedias, 2012; Jason, 2018; Kim, 2013; OAN, 2018; Spinks *et al.*, 2015; SDS, 2015; UCBA, 2018; Zayeri and Jalilian, 2013). Hence, owing to the nature of the statistical tools of this research in terms of the use of percentage parameters for the parametric statistical analysis, and non-parametric measures for the content analysis, all the results of data analyses were accepted by employing the numerical and visual methods of normality test.

CHAPTER FOUR

4.0 PRESENTATION OF RESULTS AND DISCUSSION

4.1 Changes Made by the Users that could Cause Fast Spread of Market Fires in the Federal Capital Territory of Nigeria

Changes made by the users that could cause fast spread of market fires in the Federal Capital Territory (FCT) of Nigeria imply the secondary causes of outbreaks of market fires. Table 4.1 reveals the distribution of changes made by the users that could cause fast spread of market fires with the observation numbers, and their common locations. Additionally, it shows that Garki model market has the highest number of items with regards to the changes made by the users that could cause fast spread of fire followed by Kado market; Wuse market has the lowest number of them. Moreover, it reveals that the changes made by the users that could cause fast spread of fire are common in the old section of Wuse market; they are common in both formal and informal sections of Garki model market. They are common around the cold room section in the eastern part of Kado market.

According to Course Hero (CHE), Community Medicine (CME) and other scholars, the size of a measurement scale can be taken based on the magnitude (size, extent or importance) where numbers (the identity) have an inherent order from the least to highest and they are usually represented on scale in ascending or descending order; for example, from the 1st, 2nd, 3rd to the least (CHE, 2021; CME, 2013; Formplus, 2019; Lee, 2007; Mishra *et al.*, 2018). In this case, the changes made by the users that could cause fast spread of market fires in markets are ranked from first to third positions with

respect to their extent. The real changes made by the users that could cause fast spread of fire in the markets are ranked first, while the major factors attributed to the changes made by the users that could cause fast spread of fire in the markets are ranked second, whereas, the other factors attributed to the changes made by the users that could cause fast spread of fire in the markets are ranked third.

Table 4.1: Distribution of the changes made by the users that could cause fast spread of market fires.

S/N	Market	Change Made by the Users	Number of Observations / Common Location
1	Wuse Market	Stocking Goods Very Close to the Light Bulbs Due to the Lack of Adequate Spaces in the Lock-up Shops	17 Shops (Lock-up Type) in the Old Section
		Erection of Illegal Non-fire Resistant Wooden Structures for Shops	2 Shops (Lock-up Type) in the Northern Part of the Old Section
2	Garki Model Market	Partitioning of Single Lock-up Shops with Non-fire Resistant Wood	2 Lock-up Shops in the Central Part of the Formal Section
		Use of Non-fire Resistant Wooden Shelves	135 Lock-up Shops in the Formal Section
		Use of Non-fire Resistant Wooden Bases for Keeping Goods	73 Open Stalls in the Informal Section
		Use of Non-fire Resistant Wooden Fowl Cages	2 Open Stalls in the Informal Section
		Fixing of Canopies in between the Roofs of Buildings	14 Buildings in the Market
3	Kado Market	Non-fire Resistant Wooden Attachments to Buildings	2 Store Buildings around the Cold Room Section in the Eastern Part
		Fixing of Corrugated Aluminium Roofing Sheets in between the Roofs of Buildings	4 Lock-up Shop Buildings around the Cold Room Section in the Eastern Part
		Use of Tarpaulins to Cover the Fronts of Verandahs	2 Lock-up Shop around the Cold Room Section in the Eastern Part

Source: Field work (2017).

4.1.1 Changes made by the users that could cause fast fire spread in Wuse market

The following issues are the changes made by the users that could cause fast fire spread in Wuse market. They are with regards to Table 4.1.

4.1.1.1 Stocking goods very close to the light bulbs due to the lack of adequate spaces in the lock-up shops in Wuse market

The discussion with Assistant Controller General of the Federal Fire Service of Nigeria (FFSN) via the use of descriptive survey method revealed that "the changes made by the users that cause the fast spread of fire in Nigerian markets is stocking goods on the shelves very close to the light bulbs". Hence, by this act, when there are sparks in the light bulbs due to the faults in electrical connection, there will be ignitions of goods and thereafter the spreading of fires in markets. This is because the study of Nwaogu (2015) revealed that electric sparks are among the attributed factors to most of fire outbreaks in Nigerian markets. The participant stated that stocking goods on the shelves very close to the light bulbs are very common in Wuse market. Also, it was observed that stocking of good very close to the light bulbs in 17 lock-up shops are very rampant in the old section of the market due to the lack of adequate spaces for lock-up shops. Some lock-up shops are in the range of 3.0 metres by 3.3 metres to 3.0 metres by 3.6 metres in the central part of the old section of the market. Plate XIX shows the stock of goods very close to the light bulb in a multipurpose shop in Wuse market.

Plate XIX: Stock of goods very close to the light bulb in a multipurpose shop in the central part of the old section of Wuse market. Source: Field work (2017).

4.1.1.2 Erection of illegal non-fire resistant wooden structures for shops in Wuse market

It was observed that the management of Wuse market allocated external spaces to the sales people for the erection of two illegal non-fire resistant wooden structures for lock-up shops in the northern part of the market old section. These are attributed to the inadequate numbers of sales spaces in the market in relation to the high demands for sales spaces. According to scholars like Building and Construction Authority (BCA), the materials for designing buildings against fire outbreaks should be capable of resisting flame spread of the building surface (BCA, 2017; Neufert and Neufert, 2000; Quarles, 2013). Also, Civil Engineering Home (CEH) and other scholars stated that non-fire resistant wood can easily burn and increase the rate of spread of fire when

there is fire outbreak in buildings (Chen *et al.,* 2015; CEH, 2017; Iwami *et al.,* 2004). Thus, these non-fire resistant wooden structures cause the fast fire spread in the event of outbreak of market fire because they cannot resist the surface flame spread. Plate XX shows an erection of illegal non-fire resistant wooden structure for food stuff shops with zinc and tarpaulin roof coverings in Wuse market.

Plate XX: Erection of illegal non-fire resistant wooden structure for food stuff shop with zinc and tarpaulin roof coverings in the northern part of the old section of Wuse market. Source: Field work (2017).

4.1.2 Changes made by the users that could cause fast fire spread in Garki model market

The following issues are the changes made by the users that could cause fast fire spread in Garki model market. They are with regards to Table 4.1.

4.1.2.1 Partitioning of single lock-up shops with non-fire resistant wood in Garki model market

In order to manage spaces for sales, it was seen in the central part of the formal section of Garki model market that the sales people partitioned two different single shops into two spaces with non-fire resistant wood for commercial activities due to high costs of the shops. These are also as a result of inadequate numbers of the sales points in the market in relation to high demands for sales points; they are considered as unlawful architectural interior design. Likewise, these non-fire resistant wooden partitions cause fast fire spread in the event of outbreak of fire (Chen *et al.*, 2015; CEH, 2017; Iwami *et al.*, 2004). Plate XXI shows non-fire resistant wooden wall partition in a shoe shop in Garki model market.

Plate XXI: Non-fire resistant wooden wall partition in a shoe shop in the central part of the formal section of Garki model market. Source: Field work (2017).

4.1.2.2 Use of non-fire resistant wooden shelves in Garki model market

Shelves were not incorporated into the interior design of the lock-up shops of Garki model market; as a result of this problem, the construction and use of non-fire resistant wooden shelves by the sales people in 135 shops (lock-up type) in the market formal section were found and they are also considered as unlawful architectural interior design. These cause fast fire spread in the event of outbreak of fire. Plate XXII shows a non-fire resistant wooden shelf in a provision shop in Garki model market.

Plate XXII: Non-fire resistant wooden shelf in a provision shop in the central part of the formal section of Garki model market. Source: Field work (2017).

4.1.2.3 Use of non-fire resistant wooden bases for keeping goods in Garki model market

Bases for keeping goods were not incorporated into the interior design of the open stalls in Garki model market; as a result of this problem, the construction and use of

non-fire resistant wooden bases by the sales people in 73 stalls (open type) in the informal section of the market were observed. They are also considered as unlawful architectural interior design; these non-fire resistant wooden bases cause fast fire spread in the event of outbreak of fire. Plate XXIII shows non-fire resistant wooden bases for keeping goods in the open stall in Garki model market.

Plate XXIII: Non-fire resistant wooden bases for keeping goods in the open stall in the informal section of Garki model market. Source: Field work (2017).

4.1.2.4 Use of non-fire resistant wooden fowl cages in Garki model market

Fowl cages were not incorporated into the interior design of the open stalls in Garki model market; as a result of this problem, the construction and use of non-fire resistant wooden fowl cages by the sales people for keeping fowls in two open stalls in the informal section of the market were observed. Similarly, they are considered as unlawful architectural interior design, and they cause fast fire spread in the event of

outbreak of fire. Plate XXIV shows a non-fire resistant wooden fowl cage in Garki model market.

Plate XXIV: Non-fire resistant wooden fowl cage in the informal section of Garki model market. Source: Field work (2017).

4.1.2.5 Fixing of canopies in between the roofs of buildings in Garki model market

It was noticed that the design of most of the buildings in the market have no verandahs or corridors where the sales people can stay for relaxation when there are no customers to sell goods. As a result of this problem, on 14 buildings in the market, the sales people fixed canopies in between the roofs of two or more buildings as sun shading devices, so that they can stay under them to relax and receive fresh air in the afternoon when there are no customers for them to conduct business transactions, especially during the intense sunshine. These are considered as illegal additional designs and building attachments.

According to scholars like National Fire Academy (NFA), combustibility of building materials is a prime factor to consider when designing buildings against fires (NFA, 2000; Sikazwe, 2015; Tan, 2007). These illegal additional designs and attachments to buildings cause fast fire spread from buildings to buildings when there are outbreaks of fire. This is because according to scholars such as Huntington Beach Fire Department (HBFD); Recalls and Safety Alerts (RSA), canopies are not resistant to fire (HBFD, 2010; Mitsopoulos and Dimitrakopoulos, 2007; RSA, 2019). Plate XXV shows one of the roof canopies as a shading device for sun in Garki model market.

Plate XXV: One of the roof canopies as a shading device for sun in Garki model market. Source: Field work (2017).

4.1.3 Changes made by the users that could cause fast fire spread in Kado market

The following issues are the changes made by the users that could cause fast fire spread in Kado market. They are with regards to Table 4.1.

4.1.3.1 Non-fire resistant wooden attachments to buildings in Kado market

The interview questions given to the Kado market managing company showed that non-fire resistant wooden attachments to buildings are the associated problems of tackling fire outbreaks in the market. They were found in two store buildings around the cold room section in the eastern part of the market. These were made for the expansion of businesses due to the inadequate sizes of the spaces for shops which are about 12 metres square; they cause fast fire spread in the event of outbreaks of fire. Plate XXVI shows a non-fire resistant wooden attachment to a store building in Kado market.

Plate XXVI: Non-fire resistant wooden attachment to a store building around the cold room section in the eastern part of Kado market. Source: Field work (2017).

4.1.3.2 Fixing of corrugated aluminium roofing sheets in between the roofs of buildings in Kado market

It was observed that on four lock-up shop buildings around the cold room in the eastern part of Kado market, the sales people fixed corrugated aluminium roofing sheets in between the roofs of two buildings. In some areas, they are joined with canopies as sun shading devices, so that they can stay under them to relax and receive fresh air in the afternoon when there are no customers for them to conduct business transactions, especially during the intense sunshine; they cause fast fire spread from buildings to buildings in the event of outbreak of fire. These are considered as illegal additional design and building attachments and they are attributed to the inadequate sizes of widths of the verandahs and corridors of the lock-up shops which range from 1.0 metre to 1.2 metres wide.

Contrary to the range of the widths of the verandahs and corridors in Kado market, the West Bengal Building Regulations (WBBR) stated that the minimum permissible width of verandah or corridor of a commercial building should be 1.25 metres (WBBR, 2016). In addition, section 2 of part M of the Building Regulations (BRE) stated that the ideal width of a verandah or a level landing outside the entrance door should be 1.5 metres (BRE, 2004). Also, Tamil Nadu Urban Development (TNUD) stated that the minimum width of the corridors of commercial buildings should be 2.0 metres (TNUD, 2010). Moreover, Ridge Design Guidelines (RDG) revealed that the verandahs of a building should have a minimum width of 2.5m to ensure that they are well useful (RDG, 2015). Plate XXVII shows the corrugated aluminium roofing sheets that are attached to the buildings as a roof sun shading device in Kado market.

Plate XXVII: Corrugated aluminium roofing sheets that are attached to the buildings as a roof sun shading device around the cold room section in the eastern part of Kado market. Source: Field work (2017).

4.1.3.3 Use of tarpaulins to cover the fronts of verandahs in Kado market

The use of tarpaulins to cover the fronts of verandahs of the lock-up shops against rain water were observed on two lock-up shops around the cold room in the eastern part of Kado market, and they are considered as improper market keeping. These are also attributed to the inadequate sizes of the width of the verandahs that led to the use of tarpaulins to prevent rain water from easily getting into the shops through them; they cause fast fire spread in the event of outbreak of fire. Plate XXVIII shows a tarpaulin that is attached to the lock-up shop in Kado market.

Plate XXVIII: Tarpaulin that is attached to the lock-up shop around the cold room section in the eastern part of Kado market. Source: Field work (2017).

4.2 Major Factors Attributed to the Changes Made by the Users that could Cause Fast Spread of Market Fires in the Federal Capital Territory of Nigeria

Different major factors are attributed to the changes made by the users that could cause fast spread of market fires in the Federal Capital Territory (FCT) of Nigeria. Electrical Issues, use of flammable liquids, charcoal fires, fire wood, gas cookers, kerosene stoves and arson (intentional fires) are the major factors attributed to the changes made by the users that could cause fast spread of market fires in the FCT of Nigeria. The major factors attributed to the changes made by the users that could cause fast fire spread refer to the major causes of outbreaks of market fire. Table 4.2 reveals the distribution of major factors attributed to the changes made by the users that could cause the fast spread of market fires with the observation numbers, and their common locations. In Table 4.2, the major cause of fire outbreak represents the major factor attributed to the changes made by the users that could cause fast spread of fire. In addition, the common location in Table 4.2 is the area where the major factors attributed to the changes made by the users that could cause fast spread of fire were popularly found.

Table 4.2 also indicates that the major cause of fire outbreak is due to issues of electricity and they are common in all the markets. Thus, it is deduced that fire outbreak due to electrical problems is the main cause of fire outbreak, since it was found in all the three markets. Likewise, Table 4.2 revealed that the causes of fire outbreaks due to the use of flammable liquids and charcoal fires were found in only Wuse market. Similarly, it indicates that the cause of fire outbreak due to the use of fire wood was found in only Garki model market. More over, it shows that the causes of fire outbreaks due to arson and the use of gas cookers and kerosene stoves were found

only in Kado market. Thus, it is deduced that the causes of fire outbreaks due to arson and the use of flammable liquids, charcoal fires, fire wood, gas cookers and kerosene stoves are the least common causes of fires, since each of them was found in only one particular market with no repetition of the occurrence in other markets.

Table 4.2: Distribution of attributed main factors to the changes made by the users that could cause fast spread of market fires.

S/N	Market	Major Cause of Fire Outbreaks	Number of Observations / Common Location
1	Wuse Market; Garki Model Market; Kado Market	Electrical Issues	14 Buildings in the Old Section of Wuse Market; Formal Section of Garki Model Market; 2 Buildings in the Eastern Part of Kado Market
2	Wuse Market	Flammable Liquids	5 Buildings in the Old Section Eastern Part
3	Wuse Market	Use of Charcoal Fires	Close to 2 Restaurants in the Central Part of the Old Section
4	Garki Model Market	Use of Fire Wood	Close to 1 Restaurant and 1 Open Stall in the Western Part of the Informal Section
5	Kado Market	Use of Gas Cookers	1 Restaurant around the Cold Room Section in the Eastern Part
6	Kado Market	Use of Kerosene Stoves	1 Illegal Restaurant around the Cold Room Section in the Eastern Part
7	Kado Market	Arson	1 Lock-up Shop around the Cold Room Section in the Eastern Part.

Source: Field work (2017).

4.2.1 Electrical issues attributed to the changes made by the users that could cause fast spread of market fires

Electrical issues attributed to the changes made by the users that could cause fast spread of fire were found in all the three markets. Table 4.3 reveals the distribution of

issues of electricity attributed to the changes made by the users that could cause fast spread of market fires with the observation numbers, and their common locations. In Table 4.3, the major cause of fire outbreak refers to the electrical issue attributed to the changes made by the users that could cause the fast spread of fire. Table 4.3 also revealed that the major cause of fire outbreaks from wiring problem is common in Wuse market and Kado market; thus it is again deduced that it is the main cause of fire outbreaks in the markets. Moreover, Table 4.3 revealed that the common location of the major cause of outbreak of fire from electrical issues in Wuse market is the market old section; the common location of major cause of outbreaks of fire from the electrical issues in Garki model market is the part of centre of the market formal section. Likewise, the major cause of outbreaks of fire from the electrical issues in Kado market is common in the cold room section in the eastern part of the market.

Table 4.3: Distribution of the electrical issues attributed to the changes made by the users that could cause fast spread of market fires.

S/N	Market	Major Cause of Fire Outbreaks	Number of Observations / Common Location
1	Wuse Market	Illegal Electrical Connection and Wiring	3 Shop Buildings (Lock-up Type) in the Part of Centre of the Old Section
		Indiscriminate Use of Electric Power Generators	11 Lock-up Shop Buildings in the Old Section
2	Garki Model Market	Fire Outbreaks Mostly Start from the Cold Rooms at Night as a Result of Power Surge	Central Part of the Formal Section
3	Kado Market	Electrical Equipment and Wiring	1 Building in the Cold Room Section in the Eastern Part
		Non-adherence to Electrical Precautionary Standards	1 Building in the Cold Room Section in the Eastern Part

Source: Field work (2017).

4.2.1.1 Electrical issues attributed to the changes made by the users that could cause fast spread of fire in Wuse market

The interview questions given to the Federal Fire Service of Nigeria (FFSN) showed that the causes of outbreaks of fire in Wuse market are as a result of improper market keeping such as keeping of materials that can burn close to, or in contact with the electrical wall sockets and other points that are prone to electrical sparks. Similarly,

from the interview questions administered to the National Association of Nigerian Traders (NANT), among the causes of outbreaks of fire in Wuse market is illegal electrical connection and wiring.

Likewise, it was observed that illegal electrical connection is very common in three shop buildings (lock-up type) in part of the centre of the market old section due to indiscriminate wiring for personal electric power generators as a result of unstable supply of public electric power. From the interview questions administered to the FFSN, the use of substandard electrical materials and poor electrical workmanship are some of the associated problems of tackling fire outbreaks in Wuse market. Plate XXIX shows an illegal electrical connection at the eave of a roof in Wuse market.

Plate XXIX: Illegal electrical connection at the eave of a roof in the central part of Wuse market. Source: Field work (2017).

The interview questions given to the Wuse market managing company indicated that the main cause of market fire outbreaks is electrical equipment and wiring from electric power generators. Similarly, the study of Ramamurthy (2004); Chukwu and Kalu (2015) revealed that indiscriminate use of electric power generators causes outbreaks of fire. However, it was seen that indiscriminate use of electric power generators are very common around 11 lock-up shop buildings in the old section of the market due to unstable supply of public electric power. In addition, there is a location around part of the north of the market new section where different sales people gathered many small size electric power generators in a general power house.

This power house is considered to be a centre of fire outbreaks from electric power generators in the market. This is because when there is fire outbreak from one electric power generator as a result of a spark and there is a failure to control it at the early stage, it can lead to the transfer of fire from the affected generator to other nearby generators and thereafter to all other generators in the same power house. The entire market can be set on fire by these processes. Plate XXX shows a power house with indiscriminate arrangement of small size electric power generators in Wuse market.

Plate XXX: Power house with indiscriminate arrangement of small size electric power generators around the northern part of the new section of Wuse market. Source: Field work (2017).

4.2.1.2 Electrical issues attributed to the changes made by the users that could cause fast spread of fire in Garki model market

The interview questions administered to the NANT showed that most of the fire outbreaks in Garki model market were caused by power surge. Also, the discussion with the staff of the Garki model market managing company revealed that outbreaks of fire mostly start from the cold rooms at night in the central part of the formal section of the market due to power surge because sales people in the cold rooms do not put off their electrical appliances at the close of businesses for the day.

4.2.1.3 Electrical issues attributed to the changes made by the users that could cause fast fire spread in Kado market

The discussions with the NANT and managing company of Kado market revealed that "no major fire outbreak has occurred in Kado market. All the fire outbreaks in the market were controlled at the early stages of fires". However, the interview questions given to the Kado market managing company indicated that the main cause of outbreak of fire in Kado market place is electrical equipment and wiring; this was also observed in one building in the cold room section in the eastern part of the market. The interview questions administered to the NANT indicated that among the causes of most outbreaks of fire in Kado market are due to non-adherence to electrical precautionary standards in buildings; this was also noticed in one building in the cold room section in the eastern part of the market.

4.2.2 Use of flammable liquid attributed to the changes made by the users that could cause fast spread of market fires

The use of flammable liquid attributed to the changes made by the users that could cause fast spread of fire were found in Wuse market. Table 4.4 reveals the distribution of use of flammable liquid attributed to the changes made by the users that could cause fast spread of fire in Wuse market with the observation numbers, and their common locations. It reveals that all the use of flammable liquid in the market are common in the eastern part of the old section. In Table 4.4, the major cause of fire outbreak means the use of flammable liquid attributed to the changes made by the users that could cause fast spread of market fires.

Table 4.4: Distribution of the use of flammable liquid attributed to the changes made by the users that could cause fast spread of fire in Wuse market.

S/N	Major Cause of Fire Outbreaks	Number of Observations / Common Location
1	Storing of Petrol in the Market	2 Lock-up Shops in the Eastern Part of the Old Section
2	Sales of Petrol in the Market	Close to 1 Boutique in the Eastern Part of the Old Section
3	Parking Cars Very Close to the Electric Power Generators that are Working with Petrol	Close to 1 Shop Building in the Eastern Part of the Old Section
4	Filling Electric Power Generators with Petrol while they are Working	Close to 1 Shop Building in the Eastern Part of the Old Section

Source: Field work (2017).

4.2.2.1 Storing of petrol attributed to the changes made by the users that could cause fast spread of fire in Wuse market

The focus group discussions with the sales people in Wuse market showed that "storing petrol in the market for powering of electricity generators due to epileptic nature of the supply of public electric power is among the causes of outbreaks of fire in the market". The focus group discussions with the sales people in the market further showed that "on 20th December, 2015, there was a fire outbreak in a storey building inside Wuse market due to fire from cigarette end that fell on the petrol where it was stored". However, it was observed that the sales people in two shops in the eastern part of the old section of the market are still storing petrol in the shops for powering of electricity generators. Plate XXXI shows the front of a Hair Dressing Salon where petrol is stored in a gallon in Wuse market.

Plate XXXI: Storing of petrol in a gallon in front of a hair dressing salon in the eastern part of the old section of Wuse market. Source: Field work (2017).

4.2.2.2 Sales of petrol attributed to the changes made by the users that could cause fast spread of fire in Wuse market

The focus group discussions conducted with the sales people showed that “some people now sell petrol (black market) close to a boutique in the eastern part of the old section of Wuse market”. This sales of petrol attribute to the changes made by the users that could cause fast spread of fire since it has been stated that the use of petrol in Wuse market has caused fire outbreaks. Plate XXXII shows an open area where people sell petrol in Wuse market.

Plate XXXII: Open area where people sell petrol around the boutiques in the eastern part of the old section of Wuse market. Source: Field work (2017).

