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Knowledge, Interaction, People & Leadership

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All papers in this publication have been through a review process involving initial screening of abstracts, review of full papers by at least two referees, reporting of comments to authors, revision of papers by authors and re-evaluation of re-submitted papers to ensure quality of content.

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NEA ONNIM NO SUA A, OHU

"He who does not know can know from learning"

This is the Adinkra symbol of knowledge, life-long education and continued quest for knowledge. The Akan people in West Africa believe that the search for knowledge is a life-long process. This is evident from the Akan saying "Nea onnim sua a, ohu; nea odwen se onim dodo no, se ogyae sua a, ketewa no koraa a onim no firi ne nsa" which translates into "He who does not know can become knowledgeable from learning; he who thinks he knows and ceases to continue to learn will stagnate"

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Sam Laryea, PhD
Chairman of WABER Conference

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SECTION 2: CONFERENCE PAPERS

ASSESSMENT OF FIRE SAFETY PROVISIONS IN SELECTED PUBLIC BUILDINGS IN MINNA, NIGERIA

Shittu Abdullateef Adewale[1], Okechukwu Blessing Ijeoma[2], Tsado Abel John[3] and Shehu Muhammad Aminu[4]

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In Nigeria, there have been several forms of serious disaster confronting homes, lives and properties of people and the government. The most common ones are flood, building collapse and fire, of which fire outbreak is the most frequently recorded. This study addressed the problem of fire incidents which were reported to always occur more in public and private residential buildings as a result of non-compliance of building clients and occupants to the requirements of fire safety regulations. To solve this problem, the study assessed the level of fire safety provisions in public buildings in Minna, Niger State of Nigeria. In view of this, data were collected from both primary and secondary sources. T – Test was used to determine the differences between the stipulated requirements of fire safety regulations and the available fire safety measures provided in the selected public buildings. Regression analysis was employed to determine the relationship between population of building occupants and number of fire escape routes, and building floor area respectively in the selected public buildings. A significant difference was found between stipulated and available requirements of fire safety regulations with respect to fire extinguishers, firefighting equipment and fire escape routes in public buildings. The relationships between population and number of fire escape routes, and building floor area in public buildings were found to be significant. It was concluded that fire safety requirements are not adequately provided or complied with in public buildings in Minna. It was recommended that building occupants or owners should always comply with fire safety regulations.

Keywords: escape routes, fire safety provision, public buildings, population

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Shittu, A. A., Okechukwu, B. I., Tsado, A. J. and Shehu, M. A. (2017) Assessment of fire safety provisions in selected public buildings in Minna, Nigeria. *In: Laryea, S. and Ibem, E. (Eds) Proc. 7th West Africa Built Environment Research (WABER) Conference*, 16-18 August 2017, Accra, Ghana, 314-336.

INTRODUCTION

Fire safety is defined by Hakkarainen (2002) as the requirements which are related to prevention of ignition and fire spread, limitation of fire growth, evacuation provision and prevention of fire spread between buildings. Fire prevention or fire safety in buildings therefore has one of the top priorities in the design of buildings (Klapwijk, 2012). It is essential that building occupants are trained or enlightened on the issue of fire safety. In view of this, Mallonee *et al.* (1996) described fire safety training as a way of increasing public fire safety knowledge and improving their response to a fire with the aim of reducing the number of fire-related casualties. This is because residential fires, workplace fires, and environmental fires such as bushfires result in severe and fatal burn injuries (Mallonee *et al.*, 1996).

In the context of this work, fire safety is regarded as the essential measures of fire prevention, prevention of fire spread and means of emergency evacuation and fire quench in the event of fire outbreak. Public buildings, on the other hand, are regarded as buildings which accommodate people from different places temporarily especially for the purposes of commercial or official engagements.

The studies of fire have shown that most accidental fire starts from three main causes. These are Malfunctioning of equipment. Misuse of heat sources and Electrical wiring error in housing projects. Housing has been universally acknowledged as the second most indispensable item in human need after food. Housing has a profound impact on the safety of individuals and human beings. This present study considered issues surrounding fire safety management in public buildings in Minna, Niger State.

In Nigeria, there has been serious disaster confronting the homes, lives and properties of people. The most common ones are flood, building collapse and fire. A lot has been written on flood and building collapse, but the incidence of fire is still lax in literature. Fire is still the result of flammable materials being combusted and the essential ingredient for the propagation of fire is air, which is sufficient to start ignition or means of ignition and oxidation (Shittu *et al.*, 2015).

The slightest contact of highly inflammable liquid contents, such as gasoline (petrol), paraffin (kerosene), or gas with fire brings explosive services of destruction, inferno and loss of lives and properties (Adeleke, 1993). It was in this light that the Aqua Group (1984) reported that there must be presence of the three basic elements or ingredients of fire, which is referred to as fire's own eternal triangle before fire can break out.