4.2.2.3 Parking of cars very close to the electric power generators and filling them with petrol attributed to the changes made by the users that could cause fast spread of fire in Wuse market

The focus group discussion made with the sales people in Wuse market indicated that "among the causes of outbreaks of fire in Wuse market is filling electric power generators with petrol when they are working due to the lack of patience to put off the generators before they can be filled with petrol". It was further explained that in 2016, there was fire outbreak from an electric power generator as a result of filling it with petrol in the eastern part of the old section of the market. The generator was closed to the cars that were illegally parked at the back of a shop building by that time. As a result of this, some sales people in the market gathered and pushed away the cars that

were closed to that generator to stop fire spread through those cars to the buildings in the market.

However, it was seen that as a result of inadequate car parking spaces in the market, people are still parking cars very close to the electric power generators that are working with petrol at the open space close to a lock-up shop building in the eastern part of the old section of the market. Also, the sales people still fill electric power generators with petrol while they are working in the eastern part of the old section of the market. Plate XXXIII shows the parking of cars close to the electric power generators that are working with petrol at the back of a shop building in Wuse market.

Plate XXXIII: Parking of cars close to the electric power generators that are working with petrol at the back of a lock-up shop building in the eastern part of the old section of Wuse market. Source: Field work (2017).

4.2.3 Use of charcoal fires attributed to the changes made by the users that could cause fast spread of market fires

The use of charcoal fires attributed to the changes made by the users that could cause fast spread of fire were found in Wuse market. The discussion with the Assistant Controller General of the Federal Fire Service of Nigeria (FFSN) revealed that it has been reported by the sales people in Nigerian markets that cooking in the markets is one of the causes of fire outbreaks. The Assistant Controller General incharge of the FFSN confirmed that apart from the reports from sales people in the affected Nigerian markets, fire outbreak due to cooking with fire wood was personally witnessed in 2005 in a temporary market in Area 10, Abuja that was set up in 2005 during the renovation of Wuse market but that market is no longer in existence because it has been demolished by the FCDA of Nigeria. The discussion made with the supervisor of Wuse market (staff of the market managing company) showed that cooking with fire wood is among the causes of outbreaks of fire in the market; to solve the problem of outbreaks of fire from fire wood in Wuse market, the company that manages the market stopped the sales people from cooking with fire wood in the market restaurants in January, 2016.

However, the sales people in the main restaurant and the second restaurant in the central part of the old section of the market are still indiscriminately cooking with charcoals in steel containers to minimise the costs of using alternative sources of cooking; these attribute to the changes made by the users that could cause fast spread of fire in the market. When there is strong wind that can blow the charcoal fire from the point of cooking to any material that can easily burn, the entire market can be set on

fire if appropriate control measures are not employed immediately. Plate XXXIV shows the use of charcoals in steel containers for cooking in Wuse market.

Plate XXXIV: Use of charcoals in steel containers for cooking around the main restaurant in the central part of Wuse market. Source: Field work (2017).

4.2.4 Use of fire wood attributed to the changes made by the users that could cause fast spread of market fires

The use of fire wood attributed to the changes made by the users that could cause fast spread of fire were found in Garki model market. The focus group discussion with the sales people in Garki model market revealed that among the causes of outbreaks of market fire is the use of fire wood for cooking and preparation of meats. It was seen that the sales people are still indiscriminately cooking in the premises of the illegal restaurant and also preparing meats with the use of fire wood around the open stall in the western part of the informal section of the market, in order to minimise the costs of

using other alternative means. These attribute to the changes made by the users that could cause fast spread of fire in the market. When there is strong wind that can blow the charcoal fire from the point of using the fire wood to any material that can easily burn, the entire market can be set on fire if appropriate control measures are not employed immediately. Plate XXXV shows the preparation of meats with the use of fire wood in Garki model market.

Plate XXXV: Preparation of meats with the use of fire wood in the western part of the informal section of Garki model market. Source: Field work (2017).

4.2.5 Use of gas cookers and kerosene stoves attributed to the changes made by the users that could cause fast spread of market fires

The use of gas cookers and kerosene stoves attributed to the changes made by the users that could cause fast spread of fire were found in Kado market. The focus group discussion with the sales people in Kado market showed that cooking with gas cookers

is among the causes of outbreaks of fire in the market. Similarly, cooking with gas cookers in a restaurant around the cold room section in the market eastern part was observed. The interview questions given to the Kado market managing company indicated that among the causes of outbreaks of fire in Kado market is cooking with naked fires such as fires from the kerosene stoves.

Likewise, it was noticed that around the cold room section in the eastern part of the market, people cook with the kerosene stoves that are kept inside the empty cartons in an illegal restaurant, in order to reduce the disturbance from the breeze that affects the flames of kerosene stoves. In this case, strong wind can cause the empty cartons to ignite by blowing the flames of fires to them and thereby setting up other combustible materials on fire which can further set the entire market on fire. Plate XXXVI shows the cooking with kerosene stoves inside empty cartons in an illegal restaurant in Kado market.

Plate XXXVI: Cooking with kerosene stoves inside empty cartons in an illegal restaurant around the cold room section in the eastern part of Kado market.
Source: Field work (2017).

4.2.6 Arson

The focus group discussion conducted with the Kado market sales people indicated that among the causes of outbreaks of fire in Kado market is “arson (intentional fires)”. According to the participants, a good example is the fire outbreak that occurred in a lock-up shop around the cold room section in the eastern part of the market in five years ago (2012) but it was controlled at the early stage.

4.3 Other Factors Attributed to the Changes Made by the Users that could Cause Fast Spread of Market Fires in the Federal Capital Territory of Nigeria

Other factors attributed to changes made by the users that could cause fast spread of fire were found in Wuse market and Garki model market. In this subsection, other factors attributed to the changes made by the users that could cause fast spread of fire refer to the non-architectural design features of markets that could cause fast spread of fire in the markets; they are termed minor causes of fire outbreaks. Table 4.5 reveals the distribution of other factors attributed to changes made by the users that could cause fast spread of market fires with the observation numbers, and their common locations.

Moreover, it reveals that the changes made by the users that could cause fast spread of fire are common in the central part of the old section of Wuse market, while they are common in the central part of the formal section of Garki model market. It also shows that Wuse market has the highest number of items of the changes made by the users that could cause the fast spread of fire, while Garki model market has only one number of item of the changes made by the users that could cause fast spread of fire.

Table 4.5: Distribution of other factors attributed to the changes made by the users that could cause fast spread of market fires.

S/N	Market	Attributed Factor	Number of Observations / Common Location
1	Wuse Market	Indiscriminate Use of Umbrella Stands	One Open Space in the Central Part of the Old Section
2	Wuse Market	Indiscriminate Dumping of Wastes	2 Locations in the Central Part of the Old Section
3	Wuse Market	Indiscriminate Parking of Cars on the Parts of the Road	One Open Space in the Central Part of the Old Section
4	Wuse Market	Blocking of Access Spaces for the Fire Fighting Vehicles with Goods	2 Locations in the Central Part of the Old Section
5	Garki Model Market	Blocking of Access Roads for the Fire Fighting Vehicles with Umbrella Stands and Sign Boards	2 Locations in the Central Part of the Formal Section

Source: Field work (2017).

4.3.1 Indiscriminate use of umbrella stands in Wuse market

The interview questions administered to the FFSN indicated that bad attitudes of the sales people and market management authority are the associated problems of tackling fire outbreaks in Wuse market. In the same dimension, it was observed that indiscriminate use of umbrella stands are very common in one open space in the central part of the old section of Wuse market as a result of the poor sales people that cannot afford the costs of acquiring shops, and the market management authority is not taking any control measure against them. They are considered as improper market keeping; these cause the fast fire spread in the event of outbreak of market fire. Plate XXXVII shows umbrella stands in Wuse market.

Plate XXXVII: Umbrella stands in the central part of the old section of Wuse market. Source: Field work (2017).

4.3.2 Indiscriminate dumping of wastes in Wuse market

It was noticed that there is no central collection point for wastes in Wuse market and because of this problem, indiscriminate dumping of wastes were found in two locations in the central part of the old section of the market and these have resulted to poor environmental quality in the market. These cause the fast fire spread from buildings to buildings in the event of outbreak of fire. Plate XXXVIII shows an indiscriminate dumping of waste in Wuse market.

Plate XXXVIII: Indiscriminate dumping of waste in the central part of the old section of Wuse market. Source: Field work (2017).

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4.3.3 Indiscriminate parking of cars on the parts of the road in Wuse market

The interview questions administered to the FFSN showed that the parts of Wuse market where there are adequate road spaces for the firefighting vehicles to access are blocked by the indiscriminate parking of cars on the parts of them. Similarly, indiscriminate parking of cars on the parts of the road in the part of centre of the old section of the market was noticed because of inadequate car parking spaces. This prevents firefighting vehicles from accessing the market conveniently to quench fire in case of fire inferno. Plate XXXIX shows the indiscriminate parking of cars on the parts of the road in Wuse market.

Plate XXXIX: Indiscriminate parking of cars on the parts of the road in the central part of the old section of Wuse market. Source: Field work (2017).

4.3.4 Blocking of access spaces for the fire fighting vehicles with goods in Wuse market

The observation showed that two spaces between the shop buildings for the firefighting vehicles to access are blocked with the displayed goods for sales in the part of centre of the old section of the market due to the lack of shop verandahs for displaying goods for sales; these prevent firefighting vehicles to conveniently access the market to put out fires when they break out. Plate XL shows the displayed goods for sales between the shop buildings in Wuse Market.

Plate XL: Displayed goods for sales between the lock-up shop buildings in the part of centre of the old section of Wuse market. Source: Field work (2017).

4.3.5 Blocking of access roads for the fire fighting vehicles with umbrella stands and sign boards in Garki model market

It was seen that two spaces between the shop buildings that firefighting vehicles can access in the central part of the formal section of Garki model market are blocked with umbrella stands and sign boards for enhancing sales. These prevents firefighting vehicles to conveniently access the market to put out fires when they break out. Plate XLI shows umbrella stands and sign boards between the shop buildings in Garki model market.

Plate XLI: Umbrella stands and sign boards between the lock-up shop buildings in the part of centre of the formal section of Garki model market. Source: Field work (2017).

4.4 Summary of the Changes Made by the Users that could Cause Fast Spread of Fire and their Attributed Factors in Markets

There are several factors attributed to the changes made by the users that could cause fast spread of fire in markets. They are building materials, arrangement of goods, electricity, flammable liquids, cooking materials/equipment, arson, utility materials and access roads/spaces. Table 4.6 indicates the summary distribution of the changes made by the users that could cause fast spread of fire and their attributed factors in markets. In Table 4.6, misuse of electrical equipment/appliances, mishandling of flammable liquids, misuse of cooking materials/equipment and wilful/intentional acts generate fire in the markets, while the misuse of non-fire resistant building materials, inappropriate stocking and keeping of goods, misuse of non-fire resistant utility materials and

blocking of access roads/spaces for the firefighting vehicles cause fast spread of fire in the markets.

Table 4.6: Distribution of summary of the changes made by the users that could cause fast spread of fire and their attributed factors in markets.

S/N	Attributed Factor	Changes Made / Associated Issue	Implication
1	Building Materials	Misuse of Non-fire Resistant Building Materials	Fast Spread of Fire
2	Arrangement of Goods	Inappropriate Stocking and Keeping of Goods	Fast Spread of Fire
3	Electricity	Misuse of Electrical Equipment/Appliances	Fire Generation
4	Flammable Liquids	Mishandling of Flammable Liquids	Fire Generation
5	Cooking Materials/Equipment	Misuse of Cooking Materials/Equipment	Fire Generation
6	Arson	Wilful/Intentional Acts	Fire Generation
7	Utility Materials	Misuse of Non-fire Resistant Utility Materials	Fast Spread of Fire
8	Access Roads/Spaces	Blocking of Access Roads/Spaces for the Firefighting Vehicles	Fast Spread of Fire

Source: Field work (2017).

4.5 Passive Fire Prevention and Protection Measures Adopted in Markets in the Federal Capital Territory of Nigeria

Passive protection and prevention measures against fire adopted in markets in the FCT of Nigeria were evaluated with regards to the site plans and floor plans. They were also evaluated with regards to the design of columns and beams, stair cases and ramps,

walls, doors and windows, ceilings, roof members, building fascia, finishes and other fire control measures.

4.5.1 Passive protection and prevention measures against fire with regards to the site plans in the markets

Passive protection and prevention measures against fire were evaluated with regards to the site plans in Wuse market, Garki model market and Kado market. Table 4.7 shows the distribution of the problems associated with site plans, and their number of observations; common locations in the markets. Moreover, it reveals that the three markets have equal number of items of the problems associated with site plans. The problems associated with the site plan in Wuse market are common in the old section of the market, while they are common in both formal and informal section of Garki model market. They are mostly common in the eastern part of Kado market.

Table 4.7: Distribution of the problems associated with site plans in the markets.

S/N	Market	Problem of Site Plans	Number of Observations / Common Location
1	Wuse Market	Lock-up Shop Buildings are too Close	8 Locations in the Old Section
		Width of Access Road and its Turning Radiu are not Adequate	1 Location in the Southern Part of the Old Section
		Length of the Road before the Turn Around Facility Exceeds 450 Metres	1 Location in the Central and Western Parts of the Old Section
2	Garki Model Market	Presence of Canal	1 Location between the Formal and Informal Sections
		No First Aid Centre for the Fire Victims	The Whole Market
		Inadequate Fire Exit Gates and Lack of Special Entrance Gate for the Firefighting Vehicles	The Whole Market
3	Kado Market	No Tarred Access Road for Proper Maneuvering of the Fire Fighting Vehicles	1 Location in the Western Part
		Walls of two Buildings are Joint together with Folded Roof Appearance	2 Buildings in the Eastern Part
		Erection of Structures Close to the Fire Exit Gate	2 Structures in the Eastern Part

Source: Field work (2017).

4.5.1.1 Passive protection and prevention measures against fire with regards to the site plan in Wuse market

According to scholars such as Building Regulations (BRE), Communities and Local Government (CLG) and World Health Organisation (WHO), sufficient spaces should be provided between the buildings to allow firefighting appliances to approach them; the distance between the buildings is obviously an important factor to consider (BRE, 2016; CLG, 2011; Neufert and Neufert, 2000; WHO, 2014). However, it was observed that in eight locations in the old section of Wuse market, the lock-up shop buildings are too close to each other.

The spaces between the buildings range from two metres to three metres and these cannot allow firefighting vehicles to pass or properly pass through the spaces between the buildings to fight fires in case of fire outbreaks because, according to Neufert and Neufert (2000), the width of the firefighting vehicle (truck) is 2.5 metres. Similarly, the International Association of Fire Chiefs and Fire Apparatus Manufacturers Association (IAFCFAMA) stated that the minimum width and the maximum width of the firefighting vehicles are 2.45 metres and 2.5 metres respectivey (IAFCFAMA, 2018). Moreover, Association for Specialist Fire Protection (ASFP) and London Fire Brigade (LFB) stated that these inadequate spaces between buildings can lead to easy fire spread from buildings to buildings when fire breaks out in the market (ASFP, 2004; LFB, 2015). Plate XLII shows the space between the shop buildings in Wuse market.

Plate XLII: Space between the lock-up shop buildings in the part of the centre of Wuse market old section. Source: Field work (2017).

From Table 5.2 of the BRE (2006), the minimum turning circle for the pump firefighting appliances within the kerbs of a turning facility should be 16.8 metres. This mathematically implies that the minimum inner turning radius for the pump firefighting appliances within the kerbs of a turning facility should be 8.4 metres. Appendix I shows page 124 of the BRE (2006) revealing Table 5.2. Similarly, New Zealand Fire Service (NZFS) stated that a minimum of 6.3 metres inside turning radius and 11.3 metres outside turning radius should be provided for the general fire appliance access (NZFS, 2015). However, it was noticed that in the southern part of the old section of Wuse market, the inner turning radius of the access road is not more than 4.5 metres; this is not adequate for the proper maneuvering of the firefighting vehicles.

Likewise, in the southern part of the market, the width of the road is not more than 4.5 metres; by considering the width of the road and firefighting truck, there is insufficient allowance for the firefighting truck to properly maneuver, especially with the presence of other cars or firefighting trucks on the same road. Moreover, in the central and western parts of the old section of the market, access roads were designed such that the length of roads before the turn-around facilities exceeds 450 metres. As a result of this problem, a good circulation design is lacking and therefore, the buildings are not well approachable by the firefighting vehicles. Contrary to this immediate statement, scholars like International Code Council (ICC) stated that the length of road must not exceed 228.6 metres without a turn around facility, otherwise, a special approval from the relevant authority should be required (AlSaeefan, 2014; ICC, 2006). Clarington Planning Services Department (CPSD) added that the turn around facility should even be established at any dead end portion of the access road that exceeds 90 metres (CPSD, 2017).

4.5.1.2 Passive protection and prevention measures against fire with regards to the the site plan in Garki model market

Buildings should be approachable for the firefighting vehicles in case of fire outbreaks (CLG, 2011; Neufert and Neufert, 2000; WHO, 2014). However, a canal of three metres wide was constructed in Garki model market and it divided the market into formal (lock-up shops) and informal (open stalls) sections. There are no bridges that can allow the firefighting vehicles to move from the formal part (section) to the informal part to quench fire in case of outbreak of fire. Apart from the gates at the formal section, there is no any other gate to lead people or firefighting vehicles to the

informal section of the market. Plate XLIII shows a canal in Garki model market. Additionally, the discussion with the staff of the company that manages Garki model market showed that “there is no first aid centre in the market where people that may become victims of fire outbreaks can receive immediate medical treatments before they can be transferred to the hospital”.

Plate XLIII: Canal in-between the formal and informal sections of Garki model market. Source: Field work (2017).

From the interview questions given to the Federal Fire Service of Nigeria (FFSN), the Fire Service is averagely satisfied with the design of Garki model market with respect to the fire exit gates because of the available numbers of the fire exit gates and the absence of fire exit signs to direct people to them. Apart from the main entrance gate which is 4.5 metres wide in the formal section, two other exit gates were observed. The first exit gate is for both pedestrian and vehicular exits which is 4.5 metres wide in the

formal section of the market; this is adequately wide to permit many people to have access through it at the same time when there are fire outbreaks.

The second exit gate is locked up with a pad lock and it is only for pedestrian exits which is two metres wide in the formal section of the market; this is not adequately wide to permit many people to have access through it at the same time when there are fire outbreaks. Contrary to this immediate statement, Northwest Fire District (NFD) stated that the least acceptable overall width of the gate opening should be 6.0 metres for fire safety purpose (NFD, 2017). Similarly, City of Vista Fire Department (CVFD) revealed that the exit gates should have a minimum 7.2 metres clear opening for a dual traffic direction (CVFD, 2012). In addition, Tamil Nadu Urban Development (TNUD) stated that an exit gate of a minimum width of 3.5 metres is permitted for a single traffic direction (TNUD, 2010).

Thus, the design of Garki model market is considered unsatisfactory with respect to the fire exit gates in relation to the market size in terms of the facility numbers (1,430 trading points). Plate XLIV shows a pedestrian exit gate in Garki model market. Moreover, it was noticed that in the whole market, there is no special entrance gate to allow proper in and out of the firefighting vehicles, in order to reduce the obstructions from other vehicles when the firefighting vehicles are approaching the market in times of fire outbreaks.

Plate XLIV: Pedestrian exit gate in the formal section of Garki model market
Source: Field work (2017).

4.5.1.3 Passive protection and prevention measures against fire with regards to the site plan in Kado market

According to California Fire Code (CFC), International Code Council (ICC) and Metropolitan Fire Brigade (MFB), buildings or facilities shall be accessible by the firefighting apparatus via way of an approved access road for fire apparatus with an approved driving surface such as concrete, asphalt and tar capable of giving support to the imposed load of the apparatus for fighting fire (CFC, 2009; ICC, 2007; MFB, 2014). However, it was observed that in the western part of Kado market, the access road is not surfaced with an asphalt or tar, in order to support the imposed load of the firefighting apparatus; also, to enhance proper movement and maneuvering of firefighting vehicles when there are fire outbreaks in the market. In this case, proper

movement and maneuvering of the firefighting vehicles can be hindered by mud during the raining season.

In addition, Association for Specialist Fire Protection (ASFP) and London Fire Brigade (LFB) stated that inadequate spaces between buildings can lead to easy fire spread from buildings to buildings when it breaks out (ASFP, 2004; LFB, 2015). However, it was seen that two buildings in the eastern part of the market were designed such that their walls are joint together with inadequate spaces between them, and thereby making their roofs to appear like folded type of roof. In this case, when there are outbreaks of fire within one building, the transfer of fire from affected building to the second building is absolutely inevitable. Plate XLV shows the joint buildings in Kado market.

Plate XLV: Joint buildings in the eastern part of Kado market
Source: Field work (2017).

Also, it was observed that two structures were erected close to the fire exit gate in the eastern part of the market and this brought about inadequate space for the assembling point of people at the gate in case of fire emergency. When there is fire outbreak in the market, the exit gate will be over crowded by the people that are under the escape of the risk of fire. Plate XLVI shows the erected structures that are close to the exit gate in Kado market.

Plate XLVI: Erected structures that are close to the exit gate in the eastern part of Kado market. Source: Field work (2017).

4.5.2 Passive protection and prevention measures against fire with regards to the floor plans in the markets

Passive protection and prevention measures against fire were evaluated with regards to the associated problems of floor plans in Wuse market and Garki model market. The problems associated with the floor plans in Garki model market is similar to the ones in Kado market. Table 4.8 indicates the problem distributions associated with floor plans,

and the observation numbers; their common locations in the markets. It indicates that Wuse market has the highest number of items of the problems associated with floor plans. It also indicates that the problems associated with floor plans are common in the southern part of the old section; northern and western parts of the new section of Wuse market; they are common in the southern part of the formal section of Garki model market.

Table 4.8: Distribution of the problems associated with floor plans in the markets.

S/N	Market	Problem of Floor Plans	Number of Observations / Common Location
1	Wuse Market	Floor Levels of the Primary and Secondary Evacuation Routes are not Uniform	2 Locations in the Administrative Building in the Southern Part of the Old Section
		Incorporation of Concrete steps on the Corridors of Lock-up Shop Storey Buildings	2 Buildings in the Western Part of the New Section
		No Places of Refuge on the Floors	The Whole Buildings in the Market
		Floor Plans Exceed two Numbers	2 Buildings in the Northern Part of the New Section
2	Garki Model Market	Lack of Smoke Vents in Buildings	The Whole Market
		Improper Evacuation Route	1 Location in the Administrative Building in the Southern Part of the Formal Section

Source: Field work (2017).

4.5.2.1 Passive protection and prevention measures against fire with regards to the floor plans in Wuse market

It was observed that the floor levels of the primary and secondary evacuation routes of the administrative building in the southern part of the old section of Wuse market are not uniform. Similarly, the corridors of two lock-up shop storey buildings in the western part of the new section of the market were not uniformly designed. Concrete steps were incorporated into the design of two lock-up shop storey buildings along the corridors due to the undulated nature of terrain of the ground and these have made the corridors to look like concrete stairways. In this case, the probability of accidents when people who are at the risk of fires are escaping is very high. Plate XLVII shows the concrete steps along the first floor corridor of a lock-up shop storey building in Wuse market.

Plate XLVII: Concrete steps along the first floor corridor of a lock-up shop storey building in the new section western part of Wuse market. Source: Field work (2017).

In addition, it was noticed that all the buildings in both the new and old sections of the market have no provisions on the floors to indicate the position of place of refuge (meeting place of people before they can be evacuated). It was also noticed that floors of two buildings in the northern part of the new section of the market exceed two numbers. This means that they are two storey buildings, and they can increase the rate at which fire spreads within building verticality and from buildings to adjacent buildings.

4.5.2.2 Passive protection and prevention measures against fire with regards to the floor plans in Garki model market

It was observed that smoke vents were not incorporated into the floor design of all the buildings in Garki model market; these can lead to the death of people due to suffocation during fire outbreaks. Moreover, the design of the evacuation routes was not properly considered in the administrative building in the southern part of the market. A long primary evacuation route of 1.0 metre wide was incorporated into the design of the administrative building without incorporating secondary evacuation routes in case of fire outbreak that may start from the entrance of the primary evacuation route. In cases like this, if there is severe outbreak of fire at the entrance of the primary evacuation route, all the people in the administrative building will be trapped by fire at the same time.