According to Oludare (2000), there has been emphasis on the provision of firefighting equipment for the fire service offices in the country. Millions of Naira are being spent to train fire-men in fire-men combat, but little has been done to look at fire safety in the buildings where there is likely to be occurrence of fire. In most times, fire fighters are being blamed for fire incidents in public buildings, and all their possible loopholes seriously explore. But little has been said or explored about the activities of the other

stakeholders in the construction and uses of public buildings, which are mostly responsible for the causes of fire outbreak (Makanjuola *et al*, 2009).

Some instances of fire outbreak in Nigeria included the one that occurred where two students lost their lives in the University of Ilorin, Kwara State in 2009 as a result of electrical fault. Another serious and memorable incidence of fire outbreak in Nigeria was the fire which struck the 6-storey building of the Nigeria Ports Authority (NPA) in Marina on Thursday the 19th day of June 2008 (Odueme and Ebimomi, 2008). The Nigerian Telecommunications Limited (NITEL) headquarters in the same Marina was gutted by mysterious fire in the early 80s during the second republic. Also, not too long Ibadan branch of the Central Bank of Nigeria (CBN) was up in flames leading to lost several vital documents. In the same vein, it was reported that fire outbreaks in Nigeria records 1000 death and 700 fire accidents annually.

Findings by many researchers, among which are Mogbo (1998), Anyawata (2000), Shittu (2001) and Shittu *et al*. (2013 a and b), confirmed the fact that fire incidences affect buildings of individuals, corporate organizations, government parastatals, and incidence of fire leads to damage to lives and properties and eventually financial losses. The major causes of these fire incidences have been attributed to electrical and gas faults, resulting in financial and non-financial losses. Fire incidents were also reported to have occurred more in public and private residential buildings than in other building types, this has also been attributed to the non-compliance of building clients and occupants to the requirements of fire safety regulations (Shittu *et al*., 2013b). Fire-related accidents often result in injuries and sometimes death, which can be prevented through fire safety training (Huseyin and Satyen, 2006). To estimate the extent to which fire safety training should be provided, it is essential to assess the current level of fire safety knowledge within the general community. Aliyu and Abdulrahman (2016) also reported that fire safety measures have become an issue of neglect in most tertiary institution hostel buildings in Niger State and have contributed to the continuous fire outbreak.

It is as a result of these that this study set out to examine fire safety provisions in selected public buildings in Nigeria using Minna as a case study. The choice of Minna was for the fact that Minna being the closest State capital city to Abuja experiences rapid growth in terms of construction of public buildings especially for commercial and official purposes. Most of these buildings are constructed in Minna Central Area and most of the old residential buildings are bought and converted to public buildings for commercial and official purposes. Majority of the people resident in Minna have businesses in this area. Therefore, the level of compliance to the requirements of fire safety provisions in these building types can never be over emphasized due to the population of lives and worth of properties accommodated therein. As a result of the problem identified, the following are the questions to be answered by this research:

i. What is the current trend of fire cases in public buildings in Minna?

ii. What is the difference between required number of firefighting equipment and available number of firefighting equipment provided?

iii. What is the difference between required number of fire escape routes and available number of fire escape routes provided in the selected public buildings?

iv. What is the relationship between population of building occupants and the number of fire escape routes?

v. What is the relationship between building floor area and number of escape routes?

vi. What are the measures in ensuring compliance to the requirements of fire safety provisions?

SURVEY OF PREVIOUS WORKS

The concept of fire disaster

Fire is referred to as the rapid oxidation of combustible material and gases producing heat and light (oxygen, heat and fuel) in the absence of one of these elements there cannot be fire (Aqua Group, 1984). Fire is one of the most destructive hazards which threaten buildings. It has the potential to affect the occupant, the building and its components. Also, areas not directly damaged by the flame or heat may be smoked, dirt and falling debris or by the huge volumes of water used in firefighting. According to Malven (1997), when substantial heat is generated, over 500 – 600 degrees Celsius, flashover occurs and the fire becomes fully developed, engulfing the whole compartment. Decay follows when all the fuel or oxygen within the compartment is totally consumed. An example often quoted is that a wooden log is difficult to ignite but thin sticks can be ignited easily and will burn fiercely when piled together.