In addition, the long primary evacuation route has no self-closing fire door for smoke control in case of outbreak of fire; the width of primary evacuation route of the administrative building of the market cannot allow two people who are at the risk of

fire to escape conveniently at the same time. This is because, according to Neufert and Neufert (2000), a minimum width of 1.3 metres to 1.4 metres of a corridor is needed to allow two people to pass one another unhindered in a building, while the Building Regulations (BRE) stated that a minimum width of 1.2 metres of a corridor is needed to allow two people to conveniently pass each other in a building (BRE, 2009). Similarly, Scottish Government Policy on Building Standards (SGPBS) stated that all the corridors should have an unobstructed width of at least 1.2 metres wide, and it is the minimum width for fire escape (SGPBS, 2017).

4.5.3 Passive protection and prevention measures against fire with regards to the design of columns and beams in the markets

It was noticed that non-combustible metal tiles or concrete tiles were not applied on the columns and beams to resist the spread of fires within the buildings in Wuse market. Also, they were not applied on the columns and beams to resist the spread of fires within the buildings in Garki model market and Kado market.

4.5.4 Passive protection and prevention measures against fire with regards to the design of stair cases and ramps in the markets

Wuse market is the only market in the study area where storey buildings were built as lock-up shops. There are no storey buildings in Garki model market and Kado market. Thus, passive protection and prevention measures against fire were evaluated with regards to the design of stair cases and ramps in Wuse market.

4.5.4.1 Passive protection and prevention measures against fire with regards to the design of stair cases and ramps in Wuse market

It was observed that in the northern part of the new section of Wuse market, there is a lock-up shop building of two storeys with the length of 52 metres having only two stair cases without a single ramp for the disabled people to easily use in case of fire outbreaks. Also, there are two lock-up shop buildings of one storey in the western part of the new section that have only one stair case, and one ramp. Considering the lock-up shop storey buildings with only one ramp, when there are fire outbreaks along the ramp and there are spreading to the other parts of the buildings, all the disabled people at the upper floor will be trapped by fires. In addition, by considering the storey buildings and this type of big market with high influx of the population of people, the number of the stair cases and ramps are not adequate and therefore, the escape of people along the path of upper floors and ground floors is not sufficient in times of fire outbreaks. Moreover, no provisions were made for fire emergency escape stair cases and ramps in the whole new section of the market.

It was noticed that the stairwell of the lock-up shop storey building in the western part of the new section of the market is not well lit naturally. Also, there are insufficient landing spaces in the stairwells of two lock-up shop storey buildings in the northern part of the new section of the market. According to Buildings Department (BDE), Colorado Residential Stair Guide (CRSG) and Stair Building Code (SBC), the vertical length (depth) of a stair landing should not be below the width of the required stair flight (BDE, 2011; CRSG, 2012; SBC, 2006). However, sufficient spaces for the width of the flights of the stairwells of 1.8 metres to 2.1 metres were provided in the design of

the lock-up shop storey buildings but the vertical length (depth) of the stairwell landing spaces of two storey buildings are 1.2 metres and 1.5 metres. These imply that the depth of the landing spaces are not up to the width of each stair flight. Therefore, they are considered not adequate enough for the escape of many people in times of fire outbreaks. Adequate spaces for landing is very important to accommodate many people when they are escaping in times of fire outbreaks. Plate XLVIII shows an insufficient landing space in Wuse market.

Plate XLVIII: Insufficient landing space in the northern part of the new section of Wuse market. Source: Field work (2017).

The United Kingdom Department for Families, Children and Schools (UKDFCS) stated that the preferred standard vertical width (depth) of the treads of a stair should be 0.3 metre and the preferred standard height of the risers of a stair should be 0.15 metre (UKDFCS, 2008). Similarly, it was stated by the National Building Code of India (NBCI) that the minimum depth of the tread without a nosing is 0.3 metre and the

maximum height of riser is 0.15 metre for designing building for safety of fire (NBCI, 2016). In addition, the West Bengal Building Regulations (WBBR) stated that the minimum permissible width of treads without a nosing should be 0.3 metre and the maximum permissible height of risers should be 0.15 metre for commercial buildings (WBBR, 2016).

However, in the new section western part of the market, the vertical width (depth) of the treads of the stairwells of two buildings range from 0.25 metre to 0.3 metre and the height of the risers of the stairwells of the same buildings range from 0.15 metre to 0.175 metre. This means that there are treads in the market buildings that their depths are not up to 0.3 metre; also, there are risers in the market buildings that exceed the height of 0.15 metre. Therefore, there are considered not appropriate enough for the escape of people in times of fire outbreaks. It is very important that the feet of all the people who are under the escape of the risk of fire are properly fit into the treads; also, it is not good for people to exceedingly raise their legs while escaping through the stairwells in times of fire outbreaks to avoid any possible accident.

Moreover, it was noticed that smoke vents were not incorporated into the design of the ramp wells and staircases of all the storey buildings in the whole new section of the market. Table 4.9 indicates the problem distribution associated with the design of staircases and ramps, and the observation numbers; their common locations in Wuse market. It reveals that the associated problems of the design of staircases and ramps exist only in the new section of the market where there are lock-up shop storey buildings.

Table 4.9: Distribution of the problems associated with the design of stair cases and ramps in Wuse market.

S/N	Problem of Stair Cases and Ramps	Number of Observations / Common Location
1	There is a Lock-up Shop Building of Two Storeys without a Single Ramp for the Disabled People to Use as Escape	1 Building in the Northern Part of the New Section
2	Inadequate Number of Stair Cases and Ramps for Escape	All the Buildings in the Whole New Section
3	Lack of Fire Emergency Escape Stair Cases and Ramps	All the Buildings in the Whole New Section
4	Inadequate Natural Lighting in the Stairwell of the Lock-up Shop Storey Building	1 Building in the Western Part of the New Section
5	Insufficient Landing Spaces in the Stairwells of the Lock-up Shop Storey Buildings	2 Buildings in the Northern Part of the New Section
6	Inappropriate Treads and Risers of the Stairwells for the Escape of People	2 Buildings in the Western Part of the New Section
7	Lack of Smoke Vent in the Design of the Rampwells and Stair Cases	All the Storey Buildings in the Whole New Section

Source: Field work (2017).

4.5.5 Passive protection and prevention measures against fire with regards to the design of walls in the markets

International Building Code (IBC), Quizlet Incorporation (QIN) and other scholars revealed that walls of buildings that are made up of sandcrete blocks can crack under the influence of fire especially when they contain embedded conduits and there is a possibility of fire spread (Dunn, 1996; IBC, 2006; Neufert and Neufert 2000; QIN, 2017). However, it was seen in the central part of the old section of Wuse market that walls of 10 buildings are made up of sandcrete blocks. In this case, sandcrete block walls do not have high fire resistance and there is a possibility of the spread of fire when there is fire outbreak. Plate XLIX shows the buildings that are made up of sandcrete blocks in Wuse market.

Plate XLIX: Buildings that are made up of sandcrete blocks in the central part of the old section of Wuse market. Source: Field work (2017).

It was also observed that walls of four buildings in the southern and eastern parts of the old section of Wuse market are made up of bricks. The walls of all the buildings in the new section of Wuse market are also made up of bricks; in this case, these walls have high fire resistance and there is little possibility of fire spread because bricks are very resistant to fire. Plate L shows the two storey buildings that are made up of burnt bricks in Wuse market. Likewise, it was observed that there is no wall in Garki model market and Kado market that is made up of bricks. This means that all the walls of buildings in Garki model market and Kado market are made up of sandcrete blocks; these are not adequately resistant to fire.

Plate L: Two storey buildings that are made up of burnt bricks in the central part of the new section of Wuse market. Source: Field work (2017).

Table 4.10 indicates the problem distributions associated with the design of walls, and the observation numbers; their common locations in the markets. It reveals that the associated problems of the design of walls are common in the whole new section; the

southern part of the old section, eastern and central parts of Wuse market. They are common in the whole Garki model market and Kado market.

Table 4.10: Distribution of the problems associated with the design of walls in the markets.

S/N	Market	Problem of Wall Designs	Number of Observations / Common Location
1	Wuse Market	Walls of Buildings are made up of Sandcrete Blocks	10 Buildings in the Central Part of the Old Section
2	Garki Model Market	Walls of Buildings are made up of Sandcrete Blocks	All the Buildings in the Whole Market
3	Kado Market	Walls of Buildings are made up of Sandcrete Blocks	All the Buildings in the Whole Market

Source: Field work (2017).

4.5.6 Passive protection and prevention measures against fire with regards to the design of doors and windows in the markets

Passive protection and prevention measures against fire were evaluated with regards to the associated problems of the design of doors and windows in Wuse market, Garki model market and Kado market. Table 4.11 indicates the problem distributions associated with the design of doors and windows, and the observation numbers; their common locations in the markets. It indicates that Kado market has the highest number of items of the problems associated with the design of doors and windows, and followed by Garki model market. Wuse market has the lowest number of the problem associated with the design of doors and windows. It also shows that the associated

problems of the design of windows are common in the central part of the old section of Wuse market; the problems associated with door and window designs are common in the administrative building in the southern part of Garki model market. They are common in the eastern and central parts of Kado market.

Table 4.11: Distribution of the problems associated with the design of doors and windows in the markets.

S/N	Market	Problem of Door and Window Designs	Number of Observations / Common Location
1	Wuse Market	Lock-up Shop Buildings without Windows	5 Buildings in the Central Part of the Old Section
2	Garki Model Market	Inadequate Width of External Door	1 Location in the Administrative Building in the Southern Part
		The Primary Evacuation Route has no Window for Natural Lighting to Aid Proper Escape of People	1 Location in the Administrative Building in the Southern Part
3	Kado Market	Use of Non-fire Resistant Wooden Frames/Shutters for Doors and Windows	2 Store Buildings in the Eastern Part
		Lack of Fire Exit Doors	The Whole Administrative Building in the Central Part; 2 Cold Room Buildings in the Eastern Part
		The Entrance Doors open internally	1 Location in the Administrative Building in the Central Part and 2 Store Buildings in the Eastern Part

Source: Field work (2017).

4.5.6.1 Passive protection and prevention measures against fire with regards to the design of doors and windows in Wuse market

Scholars like Health and Safety Executive (HSE) stated that the use of steel in building design is a good practice against fires (Buxton, 2011; HSE, 2010; Merritt and Ricketts, 2001; Neufert and Neufert, 2000; Wald *et al.*, 2009). It was seen that the majority of lock-up shops in both new and old sections of Wuse market have steel doors. It was observed that there are five lock-up shop buildings in the central part of the old section of the market with no windows but most of the lock-up shop buildings with windows are steel type. Also, it was noticed that lack of windows in the lock-up shop buildings for cross ventilation encourages indiscriminate use of electric power generators in the market, in order to operate fans for heat control; indiscriminate use of electric power generators in the market causes fire outbreaks.

4.5.6.2 Passive protection and prevention measures against fire with regards to the design of doors and windows in Garki model market

It was observed that an external door of 0.9 metre wide was incorporated into the design of the administrative building of Garki model market at the entrance of the primary evacuation route in the southern part of the market. This width of the external door is not wide enough for two people who are at the risk of fire to conveniently escape through it at the same time (BRE, 2009; ICC, 2013; Neufert and Neufert, 2000). Apart from the entrance door, the primary evacuation route of the administrative building of the market has no window opening or any other opening for natural lighting to aid proper escape of people in case of fire outbreak.

4.5.6.3 Passive protection and prevention measures against fire with regards to the design of doors and windows in Kado market

National Fire Academy (NFA) and other scholars revealed that combustibility of building materials is a prime factor to consider when designing buildings against fires (NFA, 2000; Sikazwe, 2015; Tan, 2007). Also, Civil Engineering Home (CEH) and other scholars revealed that non-fire resistant wood can easily burn and increase the rate of spread of fire when there is fire outbreak in buildings (Chen *et al.,* 2015; CEH, 2017; Iwami *et al.,* 2004). However, the use of non-fire resistant wooden frames/shutters for doors and windows in two store buildings in the eastern part of Kado market was seen. These are common where there are non-fire resistant wooden attachments to buildings. Plate LI shows a non-fire resistant wooden door of a store building in Kado market.

Plate LI: Non-fire resistant wooden door of a store building in the eastern part of Kado market. Source: Field work (2017).

In addition, it was noticed that fire exit doors were not incorporated into the design of the administrative building in the central part of the market, and two cold room buildings in the eastern part of the market that were revealed to be prone to fire outbreaks by the sales people who were members of the focus group discussions. Also, the entrance doors of the administrative building in the central part of the market, and two store buildings in the eastern part of the market open internally instead of opening externally to ease proper escape of people in times of fire outbreaks.

4.5.7 Passive protection and prevention measures against fire with regards to the design of ceilings in the markets

Passive protection and prevention measures against fire were evaluated with regards to the associated problems of the design of ceilings in Wuse market and Garki model market. The ceiling design in Garki model market is similar to the ceiling design in Kado market. Table 4.12 indicates the problem distributions associated with the design of ceilings, and the number of observations; their common locations in the markets. Aditionally, it indicates that the associated problems of the ceiling design in Wuse market are common in the central part of the old section of the market; they are common in the formal section of Garki model market.

Table 4.12: Distribution of the problems associated with the design of ceilings in the markets.

S/N	Market	Problem of Ceiling Designs	Number of Observations / Common Location
1	Wuse Market	Ceilings are Non-fire Resistant Wooden Type	2 Lock-up Shops in the Central Part of the Old Section
2	Garki Model Market	Ceilings are Non-fire Resistant Asbestos Type	73 Lock-up Shops in the Formal Section

Source: Field work (2017).

4.5.7.1 Passive protection and prevention measures against fire with regards to the design of ceilings in Wuse market

It was observed that two of the lock-up shops in the central part of the old section of the market are made up of non-fire resistant wooden ceilings. Plate LII shows a non-fire resistant wooden ceiling in a lock-up shop in Wuse market.

Plate LII: Non-fire resistant wooden ceiling in a lock-up shop in the central part of Wuse market. Source: Field work (2017).

4.5.7.2 Passive protection and prevention measures against fire with regards to the design of ceilings in Garki model market

It was noticed that 73 lock-up shops in the formal section of Garki model market are made up of non-fire resistant asbestos ceiling boards; these can easily burn and increase the rate of spread of fire when there is fire outbreak. Plate LIII shows a non-fire resistant asbestos ceiling board in a provision shop in Garki model market.

Plate LIII: Non-fire resistant asbestos ceiling board in a provision shop in the central part of the formal section of Garki model market. Source: Field work (2017).

4.5.8 Passive protection and prevention measures against fire with regards to the design of roof members in the markets

Passive protection and prevention measures against fire were evaluated with regards to the associated problems of the design of roof members in Wuse market, Garki model market and Kado market. Table 4.13 reveals the distribution of problems associated with the design of roof members, and their number of observations; common locations in the markets. Moreover, it indicates that Garki model market has the highest number of items of the problems associated with the design of roof members, and followed by Wuse market; Kado market has the lowest number of item of the problem. Table 4.13 also shows that the problems associated with the design of roof members are common in the northern part of the old section of Wuse market market, while they are common

in both formal and informal sections of Garki model market. The problem is common in the central part of Kado market.

Table 4.13: Distribution of the problems associated with the design of roof members in the markets.

S/N	Market	Problem of Roof Members	Number of Observations / Common Location
1	Wuse Market	No Wall Barriers Against the Spread of Fires on the Middles of the Roofs	All the Buildings in the Whole Market
		The Roof of the Illegal Shop Building is Made Up of Non-fire Resistant Zinc and Tarpaulin Roof Coverings	1 Building in the Northern Part of the Old Section
2	Garki Model Market	Roof Eaves are Very Close and Almost Touching Each Other	10 Stall Buildings in the Informal Section
		The Roof Coverings of Buildings are Non-fire Resistant Asbestos Roofing Sheets	All the Buildings in the Formal Section
		The Roof Coverings of Buildings are Non-fire Resistant Aluminium Roofing Sheets	All the Buildings in the Informal Section
3	Kado Market	Roof Structural Members of the Open Stall are Non-fire Resistant Wooden Type	1 Stall Building in the Central Part

Source: Field work (2017).

4.5.8.1 Passive protection and prevention measures against fire with regards to the design of roof members in Wuse market

According to Nebosh Fire Certificate (NFC) and Ohio Building Code (OBC), the fire spread from buildings to buildings can be stopped by the roof fire resistant qualities and they must give a fire barrier and resist the flame surface spread (NFC, 2013; OBC, 2016). However, it was noticed that all the roofs of buildings in the whole market were not designed against the spread of fires. The roofs of buildings are long without the extension of walls on the middles and beyond the total heights of roofs to serve as the barriers to the spread of fires at specified lengths. This means that there are no extension of walls on the middles and beyond the total heights of the roofs to serve as breakers of the spread of fires for buildings. Plate LIV shows a long gable roof without wall barriers against the spread of fires in Wuse market.

Plate LIV: Long gable roof without wall barriers against the spread of fires in the central part of Wuse market. Source: Field work (2017).

According to Fire Centre (FCE) and other scholars, examples of the roofing sheet that have high fire resistance are: clay roof tiles, concrete roof tiles and profiled metal sheet (FCE, 2017; Fricklas, 2015; Neufert and Neufert 2000). However, the roof of an illegal shop building in the northern part of the old section of the market is made up of zinc and tarpaulin roof coverings. These roof covering materials do not have high fire resistance. Plate XX also shows an erection of an illegal shop with zinc and tarpaulin roof coverings in the northern part of the old section of Wuse market.

4.5.8.2 Passive protection and prevention measures against fire with regards to the design of roof members in Garki model market

It was noticed that all the roofs of buildings in the whole Garki model market were absolutely not designed against fires. The distance that exits in between buildings or between the boundary and building is obviously a crucial factor to consider as it is the severity of the outbreaks of fire that are ascertained via the fire loads of buildings (BRE, 2016; Neufert and Neufert, 2000). However, the roof eaves of 10 stall buildings in the informal section of the market are very close and almost touching each other. These can lead to easy spread of fire when there is fire outbreak. Plate LV shows the closeness of the roofs in Garki model market.

Plate LV: Closeness of the roofs in the eastern part of the informal section of Garki model market. Source: Field work (2017).

The roof coverings of all the buildings in the formal section of the market are non-fire resistant asbestos roofing sheets; this means that the roofing sheets have no high fire resistance. In addition, the roof coverings of all the buildings in the informal section of the market are corrugated aluminium roofing sheets; these roofing sheets have no high fire resistance. Plates LVI and LVII show a building with non-fire resistant asbestos roofing sheets, and buildings with non-fire resistant aluminium roofing sheets in Garki model market.

Plate LVI: Building with non-fire resistant asbestos roofing sheets in the southern part of the formal section of Garki model market. Source: Field work (2017).

Plate LVII: Buildings with non-fire resistant aluminium roofing sheets in the eastern part of the informal section of Garki model market. Source: Field work (2017).

4.5.8.3 Passive protection and prevention measures against fire with regards to the design of roof members in Kado market

According to Building and Construction Authority (BCA) and other scholars, building materials for designing buildings against fire outbreaks should be able to resist surface flame spread (BCA, 2017; Neufert and Neufert, 2000; Quarles, 2013). However, it was observed that the roof structural members of an open stall in the central part of the market are non-fire resistant wooden type. These can increase the rate of fire spread in the event of outbreak of fire. Plate LVIII shows a non-fire resistant wooden structural members of the roof of an open stall in Kado market.

Plate LVIII: Non-fire resistant wooden structural members of the roof of an open stall in the central part of Kado market. Source: Field work (2017).

4.5.9 Passive protection and prevention measures against fire with regards to the design of building fascia in the markets

Passive protection and prevention measures against the outbreaks of fire were evaluated with regards to the associated problems of the design of building fascia in Wuse market and Garki model market. The design of building fascia in Wuse market is similar to the design of building fascia in Kado market. Table 4.14 indicates the problem distributions associated with the design of building fascia, and the number observations; their common locations in the markets. Additionally, it reveals that the associated problems of the design of building fascia in Wuse market are common in the central part of the old section of the market; they are common in both formal and informal sections of Garki model market.

Table 4.14: Distribution of the problems associated with the design of building fascia in the markets.

S/N	Market	Problem of Building Fascia	Number of Observations / common location
1	Wuse Market	Lock-up Shop Buildings are Made up of Non-fire Resistant Wooden Fascia	2 Buildings in the Central Part of the Old Section
2	Garki Model Market	The Building Fascia are Ordinary Aluminium Type	18 Buildings in the Formal and Informal Sections

Source: Field work (2017).

4.5.9.1 Passive protection and prevention measures against fire with regards to the design of building fascia in Wuse market

It was observed that two lock-up shop buildings in the central part of the old section of Wuse market are made up of non-fire resistant wooden fascia; these can easily burn and increase the rate of spread of fire when there is fire outbreak. Plate LIX shows a non-fire resistant wooden fascia of a lock-up shop building in Wuse market.

Plate LIX: Non-fire resistant wooden fascia of a lock-up shop building in the central part of the old section of Wuse market (source: field work, 2017).

4.5.9.2 Passive protection and prevention measures against fire with regards to the design of building fascia in Garki model market

It was seen that the fascia of 18 buildings in the formal and informal sections of Garki model market are ordinary aluminium type. Ordinary aluminium building fascia is not resistant to fires. Plate LX shows a non-fire resistant aluminium fascia of a lock-up shop building in Garki model market.

Plate LX: Non-fire resistant aluminium fascia of a lock-up shop building in the formal section of Garki model market. Source: Field work (2017).

4.5.10 Passive protection and prevention measures against fire with regards to the finishes of buildings in the markets

All the paints on the walls of buildings in Wuse market, Garki model market and Kado market are not resistant to fire. It was observed that the paints on the walls of four buildings in the central and eastern parts of the old section of Wuse market are already peeling and they are not resistant to fire. In addition, it was seen in Kado market that the floor finishes of buildings were not adequately designed against fire outbreaks. The use of concrete floor tiles or non-combustible metal floor tiles was not found in any part of the market to resist the spread of fires within the buildings.

4.5.11 Passive protection and prevention with regards to other fire control measures in the markets

Passive prevention and protection against fire were evaluated with regards to the problems associated with other fire control measures in Wuse market, Garki model market and Kado market. Table 4.15 reveals the distribution of other control measures for fire and their associated issues; common locations in the markets. It also reveals that Wuse market has the highest number of the issues associated with other fire control measures, and followed by Kado market. Garki model market has the lowest number of the issue associated with other fire control measures.

Moreover, Table 4.15 shows that the location of training of the sales people on the protection and prevention measures against fire is the open area in the southern part of Wuse market. The location of training of the sales people on protection and prevention measures against fire is the open area in the southern part of Garki model market, while the location of training of the sales people on protection and prevention measures against fire is the open area in the western part of Kado market.

Table 4.15: Distribution of other fire control measures and their associated issues in the markets.

S/N	Market	Interval of Training on Fire Prevention and Protection Measures; Related Issue	Common Location
1	Wuse Market	The Training of the Sales People by the FFSN is Every Five to Eleven Months	Open Area in the Southern Part
		The Training of the Sales People by the NANT is About Every Four Months	Open Area in the Southern Part
		The Training of the Sales People by the Managing Company of the Market is Every One to Two Years	Open Area in the Southern Part
		Most of the Sales People are not Responding to Calls for Training	The Whole Market
2	Garki Model Market	The Training of the Sales People by the Managing Company of the Market is Every Five to Eleven Months	Open Area in the Southern Part
3	Kado Market	The Training of the Sales People by the Managing Company of the Market is Every One to Two Years	Open Area in the Western Part
		After the Training on How to Use Fire Protection Devices, Some Market Traders Will not be Able to Use them After a While	The Whole Market

Source: Field work (2017).

4.5.11.1 Passive protection and prevention with regards to other fire control measures in Wuse market

The interview questions given to the Federal Fire Service of Nigeria (FFSN) revealed that the FFSN organises training for the sales people in Wuse market every five to eleven months on how to prevent fire outbreaks and how to use fire protection devices. It organises fire prevention and awareness campaign and engages in the fire risk assessment in Wuse market. The interview questions administered to the National Association of Nigerian Traders (NANT) showed that the training of the sales people on how to use fire protection devices is about every four months in Wuse market and the sales people were able to operate them during the training. The interview questions given to the managing company of Wuse market indicated that training of the sales people with regards to the use firefighting devices is every one to two years.