According to Patterson (1993), building fire safety in its most simplified form is based on three general strategies; first is to prevent ignition; if it occurs, to prevent spread; and if spread occurs, to minimize damages to the lives and properties, occupants and fire-fighters. Mogbo (1998) researched on the environment and fire incidences in Nigeria and the implications on public policies and politics. Shittu (2001) studied the incidence of fire outbreak in public and residential buildings of Kwara State from 1990 - 1999. Shittu (2007) researched on a comparative analysis of fire outbreak between the military and civilian era in Niger State in domestic and public buildings and Shittu (2009) studied the incidence of fire outbreak in North-Central Nigeria. Nwabueze (2012) also studied the enhancement of fire safety in hostel designs, and Shittu *et al.* (2013a and b) and Shittu *et al.* (2016) studied the appraisal of fire safety provisions in tertiary institutions buildings in Minna, Niger State and Katsina, Katsina State respectively. These previous researches have shown that the incidence of fire outbreak is a national issue affecting all building types and requires urgent attention in form of prevention against ignition and fire spread and compliance to fire safety regulations.

Causes of fire

The problem of fire in human settlements can be disaggregated into cause of the fire, spread of the fire, escape from the fire and fire-fighting. According to Shittu (2007), majority of fire outbreaks in domestic buildings were caused by electrical fault rather than gas faults. Fire in buildings can be credited to various factors. According to Hassan (1999) the causes of fire can be grouped under Accidents, Carelessness and Willful acts.

Marsha and Williams (2012) reported the following common causes of residential fires: Careless cooking; Faulty wiring, especially in old houses; Overloaded electrical outlets; Careless smoking; Space heaters; Careless use of candles and incense; Storing belongings too close to furnaces and hot water heaters; Vandalism, drug use, and makeshift heat sources in vacant buildings; Kids playing with matches; and Arson. In addition, Aliyu and Abdulrahman (2016) attributed the causes of fire to accident, faulty electrical equipment and wiring system, fire spread and carelessness.

Classification of fire

Hassan (1999) and Aliyu and Abdulrahman (2016) classified fire into four classes:

i. Class A is a type of fire involving burning materials e.g. wood, paper, textile and other combustible materials. Fire in this class are best extinguished by water agent in form of jet or spray, this blanket (fire blanket) can be used to cover the fire in an enclosure.

ii. Class B fire involves flammable substances e.g. petrol, kerosene, paint and other inflammable solvents. This class of fire is best extinguished with foam or dry powder, carbon dioxide (CO_2).

iii. Class C is a type of fire involving combustible gases or liquefied petroleum gases in form of liquid or gas leak e.g. propane, butane, methane, etc. This can be extinguished with foam, dry powder, and CO2 water agent spray to the container.

iv. Class D is a type of fire involving metals e.g. calcium, potassium, aluminum etc. Powdered granite, limestone, dry sand and dried powdered extinguisher are best used for this class of fire.

Factors influencing fire spread

According to Ahiamba (1985), the rate of spread of fire depends on the fuel and available oxygen. Also, it depends on the construction of the building. The rate of fire spread depends on the following: -

1. Combustibility: This is the rate at which a material burns. For example, petrol has much higher combustibility than wood.

2. Flammability: Hydrocarbon gases are more flammable than hydrocarbon liquids. In the same way hydrocarbon liquid are more flammable than ordinary combustible. Example, cooking gas is more flammable than petrol or kerosene, and petrol is more flammable than wood.

3. Design and construction: A well designed and constructed building will help to reduce the rate of fire spread. For example, a tall building with a badly designed and constructed stairwell and lift shafts will favour fire spread in the building from one floor to another.

4. Contents of building: The material of furnishing (fuel) to a great extent determines the rate of fire spread. Timber furnishing and finish will favour fire spreading and its sustenance unlike steel which is considerably, the reverse.

Cases of fire outbreak in Niger State - Nigeria

Mogbo (1998) pointed out that the following private and public buildings had faced the trauma of fire outbreak:

(a) The incidence in part of the Kure Ultra-modern, Minna, Niger Sate burning down about 50 shops.

(b) Federal Polytechnic at Bida in Niger State respectively.

(c) A fire broke out opposite NANA'S PLACE were residential buildings were razed to the ground.

(d) There were also other cases where a fire broke out in Jatau community in Minna, Niger State where lives and properties were lost.

Daily independent, August 26, 2010, reported a fire incident that gutted about eight rooms of the G-block of a male hostel at Usman Danfodio University, Sokoto. Christianity Today Magazine, March 12, 2004, again reported the case of a building fire that destroyed twenty-six lives in Nigeria, because there was only one entrance and exit to the building. In addition, in 2005, fire incident occurred in the female hostel of the Federal University of Technology, Minna, Niger State which destroyed property and another incidence also occurred in 2009 and at the Bosso campus (temporary site) of the same institution. A recent incidence of fire outbreak was reported by Voice of the Nigerian Tertiary Institutions in 2013 that the Community Campus Radio Station of the Federal University of Technology, Minna, popularly referred to as Search FM 92.3 was gutted by a mid-night inferno on Wednesday 16, January 2013 destroying properties worth over =N= 50 million. The fire outbreak which occurred around 12:00 a.m. as a result of electric spark gutted the whole studio and other offices of the station. This is in line with the discoveries of Shittu (2001), Shittu (2007) and Shittu (2009) that the major cause of fire outbreak in Nigeria is electrical faults.