The discussions with the sales people in the market revealed that “the venue for training on the protection and prevention measures against fire is at the open area in the southern part of the market”. In view of all these training intervals for the sales people in Wuse market, they are considered adequate but the discussions with the sales people in the market revealed that the majority of them in the whole market are not respondings to calls for the training with regards to the use of firefighting devices as a result of non-availability of functional firefighting devices in the market to encourage them to participate in the training.

4.5.11.2 Passive protection and prevention with regards to other fire control measures in Garki model market

The interview questions administered to the company that manages Garki model market showed that the training of the sales people with respect to the use of firefighting equipment is every five to eleven months and sales people were able to operate them during the training but the discussion made with the staff of the market managing company revealed that the majority of sales people hardly respond to calls for drills, and this is a challenge for them. The discussion with the sales people showed that “the venue for the training on protection and prevention measures against fire is at the open area in the southern part of the market”. In view of this training interval for the sales people in Garki model market, it is considered adequate. The interview questions given to the market managing company indicated that crowd control when putting out fires is a problem resulting from dealing with fire outbreaks.

4.5.11.3 Passive protection and prevention with regards to other fire control measures in Kado market

The interview questions given to the Kado market managing company indicated that the training for the sales people with regards to the use firefighting devices is every one to two years and sales people were able to operate them during the trainings. How ever, the focus group discussion conducted with the market traders revealed that after the training on how to make use of fire protection equipment, the sales people can operate them immediately but after a while or before the next training time, some market sales people will not be able to make use of them. This means that lack of constant practice on the use of fire protection devices by the sales people is traceable to this problem.

The focus group discussions made with the traders also indicated that “the venue for the training on protection and prevention measures against fire is at the open area in the western part of the market”.

4.6 Active Fire Protection Measures Adopted in Markets in the Federal Capital Territory of Nigeria

Protection measures against fire were actively evaluated with regards to the associated problems of the devices for fighting fire in Wuse market, Garki model market and Kado market. Table 4.16 indicates the issue distributions associated with the devices for fighting fire adopted in the markets with the observation numbers, and their common locations. Additionally, it indicates that Wuse market has the highest number of the issues associated with the firefighting equipment, and followed by Garki model market. Kado market has the lowest number of the issues associated with firefighting equipment. Moreover, it indicates that the associated issues of firefighting devices are common in the new and old sections of Wuse market; they are common in the central and southern parts of the formal section of Garki model market. They are common in the central part of Kado market.

Table 4.16: Distribution of the associated issues of fire fighting devices adopted in the markets.

S/N	Market	Issue Associated with Fire Figthing Equipment	Number of Observations / Common Location
1	Wuse Market	Fire Protection Devices are not Maintained Properly	The Whole Market
		Insufficient Equipment for Fighting Fire	The Whole Market
		Lack of Firefighting Equipment in the Entire Open Stalls and Lock-up Shops	The Whole Old Section
		The Fire Hose Reels are not in Good Condition	4 Numbers in the Western Part of the New Section
		Engagement of Substandard Extinguishers for Fire Cause Rapid Fire Spreads	The Whole Market
		Low Salaries of the Workers in Control of Extinguishers for Fire	The Whole Market
		No Front Verandahs or Corridors to Mount Extinguishers for Fire or other Wall Mountable Extinguishers for Fire	17 Buildings in the Eastern and Central Parts of the Old Section
		No Fire Warden Phone is Mounted on the Walls of Buildings	The Whole Market
2	Garki Model Market	Insufficient Number of Portable Fire Extinguishers	2 Numbers in the Central and Southern Parts of the Formal Section
		Insufficient Number of Fire Hose Reels and they are not in Good Condition	3 Numbers in the Central Part of the Formal Section
		The Primary Evacuation Route has no Emergency Lighting	1 Location in the Administrative Building in the Southern Part of the Formal Section
3	Kado Market	Inadequate Number of Portable Extinguisher for Fire	4 Numbers in the Central Part
		Inadequate Inspection Interval of Portable Fire Extinguishers	The Whole Market

Source: Field work (2017).

4.6.1 Active fire protection measures adopted in Wuse market

Devices for fighting fire are to be maintained frequently in an operable order. From the National Fire Protection Association (NFPA), devices for fighting fire should be maintained in not more than a year interval (NFPA, 1998). Fire Protec (FPR) and Marsden Fire Safety (MFS) further explained that the interval of visual inspection of devices for protecting fire should be on the basis of every month, and their main maintenance or service intervals should be on the basis of every year (FPR, 2016; MFS, 2018).

In contrast of these immediate statements with respects to the fire protection device maintenance intervals, the interview questions given to the Federal Fire Service of Nigeria (FFSN) showed that the devices for fire protection in Wuse market have improper maintenance. From the discussion made with the market management staff, their maintenance is only after use. This means that they do not receive maintenance at all, otherwise, there is an event of outbreak of fire that will cause their maintenance after application. Additionally, it means that if there is no outbreak of market fire for a long time like two or more years, they will never be maintained; this affirmed that the devices for protecting fire in Wuse market are not receiving proper maintenance as pointed out by the FFSN from the administered interview questions.

According to scholars like Access Intelligence (AIN), devices for protecting fire should be situated where their accessibilities can be achieved for immediate application to put out expected fires; a good market should be sufficiently protected against outbreaks of

fire, so as to save human lives, properties and goods (AIN, 2016; Leo, 2014; Oladokun and Emmanuel, 2014). Yet, it was observed that devices for protecting fire are not sufficient in Wuse market and thus, the market is not sufficiently protected against outbreak of fires. From the company that manages Wuse market, the old section of the market is made up of 500 open stalls and 1,365 lock-up shops. However, the lock-up shops and open stalls in the entire old section of the market lacks even a device for protecting fire as revealed by observation.

Fire hose reels are strategically situated at building areas to provide a good amount of accessible and controlled water supply for putting out fires (Grundfos, 2016). Still, it was observed that two buildings exist in the eastern and northern parts of the new section of the market with no single fire hose reel or other devices for protecting fire. However, there exist other two buildings in the market with attached fire hose reel at the ground level and first floor level as found in the western part of the new section but the focus group discussion made with the market traders indicated that “all the fire hose reels are not in good working order”. Plate LXI indicates a fire hose reel that is not functioning at the ground floor level of a shop building in Wuse market. Additionally, the discussion made with the Assistant Controller General of the FFSN showed that the application of extinguishers for fire that are not standard causes the fast fire spread in markets in Nigeria and it was mentioned that they were seen in Wuse market. This is attributed to the financial management issues that have resulted to ineffective active preparedness against market fire. Thus, application of standard extinguishers in the markets is important to prevent the fire growths at their initial stages.

Plate LXI: Non-functioning fire hose reel at the ground floor level of a shop building in the northern part of the new section of Wuse market. Source: Field work (2017).

The discussion made with the staff of the managing company of Wuse market showed that the managing company has extinguishers for fire; there exit an extinguisher (portable type) on the ground floor of entrance hall of the management office building in the southern part of the old section of the market. Also, a portable extinguisher for fire was seen at the entrance of security post in the southern part of the old section of the market, and another one was seen at the police station in the southern part of the old section of the market. Likewise, the discussion made with the staff of the management company of the market revealed that there exist a steel cage by the side of the building in the management office where four portable extinguishers for fire (wheel type) are kept. Hence, the total addition of the extinghishers for fire of the managing company of the market is seven. Plate LXII shows fire extinguishers (wheel type) in a steel cage beside the management office in Wuse market.

Plate LXII: Fire extinguishers (wheel type) in a steel cage besides the building of the management office in the southern part of the old section of Wuse market. Source: Field work (2017).

The interview questions given to the company that manages Wuse market showed that a patrol team exist in the market and it comprised of 25 trained people. Among their duties is to go through the entire market to check for minor outbreaks of fire and to fight the fire with the managing company extinguishers in the market. It implies that in the event of fire, the patrol team in the market will have to speedily go to the building of the management office where extinguishers for fire are kept to convey them to the points of outbreaks of fire to extinguish them. Thus, by this kind of long processes, there exist a possibility of market fires to have done severe damages to the properties and goods of the market traders before they can be handled owing to the fact that there exist market trading points that are above 750 metres from where the extinguishers for fire that belong to the market management company are positioned.

The interview questions given to the company that manages Wuse market showed that the worker salaries of the patrol team in the market are between 20,000 Naira to 30,000 Naira; this is not satisfactory because it is rather low. In a given organisation, it is crucial that staff have a good job satisfaction, so that the best services can be gotten under good condition of work (Dobre, 2013; Sageer *et al.,* 2012 and Tella *et al.,* 2007). Additionally, it was seen that 17 buildings exist in the central and eastern parts of the old section of the market with no corridors or front verandahs to mount extinguishers for fire on their walls or to fix other wall mountable protection devices for fire. Likewise, there exist no building in the entire market with wall mounted warden phones for fire. Regarding this, there exist a difficulty of passing information to the fire wardens in the event of outbreaks of fire at the initial fire stages.

4.6.2 Active fire protection measures adopted in Garki model market

From the company that manages Garki model market, there are 558 total number of open stalls and 872 total number of lock-up shops in Garki model market. However, only two portable fire extinguishers were seen in the market. One portable fire extinguisher was found on the wall of a lock-up shop building in the formal section central part of the market; another one was found on the front wall of the building of management office in the southern part of the formal section of the market. In addition, three fire hose reels were found in the central part of the formal section of the market. There is no protection device for fire that was found in the informal section of the market that is made up of several open stalls. Therefore, fire protection devices are not sufficient in Garki model market by putting into consideration the number of the observed fire protection devices in relation to the market size regarding the available

facility numbers (1,430 sales points). The focus group discussion made with the market traders showed that “all the market fire hose reels are not in good condition”. Plate LXIII shows a non-functioning fire hose reel in Garki model market.

Plate LXIII: Non-functioning fire hose reel in the central part of the formal section of Garki model market. Source: Field work (2017).

It was noticed that the primary evacuation route of the administrative building of the market has no emergency lighting for people who are at the risk of fire to see well and properly escape in case of electric power cut or failure during fire outbreaks. In addition, the interview questions given to the company that manages Garki model market showed that the company has only one qualified electrical inspector and his responsibility is to go through the market place to check for electrical wiring and fittings in the market so that anywhere electrical faults are detected, repairs can be made on them to reduce fire outbreaks in the market. However, by considering only one electrical inspector in the market with regards to the market size and respecting the available number of facilities and how markets in Nigeria are prone to frequent fire

outbreaks, the rationale for this is inadequate with regards to the only one number of qualified electrical inspector. The interview questions administered to the company that manages Garki model market also revealed that the monthly salary of the electrical inspector of the market is 35,000 Naira and this is not satisfactory because it is rather low. In an organisation, it is crucial that staff have a good job satisfaction, so that the best services can be gotten under good condition of work (Dobre, 2013; Sageer *et al.*, 2012 and Tella *et al.*, 2007).

4.6.3 Active fire protection measures adopted in Kado market

The discussion made with the company that manages Kado market showed that "the managing company of the market deals with fire outbreaks by instructing all the sales people to mandatorily have fire extinguishers in the shops". However, the focus group discussion made with the traders in Kado market showed that it is not all the sales people that kept to the instruction of mandatory possession of fire extinguishers in the shops.

From the company that manages the market, there exist 86 open stalls, 237 lock-up shops, 25 cold rooms/ware houses and other sales points in the market. However, only one portable fire extinguisher was found in the management office in the central part of the market; three portable fire extinguishers were found on the lock-up shop buildings in the central part of the market without any other one in the remaining parts of the market. Apart from these few portable fire extinguishers that were observed, there are no other fire protection devices such as fire hydrants, fire alarm systems, hose reels,

automatic fire suppression systems, and sprinklers in the market. Therefore, fire protection devices are considered inadequate with regards to the market size and respecting the available number of facilities (353 sales points). Plate LXIV shows a portable extinguisher for fire which is attached to the front wall of a lock-up shop building in Kado Market.

Plate LXIV: Portable extinguisher for fire which is attached to the front wall of a lock-up shop building in the central part of Kado market. Source: Field work (2017).

Associated Fire Protection (AFP) and Keystone Fire Protection (KFP) stated that the interval of visual inspection of protection devices for fire should be every month, and their main intervals of service or maintenance should be every year (AFP, 2019; KFP, 2019). However, the interview questions given to the company that manages Kado market showed that the interval of inspection and maintenance of the portable extinguishers for fire in the market is about every six months, and this is considered adequate in terms of maintenance but the inspection interval is not adequate. In

addition, the interview questions given to the company that manages Kado market showed that there exist no patrol team in the market to go through the market to check for minor fire outbreaks, so that they can be tackled with fire extinguishers. Thus, the market depends mostly on the Federal Fire Service of Nigeria (FFSN) in case of any major fire outbreak that may arise. Also, the managing company of the market has no electrical inspector to go through the market to check for electrical wiring and fittings in the market, so that where electrical faults are detected, repairs can be made on them to reduce fire outbreaks in the market.

4.7 Summary of Passive and Active Fire Prevention and Protection Measures and their Associated Issues in Markets

Building components, fire control measures and devices are the factors associated with active and passive protection and prevention measures against market fires. These associated factors are sites, floors, columns and beams, stair cases and ramps, walls, doors and windows, ceilings, roof members, building fascia, fire protection devices and other fire control measures. Table 4.17 shows the distribution of active and passive protection and prevention measures against fire and their associated issues in the markets.

In Table 4.17, lack of windows in shops that encourages indiscriminate use of electric power generators to power fans and air conditioning system for ventilation and cooling; low turn out of the sales people for training against fires, poor constant practice of fire protection devices; inadequate and poor handling of firefighting equipment facilitate

fire in the markets. Whereas, improper planning of sites and floors; use of non-combustible metal tiles or non-concrete tiles; other low fire resistant building materials and lack of roof fire barriers cause the spread of fire in the markets, while improper site escape routes, lack of floor refuge places, poor consideration of fire emergency or fire escape in the design of doors, stair cases and ramps facilitate fire victims. Passive and active fire prevention and protection measures are ranked into three positions in this context. Those with the implication of facilitation of fire and fire victims; fast fire spread are ranked first, while those with the implication of spread of fire and facilitation of fire victims are ranked second, whereas, those with the implication of only spread of fire are ranked third.

Table 4.17: Distribution of passive and active prevention and protection measures against fire and their associated issues in the markets.

S/N	Building Component, Fire Control Measure/Device	Associated Issue	Implication
1	Sites	Improper planning / Escape Routes	Spread of Fire / Facilitation of Fire Victims
2	Floors	Improper Planning / Lack of Refuge Places	Spread of Fire / Facilitation of Fire Victims
3	Columns and Beams	Use of Non-combustible Metal Tiles or Concrete Tiles	Spread of Fire
4	Stair Cases and Ramps	Poor Fire Emergency Consideration	Facilitation of Fire Victims
5	Walls	Application of Materials with Low Fire Resistant	Spread of Fire
6	Doors and Windows	Absent of Windows in Shops / Poor Consideration of Fire Escape and Use of Materials with no Fire Resistance	Facilitation of Fire and Fire Victims; Fast Fire Spread
7	Ceilings	Application of Materials with no Fire Resistance	Fast Fire Spread
8	Roof Members	Lack of Fire Barriers and Use of Materials with no Fire Resistance	Fast Fire Spread
9	Building Fascia	Use of Non-fire Resistant Materials	Fast Fire Spread
10	Other Fire Control Measures	Low Turn Out of the Sales People for Training against Fires; Poor Constant Practice of Fire Protection Devices	Facilitation of Fire
11	Fire Protection Devices	Inadequate and Poor Handling of Firefighting Equipment	Facilitation of Fire

Source: Field work (2017).

4.8 Data from the Sales People in the Study Area via Focus Group Discussions

The focus group discussions elicited information from the sales people with regards to the protection and prevention measures against fire adopted in the research domain

(Wuse market, Garki model market and Kado market). The participants were welcomed with candies/sweets and soft drinks, in order to make them relax and be happy to give proper responses. The responses of participants with regards to the changes made by the users that could cause fast spread of fire; the active and passive protection and prevention measures against fire adopted in the markets were discussed.

4.8.1 Responses of the participants with regards to the changes made by the users that could cause fast spread of market fires

The majority of participants of the focus group discussions responded that "non-fire resistant wooden attachments to shops for the expansion of businesses, and the erection of non-fire resistant wooden structures for shops due to the high demand for sales spaces are the changes made by us (sales people) that could cause fast spread of market fires". The majority of participants further responded that other changes made by them that could cause fast spread of market fires are: "fixing of canopies in between the roofs of buildings as sun shading devices due to lack of verandahs or corridors in the shops, and the use of tarpaulins to cover front verandahs of shops, in order to stop rain water from entering our shops due to inadequate width of the verandahs".

In addition, most of the participants of focus group discussions responded that the major factor attributed to the changes made by them that could cause fast spread of market fires is electricity issue. According to the participants, "illegal electrical connections from the nearby shops, so that some of us will not be paying electricity bills are some of the factors attributed to the changes made by us that could cause fast

spread of market fires". Most of the participants further responded that other factors attributed to the changes made by the users that could cause fast spread of market fires are: "the sales of petrol and cooking with naked fires such as fire wood and charcoal fires in the markets, in order to minimise the cost of alternative sources of cooking".

4.8.2 Responses of the participants with regards to the active and passive protection and prevention measures against fire adopted in the markets

The majority of participants of the focus group discussions responded that "the trainings against fire outbreaks in the market are adequate but most of us (sales people) do not respond to calls for training because fire protection devices in the markets are very few to encourage us to go for training". Some of the participants responded that "we are not aware of ways of fire escape (fire exits) in the markets". This means that some of the sales people are not well educated about fire exits because it was actually observed that there are inadequate fire exits in the markets.

In addition, most of the participants of focus group discussions responded that "fire protection devices in the markets are inadequate and the majority of the available ones are not in good condition". This means that the government of Nigeria is not serious with the maintenance and supply of fire protection devices to the markets because according to National Association of Nigerian Traders (NANT) and Nigerian Constitution (NCO), each local government in Nigeria has the responsibility to establish and maintain all the markets within its area as stated under the Schedule Four

of the Functions of a Local Government Council in the Nigerian Constitution (NANT, 2016; NCO, 1999).

4.9 Data from the Sales People in the Study Area via Questionnaires

Questionnaires were given to the sales people in the research domain (Wuse market, Garki model market and Kado market). Each questionnaire had two sections which are sections A and B. From section A, the socio-economic and demographic features of the sales people (respondents) were documented, and section B with nine different numbers of questions was used in documenting the responses with regards to the attitudes and perceptions of the sales people towards fire prevention and protection measures. Question one of section B was used to give a response to the research question one. The other questions in section B were used to give a response to the research question two. The returned questionnaires were coded and analysed by the use of Micro-soft Excel of 2016 version and Statistical Package for the Social Sciences (SPSS) of 23 version.

4.9.1 Socio-economic and demographic features of the sales people

Socio-economic and demographic features of the sales people (respondents) in the domain of study is very important in the discussion of the results of the research, so as to determine the research authenticity. Hence, number of respondents, age of the respondents and respondent educational level in the markets were considered in this subsection.

4.9.1.1 Number of the respondents

The total numbers of the sales people (respondents) in Wuse market, Garki model market and Kado market are 419 (53.9%), 287 (36.9%) and 71 (9.2%) respectively. The respondents comprise of males and females. This result shows that there was strict regards to the proposed numbers of the respondents for the distribution of questionnaires in the domain of study. Table 4.18 shows the number (frequency) of respondents in Wuse market, Garki model market and Kado market.

Table 4.18: Number of the respondents in Wuse market, Garki model market and Kado market.

Market	Frequency	Percent
Wuse	419	53.9
Garki	287	36.9
Kado	71	9.2
Total	777	100.0

Source: Field work (2017).

4.9.1.2 Gender of the respondents

The total number of female sales people and male sales people in the study domain are 400 (51.5%) and 377 (48.5%) respectively. This result indicates that there is almost an even distribution of questionnaires to the respondents (sales people) in the domain of the study.

4.9.1.3 Age of the respondents

The sales people who are 27 – 37 years have the highest number of respondents which is 243 (31.3%) and followed by those who are 49 years and above with 181 (23.3%) number of respondents. The group of age of 38 – 48 years has 169 (21.8%) number of respondents and the group of age of 16 – 26 years has 157 (20.2%) number of respondents. The group of age of 15 years and below comes last with 27 (3.5%) number of respondents. Table 4.19 reveals the distribution of the age of respondents in the domain of the study.

Table 4.19: Distribution of the age of respondents.

Age	Frequency	Percent
15 Years and Below	27	3.5
16-26 Years	157	20.2
27-37 Years	243	31.3
38-48 Years	169	21.8
49 Years and Above	181	23.3
Total	777	100.0

Source: Field work (2017).

4.9.1.4 Level of education of the respondents

The sales people that have tertiary education have the highest number of respondents which is 370 (47.6%) and it is followed by the respondents that have secondary education with 268 (34.5%) number of respondents. The numbers of the respondents that have primary education and non-formal education are 110 (14.2%) and 29 (3.7%)

respectively. Table 4.20 reveals the distribution of the educational background of respondents in the domain of the study.

Table 4.20: Distribution of the educational background of respondents.

Educational Background	Frequency	Percent
No Formal Education	29	3.7
Primary Education	110	14.2
Secondary Education	268	34.5
Tertiary Education	370	47.6
Total	777	100.0

Source: Field work (2017).

4.10 Data from the Sales People with Respect to the Factors Attributed to the Changes Made by the Users that could Cause Fast Spread of Market Fires

In this context, the factors attributed to the changes made by the users that could cause fast spread of market fires imply the primary or main causes of outbreaks of fire in the domain of the study. Out of 777 questionnaires administered to the sales people in the study area, 641 (82.5%) sales people responded that the major cause of outbreaks of fire in the market is electrical equipment/wiring and 25 (3.2%) sales people responded that arson (intentional fires) is the major cause of outbreaks of fire in the market. 44 (5.7%) sales people responded that smoking (fire from cigarette end) is the major cause of outbreaks of fire in the market and 59 (7.6%) sales people responded that they do not have the knowledge of the major cause of outbreaks of fire in the market. Eight (1.0%) sales people responded that other causes of outbreaks of fire in the market are spirituality; cooking with gas cookers and other naked fires.

Table 4.21 reveals the major causes of outbreaks of fire in the domain of the study. The majority of the sales people responded that the major cause of outbreaks of fire in the market is electricity/wiring. Therefore, it became important that emphasis is given to the fire outbreaks from electricity/wiring in the proposed additional guidelines to improve the National Fire Safety Code of Nigeria (NFSCN).

Table 4.21: Main causes of fire outbreaks.

Response (Cause of Fire)	Frequency	Percent
Electrical equipment/wiring	641	82.5
Arson (Intentional fires)	25	3.2
Smoking (fire from cigarette end)	44	5.7
Do not know	59	7.6
Others	8	1.0
Total	777	100.0

Source: Field work (2017).

4.11 Research Question One: What are the Changes Made by the Users that could Cause Fast Spread of Market Fires in the Federal Capital Territory of Nigeria?

Having discussed the changes made by the users that could cause fast spread of market fires in the Federal Capital Territory of Nigeria, the following research findings have answered research question one:

i. Stocking goods on the shelves very close to the light bulbs due to lack of adequate spaces for the lock-up shops causes fast fire spread in Wuse market.

ii. The design of most of the buildings in Garki model market have no verandahs or corridors; as a result of this problem, the sales people fixed canopies in between the roofs of two or more buildings as sun shading devices in the market, so that they can stay under them to relax and receive fresh air in the afternoon when there are no customers for them to conduct business transactions. These cause fast fire spread from buildings to buildings in times of fire outbreaks.

iii. Non-fire resistant wooden attachments to buildings for the expansion of businesses in Kado market as a result of inadequate sizes of the spaces for shops which are about 12 metres square cause fast fire spread in the event of outbreaks of fire.

iv. The use of tarpaulins to cover the fronts of verandahs of the lock-up shops against rain water in Kado market cause the fast spread of fire from one building to another building when there are fire outbreaks, and these are attributed to the inadequate sizes of widths of the verandahs that led to the use of tarpaulins to prevent the rain water from easily getting into the shops through them.

4.11.1 Findings from the major factors attributed to the changes made by the users that could cause the fast spread of market fires in the Federal Capital Territory of Nigeria

Apart from the known primary causes of outbreaks of fire or the major factors attributed to the changes made by the users that could cause fast spread of fire in Nigerian markets, the following research findings are the additional primary causes of outbreaks of fire or major factors attributed to the changes made by the users that could

cause fast spread of market fires in the Federal Capital Territory **(**FCT) of Nigeria. These research findings have also answered research question one. They are Electrical Issues, use of flammable liquids, charcoal fires and fire wood. The research data from the sales people revealed that the major cause of outbreaks of fire in the research domain is electricity/wiring, while cooking with gas cookers and other naked fires have the least cause of outbreaks of fire in the domain of the study.

4.11.1.1 Findings from the electrical issues attributed to the changes made by the users that could cause fast spread of market fires

The following items are the findings from the electrical issues attributed to the changes made by the users that could cause fast spread of market fires:

i. Indiscriminate use of electric power generators as a result of unstable supply of public electric power attributes to the changes made by the users that cause the fast spread of fire in Wuse market.
ii. Fire outbreaks in Garki model market mostly start from the cold rooms at night because the sales people in the cold rooms do not put off their electrical appliances at the close of businesses for the day.

4.11.1.2 Findings from the use of flammable liquid attributed to the changes made by the users that could cause fast spread of market fires

The following items are the findings from the use of flammable liquid attributed to the changes made by the users that could cause fast spread of market fires:

i. Sales of petrol attributes to the changes made by the users that cause the fast fire spread in Wuse market.
ii. Due to inadequate car parking spaces in Wuse market, people park cars very close to electric power generators that are working with petrol in the market, and the sales people fill electric power generators with petrol while they are working due to lack of patience to put off the generators before they can be filled. These attribute to the changes made by the users that cause the fast spread of fire in the market.

4.11.1.3 Findings from the use of charcoal fires and fire wood attributed to the changes made by the users that could cause fast spread of market fires

The following items are the findings from the use of charcoal fires and fire wood attributed to the changes made by the users that could cause fast spread of market fires:

i. Indiscriminate cooking with charcoal fires in steel containers around the restaurants to minimise the costs of using alternative sources of cooking attributes to the changes made by the users that cause the fast spread of fire in Wuse market.
ii. Indiscriminate use of fire wood for cooking at the premises of the illegal restaurant and to also prepare meat around the open stall, in order to

minimise the costs of using other alternative means attributes to the changes made by the users that cause the fast spread of fire in Garki model market.

4.11.2 Findings from other factors attributed to the changes made by the users that could cause fast spread of market fires in the Federal Capital Territory of Nigeria

Moreover, having discussed other factors attributed to the changes made by the users that could cause fast spread of market fires in the FCT of Nigeria, the following research findings have answered research question one:

i. Indiscriminate use of umbrella stands in Wuse market as a result of the poor sales people that cannot afford the costs of acquiring shops in the market, and the market management authority is not taking any control measure against them. These cause fast fire spread in the event of outbreaks of fire in the market.
ii. Lack of central collection points for waste in Wuse market.
iii. Blocking of some access roads for the firefighting vehicles in Wuse market by the indiscriminate parking of cars on the parts of them due to inadequate car parking spaces.

4.12 Data from the Sales People with Respect to the Passive Fire Prevention and Protection Measures Adopted in the Markets

Data from the sales people with regards to the ways of escape of people (fire exits), signs for fire exits (signage), compliance with signage, levels of satisfaction with fire

exits in the domain of the study were considered with the issues pertaining to them. Data from the sales people with regards to training on the use of firefighting devices in the domain of the study were also considered with issues pertaining to them.

4.12.1 Ways of escape of people

From the 777 questionnaires administered to the sales people in the domain of the study, 610 (78.5%) sales people responded that there are fire exits (escape ways) in case of outbreaks of fire in the market. 53 (6.8%) sales people responded that there are no fire exits in the event of outbreaks of fire in the market, while 114 (14.7%) sales people responded that they do not have awareness of fire exits in the event of outbreaks of market fire. Table 4.22 reveals the knowledge of fire exits by the sales people in the domain of the study. The result reveals that some sales people do not know of the existence of fire exits and some sales people are not aware of the fire exits in the market. This means that some sales people in the market are not well educated about fire exits. It was observed during the research that there are actually fire exits in the markets.

Table 4.22: Knowledge of fire exits by the sales people.

Response	Frequency	Percent
Yes	610	78.5
No	53	6.8
Not aware	114	14.7
Total	777	100.0

Source: Field work (2017).

4.12.2 Signs for fire exits

Out of 777 questionnaires administered to the sales people in the study area, 776 (99.9%) sales people responded that there are no signs for fire exits (signage) in the market. It was actually observed that there is no signage in the study area. However, one (0.1%) sales person responded that there is signage in the market. It means that this sales person is not well educated about the meaning of signage.

4.12.3 Compliance with signage

There is no sales person that responded that there is compliance with the signs for fire exits (signage) in the market in times of fire outbreaks. 768 (98.8%) sales people responded that there are no market signage that will lead to compliance in times of fire outbreaks. It was actually seen that there are no signage in the study area for compliance in times of fire outbreaks. However, nine (1.2%) sales people responded that there is no compliance with market signage in times of fire outbreaks; this means that they do not comply with the existence of signage in the market. It means that these sales people are not well educated about the meaning of signage. Table 4.23 shows the compliance with signage by the sales people in the study area.

Table 4.23: Compliance with signage by the sales people.

Response	Frequency	Percent
No	9	1.2
No signs for the fire exists to comply with	768	98.8
Total	777	100.0

Source: Field work (2017).

4.12.4 Levels of satisfaction of the sales people with fire exits

From the 777 questionnaires administered to the sales people in the study area, 11 (1.4%) sales people responded that they are very satisfied with market fire exits, and 51 (6.6%) sales people responded that they are satisfied with the market fire exits. However, it was actually observed that there are fire exits in the study area but their satisfactions are at the average levels, except the fire exits in Garki model market that are not satisfactory. 266 (34.2%) sales people affirmed that they are neither satisfied nor dissatisfied with fire exits in the markets. Whereas, 323 (41.6%) sales people responded that they are dissatisfied with the market fire exits, while 126 (16.2%) sales people responded that they are very dissatisfied with the market fire exits. Table 4.24 shows the satisfaction levels of sales people with fire exits in the domain of the study.

Table 4.24: Levels of the satisfaction of sales people with fire exits.

Level of Satisfaction (Response)	Frequency	Percent
Very satisfied	11	1.4
Satisfied	51	6.6
Neither satisfied nor dissatisfied	266	34.2
Dissatisfied	323	41.6
Very dissatisfied	126	16.2
Total	777	100.0

Source: Field work (2017).

4.12.5 Training with regards to the use of fire fighting equipment

Out of 777 questionnaires administered to sales people in the domain of the study, 161 (20.7%) sales people responded that they have received training in the market on how

to use firefighting devices. The interview questions administered to the Federal Fire Service of Nigeria (FFSN), National Association of Nigerian Traders (NANT) and the company that manages the markets revealed that there are regular trainings for the traders in the domain of the study with regards to the use firefighting devices.

However, 432 (55.6%) sales people responded that they have not received market training on how to use firefighting devices, and 184 (23.7%) sales people responded that there are no devices for fighting market fire that will lead to a need of receiving training on how to employ or make use of them. It means that the majority of the sales people in the domain of the study are not giving responses to calls for training of how to employ or make use of the devices for fighting fire. In addition to this immediate statement, the discussion made with the staff of managing company of Garki model market affirmed that most of the sales people do not respond to fire drill calls. Table 4.25 shows the responses to training by the sales people with regards to how to make use of firefighting devices in the research domain.

Table 4.25: Responses to training by the sales people with respect to how to make use of devices for fighting fire.

Response	Frequency	Percent
Yes	161	20.7
No	432	55.6
No firefighting equipment	184	23.7
Total	777	100.0

Source: Field work (2017).

4.13 Data from the Sales People with Respect to the Active Fire Protection Measures Adopted in the Markets

Issues of active protection measures against fire adopted in the markets with regards to the availability and operations of firefighting equipment were considered. Issues of active protection measures against fire adopted in the markets with regards to the levels of satisfaction with firefighting equipment were also considered.

4.13.1 Availability of fire fighting devices

Out of 777 questionnaires given to the sales people in the study area, 366 (47.1%) sales people responded that there are devices for fighting fire in the market. It was actually observed that there are firefighting equipment in the study area but they are not adequate. However, 411 (52.9%) sales people responded that there are no devices for fighting fire in the market. This means that the majority of the sales people (respondents) have not seen the devices for fighting fire in the market because they are very few in number. Therefore, it is deduced that the devices for fighting fire are not sufficient in the study area.

4.13.2 Knowledge of the use of fire fighting equipment

Out of 777 questionnaires administered to the sales people in the study area, 170 (21.9%) sales people responded that they have the knowledge of how to make use of equipment for fighting fire in the market. 336 (43.2%) sales people responded that they do not have the knowledge of how to make use of equipment for fighting fire in the market, and 271 (34.9%) sales people responded that there are no equipment for

fighting fire in the market that will give encouragement to the sales people to learn how to operate them. This means that most of the market traders do not have the knowledge of how to make use of equipment for fighting fire because the majority of them do not respond to training calls on how to make use of them. Table 4.26 reveals the responses of sales people in the domain of the study with regards to the knowledge of the use of firefighting equipment.

Table 4.26: Responses of the sales people with regards to the knowledge of the use of fire fighting equipment.

Response	Frequency	Percent
Yes	170	21.9
No	336	43.2
No firefighting equipment	271	34.9
Total	777	100.0

Source: Field work (2017).

4.13.3 Levels of satisfaction of the sales people with equipment for fighting fire

Out of 777 questionnaires given to the sales people in the study area, three (0.4%) sales people responded that they are very satisfied with the equipment for fighting fire in the market, and 22 (2.8%) sales people responded that they are satisfied with the equipment for fighting fire in the market. 129 (16.6%) sales people responded that they are neither satisfied nor dissatisfied with the equipment for fighting fire in the market. 235 (30.3%) sales people responded that they are dissatisfied with the equipment for fighting fire in the market, while 388 (49.9%) sales people responded that they are very dissatisfied

with the equipment for fighting fire in the market. These affirmed that the equipment for fighting fire are not sufficient and they are not in perfect condition in the domain of the study by considering the satisfaction levels of the sales people in the domain of the study. Table 4.27 reveals the satisfaction levels of the sales people with the firefighting equipment in the domain of the study.

Table 4.27: Satisfaction levels of the sales people with the fire fighting equipment.

Response (Level of Satisfaction)	Frequency	Percent
Very satisfied	3	0.4
Satisfied	22	2.8
Neither satisfied nor dissatisfied	129	16.6
Dissatisfied	235	30.3
Very dissatisfied	388	49.9
Total	777	100.0

Source: Field work (2017).

4.14 Research Question Two: What Passive and Active Fire Prevention and Protection Measures Put in Market Places in the Federal Capital Territory of Nigeria?

Having discussed the associated issues of the passive and active prevention and protection measures against market fires that were put in place in the Federal Capital Territory (FCT) of Nigeria, the following research findings have answered research question two. They are issues of passive protection and prevention measures against fire with regards to site plans, floor plans, and the design of columns and beams, stair cases and ramps, walls, doors and windows, ceilings, roof members, building fascia;

the use of paints, and other fire control measures. Also, they are issues of active fire protection measures with emphasis on the firefighting equipment in the markets.

4.14.1 Findings from the passive protection and prevention measures against fire with regards to the site plans in the markets

The following items are the issues associated with the passive protection and prevention measures against fire with regards to the market site plans:

i. Two to three metres range of spaces between buildings were found in the old section of Wuse market and these are rather inadequate; they can lead to easy fire spread from buildings to buildings in the event of outbreaks of fire in the market. In addition, the firefighting vehicles cannot pass or properly pass through the affected spaces between the buildings to fight fires in case of fire outbreaks.

ii. A canal of three metres wide divided Garki model market into formal and informal sections and there are no bridges or another access that can allow firefighting vehicles to move from the formal part to the informal part to quench fire in case of outbreak of fire.

iii. In the eastern part of Kado market, two buildings were designed such that their walls are joint together with inadequate spaces between the buildings and thereby making their roofs to appear like folded type of roof. When there is fire outbreak in one of the buildings, the transfer of fire from the affected building to the second building is absolutely inevitable.

iv. Structures were erected close to the fire exit gate in the eastern part of Kado market and this brought about inadequate space for the assembling point of

people at the gate in case of fire emergency. When there is fire outbreak in the market, the exit gate will be over crowded by the people that are under the escape of the risk of fire.

4.14.2 Findings from the passive protection and prevention measures against fire with regards to the floor plans in the markets

The following items are the issues associated with the passive protection and prevention measures against fire with regards to the floor plans in the markets:

i. Concrete steps were incorporated into the design of some storey buildings along the corridors in Wuse market due to the undulated nature of terrain of the ground and these have made the corridors to look like concrete stairways. In this case, the probability of accidents when people who are at the risk of fires are escaping is very high.

ii. Smoke vents were not incorporated into any part of the floor design of buildings in Garki model market and this can lead to the death of people due to suffocation during fire outbreaks.

4.14.3 Findings from the passive protection and prevention measures against fire with regards to the design of columns and beams in the markets

Non-combustible metal tiles or concrete tiles were not applied on the columns to resist the spread of fires within the buildings in the markets. Also, non-combustible metal tiles or concrete tiles were not applied on the beams to resist the spread of fires within the buildings in the markets.

4.14.4 Findings from the passive protection and prevention measures against fire with regards to the design of stair cases and ramps in the markets

The following items are the issues associated with the passive prevention and protection measures against fire with regards to the design of stair cases and ramps in the markets:

i. Lock-up shop storey buildings with only one ramp in Wuse market were found; when there are fire outbreaks along the ramp and there are spreading to the other parts of the buildings, all the disabled people at the upper floor will be trapped by fires.

ii. There is no design of fire emergency escape stair cases in all the lock-up shop storey buildings in Wuse market.

iii. Sufficient spaces for the width of flights of the stairwells of 1.8 to 2.1 metres were provided in the design of the lock-up shop storey buildings in Wuse market but the vertical length (depth) of the stairwell landing spaces of some storey buildings are 1.2 to 1.5 metres. These mean that the depths of the landing spaces are not up to the widths of each stair flight; they are considered not adequate enough to accommodate many people when they are escaping in times of fire outbreaks.

4.14.5 Finding from the passive protection and prevention measures against fire with regards to the design of walls in the markets

All the walls of buildings in Kado market and Garki model market are made up of sandcrete blocks; the buildings that are made up of sandcrete block walls were also

found in Wuse market. These walls can crack under the influence of fire, and there is a possibility of fire spread.

4.14.6 Findings from the passive protection and prevention measures against fire with regards to the design of doors and windows in the markets

The following items are the issues associated with the passive prevention and protection measures against fire with regards to the design of doors and windows in the markets:

i. The shops that do not have windows for cross ventilation were found in Wuse market and these encourage the use of electricity generators indiscriminately in the market, in order to operate fans for heat control; indiscriminate use of electricity generators in the market is one of the causes of outbreaks of fire.

ii. In the administrative building of Garki model market, apart from the entrance door, the primary evacuation route has no window or any other opening for natural lighting to aid proper escape of people in case of outbreak of fire.

iii. The use of wooden frames/shutters that are not fire resistant for doors and windows was found in Kado market, especially where there are non-fire resistant wooden attachments to buildings. These can easily burn and increase the rate of spread of fire when there is fire outbreak in the market.

4.14.7 Findings from the passive protection and prevention measures against fire with regards to the design of ceilings in the markets

The following items are the issues associated with the passive protection and prevention measures against fire with regards to the design of market ceilings:

i. The buildings that are made up of non-fire resistant wooden ceilings were found in Wuse market; these can easily burn and increase the rate of spread of fire when there is fire outbreak.

ii. The buildings that are made up of non-fire resistant asbestos ceiling boards were found in Garki model market; these can easily burn and increase the rate of spread of fire when there is fire outbreak.

4.14.8 Findings from the passive protection and prevention measures against fire with regards to the design of roof members in the markets

The following items are the issues associated with the passive prevention and protection measures against fire with regards to the design of roof members in the markets:

i. The roofs of buildings in Wuse market are long without the extension of walls on the middles and beyond the total heights of roofs to serve as the barriers to the spread of fires at specified lengths.

ii. The roof eaves that are very close and almost touching each other were found in the informal section of Garki model market; these can lead to easy spread of fire when there is fire outbreak.

4.14.9 Findings from the passive protection and prevention measures against fire with regards to the design of building fascia in the markets

The following items are the issues associated with the passive protection and prevention measures against fire with regards to the design of building fascia in the markets:

i. Non-fire resistant wooden fascia boards of buildings were found in Wuse market; these can easily burn and increase the rate of spread of fire when there is fire outbreak.

ii. Non-fire resistant aluminium fascia of buildings were found in Garki model market; this fascia material has no high fire resistance.

4.14.10 Findings from the passive protection and prevention measures against fire with regards to the finishes of buildings in the markets

The following items are the issues associated with the passive protection and prevention measures against fire with regards to the finishes of market buildings:

i. Paints on the walls of some buildings in Wuse market are already peeling and they are not resistant to fire. Also, no paint in Garki model market and Kado market is resistant to fire.

ii. Floor finishes of buildings in Kado market were not adequately designed against fire outbreaks, such that the use of concrete floor tiles or non-combustible metal floor tiles was not found in any part of the market to resist the spread of fires within the buildings.

4.14.11 Findings from the passive protection and prevention measures against fire with regards to other fire control measures in the markets

The following items are the issues associated with the passive fire prevention and protection with regards to other fire control measures in the markets:

i. Most of the traders in the markets are not responding to calls for training with respect to the prevention and protection measures against fire.
ii. After the training with regards to the use firefighting devices in Kado market, the sales people can operate them immediately but after a while or before the next training time, some sales people will not be able to operate them. This means that lack of constant practice on the use of fire protection devices by the sales people is traceable to this problem.
iii. Some sales people in the markets are not well educated about signage (signs for fire exits).

4.14.12 Findings from the active protection measures against fire adopted in markets in the Federal Capital Territory of Nigeria

The following research findings are the issues associated with the active protection measures against fire that were adopted in market places in the Federal Capital Territory (FCT) of Nigeria:

i. Fire protection devices are never maintained until after use in Wuse market. Thus, they lack proper maintenance.

ii. There are insufficient devices for fire protection in the markets by considering the numbers of the observed fire protection devices in relation to the sizes of the markets in terms of the number of the available facilities.

iii. Engagement of substandard extinguishers for fire causes fast fire spreads in Wuse market due to financial management issues that have resulted to ineffective active preparedness against market fire.

iv. Majority of the market traders do not have the knowledge of how to make use of equipment for fighting fire.

4.15 Descriptive Statistics of the Data Collected from the Sales People in the Markets via Questionnaires

According to Lund Research Limited (LRL), Research Guide (RGU) and other scholars, descriptive statistics is summarising and organising the research data, so that the basic features of the data can be easily explained and understood; it helps to simplify large amounts of research data in a sensible/meaningful way (LRL, 2018; Narkhede, 2018; RGU, 2019; Trochim, 2006). Owing to the large amounts of this research data from different sales people in different markets, descriptive statistics was used to simplify the large amounts of the data in a sensible/meaningful way. The data from the three markets were analysed together to get the combined analysis of the research data, in order to be informed of the protection and prevention measures against fire in the study domain at the same time. Appendix J shows the descriptive statistics of the data collected from the sales people in the markets via questionnaires. In Appendix J, “Q” represents question and “N” represents sample size. Respondents are comprised of males and females; they are also comprised of different age brackets, educational backgrounds and religious backgrounds.

In Appendix J, Q 1 represents question one in section B of the questionnaires administered to the sales people regarding the primary or major causes of outbreaks of fire in the markets (changes made by the users that could cause fast spread of market fires). Likewise, Q 2, Q 3, Q 4, Q 5 and Q 7 represent questions two, three, four, five and seven respectively in section B of the questionnaires administered to the sales people with regards to the passive prevention and protection measures against fire that was adopted in the markets. Moreover, Q 6, Q 8 and Q 9 represent questions six, eight and nine respectively in section B of the questionnaires administered to the sales people with regards to the active protection measures against fire that was adopted in the markets.

The actual total number of the questionnaires that were distributed in the markets is 777. From Appendix J, the total number of sample size is 777 for all the variables under the correspondent, and the total number of the valid sample size (listwise) is 777 under the same correspondent. Thus, by adopting the numerical and visual methods of normality test, the data from the questionnaires were normally and appropriately distributed in Appendix J, and these have made the results of data analyses to be acceptable because according to scholars such as Open Anesthesia (OAN), Statistics and Data Sciences (SDS) and University of Cincinnati Business Analytics (UCBA), they are in line with the rules of normality test (Baghban *et al.*, 2013; Fitrianto and Chin, 2016; Ghasemi and Zahedias, 2012; Jason, 2018; Kim, 2013; OAN, 2018; Spinks *et al.,* 2015; SDS, 2015; UCBA, 2018; Zayeri and Jalilian, 2013). Comparing the actual total number of the questionnaires that were distributed in the markets, and the total number of sample size of all the variables under the

correspondent, and the total number of the valid sample size (listwise), no error is detected because all of them have uniform numbers.

Also, the actual number of markets that were studied is three. From Appendix J, the minimum value of market is 1.00 and the maximum value of markets is 3.00. This implies that the number of the markets that were studied ranges from 1.00 to 3.00, and this in turn has made the results of data analyses to be acceptable via numerical and visual methods of normality test because they are also in line with the rules of normality test. Comparing the actual number of markets that were studied and the ranges of markets that were studied at their maximum value in Appendix J, no error is detected because the actual number of markets that were studied corresponds with the maximum number (value) of the markets in Appendix J.

Similarly, other variables under the correspondent range from the minimum values of 1 to their different maximum respective values. Hence, their maximum values in Appendix J corresponds with their maximum numbers in the questionnaires administered to the sales people in the markets, and this in turn has made the results of data analyses to be acceptable via numerical and visual methods of normality test. In the same dimension, this acceptance is in line with the rules of normality test.

In Appendix J, the descriptive statistics showed that the values of mean, standard deviation and variance with regards to different variables under the correspondent differ significantly. This means that there are significant relationships of the variables within the descriptive statistics (mean, standard deviation and variance). Thus, it further implies that there are significant relationships within the primary or main

causes of fire (changes made by the users that could cause fast spread of fire in the markets); active and passive protection and prevention measures against market fires.

4.16 Determination of the Adequacy of the National Fire Safety Code of Nigeria for Fire Safety in the Design of Markets in the Federal Capital Territory of Nigeria

According to International Fire Code (IFC), National Fire Protection Association (NFPA), National Institute of Building Sciences (NIBS) and Nigerian Society of Engineers (NSE), an ideal National Fire Safety Code is supposed to adequately cover both passive and active prevention and protection measures against fire within or around buildings and facilities (IFC, 2012; NFPA, 2016; NIBS, 2017; NSE, 2016). However, the current 2013 edition of the National Fire Safety Code of Nigeria (NFSCN) gives little consideration to the use of building design to reduce outbreaks of fire and the spread of fires in buildings (passive protection and prevention measures against fire); this is a serious weakness. This is also a serious problem that this research has reduced.

As a result of this problem of the weakness of the NFSCN, generating additional guidelines are the passive protection and prevention measures against fire to reduce fire outbreaks and the spread of fires in Nigerian markets, so as to strengthen the optimum goals of the NFSCN. However, in generating the guidelines for designing market against outbreak of fire, active protection measures against fire were still given consideration but more emphasis was given to the passive protection and prevention measures against fire to improve the NFSCN.