Fire safety

Fire safety is defined by Encyclopaedia Americana (1993) as the precautions that are taken to prevent or reduce the likelihood of fire that may result in death, injury or loss of property. Passive Fire Protection Federation (2013) viewed fire safety from three perspectives of passive protective measures as given below;

i. Passive fire protection is the primary measure integrated within the constructional fabric of a building to provide inherent fire safety and

protection by responding against flame, heat and smoke to maintain the fundamental requirements of building compartmentation, structural stability, fire separation and safe means of escape.

ii. Passive fire protection measures achieve their intended purpose by raising the fire resistance of the structure, protecting the structure against the effects of fire, reducing fire spread through secondary ignition, limiting the movement of flame and smoke, and minimizing the danger of fire-induced collapse or structural distortion.

iii. Passive fire protection design, incorporating passive fire protection materials, systems and assemblies, serves by fire containment to protect life, safeguard the building structure, protect assets, maintain building serviceability after fire, minimize rebuild costs, and facilitate quick business recovery and continuity.

Effective fire safety in buildings goes beyond meeting codes. It requires a systematic and diligent approach on the part of the architect for fire prevention, protection and control in all the aspects of building design, construction and use (Malven, 1997).

In view of this and reporting on the theory of fire safety design, Aliyu and Abdulrahman (2016) reported that the rate of fire spread depends on the following: -

i. Combustibility

This is the rate at which a material burns. For example, petrol has much higher combustibility than wood.

ii. Flammability

Hydrocarbon gases are more flammable than hydrocarbon liquids. In the same way hydrocarbon liquid are more flammable than ordinary combustible. Example, cooking gas is more flammable than petrol or kerosene and petrol is more flammable than wood.

iii. Design and construction

A well designed and constructed building will help to reduce the rate of fire spread. For example, a hostel building with a badly designed and constructed stairwell and no room compartmentalization will favour fire spread in the building from one floor to another.

iv. Contents of building

The material of furnishing (fuel) to a great extent determines the rate of fire spread. Timber furnishing and finish will favour fire spreading and its maintenance unlike steel which is considerably the reverse.

Findings from the study of Marsha and Williams (2012) suggested that fire safety messages that trigger an emotional response might be the most effective at motivating behaviour change. While incentives, such as gift cards or mortgage or rent rebates may help with the initial adoption of some fire safety measures, real-life stories of loss and devastation shared by ordinary, relatable citizens will not only grab residents' attention, they

might also give people the intrinsic motivation necessary to sustain appropriate fire safety practices over time.

General requirement of fire safety

The following requirements are enforced under the law:

1. Evacuation of building: Whenever an unfriendly fire occurs in any building, premises, or fire area of any kind, or upon the initiation of a fire alarm all occupants shall evacuate the building, premises or fire areas immediately and shall not re-enter the building, premises, or fire area unless permission is given by the fire chief or fire office in charge of the scene.
2. Notify the fire department/fire service: Whenever an unfriendly fire occurs in any building or premises of any kind, the owner, manager, occupant or any person in control of such building or premises upon discovery of any fire even though it has apparently been extinguished, immediately shall cause notice of the existence of such fire, circumstances of same and the location therefore to be given to the fire department.
3. Maintaining a fire hazard: No person shall knowingly maintain a fire hazard
4. Notification of fire department of inoperative fire safety equipment: Persons owning, controlling, or otherwise having charge of any fixed fire extinguishing or fire warning system or stand pipe system shall notify the fire department and office of the state fire marshal at any time such system or systems are inoperable or taken out of service. Both shall also be notified when service is installed.
5. Interference with fire protection equipment: No person shall render any portable or fixed fire extinguishing system or device or any fire warning system inoperative or inaccessible, except as may be necessary during emergencies, maintenance, drills or prescribed testing.

Fire prevention

Fire prevention in buildings is required to prevent premature structural failure and to limit fire spread (Herbert, 1999). Herbert (1999) also asserted that for these purposes, the following provisions are necessary: - sub-division of the building into a number of fire compartments which are: elements of structure to be provided with appropriate fire resistance; compartmentation of places of special fire risk; restrictions to linings of walls and ceilings so as to limit their contribution to the development of fire and to have adequate resistance to the spread of fire along their surfaces; the provision of fire doors to limit the spread of fire and smoke; limitation of fire spread at junctions between building components, service penetrations and in cavities; and structural fire preventions are also necessary to protect the means of escape.