The discussions with the staff of Market Operating Bodies in the FCT such as the Federal Fire Service of Nigeria (FFSN), National Association of Nigerian Traders (NANT) and the company that manages the markets (Abuja Markets Management Limited) revealed that the current NFSCN is inadequate with respect to the frequent fire outbreaks in markets. It was further emphasised that by considering the design of Kado market, Garki model market, Wuse market and many other Nigerian markets as well, there is a need for an improvement on the NFSCN with regards to market designs.

4.17 Research Question Three: How Adequate is the National Fire Safety Code of Nigeria for Fire Safety in the Design of Markets in the Federal Capital Territory of Nigeria?

Having determined the sufficiency of the National Fire Safety Code of Nigeria (NFSCN) for fire safety in market designs in the FCT of Nigeria, the discussions in this section have answered research question three. The 2013 edition of the NFSCN which is currently in use gives little consideration to the use of building design to reduce outbreaks of fire and the spread of fires in buildings (passive protection and prevention measures against fire); this is a serious weakness. As a result of this weakness, the current NFSCN is not adequate with respect to the frequent fire outbreaks in markets.

4.18 Opinions of Some Organisations with Respect to the Proposed Additional Guidelines for Market Design against Fire Outbreaks in Nigeria

The opinions of the organisations that are relevant to this research such as the FFSN, NANT and the company that manages the markets (Abuja Markets Management

Limited) were obtained during the research. Table 4.28 reveals the distribution of the opinions of organisations with respect to the proposed additional guidelines for market design against fire outbreaks in Nigeria.

Table 4.28: Distribution of the opinions of organisations with respect to the proposed additional guidelines for market design against fire outbreaks

S/N	Organisation	Opinion
1	Federal Fire Service of Nigeria	Underground Water Reservoir(s) in all the Nigerian Markets Should be Provided Mini Fire Service Stations Should be Provided in the Nigerian Markets
2	National Association of Nigerian Traders	Use of Interior Decorative Materials of Buildings that are not Resistant to Fire Should be Avoided in Markets.
3	The Company that Manages the Markets (Abuja Markets Management Limited)	Electric Power Distribution Boards must be Accessible from Outside the Shop Buildings in Markets

Source: Field work (2017).

4.18.1 Opinions of the federal fire service of Nigeria with respect to the proposed additional guidelines for market design against fire outbreaks in Nigeria

The discussion made with the Assistant Controller General of the Federal Fire Service of Nigeria (FFSN) indicates that “the FFSN discharges its duties perfectly but many Nigerians have been complaining that the discharge of their services is ineffective and inadequate with respect to many fire outbreaks in Nigerian markets”. The participant said, the reason for the complains is because most times when there are fire outbreaks in many Nigerian markets, the FFSN usually go to extinguish fires with the firefighting

vehicles (trucks) but if the fires are the major ones, the extinguishing water usually finish in the process, and before the firefighters can get back to their office stations to re-fetch water and return to the markets to continue fighting fires because of the problem of unavailability of water in the markets, serious damages must have been done to such markets.

The participant suggested that in proposing the additional guidelines for market design against fire outbreaks in Nigeria, addressing this problem of water unavailability in Nigerian markets should be taken as one of the top priorities. Then, the participant concluded that there should be a provision for underground water reservoir(s) in all the Nigerian markets in proposing additional guidelines for market design against fire outbreaks, so that when there are fire outbreaks in markets, there must be an availability of adequate water to extinguish them, in order to minimise further loss of goods, properties and human lives.

In addition, absence of mini stations for fire service in the domain of the study were identified by the staff of the FFSN, and it was suggested that mini fire service stations should be part of the proposed additional guidelines for market design against fire outbreaks in Nigeria. It was later stated that the availability of mini fire service stations in Nigerian markets will help in prompt fighting of fires, in case the main fire service stations will be far from the markets that may be affected, in order to stop fires from reaching the levels that will be difficult to control. It was further stated that if the mini fire service stations can be incorporated into the proposed additional guidelines for market design against fire outbreaks in Nigeria, there shall be reduction of serious

damages to goods, market buildings and other market properties. Also, there shall be reduction of the loss of human lives and injuries to the people in Nigerian markets.

4.18.2 Opinions of the national association of Nigerian traders with respect to the proposed additional guidelines for market design against fire outbreaks in Nigeria

The discussion with the staff of the National Association of Nigerian Traders (NANT) revealed that “there is a need for proper market keeping in Wuse market, Garki model market and Kado market”. This means that the use of interior decorative materials of buildings that can easily burn in the markets should be avoided. For example, the interior decorative materials of buildings that can easily burn such as carpets should not be used in the market places to reduce easy transfer of fires from one building material to another building material through them. When there are fires due to sparks in the surge protectors, extension wires, stabilisers and other electrical equipment, the probability of the transfer of fires from the ignition points through the carpets to other materials in the market buildings is very high. Hence, fire resistant floor tiles with good aesthetic qualities should be incorporated into the proposed additional guidelines for market design against outbreaks of fire in Nigeria, so as to curtail the rate of carpet uses in the markets.

4.18.3 Opinions of Abuja markets management limited with respect to the proposed additional guidelines for market design against fire outbreaks in Nigeria

The discussion made with the staff of the company that manages the markets (Abuja Markets Management Limited) showed that in most cases when there are fire outbreaks

in the lock-up shops in markets (especially at nights) when the shop owners are not available, the outcomes are always serious damages to the affected lock-up shops before the arrival of the shop owners to open the doors for the removal of electric power control fuses from the electric power distribution boards to reduce the negative effects or increase of fires from electricity, and to also put out fires.

It was suggested that electric power distribution boards must be accessible from outside the market shops, so that in the event of outbreaks of fire from electric power distribution boards, electrical equipment or any part of the lock-up shops, then, electric power control fuses can be removed by the management staff of the markets or other people in the absence of the shop owners. It was stated that this measure will help to reduce the spread of fires in markets which will in turn reduce the damages to the goods and properties; this should be incorporated into the proposed additional guidelines for market design against fire outbreaks in Nigeria.

4.19 Research Question Four: What Additional Guidelines can be Proposed to Improve Market Design against Fire Outbreaks in Nigeria?

Having discussed the opinions of some organisations with respect to the proposed additional guidelines for market design against fire outbreaks in Nigeria, the following research findings have answered research question four. Thus, they were discussed with each organisation that participated in this research.

4.19.1 Findings from the federal fire service of Nigeria with respect to the proposed additional guidelines for Nigerian market design against fire outbreaks

The FFSN stated that underground water reservoir(s) in all the Nigerian markets should be provided in the proposed additional guidelines for market design against fire outbreaks, so that when there are fire outbreaks in the markets, there must be an availability of adequate water to extinguish them. Also, the FFSN suggested that mini fire service stations should be part of the proposed additional guidelines for market design against fire outbreaks in Nigeria.

4.19.2 Findings from the national association of Nigerian traders with respect to the proposed additional guidelines for Nigerian market design against fire outbreaks

The National Association of Nigerian Traders stated that the interior decorative materials of buildings that can easily burn such as carpets should not be used in the market places to avoid easy transfer of fires from one building material to another building material through them. Hence, it was suggested that fire resistant floor tiles with good aesthetic qualities should be incorporated into the proposed additional guidelines for market design against outbreaks of fire in Nigeria, so as to curtail the rate of carpet uses in the markets.

4.19.3 Findings from Abuja markets management limited with respect to the proposed additional guidelines for Nigerian market design against fire outbreaks

Electric power distribution boards must be accessible from outside the lock-up shops in market places, so that in the event of outbreaks of fire from electric power distribution boards, electrical equipment or any part of the lock-up shops, then, electric power control fuses can be removed by the management staff of the markets or other people in the absence of the shop owners. This should be incorporated into the proposed additional guidelines for market design against fire outbreaks in Nigeria.

4.20 Summary of Research Findings

The changes made by the users that could cause fast spread of fire in markets are misuse of non-fire resistant building materials, inappropriate stocking and keeping of goods. Major factors attributed to the changes made by the users that could cause fast spread of fire in markets are misuse of electrical equipment/appliances, mishandling of flammable liquids, misuse of cooking materials/equipment and arson (wilful/intentional acts). Other factors attributed to the changes made by the users that could cause fast spread of fire in markets are misuse of non-fire resistant utility materials and blocking of access roads/spaces for the firefighting vehicles. Passive and active prevention and protection measures against fire and their associated issues in the markets are improper planning against fire such as lack of refuge places, poor consideration of fire escape, use of materials that are not resistant to fire and absence of fire barriers. Others are low turnout of the sales people for training against fires, poor constant practice of fire protection devices; inadequate and poor handling of firefighting equipment.

The current 2013 edition of the NFSCN is not adequate with respect to the frequent outbreaks of market fires. This is because it gives little consideration to the use of building design to reduce outbreaks of fire and the spread of fires in buildings. The FFSN stated that underground water reservoir(s) and mini fire service stations in all the Nigerian markets should be provided in the proposed additional guidelines for market design against fire outbreaks. The National Association of Nigerian Traders recommended that the interior decorative materials of buildings that can easily burn such as carpets should not be used in the market places. The managing company of the markets (Abuja Markets Management Limited) suggested that electric power distribution boards must be accessible from outside the lock-up shops in market places, so that in the event of outbreaks of fire from electric power distribution boards, electrical equipment or any part of the lock-up shops, then, electric power control fuses can be removed by the management staff of the markets or other people in the absence of the shop owners.

4.21 Normality Test

Percentages were employed in presenting all the data of research collected via questionnaires given to the traders. This means that the parameter which was used for the data analysis obtained via questionnaires given to the traders is percentage. Hence, by adopting the numerical and visual methods of normality test for the parametric analysis, the percentage parameters were normally and appropriately distributed throughout the whole analyses, and these have made the results of data analyses to be acceptable because according to scholars such as Open Anesthesia (OAN), Statistics and Data Sciences (SDS) and University of Cincinnati Business Analytics (UCBA),

they are in line with the rules of normality test (Baghban *et al.*, 2013; Fitrianto and Chin, 2016; Ghasemi and Zahedias, 2012; Jason, 2018; Kim, 2013; OAN, 2018; Spinks *et al.*, 2015; SDS, 2015; UCBA, 2018; Zayeri and Jalilian, 2013).

In addition, by employing the numerical and visual methods of normality test for the Descriptive Statistics of the data of research obtained from the sales people in the markets, the results of analyses of data were acceptable because they are also in line with the rules of normality test. Similarly, by adopting the visual method of normality test for the content analyses, the results of content analyses were accepted because of the normal and appropriate comparisons of the research data within the themes and sub-themes. In the same dimension, these are in line with the rules of normality test. Specifically, the additional guidelines that were suggested by the Market Operating Bodies such as the Federal Fire Service of Nigeria, National Association of Nigerian Traders, and the company that manages the markets (Abuja Markets Management Limited) to improve the National Fire Safety Code of Nigeria was validated by visual method of normality test. In this case, it was ensured that the suggested additional guidelines by the Market Operating Bodies are in line with the real life situations of the markets via observations.

CHAPTER FIVE

5.0 PROPOSED ADDITIONAL GUIDELINES FOR MARKET DESIGN IN NIGERIA

5.1 Proposed Additional Guidelines for Designing Regional Built-up Markets against Fire in Nigeria

Giving regards to the research findings and the current 2013 edition of the National Fire Safety Code of Nigeria, the following proposed additional guidelines for designing regional built-up markets against fire were generated and these should be followed when architects are designing Nigerian markets. The reason for these proposed additional design guidelines is to assure maximum values and qualities in the design of regional built-up markets against fire in Nigeria. These proposed additional guidelines were validated via visual method of normality test by systematically comparing the research findings and the proposed additional guidelines. This is to ensure that these proposed additional guidelines were linked to the appropriate research findings.

5.1.1 Site plans

The following items are the proposed additional guidelines for designing the sites of the regional built-up markets. They are car parking spaces, generator houses and waste collection structures, spaces between market buildings, restaurants, cold rooms, access roads, first aid centres and external signage, fire exit gates, emergency entry gates, mini fire service stations, underground water reservoirs.

5.1.1.1 Car parking spaces

i. Adequate car parking spaces should be considered as very important during the design stage of market sites to reduce indiscriminate parking of cars on the parts of roads in markets, in order to allow firefighting vehicles to conveniently access the markets to fight fires in case of fire outbreaks.

ii. The sizes of the car parking spaces should be with regards to the market sizes based on the number of available points of trading with their expected population of car owners. Preferably, a maximum ratio of one parking space to 10 cars (1:10) should be provided in market places with respect to the number of car owners within the market primary external region or metropolis of the user bases, in order to have sufficient parking spaces since people use markets at different times. However, the number of car owners outside the coverage of the market primary external region or metropolis of the user bases that will be expected to come to the markets should also be considered as the factor of safety, in order to reduce the car parking problems in markets.

5.1.1.10 Generator houses and waste collection structures

i. All the market sites must have main fire resistant generator houses, in order to reduce the indiscriminate use of personal electric power generators when there is no supply of public electric power. These will also reduce the storing and sales of petrol in the markets for powering them. Standby fire resistant generator houses should also be provided in the markets.

ii. Waste collection structures (open to sky type) with the height of 1.5 metres should be designed at specified locations on the market site plans where

wastes such as empty cartons and papers among others will be gathered for the waste collection trucks to dispose them. These will reduce the fire spread through the wastes to other materials or buildings that are combustible in the event of outbreaks of market fire.

5.1.1.11 Spaces between market buildings

The spaces between market buildings must be at least eight metres, in order to reduce fire spreads within market buildings. Adequate spaces between market buildings will also allow proper air movement in the internal built environments, in order to have proper natural air ventilation in markets and this will in turn reduce the over dependence on the use of fans and other electrical appliances for artificial ventilation. Figure 5.1 shows an example of the part of proposed site plan of a market with the spaces of eight metres between shop buildings.

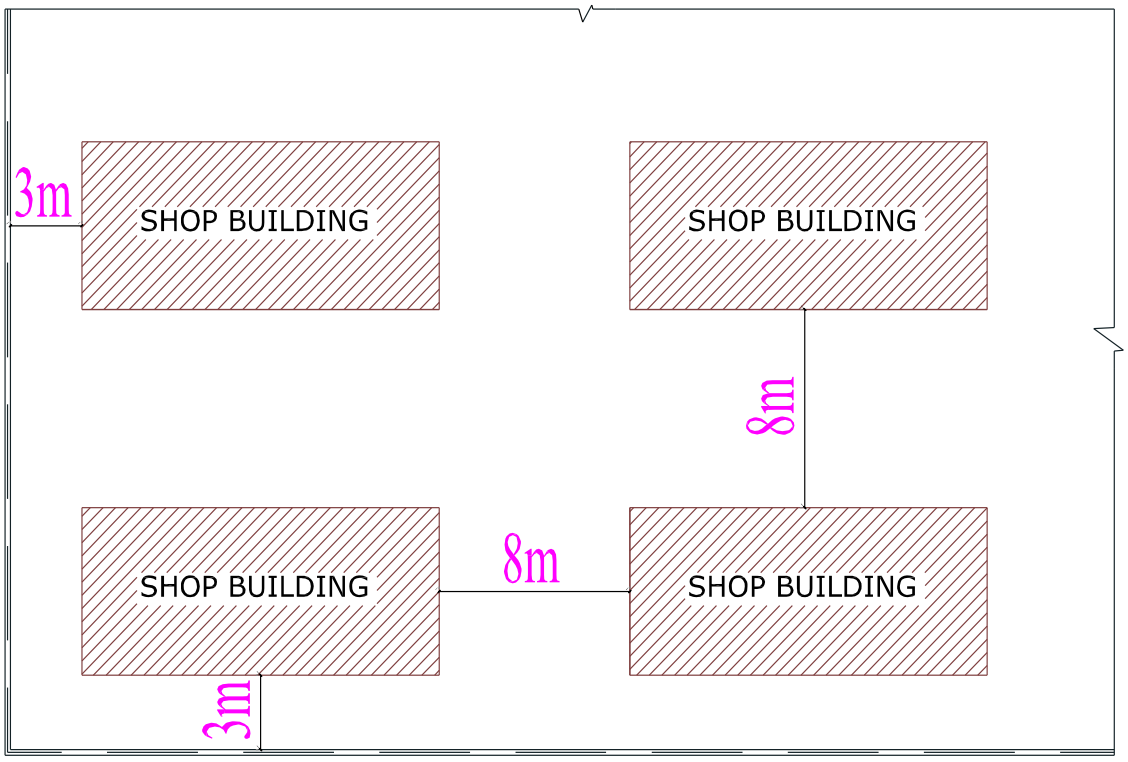

Figure 5.1: Part of the proposed site plan of a market with the spaces of eight metres between shop buildings.

5.1.1.12 Restaurants

i. Adequate numbers of standard restaurants should be designed at specified locations with regards to the market sizes to eliminate illegal restaurants randomly situated in markets. At most, an area with 150 shops should have a restaurant.

ii. There should be adequate setbacks or spaces of at least 20 metres between the restaurants and other buildings to reduce the transfer of fires from the restaurants to other market buildings; these setbacks or spaces can either be used as loading or off-loading bays. Figure 5.2 shows an example of the part of proposed site plan of a market with the spaces of 20 metres between the restaurant and other buildings.

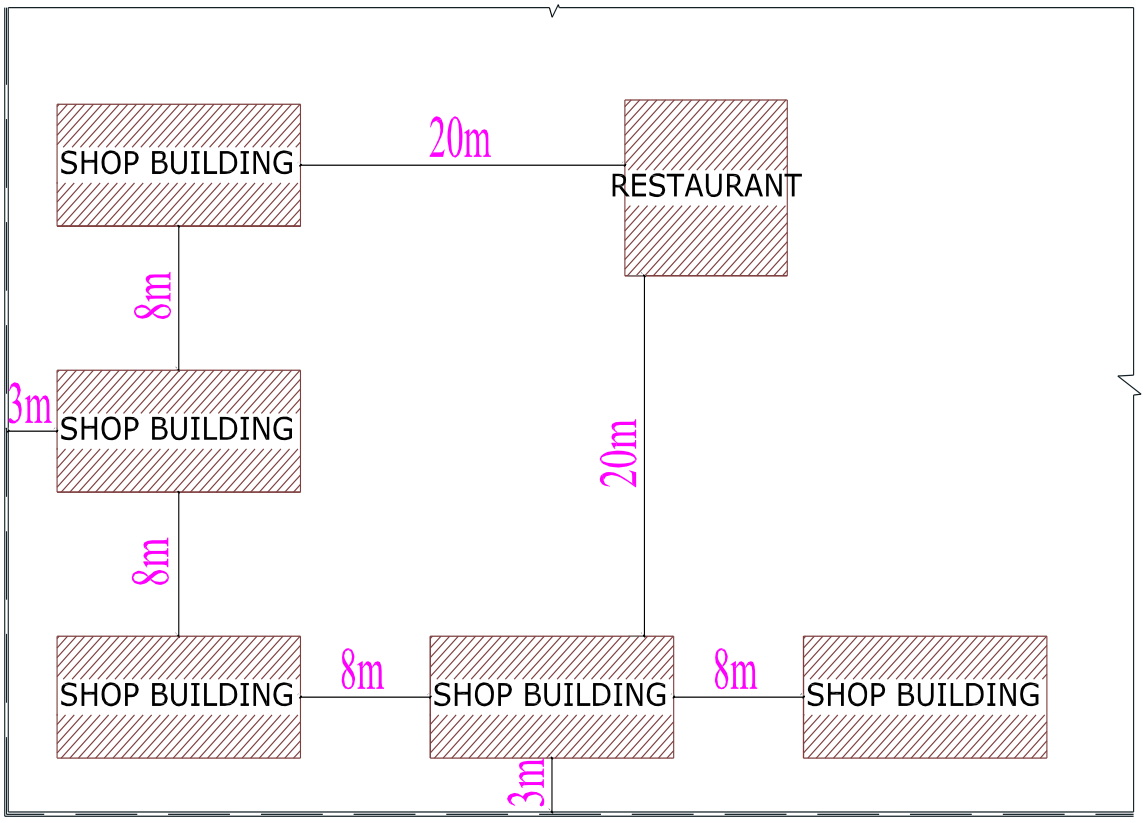

Figure 5.2: Part of the proposed site plan of a market with the spaces of 20 metres between the restaurant and other buildings.

5.1.1.13 Cold rooms

i. There should be a specified section for the cold room buildings or the cold rooms of lock-up shops in the market, if the size of the market is small, so that if there are fire outbreaks in the cold room buildings or cold room of lock-up shops that could not be controlled at the early stages, only this one specified section of the market will be burnt before the arrival of firefighters, in order to reduce the spread of fires from the cold room buildings or the cold rooms of lock-up shops to other market buildings.

ii. There should be different numbers of specified sections for the cold room buildings or the cold rooms of lock-up shops in the market, if the size of the market is big, so that if there are fire outbreaks in the cold room buildings or

cold room of lock-up shops that could not be controlled at the early stages, only these specified sections of the market will be burnt before the arrival of firefighters, in order to reduce the spread of fires from the cold room buildings or the cold rooms of lock-up shops to other market buildings.

iii. Likewise to the guideline for the restaurants in 5.1.1.4 (ii), there should be an adequate setbacks or spaces of at least 20 metres between the cold room buildings or lock-up shops with cold rooms and other buildings to reduce the transfer of fires from the cold rooms to other buildings in markets; again, these setbacks or spaces can either be used as loading or off-loading bays.

5.1.1.14 Access roads

i. The inner turning radius of the access roads in markets should not be less than than 7.5 metres, in order to ensure proper maneuvering of the firefighting vehicles.

ii. The width of access roads in markets should not be less than 6.0 metres, in order to also ensure proper maneuvering of the firefighting vehicles.

iii. Access roads within the markets should be designed such that the lengths of roads before the turn-around facilities (turning points) should not exceed 300 metres, in order to maximise good circulation designs for the firefighting vehicles. Figure 5.3 shows an example of the proposed access roads of a market with the maximum lengths of 300 metres before the turn-around facilities (turning points).

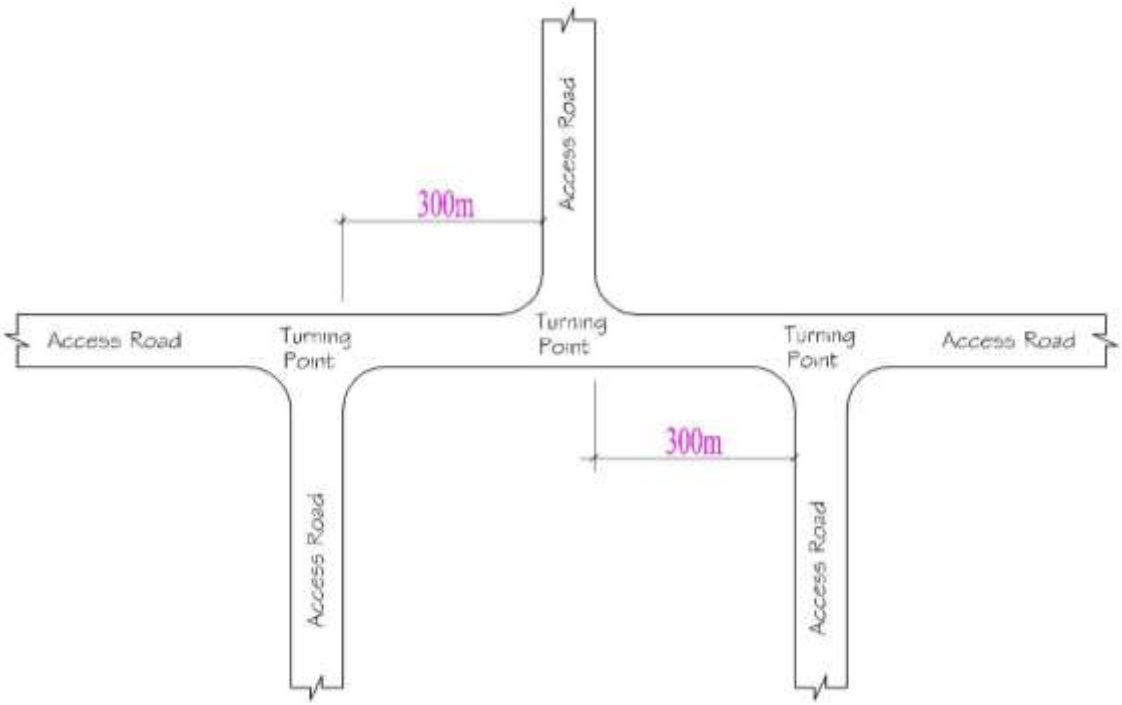

Figure 5.3: Part of the proposed access roads of a market with the maximum lengths of 300 metres before the turn-around facilities (turning points).

iv. Access roads within the markets should be surfaced with concrete, asphalt, tar or any other road paving material, so as to ensure proper movement and maneuvering of the firefighting vehicles.

v. There should be bridges at specified intervals on the canals in markets to allow the accessibility of firefighting vehicles.