Fire warning and alarm systems

The provision of an appropriate fire detection and alarm system is an essential element of the fire safety measures in a hostel (Malven, 1997). It provides early warning of the occurrence of fire and thereby facilitates the activation of appropriate emergency procedures, including evacuation. Early detection also improves the chances of restricting the growth and spread of fire within the building by the use of first aid fire-fighting equipment, where safe to do so, and by early call-out of the fire services (Herbert, 1999). A fire detection and alarm system should be provided in all hostels. The system should incorporate automatic fire detection (heat or smoke type detectors, as appropriate) throughout the premises and suitably located manual activation facilities. Large buildings should be divided into fire alarm zones, as required by the standard, which will facilitate identification of the alarm source.

In order to make fire detection and alarm system to effectively serve its purpose, there is the need for an adequate provision of escape routes in buildings. This enables the occupants to exit the building and seek for help immediately. Unfortunately, previous studies including that of Shittu *et al.* (2015) and (2016) have reported that the provision of fire escape routes in buildings is inadequate.

Research gap identified

A lot has been written on flood and building collapse but the incidence of fire outbreak is still lax in literature, in spite of the fact that fire disaster occurs more frequently than flood and building collapse. Efforts have been made by many researchers to address the problem of fire outbreak.

In the foreign scene, Huseyin and Satyen (2006) researched on the level of fire safety knowledge among people of different age groups and investigate its relationship to the level of fire safety training, and the manner in which people from different age groups would respond to a fire based on their fire safety training in Melbourne, Australia. The study revealed that middle-aged individuals would respond more accurately to a fire than younger and older adults. The findings demonstrate the importance of fire safety training in enhancing people's fire safety knowledge and their response in the event of a fire which could lead to a reduction in the rate of fire casualties. The study therefore suggested an incorporation of fire safety training as part of health improvement programs to reduce the number of fire-related injuries and fatalities.

In addition, Marsha and Williams (2012) carried out a qualitative study on Fire Safety Education & Outreach Programs at Memphis, Tennessee. The study revealed that for a variety of reasons, fire danger is not as salient or as pressing a concern for most Memphis residents as is crime. However, the statistics regarding the frequency of residential fires in high-risk Memphis neighbourhoods shocked most of these participants into a much more proactive and preventative mindset. Addressing the problem will require a long-term, coordinated effort and the great majority of respondents believe that responsibility lies with the Fire Department, elected officials,

community leaders, property owners, and residents themselves. The study of Marsha and Williams (2012) also showed that there are four key strategies to effective fire prevention and safety. These are:

1. Raise awareness of the risk of fire danger and educate the public regarding ways to protect themselves, their families, and their property.
2. Provide financial assistance (in the form of grants) to low income and elderly homeowners who are in need of electrical wiring upgrades.
3. Tear down vacant buildings.
4. Strictly enforce building codes in rental properties.

Also in the field of fire safety education and awareness, Clare, Garis, Plecas and Jennings (2012) researched on reduced frequency and severity of residential fires following delivery of fire prevention education by on-duty fire fighters using a cluster randomized controlled study in Surrey, British Columbia. The study specifically examined the frequency and severity of fires pre and post - the home visit intervention in comparison to randomized high-risk cluster controls. The study discovered that the frequency of fires has reduced in the city overall, however, the reduction in the intervention cohorts was significantly larger than for controls. In addition, it was found that when fires did occur within the intervention cohorts, smoke detectors were activated more frequently and the fires were confined to the object of origin more often post-home visits. No equivalent pattern was therefore observed for the cluster control. It was concluded that on-duty fire-fighters can reduce the frequency and severity of residential fires through targeted, door-to-door distribution of fire prevention education in high-risk areas.

In the context of the Nigerian research domain, Shittu (2001) discovered that the amount of fire outbreak in residential and public building of Kwara State and discovered that the amount of financial loss due to fire incidences on the average was about 4% of capital expenditure from 1990-1999. Shittu (2007) studied the incidence of fire outbreak in Niger State from 1993-2004 between the military (1993 - 1998) and civilian (1999 - 2004) political dispensations and found out that the incidence of fire outbreak in both domestic and public buildings were significantly more frequent during the civilian era than the military era in Nigeria. Shittu *et al.* (2013) researched on the appraisal of fire safety provisions in tertiary institutions buildings in Minna, Niger State of Nigeria and revealed that building clients and users do not comply with fire safety regulations with respect to the provisions of firefighting equipment's and number of escape routes in buildings. Shittu *et al.* (2015), on the other hand, studied the relationship between cost of fire incidences and capital expenditure in Kwara State and discovered that there is no improvement in the trend of fire incidence in Kwara State over the last two decades.

Finally, Aliyu and Abdulrahman (2016) researched on the assessment of fire safety provisions in tertiary institution hostel buildings in Niger State. The study used a well-structured questionnaire and observation schedule to

acquire data in some selected tertiary institutions in Niger State. The study found that the fire safety equipment is not available or not functional in the hostels also; most of the students in the hostels are not conversant with the usage of such equipment. It was recommended that proper scrutiny of hostel buildings be made by the school management from time to time to ensure that all fire safety precautions are in functional condition, and orientation of students in the hostels about what to do in occurrence of fire outbreak.