5.1.1.15 First aid centres and external signage

i. Markets must have first aid centres where victims of fire outbreaks can receive immediate medical treatments before they can be transferred to hospitals.

ii. Markets must have external signage stands (stand-alone type of external signs for fire exits) to be positioned on the sites (outside the market

buildings) at different locations to direct people to the fire exit gates, so that when there are fire outbreaks, people who are at the risk of fires can easily escape.

5.1.1.16 Fire exit gates

i. All markets must have adequate numbers of fire exit gates and these should be determined by the architects with respect to the sizes of markets in terms of the numbers of available facilities and expected human population. At most, in every 100 metres of the length of market fence, a fire exit gate should be established.

ii. All the fire exit gates of markets must be wide enough (at least six metres) at any proper location to allow adequate evacuation of masses including the disabled people who are at the risk of fires that may need help at the same time.

iii. There should be a provision of adequate spaces as the areas of refuge for the people around all the fire exit gates in markets. This means that no structure should be erected close to the fire exit gates, in order to have adequate spaces for assembly points.

5.1.1.17 Emergency entry gates

Markets should have emergency entry gates of a minimum of six metres wide to allow proper in and out of the firefighting vehicles at the same time, in order to reduce the obstructions from other vehicles when the firefighting vehicles are approaching markets in times of fire outbreaks.

5.1.1.18 Mini fire service stations

i. All markets must have a mini fire service station on the sites for immediate fighting of fire outbreaks before the arrival of the major firefighting vehicles from the main fire service stations to continue extinguishing fires.

ii. All the access roads in markets must have links to all the mini stations for fire service in the markets, in order to ensure adequate firefighting.

5.1.1.19 Underground water reservoirs

i. Depending on the sizes of markets, there must be underground water reservoir(s) of a minimum capacity of 16,000 litres (4,000 gallons) at different intervals or a specified location for fighting fires.

ii. All the access roads in markets must be linked to all the underground water reservoirs in the markets, in order to ensure adequate firefighting.

5.1.2 Floor plans

The following items are the proposed additional guidelines for designing the floors of buildings for the regional built-up markets. They are lock-up shops, places of refuge and number of floors, smoke vents, evacuation routes and front verandahs/corridors.

5.1.2.1 Lock-up shops

i. The size of the space for the lock-up shops on the floor plans must not be less than 18 metres square, so that they can be spacious enough to reduce the rate at which the sales people stock goods close to the ceiling light

bulbs, in order to avoid goods from being ignited when there are electric sparks in the light bulbs. Adequate spaces for the lock-up shops will also reduce non-fire resistant wooden attachments to buildings for the expansion of businesses in markets.

ii. Markets should be designed such that steps are avoided on the corridors of lock-up shops, so as to curtail accidents by the time people who are at the risk of fires are escaping through them. Therefore, all the markets with undulated nature of sites must be given proper foundation step treatments to avoid the introduction of steps on the super structures.

5.1.2.6 Places of refuge and number of floors

i. Where it is necessary and based on the kind of building in the market, floor plans should indicate the positions of places of refuge (meeting places of people before they can be evacuated), in order to maximise safety of people in times of fire outbreaks.

ii. The design of market buildings should not exceed two floors or one storey, so as to curtail the rate of spread of fires within the building verticality and from buildings to adjacent buildings.

5.1.2.7 Smoke vents

i. Floor plans of market buildings should indicate the locations of smoke vents along all the escape routes including the staircases and ramp wells at appropriate intervals (from the intervals of four metres to ten metres), in order to reduce suffocation as a result of the smoke from fires.

ii. The locations of smoke vents in the market buildings should at least start at four metres from the starting points of the fire escape routes, in order to reduce suffocation as a result of smoke from fires.

5.1.2.8 Evacuation routes

i. Where it is necessary and based on the kind of building in the market, floor plan should incorporate the position of primary and secondary evacuation routes.

ii. The width of all the evacuation routes in the market buildings should not be less than 1.8 metres, in order to allow three people who are at the risk of fires to escape properly. Exceptionally, the minimum width of 1.2 metres can be allowed in the administrative buildings or other buildings with a low human population, in order to allow two people who are at the risk of fires to escape properly.

5.1.2.9 Front verandahs/corridors

i. Floors of lock-up shops in markets must be planned to have front corridors/verandahs, in order to reduce the use of canopies as roof sun shading devices for the sit out areas which in turn cause the fast spread of fire in markets. Figure 5.4 shows an example of the proposed floor design of the lock-up shop of a market building displaying a front corridor.

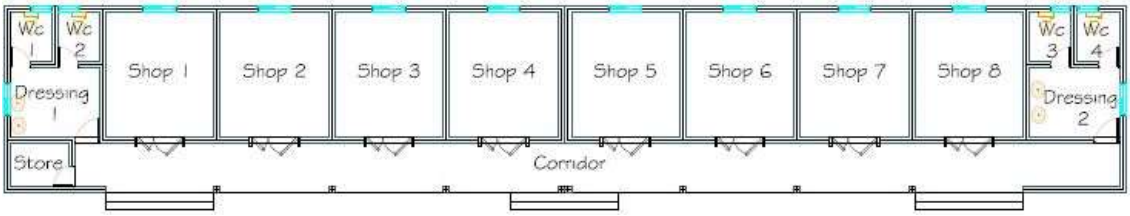

Figure 5.4: Proposed floor design of the lock-up shop of a market building displaying a front corridor, and the positions of the high level mini windows of the shops.

ii. Also, the front verandahs/corridors of the floors of lock-up shops can be used for displaying goods for sale and they will in turn reduce the rate at which the sales people display goods along the access spaces for the firefighting vehicles.

iii. The front verandahs/corridors of the floors of lock-up shops must have a minimum vertical width (depth) of 1.8 metres to reduce the rate at which the sales people use aluminium roof for sun shading devices in the sit out areas, and to also reduce the rate at which the rain water enters the lock-up shops and thereby reduce the use of tarpaulins to cover the fronts of verandahs, in order to reduce the fast spread of fires through them.

5.1.4 Design of stair cases and ramps

The following items are the proposed additional guidelines for designing the staircases and ramps of buildings for the regional built-up markets. They are fire emergency escape stairs, normal stair cases and fire emergency escape ramps.

5.1.3.1 Fire emergency escape stairs

i. The vertical lengths (depths) of landing spaces of the fire emergency stair wells of lock-up shop storey buildings should not be less than the widths of the stair flights, and they should have minimum widths of 1.8 metres to allow three people who are at the risk of fire to escape through them unhindered at the same time.

ii. The threads of fire emergency escape stairs of the market buildings should have a minimum vertical width (depth) of 0.3 metre to allow the feet of the people who are at the risk of fire to conveniently fit into them, so as to curtail the rate of fall of the people on the fire emergency escape stairs.

iii. The risers of fire emergency escape stairs of the market buildings should have a maximum height of 0.15 metre, so as to curtail the rate of fall of the people on the fire emergency escape stairs.

5.1.3.2 Normal stair cases

The lock-up shop storey building in markets should be designed such that the number of shops per normal staircase should not exceed six, in order to ensure their adequacy for sufficient escape of people in times of fires.

5.1.3.3 Fire emergency escape ramps

i. Storey buildings in markets must be designed to have a fire emergency escape ramps for the disable people who are at the risk of fire.

ii. Fire emergency escape ramps in buildings in the markets should be planned in such away that the disabled people who are at the risk of fire can find themselves outside the market buildings immediately after the escape rampwells and they should be located externally in the market buildings to avoid obstruction by people. Figure 5.5 shows an example of the proposed floor plan of a market building with an emergency escape ramp.

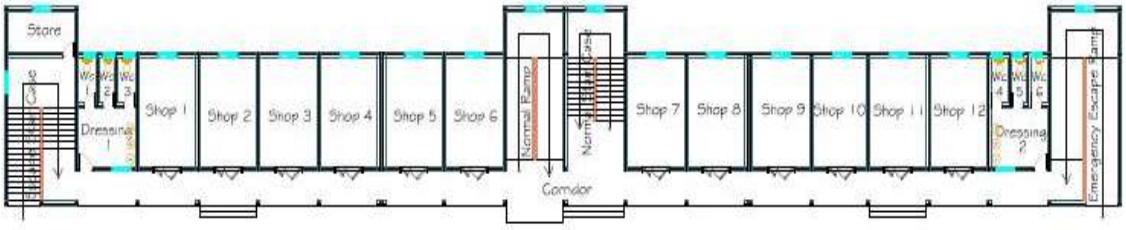

Figure 5.5: Proposed floor plan of a market building with an emergency escape ramp.

5.1.4 Design of walls

The following items are the proposed additional guidelines for designing the walls of buildings for the regional built-up markets. They are inner walls of front verandahs/corridors and non-use of sandcrete block walls.

5.1.4.1 Inner walls of front verandahs/corridors

i. Having incorporated the mandatory front verandahs/corridors into the design of the floor plans of lock-up shops of the market buildings, the inner walls of front verandahs/corridors of the lock-up shops should be where electrical power distribution boards will be appropriately mounted to allow open and quick access for the removal of electrical power fuses by the staff of the managing companies of markets or other people in case the shop

owners will not be available during the outbreaks of fire, so as to curtail the effects of lock-up shop fires.

ii. Likewise, the inner walls of front verandahs/corridors should be employed appropriately as the positions where the needed wall mountable devices for fire protection such as fire hose reels, portable extinguishers for fire and warden phones for fire shall be fixed upon.

5.1.5.3 Non-use of sandcrete block walls

Sandcrete blocks should not be used as design specifications for the construction of market buildings because they are not well resistant to fire. Brick walls are preferable to sandcrete block walls because bricks are very resistant to fire.

5.1.6 Design of doors and windows

The following items are the proposed additional guidelines for designing the doors and windows of buildings for the regional built-up markets. They are fire escape doors and window openings.

5.1.5.1 Fire escape doors

The fire escape doors (external doors) of market buildings at the primary evacuation route should have a minimum width of 1.8 metres, in order to allow three people who are at the risk of fire to escape conveniently at the same time.

5.1.5.2 Window openings

i. The shop buildings in markets should be designed to have high level mini windows at the opposite or adjacent opposite of their entrance doors. The windows should allow adequate stocking of goods, in order to achieve a cross ventilation through them and the entrance doors of lock-up shops. A cross ventilation in the lock-up shops will reduce the over dependence on the use of fans and other electrical appliances to control temperatures since they are among the causes of outbreaks of fire in the markets. Figure 5.4 also shows an example of the proposed floor plan of a lock-up shop building with the positions of high level mini windows of the lock-up shops, while Figure 5.6 shows an example of the proposed back elevation of a lock-up shop building with the arrangement of high level mini windows and the normal toilet windows below their heights.

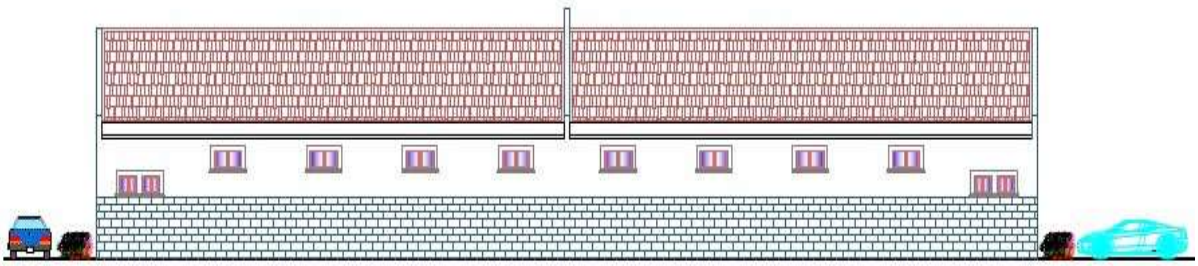

Figure 5.6: Proposed back elevation of a lock-up shop building with the arrangement of high level mini windows and the normal toilet windows below their heights.

ii. The evacuation routes in market buildings must have window openings for natural lighting where there are no provision for other openings apart from doors, in order to aid proper escape of people through adequate natural lighting, if the windows are opened during the fire outbreaks. These will

also reduce suffocation of people in case of fire outbreaks in the evacuation routes of market buildings.

5.1.7 Design of ceilings or head rooms

The following items are the proposed additional guidelines for designing the ceilings or head rooms of buildings for the regional built-up markets. They are composite ceilings and head rooms.

5.1.6.1 Composite ceilings

Composite ceilings [non-combustible metal plates covered with Plaster of Paris (P.O.P) at the bottoms with fire resistant paints of at least two hours rating on the outer part of P.O.P] should be used for the design of market buildings, so that when there are fire outbreaks spreading through the P.O.P after at least two hours, the non-combustible metal plates will automatically stop the fires from spreading to the roof members. Figure 5.7 shows an example of the section of a proposed shop building revealing the composite ceiling arrangement connected to the roof structural members.

Figure 5.7: Section of a proposed shop building revealing composite ceiling arrangement connected to the roof structural members.

5.1.6.3 Head rooms

i. Since the restaurants and cold room buildings or cold rooms of the lock-up shops in markets are prone to fire outbreaks, their head rooms must be decked to be able to resist fires and to also avoid the transfer of fires from them to other building materials or other parts of the market buildings.

ii. The head rooms of verandahs or corridors where the electrical power distribution boards will be mounted should be decked to be able to resist fires in case of fire outbreaks from the electrical power distribution boards

as a result of misuse of electrical appliances in the lock-up shops or as a result of any electrical fault.

5.1.7 Design of roof members

The following items are the proposed additional guidelines for designing the roof members of buildings for the regional built-up markets. They are wall barriers and roof structural members.

5.1.7.1 Wall barriers

i. The roofs of buildings in markets that are up to 40 metres of lengths should have at least 0.6 metre heights of wall barriers above the total heights of roofs at the middles of the total horizontal lengths of buildings to reduce the spread of fires within the roof coverings and roof structural members. Figure 5.8 shows an example of a proposed market shop building with 0.6 metre height of the wall barrier to curtail fire spreads at the middle of its total horizontal length.

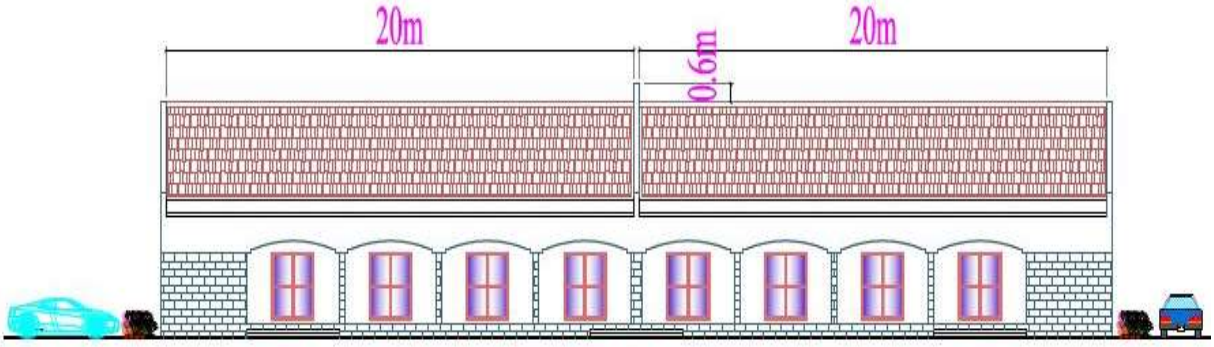

Figure 5.8: Proposed market shop building with 0.6 metre height of the wall barrier at the middle of its total horizontal length.

ii. In addition, by still maintaining the minimum of 0.6 metre heights of the wall barriers to reduce the spread of fires, architects should determine the lengths of horizontal intervals of the wall barriers above the total heights of roofs of the market buildings that the lengths are more than 40 metres. This means that if the roofs of market buildings are very long (exceeding the lengths of 40 metres), at most, in every 20 metres of length, wall barrier must be established to reduce the spread of fires within the roof coverings and roof structural members. Figure 5.9 shows an example of a proposed market shop building with 0.6 metre heights of the wall barriers at determined intervals along the horizontal length of the building to reduce the spread of fires.

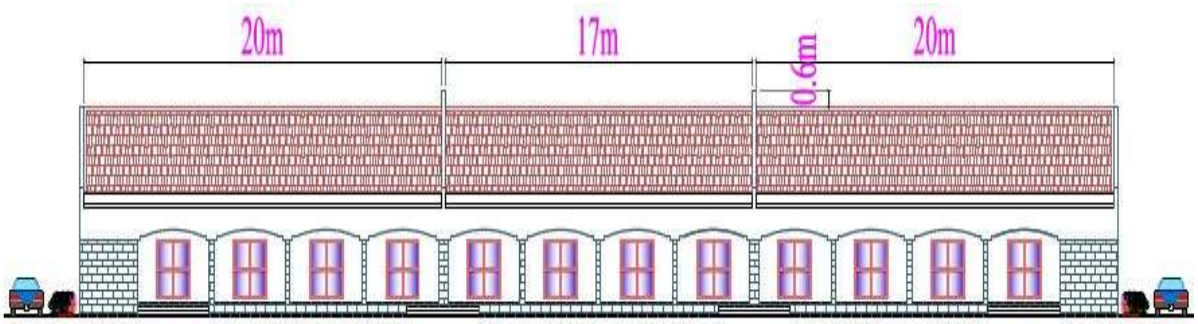

Figure 5.9: Proposed market shop building with 0.6 metre heights of the wall barriers at determined intervals along the horizontal length of the building.

5.1.7.3 Roof structural members

All the roof structural members of the market buildings must be steel type irrespective of how high are the roofs above the floor levels immediately below them, in order to reduce the spread of fires within the roof members when the electrical wires in the ceiling may be burning as a result of electrical faults.

5.1.8 Design of building fascia

The following items are the proposed additional guidelines for designing the fascia of buildings for the regional built-up markets. They are non-combustible metal and concrete building fascia, and fire resistant treated building fascia.

5.1.8.1 Non-combustible metal and concrete building fascia

i. Fascia of all the buildings in markets must be designed to be able to withstand fires. For example, the design of building fascia can be made up of non-combustible metal plates instead of ordinary aluminium or wooden fascia boards, because ordinary aluminium or wooden fascia boards have low resistance to fires.

ii. Design of fascia of market buildings can also be concrete type, in order to achieve high fire resistance in them.

5.1.8.2 Fire resistant treated building fascia

If ordinary wood or aluminium must be used as design specifications for building fascia, then, fire resistant treated wood or aluminium with the fire resistant period of at least two hours should be used for such design specifications.

5.1.10 Interior design

The following items are the proposed additional guidelines for the interior design of buildings for the regional built-up markets. They are shelves, bases for keeping goods, and fowl cages.

5.1.9.1 Shelves

i. Shelves must be incorporated into the design of lock-up shops of markets to stop the sales people from constructing non-fire resistant wooden shelves in the lock-up shops.

ii. Design specifications for shelves in the lock-up shops should be non-combustible metal plates in addition to any other building materials that can resist fires as specified in the current (2013) National Fire Safety Code of Nigeria (NFSCN), so as to curtail the rate at which fire spreads from them to other interior building materials, goods and properties in the event of outbreaks of fire.

iii. The minimum distance between the ceilings or head rooms of lock-up shops and the total heights of shelves in the lock-up shops in markets should be 1.5 metres, so as to minimise the risk of having contacts between the electric bulbs under/around the ceiling and goods on the shelves as a result of stocking goods on the shelves very close to the electric bulbs by the sales people. This will minimise the transfer of fires from the electric bulbs to the goods on shelves when there are electrical faults that may lead to the sparks of the bulbs.

5.1.10.2 Bases for keeping goods, and fowl cages

i. Bases for keeping goods, and fowl cages must be incorporated into the design of open stalls of markets to stop the sales people from constructing non-fire resistant wooden bases for keeping goods, and non-fire resistant wooden fowl cages in the open stalls.

ii. The design specifications for the bases for keeping goods, and fowl cages in the open stalls of markets should be non-combustible metal plates in addition to any other building materials that can resist fires as specified in the 2013 edition of the NFSCN, so as to curtail the rate at which fire spreads from them to other interior building materials, goods and properties in the event of outbreaks of fire.

5.1.11 Finishes

The following items are the proposed additional guidelines for the finishes of buildings for the regional built-up markets:

i. Floors of the buildings in markets must be finished with concrete floor tiles or other tiles that can resist fires for at least four hours.

ii. The floor tiles must be very beautiful to reduce the use of floor carpets in markets, since carpets have no fire resistance and they can transfer the flames of fires from one material or property to others in market buildings.

CHAPTER SIX

6.0 CONCLUSION AND RECOMMENDATIONS

6.1 Conclusion

Prevention and protection measures against market fires in the Federal Capital Territory of Nigeria were evaluated in this research as a result of frequent fire outbreaks in markets in different locations in Nigeria which have resulted to the loss of substantial goods, properties and human lives. The results of this research revealed that among the changes made by the users that cause fast spread of market fires is fixing of canopies in between the roofs of two or more buildings as sun shading devices by the sales people. The major factors attributed to the changes made by the users that cause fast spread of market fires are from electricity related issues such as indiscriminate use of personal electricity generators. Among other factors that cause fast spread of market fires are the sales of petrol, and cooking with naked fires such as fire wood and charcoal fires.

Among the design issues of the markets are rampant use of combustible building materials; some buildings were designed with inadequate spaces between them and this issue cannot allow firefighting vehicles to pass or properly pass through the spaces between the buildings to fight fires in case of fire outbreaks. Moreover, two buildings were designed in the market such that their walls are joint together and thereby making their roofs to appear like folded type of roof; when there is fire outbreak in any of the buildings, the transfer of fire from the affected building to the second building is absolutely inevitable. Furthermore, there are some market buildings without front corridors or verandahs for mounting extinguishers for fire or other mountable devices

for fire protection on their inner walls. Consideration of the design of the markets that were studied revealed that there is a need for an improvement on the National Fire Safety Code of Nigeria (NFSCN) with regards to market design. The results of this research were used to propose additional guidelines to improve the NFSCN with respect to market design.

6.1.1 Contribution to knowledge

This research has proposed additional design solutions for architects; in a greater dimension, they will help to reduce fire incidences in Nigerian markets. The proposed additional design guidelines have improved the current (2013) NFSCN. The research has laid a base for a continuous and future study with regards to the evaluation of protection and prevention measures against market fires in Nigeria, so as to acquire continuously improved design of markets against outbreaks of fire. It has also informed the government of Nigeria, market managers and the general public by highlighting the various inappropriate activities that cause the fast spread of fire in markets, and how they can be prevented.

6.1.2 Areas for further research

The rates of combustion of building materials per time were not considered in this research, in order to know the rates of burning of the markets per time in relations to human interventions. Also, the research did not investigate the resultant effects of previous fire outbreaks on the sales people in the study area. Likewise, there is no assessment that was carried out with regards to the number of sales people that have

fire insurance cover, in order to know how the sales people are prepared to recover their lost goods and properties when there are fire outbreaks in the markets. All the statements in this subsection are the gaps in this research. Therefore, it is recommended that in subsequent research of this nature, these gaps should be filled.

6.2 Recommendations

From the findings of this study, recommendations were made to minimise the outbreaks of fire in Nigerian markets as follows:

i. Government of Nigeria should provide more regional built-up markets with bigger numbers of sales points in different locations in Nigeria, so that many people can get spaces for sale, in order to reduce the erection of illegal non-fire resistant wooden structures for lock-up shops in market places. These will also reduce the indiscriminate use of umbrella stands in markets for business activities, so as to curtail the rate of fire spreads in the markets through them. Likewise, they will reduce the rate at which the sales people partition single lock-up shops with non-fire resistant wood for two different sales spaces due to high demands for lock-up shops.

ii. Management authorities of markets in Nigeria should ban cooking with naked fires such as fire wood and charcoal fires, and there must be appropriate actions to that effect, in order to reduce fire outbreaks from them.

iii. Management authorities of markets in Nigeria should make it a law for all the sales people to put off electrical equipment when they are not in use by the time businesses are closed at night, so as to curtail their overheating or

any other factor that can lead to fire outbreaks in markets. Alternatively, there should be provision for the central or general control switches for all the market buildings in Nigeria, in order to make all the electrical power supply of the market buildings to be off from them by the market management personnel at night, while living all the external lighting to be on for security reasons. These will eliminate the overheating of electrical appliances that can lead to fire outbreaks at night.

iv. Authorities that manage Nigerian markets should create enforcements for the mandatory trainings of fire consciousness and preparedness for all the sales people in markets, since the majority of them are not responding to calls for training of how to prevent fire outbreaks and the use of fire protection devices. This implies that provision should be made for the enforcements of trainings for all market traders with regards to the protection and prevention measures against market fires by the Markets Operating Bodies such as the authorities that manage markets, National Association of Nigerian Traders, and Federal Fire Service of Nigeria with constant yearly certificates of participation to be given to them, and such certificates of participation should be subject to yearly expiration, so as to annually qualify the traders to conduct market business transactions.

v. During the training of the sales people with regards to protection and prevention measures against market fires by the Operating Bodies of markets, they should be well educated with regards to the knowledge of signage (signs for fire exits) to aid appropriate fire exits in case of serious outbreaks of fire that may fail to be controlled in the markets.

vi. Nigerian government should make sure that all the protection devices for market fires should have constant and proper maintenance in an acceptable order by the authorities that manage markets. This will allow easy fire control at the early stages in the event of outbreaks of fire, so as to curtail the rate of fires spread in buildings in the markets. To ensure this achievement, provision for the constant inspection of protection devices for fire should be made in markets by the representatives of government on annual basis to make sure that they are well and constantly maintained through their appropriate workability tests.

vii. Nigerian government should completely ban the use of substandard extinguishers for market fires, so that in the event of outbreaks of fire, standard extinguishers for fire can be employed to easily combat them at the early stages, so as to curtail the rate of fires spread in buildings in the markets. To make this achievement, provision for constant inspection of extinguishers for fire should be made in markets by the representatives of government on annual basis with subsequent actions to curtail the rate of use of substandard extinguishers for fire.

viii. The current 2013 edition of the NFSCN should be reviewed to adequately focus on the use of building design to reduce outbreaks of fire and the spread of fires in buildings (passive protection and prevention measures against fire). This will ensure maximum efficiency, so as to curtail the loss of properties, goods and human lives in Nigerian markets.

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APPENDICES

Appendix A: Questionnaires Administered to the Sales People in the Study Area

This questionnaire seeks to elicit information on the fire prevention and protection measures in Nigerian markets: the case studies of Wuse market, Garki model market and Kado market of the Federal Capital Territory of Nigeria. It is for the purpose of an academic exercise. Please, you are requested to complete the items. The confidentiality of your responses is assured.

Instructions: Please, kindly tick the spaces [√] provided for the questions to answer appropriately.

Section A: demographic and socio-economic features

1. Gender: a. Male [ ] b. Female [ ].
2. Age: a. 15 years and below [ ] b. 16 – 26 years [ ] c. 27 – 37 years [ ] d. 38 – 48 years [ ] e. 49 years and above [ ].
3. Educational background: a. No formal education [ ] b. Primary education [ ] c. Secondary School [ ] d. Tertiary education [ ].
4. Religion: a. Christian [ ] b. Muslim [ ] c. Traditionalist [ ] d. No religion [ ] e. Other: please, specify: ….……..

Section B: attitudes and perceptions of the sales people

1. What is the main cause of fire outbreaks in this market?
   a. Electrical equipment/wiring [ ] b. Arson (Intentional fires) [ ]
   c. Smoking (fire from cigarette end) [ ] d. Do not know [ ] e. Others [ ]: please specify: ….…….....
2. Are there ways of escape of people (fire exits) in case of fire outbreaks in this market? a. Yes [ ] b. No [ ]. c. Not aware [ ].
3. Are there signs for fire exits in this market? a. Yes [ ] b. No [ ].
4. Do you comply with signage (signs for fire exits) in times of fire outbreaks in this market? a. Yes [ ] b. No [ ] c. No signage to comply with [ ].

5. If there are ways of escape of people (fire exits) in this market, what is the level of your satisfaction with regards to them in case of fire outbreaks? a. Very satisfied [ ] b. Satisfied [ ] c. Neither satisfied nor dissatisfied [ ] d. Dissatisfied [ ] e. Very dissatisfied [ ].
6. Do you have firefighting equipment in this market? a. Yes [ ] b. No [ ].
7. Have you ever received training on how to use firefighting devices in this market? a. Yes [ ] b. No [ ] c. No firefighting equipment [ ].
8. Do you know how to operate firefighting equipment in this market? a. Yes [ ] b. No [ ] c. No firefighting equipment [ ].
9. What is the level of your satisfaction with regards to the firefighting equipment in this market? a. Very satisfied [ ] b. Satisfied [ ] c. Neither satisfied nor dissatisfied [ ] d. Dissatisfied [ ] e. Very dissatisfied [ ].

Thank you very much for the given time and assistance.

Appendix B: Interview Questions Administered to the Managing Company of Wuse Market, Garki Model Market and Kado Market (Abuja Markets Management Limited)

These interview questions were designed for a research on the evaluation of fire prevention and protection measures in Nigerian markets: the case studies of Wuse market, Garki model market and Kado market. The answers provided shall therefore be treated confidentially.

Section A: the approach and challenges of managing market fires.

Please, kindly tick the spaces [√] provided to answer appropriately.

1. What is the main cause of fire outbreaks in this market? a. Electrical equipment/wiring [ ] b. Arson (Intentional fires) [ ] c. Smoking (fire from cigarette end) [ ] d. Do not know [ ] e. Others: please specify: …….....
2. Are there ways of escape of people (fire exits) in case of fire outbreaks in this market? a. Yes [ ] b. No [ ].
3. Are there signs for fire exits in this market? a. Yes [ ] b. No [ ].
4. Are there adequate signs for the fire exits in this market? a. Yes [ ] b. No [ ].
5. What is the level of your satisfaction with regards to the ways of escape of people (fire exits) in case of fire outbreaks in this market? a. Very satisfied [ ] b. Satisfied [ ] c. Neither satisfied nor dissatisfied [ ] d. Dissatisfied [ ] e. Very dissatisfied [ ].
6. Can firefighting vehicles access this market? a. Yes [ ] b. No [ ].
7. Can firefighting vehicles move through this market to quench fire in case of fire outbreaks? a. Yes [ ] b. No [ ]. c. No access for firefighting vehicles [ ].
8. Does this company take time to train or teach the sales people in the market on how to use fire protection devices? a. Yes [ ] b. No [ ].
9. How often do this company train or teach the sales people in this market on how to use fire protection devices? a. 4 months and below [ ] b. 5 – 11 months [ ] c. 1 – 2 years [ ] d. 3 years and above [ ] e. No training for sales people [ ].
10. Are the sales people able to operate fire protection devices after learning how to use them? a. Yes [ ] b. No [ ] e. No training for the sales people [ ]

Section B: kind/adequacy of firefighting equipment and personnel

Please, kindly fill the spaces provided to answer appropriately.

1.

Firefighting Equipment in the Market	**Available Number**	**Inspection and Maintenance Interval**
Emergency Lighting System		
Fire Alarm System		
Automatic Fire Suppression System		
Sprinkler System		
Street Fire Hydrants		
Fire Hose Reels		
Portable Fire Extinguishers		
Others (Please, specify): …… …… ……		

2.

Description of Labour/Worker with Respect to the Prevention of Fire Outbreaks in the Market	**Available Number**	**Range of Salary in Naira**
Fire Warden		
Market Patrol Team		
Qualified Electrical Inspector		
Others (Please, specify) ……..……... …… ……		

3. How does this company deals with fire outbreaks in this market?

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4. What are the problems that result from dealing with the fire outbreaks in this market?

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6. What does this company intends doing about these problems?

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7. In the opinion of this company, how can fire outbreaks in this market be reduced?

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Thank you very much for the given time and assistance of this company.

Appendix C: Interview Questions Administered to the National Association of Nigerian Traders of the Federal Capital Territory of Nigeria

These interview questions were designed for a research on the evaluation of fire prevention and protection measures in Nigerian markets: the case studies of Wuse market, Garki model market and Kado market. The answers provided shall therefore be treated confidentially. Please, fill and tick the spaces [√] provided to answer appropriately.

1. What are the main causes of fire outbreaks in Wuse market, Garki model market and Kado market that are known to you?
   a. Wuse market: ……
   ……
   ……
   b. Garki model market: ..……....
   ……....
   .....
   c. Kado market:...……
   ……
   ……
2. How can you access the design of Wuse market, Garki model market and Kado market against fire outbreaks?
   a. Wuse market: ..……..
   ……
   ……
   b. Garki model market: ..……....
   ……....
   .....
   c. Kado market: ..……
   ……
   ……

3. Does this association takes time to involve the members to learn about the uses of fire protection devices in Wuse market, Garki model market, and Kado market? a. Yes [ ] b. No [ ] c. No fire protection devices to learn in the market(s) [ ]; please, specify the market(s): ……..……...
……
4. How often this association does organise training for the sales people in the markets on how to use fire protection devices? a. 4 months and below [ ] b. 5 – 11 months [ ] c. 1 – 2 years [ ] d. 3 years and above [ ] e. No training for the sales people [ ].

5. Are the sales people able to operate fire protection devices after learning how to use them? a. Yes [ ] b. No [ ] e. No training for the sales people [ ].
6. How does this association deals with fire outbreaks in Wuse market, Garki model market and Kado market?
   a. Wuse market: …….……
   ……
   ……
   b. Garki model market: ……....
   ……....
   .....
   c. Kado market: ……
   ……
   ……
7. What are the problems that result from dealing with fire outbreaks in Wuse market, Garki model market, and Kado market?
   a. Wuse market: .……
   ……
   ……
   b. Garki model market: ……....
   ……....
   .....
   c. Kado market: ..……
   ……
   ……

8. In the opinion of this association, how can fire outbreaks in Wuse market, Garki model market and Kado market be reduced?

   a. Wuse market: ……...

   ……

   ……

   ……

   ……

   ……

   b. Garki model market: ……....

   ……....

   .....

   .....

   .....

   .....

   c. Kado market: ..……

   ……

   ……

   ……

   ……

   ……

Thank you very much for the given time and assistance of this association.

Appendix D: Interview Questions Administered to the Federal Fire Service of Nigeria in the Federal Capital Territory of Nigeria

These interview questions seek to elicit information on the fire prevention and protection measures in Nigerian markets: the case studies of Wuse market, Garki model market and Kado market of the Federal Capital Territory of Nigeria. They are for the purpose of an academic exercise. Please, you are requested to complete the items. The confidentiality of your responses is assured.

1. What are the salient attributed causes of fire outbreaks in Wuse market, Garki model market and Kado market that are known to you?
   a. Wuse market: ……..……....
   ……
   ……
   ……
   ……
   b. Garki model market: ...……...
   ……....
   .....
   .....
   .....
   c. Kado market: ..……
   ……
   ……
   ……
   ……
2. Can the firefighting vehicles of the Federal Fire Service of Nigeria access Wuse market, Garki model market and Kado market in case of fire outbreaks?
   a. Yes [ ] b. No [ ] c. I do not know [ ] d. Not in all the three markets [ ]; please, specify the market(s) they cannot access: ……
   …….....

3. If there are access roads for the firefighting vehicles, can firefighting vehicles of the Federal Fire Service of Nigeria move through Wuse market, Garki model market and Kado market to quench fires, in case of fire outbreaks? a. Yes [ ] b. No [ ]. c. I do not know [ ] d. Not in all the three markets [ ]; please, specify the market(s) that the firefighting vehicles cannot move through: ……..…… …….....
4. Are there ways of escape of people (fire exits) in case of fire outbreaks in Wuse market, Garki model market and Kado market? a. Yes [ ] b. No [ ]. c. I do not know [ ] d. Not all the three markets [ ]; please, specify the market(s) that does or do not have fire exits: ……
5. What is the level of your satisfaction with regards to the ways of escape of people in case of fire outbreaks in the market(s) where there are fire exits? a. Very satisfied [ ] b. Satisfied [ ] c. Neither satisfied nor dissatisfied [ ] d. Dissatisfied [ ] e. Very dissatisfied [ ].
6. Please, can you give reasons for your answer in number five (5) above?
   a. Wuse market: ..…….……..
   ……
   b. Garki model market: ……..
   ..……..
   c. Kado market: ..……
   ……
7. If there are fire exits in Wuse market, Garki model market and Kado market, are there signs for the fire exits in those markets? a. Yes [ ] b. No [ ] c. I do not know [ ] d. Not in all the three markets [ ]; please, specify the market(s) that does or do not have the signs for fire exits: ……...…….……
8. If there are signs for the fire exits in Wuse market, Garki model market and Kado market, are they adequate in those markets? a. Yes [ ] b. No [ ] c. I do not know [ ] d. Not in all the three markets [ ]; please, specify the market(s) that does or do not have adequate signs for fire exits: ...…….....……

9. Does this organisation takes time to educate the sales people in Wuse market, Garki model market and Kado market on how to prevent fire outbreaks in the markets? a. Yes [ ] b. No [ ]. c. Not in all the three markets [ ]; please, specify the market(s) that this organisation is not educating: …….....
10. If this organisation does educate the sales people in Wuse market, Garki model market and Kado market on how to prevent fire outbreaks, how often is this exercise being carried out? a. 4 months and below [ ] b. 5 – 11 months [ ] c. 1 – 2 years [ ] d. 3 – 4 years [ ] e. 5 years and above [ ].
11. How can you assess the pattern of the design of Wuse market, Garki model market and Kado market against fire outbreaks?

    a. Wuse market: .....

    ……...

    .....

    b. Garki model market: ..……

    ……

    ……....

    c. Kado market: ..……

    ……

    ……
12. Are there fire protection devices in Wuse market, Garki model market and Kado market? a. Yes [ ] b. No [ ]. c. I do not know [ ]. d. Not in all the three markets [ ]; please, specify the market(s) that does or do not have fire protection devices: ...…….. …….....
13. If there are fire protection devices in Wuse market, Garki model market and Kado market, are they adequate in those markets? a. Yes [ ] b. No [ ] c. I do not know [ ] d. Not in all the three markets [ ]; please, specify the market(s) that does or do not have adequate fire protection devices: ...……..…..…….....
14. Does this organsation takes time to educate the sales people in Wuse market, Garki model market and Kado market on how to use fire protection devices? a. Yes [ ] b. No [ ].

15. How often does this organisation educate the sales people in those markets on how to use fire protection devices? a. 4 months and below [ ] b. 5 – 11 months [ ] c. 1 – 2 years [ ] d. 3 years and above [ ] e. No education [ ].
16. What measures had the Federal Fire Service of Nigeria put in place to manage fire outbreaks in Wuse market, Garki model market and Kado market?
    a. Wuse market: .....
    ……...
    b. Garki model market: ..……
    ……
    c. Kado market: ..……
    ……
17. What are the challenges the Federal Fire Service of Nigeria is facing with respect to the fire management in Wuse market, Garki model market and Kado market?
    a. Wuse market: .....
    ……...
    b. Garki model market: ..……
    ……
    c. Kado market: ..……
    ……
18. In the opinion of this organisation, how can fire outbreaks in Wuse market, Garki model market and Kado market be reduced?
    a. Wuse market: .....
    ……...
    .....
    .....
    b. Garki model market: ..……
    ……
    ……
    ……

c. Kado market: ..……
……
……
……

Thank you very much for the given time and assistance of this organisation.

Appendix E: Discussion Guide for the Staff of the Federal Fire Service of Nigeria, National Association of Nigerian Traders, and Managing Company of the Markets

This discussion seeks to elicit information on the evaluation of fire prevention and protection measures in Nigerian markets. The case studies of Wuse market, Garki model market and Kado market. It is for the purpose of an academic exercise. Please, you are requested to respond to the questions accordingly. The confidentiality of your responses is assured.

The following items were addressed during the discussion with the staff of the Federal Fire Service of Nigeria, National Association of Nigerian Traders, and the managing company of the markets.

1. The causes of fire outbreaks in the markets.
2. Ways by which fire outbreaks in the markets can be curtailed.
3. The design of the markets against fire outbreaks.
4. Fire drills for the sales people in the markets.
5. Fire protection devices in the markets; their maintenance and adequacies.
6. Determination of the adequacy of the National Fire Safety Code of Nigeria with respect to markets.
7. The development of appropriate guidelines to improve market design against fires.

Appendix F: Focus Group Discussion Guide for the Sales People in the Study Area

This focus group discussion seeks to elicit information on the evaluation of fire prevention and protection measures in Nigerian markets: the case studies of Wuse market, Garki model market and Kado market. It is for the purpose of an academic exercise. Please, you are requested to respond to the questions accordingly. The confidentiality of your responses is assured.

The following items were addressed during the focus group discussion with the sales people in the markets.

1. The causes of fire outbreaks in the study domain.
2. The design of the markets against fires.
3. Ways of escape of people from the markets in case of fire outbreaks.
4. Ways by which firefighting vehicles can access the markets.
5. Fire protection devices in the study domain.
6. Fire signs and notices in the study domain.
7. The training and fire management strategies by the respondents.
8. Views of the respondents on how fire outbreaks in the markets can be reduced.

Appendix G: Observation Schedule

The following were critically observed during the research in the study area.

Items/ check list	**Results/ observations**
<u>Lock-up shops</u> • Observe the activities that are taking place in the lock-up shops which can cause fire outbreaks. • Check if there are conversions of the lock-up shops to other uses that can cause the fast spread of fire.	
<u>Open stalls</u> • Observe the activities that are taking place in the open stalls which can cause fire outbreaks. • Check if there are conversions of the open stalls to other uses that can cause the fast spread of fire.	
<u>Architectural design of the market</u> • Check the pattern of the roof design of buildings in the market against fire outbreaks. • Check the building materials that were used for the construction of the market against fire outbreaks. • Check if there are ways of escape of people (fire exits) in case of fire.	

• Check if there are ways for the firefighting vehicles to access the market. • If there are ways for the firefighting vehicles to access the market, check if there are ways for them to move through the market in case of emergency.	
Fire alarm systems • Check if fire alarm systems are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	
Automatic fire suppression systems • Check if automatic fire suppression systems are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	
Fire sprinkler systems • Check if fire sprinkler systems are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	

Street fire hydrants • Check if street fire hydrants are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	
Fire hose reels • Check if fire hose reels are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	
Portable fire extinguishers • Check if portable fire extinguishers are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy. • Also, if they are available, then, check their spacing.	
Other fire protection devices • Check if other fire protection devices are available. • If they are available, then, check the available numbers, in order to evaluate their adequacy.	

Appendix H: Replied Letter of Request for the Photocopies of the Architectural Design of Wuse Market, Garki Model Market and Kado Market

FEDERAL CAPITAL DEVELOPMENT AUTHORITY
P. M. B. 24 GARKI – ABUJA, - FCT., NIGERIA
DEPARTMENT OF PUBLIC BUILDING

The Head of Department
Department of Architecture,
Federal University of Technology,
Minna, Niger State,
Nigeria.

RE: REQUEST FOR THE PHOTOCOPIES OF THE ARCHITETURAL DESIGNS OF WUSE MARKET, GARKI MODEL MARKET AND KADO MARKET OF ABUJA.

We write to acknowledge the receipt of your letter dated 13th Febuary, 2018 in which you requested for photocopies of the Architectural designs of Wuse Market, Garki Model Market and Kado Market.

2. We are sorry to inform you that the Department may not be able to furnish you with the requested designs as you may wish to know that the design of the listed market was done in a long time ago when it was not possible to have soft copies, however the hard copies were lost in transit.

3. Therefore, we advise that you seek alternative.

4. Please accept my regards.

FOR: **QS. Odigie O. A.** FNIQS
Director, Public Building Department.
FCDA/DPB/286/Vol.1/205
14th Febuary, 2018.

RECEIVED
14 FEB 2018

Appendix I: Page 124 of the Building Regulations (2006) Revealing Table 5.2

Table 5.1 **Vehicle access to buildings**

Volume of building (m^3)	Height of top storey above ground (m)	Provide vehicle access	Type of appliance
up to 7,000	under 10	at rate of 2.4 m in length for every 90 m^2 of ground floor area	pump
	over 10	to 15% of perimeter	high reach
7,000-28,000	up to 10	to 15% of perimeter	pump
	over 10	to 50% of perimeter	high reach
28,500-56,000	up to 10	to 50% of perimeter	pump
	over 10	to 50% of perimeter	high reach
56,000-85,000	up to 10	to 75% of perimeter	pump
	over 10	to 75% of perimeter	high reach
over 85,000	up to 10	to 100% of perimeter	pump
	over 10	to 100% of perimeter	high reach

Note: See 5.0.4 and Diagram 31 for the definition of 'perimeter'.

Design of Access Routes and Hard-standings

5.2.4 A vehicle access route may be a public or private road, or other route, which, including any manhole or other covers, meets the standards in Table 5.2, Diagram 32 and the following paragraphs.

Access routes to buildings with any storey at more than 10 m above ground level should meet the standards for high reach appliances. For lower buildings the access should be to the standards for pumping appliances.

Where access is provided to an elevation in accordance with Table 5.2, overhead obstructions such as overhead cables that would interfere with the setting of ladders etc., should be avoided in the area shown on Diagram 32.

Where access roadways are provided within the site of a building, turning facilities for appliances, in accordance with the requirements of Table 5.2 should be provided in any dead-end access route that is more than 20 m long.

Table 5.2 **Vehicle access route specifications**

Appliance type	Minimum width of road between kerbs (m)	Minimum width of gateways between kerbs (m)	Minimum turning circle between kerbs (m)	Minimum turning circle between walls (m)	Minimum clearance height (m)	Minimum carrying capacity (tonnes)
Pump	3.7	3.1	16.8	19.2	3.7	12.5
High Reach	3.7	3.1	26	29	4	16.25

Note:
Use of these figures will cater for nearly all of the fire appliances in use at present. Some fire authorities use different sized appliances and it is therefore advisable that the relevant fire authority be consulted.

Appendix J: Descriptive Statistics of the Data Collected from the Sales People in the Markets via Questionnaires

Correspondent	N	Minimum	Maximum	Mean	Standard Deviation	Variance
Market	777	1.00	3.00	2.4479	.65619	.431
Gender	777	1.00	2.00	1.5148	.50010	.250
Age	777	1.00	5.00	3.4118	1.14997	1.322
Education	777	1.00	4.00	3.2600	.83688	.700
Religion	777	1.00	4.00	1.5393	.65118	.424
Q 1	777	1.00	5.00	1.4144	.96762	.936
Q 2	777	1.00	3.00	1.3616	.72455	.525
Q 3	777	1.00	2.00	1.9987	.03587	.001
Q 4	777	1.00	3.00	2.9884	.10707	.011
Q 5	777	1.00	5.00	1.9884	1.07027	1.145
Q 6	777	1.00	2.00	1.5290	.49948	.249
Q 7	777	1.00	3.00	2.0296	.66612	.444
Q 8	777	1.00	3.00	2.1300	.74255	.551
Q 9	777	1.00	5.00	2.7284	1.34303	1.804
Valid N (Listwise)	777					

Source: field work, 2017.