These studies have however failed to study the incidence of fire outbreak in relation to level of compliance of building clients and occupants/users to the requirements of fire safety regulations. Although Shittu *et al.* (2013b) made an effort along this direction but did not consider the major building types mostly affected by the incidence of fire outbreak which are public and private residential buildings. In order to fill this gap in knowledge, this study was set out to assess level of fire safety provisions in public buildings in Minna, Niger State of Nigeria. In order to achieve this, the study set out to achieve the following objectives:

i. To review the current trend of fire cases in public buildings in Minna.

ii. To determine the difference between the required number of fire extinguishers and the available number of fire extinguishers provided in the selected public buildings.

iii. To determine the difference between required number of firefighting equipment and available number of firefighting equipment provided.

iv. To determine the difference between required number of fire escape routes and available number of fire escape routes provided.

v. To determine the relationship between population of building occupants and the number of fire escape routes.

vi. To determine the relationship between building floor area and number of escape routes.

The objectives of the study led to the formulation of the following null hypotheses:

H_o1: The differences between available and required firefighting equipment, fire extinguishers and fire escape roués are statistically not significant.

H_o2: The relationship between population/building floor area and number of fire escape routes is statistically not significant.

The review of literature gave rise to the theoretical framework upon which the research methodology for this study is based (see Figure 2.1).

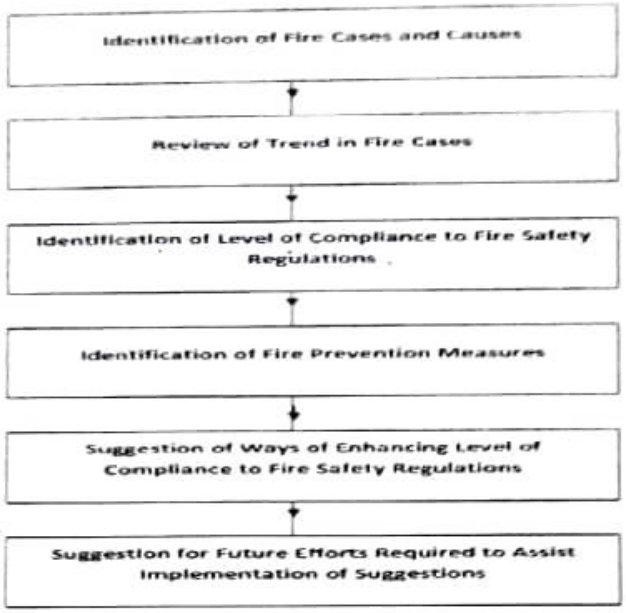

Figure 2.1: Theoretical Framework.

RESEARCH METHODOLOGY

This study adopted a mixed methods research approach. The study encompassed a review of literature survey from journals, conference papers and post projects to identify the major barriers in the appraisal of fire safety provisions in public buildings. Data collection was from both primary and secondary sources. The use of interview and physical measurement were employed to gather data from the primary source on the level of compliance of buildings owners/occupants to the requirement of fire safety regulation.

The study examined selected public buildings in Minna Central Area of Niger State, Nigeria. The selected public buildings were mostly commercial public buildings situated along Bosso Road in Minna Central. The choice of Minna Central Area was because it is an area where compliance to Fire Safety Regulations is most likely to occur. Ten public buildings were purposively selected from the public buildings situated along Bosso Road in Minna Central based on the age of the building, size and population of occupants in the buildings.

Primary source of data collection was also through direct measurement of floor areas and number of escape routes from the public buildings sampled. Data on the recorded cases of fire outbreak and losses were collected from the archive of Niger State Fire Service, Minna as the secondary source of data collection. Data was collected on recorded fire cases for a period of ten years (2006-2015).

Table 3.1 Procedure for Data Collection and Analysis

S/NO	OBJECTIVES	DATA REQUIRED	VARIABLES	SOURCE	METHOD OF ANALYSIS
1	To review the current trend of fire cases in public buildings in Minna, Niger State.	Archival Data (Data Collection Checklist)	Number of recorded cases of fire incidents	Niger State Fire Service	Descriptive (bar and line graphs)
2	To determine the difference between the required number of fire extinguishers and the available number of fire extinguishers provided.	Archival and Primary Data (Checklist & Physical Measurement)	Number of Fire extinguishers required by Fire Safety Regulations. Number of Fire Extinguishers Available in Sampled Buildings.	Fire Safety Regulation and Physical Measurement.	Inferential (T - Test)
3	To determine the difference between required number of firefighting equipments and available number of firefighting equipments provided.	Archival and Primary Data (Checklist & Physical Measurement)	Number of Fire Fighting Equipments Required by Fire Safety Regulations. Number of Fire Fighting Equipments Available.	Fire Safety Regulation and Physical Measurement.	Inferential (T - Test)
4	To determine the difference between required number of fire escape routes and available number of fire escape routes provided.	Archival and Primary Data (Checklist & Physical Measurement)	Number of Fire Escape Routes Required by Fire Safety Regulations. Number of Fire Escape Routes Available.	Fire Safety Regulation and Physical Measurement.	Inferential (T - Test)
5	To determine the relationship between population of building occupants and the number of fire escape routes.	Archival and Primary Data (Checklist & Physical Measurement)	Population of building occupants (independent variable) and number of fire escape routes (dependent variable).	Interview and Physical Measurement.	Inferential (Regression Analysis)
6	To determine the relationship between building floor area and number of escape routes	Archival and Primary Data (Checklist & Physical Measurement)	Building floor area (independent variable) and number of fire escape routes (dependent variable).	Interview and Physical Measurement.	Inferential (Regression Analysis)

Source: Researchers' Field Survey (2016)

The use of bar and line graphs was employed to review the current trend of the incidence of fire outbreak in Niger State from 2006 – 2015. The use of T - Test was employed to determine the differences between the required number of fire extinguishers and the available number of fire extinguishers provided in the selected public buildings; between the required number of firefighting equipment and the available number of firefighting equipment provided and between the required number of fire escape routes and the available number of fire escape routes provided. The use of regression analysis was employed to determine the relationships between the

population of building occupants and the number of fire escape routes; and between the floor area of buildings and the number of fire escape roués provided in the selected buildings. This was justified by the studies of Shittu *et al.* (2013b) and (2016) where it was discovered that number of fire escape routes depends on the population of building occupants and building floor area. Table 3.1 gives the procedure for data collection and analysis for this study based on the theoretical framework.

The decision rule used for the T – test in this study is given below:

- If $T_{calculated} > T_{tabulated}$ then the difference is significant i.e. reject H_o
- If $T_{calculated} < T_{tabulated}$ then the difference is not significant i.e. accept H_o

Below are the decision rules for each of the tools of the regression analysis employed in this study:

F test:

The decision rule here states that:

- If $F_{calculated} > F_{tabulated}$ then relationship is significant i.e. reject H_o
- If $F_{calculated} < F_{tabulated}$ then relationship is not significant i.e. accept H_o

P test:

The decision rule here states that:

- If P value < significance level then relationship is significant i.e. reject H_o
- If P value > significance level then relationship is not significant i.e. accept H_o

Coefficient of determination (R^2):

The decision rule here states that:

- If $R^2 \geq 50\%$ then relationship is strong.
- If $R^2 < 50\%$ then relationship is weak.

RESULTS AND DISCUSSIONS

Data presentation

The data collected for the study are presented in the Appendix section as Tables A1 and A2. Table A1 shows the data collected on fire statistics for a ten- year period (2006 - 2015). This data helped to make a review of fire trend in the recent time. Table A2 gives a presentation of data collected for 10 selected public buildings. This assisted to assess the level of fire safety provisions in public buildings of Minna.

Results of current trend of fire outbreak in Niger state from 2006 – 2015

The results of the descriptive analysis are presented in Figures 4.1 – 4.3. The discussion for each figure thereafter follows below. Figure 4.1 shows the trend of fire outbreak in public buildings of Niger State from 2006 – 2015.

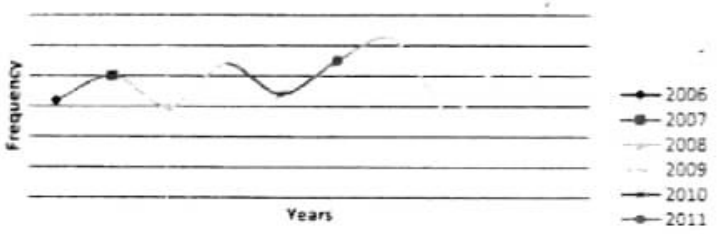

Fig. 4.1: A Ten - year Trend Fire Outbreak in Public Buildings in Niger State from 2006 - 2015

Figure 4.1 shows that fire outbreak in public buildings in Niger State has fluctuated between 2006 and 2015. The highest cases were recorded in year 2012 while the least recorded cases of fire outbreak were in year 2006. The trend differs from that observed by Shittu (2001) where the cases of fire in public buildings were observed to constantly increase from 1993 – 2004. Figure 4.2 shows a trend comparison of the major causes of fire outbreak in Niger State from 2006 – 2015.

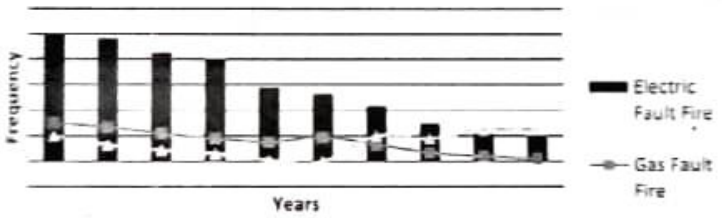

Fig. 4.2: Trend Comparison of Major Causes of Fire Outbreak in Niger State from 2006 - 2015

It was revealed in Figure 4.2 that the cases of fire outbreak occur more as a result of electrical faults than gas faults and bush burning. In the last two years under review, the cases of fire outbreak due to bush burning became the highest recorded. While cases of fire outbreak due to gas faults and bush burning fluctuated over the period under review, cases of fire outbreak due to electrical faults decreased constantly over the period under review. It was most importantly that there was an improvement in the recorded cases of fire due to these three major causes of fire outbreak. This is because the recorded cases of fire outbreak due to each of these causes decreased significantly during the last five years under review, except for the causes of fire outbreak due to bush burning. The result of this analysis agrees with the findings of Shittu (2001), Shittu (2007) and Shittu (2009) where it was also discovered that the cases of fire outbreak recorded as a result of electrical faults were higher than the ones for gas faults and bush burning. Figure 4.3 shows the trend comparison between the amount of financial loss

and financial salvage during the incidence of fire outbreak in Niger State from 2006 – 2015

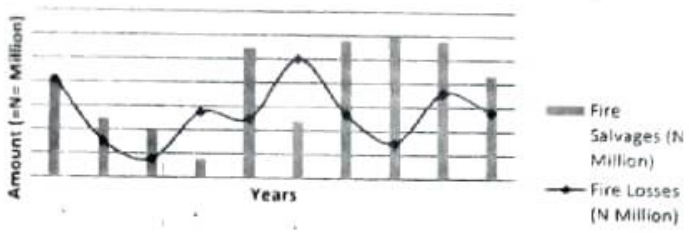

Fig. 4.3: Trend Comparison between the Amounts of Financial Loss and Financial Salvage during Fire Outbreak in Niger state from 2016 - 2015

It was shown in Figure 4.3 that the amount of financial losses recorded is usually less than the amount of financial salvage over the study period, except in 2009 and 2011. This implies that more properties are being saved than the ones lost to fire outbreak. This agrees with the findings of Shittu (2001) and Shittu (2007) where it was also discovered that the amount of financial losses recorded is usually less than the amount of financial salvage from 1990 – 1999 in Kwara State and 1993 – 2004 in Niger State respectively.

Results and discussions for t - tests

The first T – Test shows that there exists a statistically significant difference between the required number of escape routes and the available number of escape routes in the selected public buildings in Minna. The observed mean value of the number of required escape routes was 2.40 while that of the number of available escape routes was 1.00. The observed T calculated value from the result of the analysis was 5.250 and was greater than the T tabulated value of 2.26, while the Probability (P) value of 0.001 observed was less than the level of significance of 0.05 which the analysis was based upon. The null hypothesis was therefore rejected based on these. This therefore implies that the standard number of escape routes required is not being complied with in public buildings in Minna. This agrees with the findings of the study of Shittu *et al.* (2013b) where it was also found that the standard number of escape routes required is not being complied with in tertiary institution buildings in Minna. The results of the first T – Test are summarised in Table 4.1.

Table 4.1: T – Test between the Required and Available No. of Escape Routes

Test No	Variables X_1	Variables X_2	Type of Model	Observations Mean Value (%)	T_{cal}	T_{tab}	P_{value}	LOS	Remark	Action On Hypothesis
1	Required No. of Escape Routes	Available No. of Escape Routes	Paired Sample	$X_1 = 2.40$ $X_2 = 1.00$	5.250	2.26	0.001	0.05	SSD	Reject H_0

Source: Researchers' Field Survey (2016)

KEY: SSD: Statistically Significant Difference

The second T – Test shows that there exists a statistically significant difference between the required number of fire extinguishers and the available number of fire extinguishers in the selected public buildings in Minna. The observed mean value of the number of required fire extinguishers was 10.70 while that of the number of available number of fire extinguishers was 6.40. The observed T calculated value from the result of the analysis was 3.023 and was greater than the T tabulated value of 2.26, while the Probability (P) value of 0.014 observed was less than the level of significance of 0.05 which the analysis was based upon. The null hypothesis was therefore rejected based on these. This therefore implies that the standard number of fire extinguishers required is not being complied with in public buildings in Minna. This is in line with the findings of the study of Shittu *et al.* (2013b) where it was also discovered that the standard number of fire extinguishers required is not being complied with in tertiary institutions buildings in Minna. The results of the second T – Test are summarised in Table 4.2.

Table 4.2: T – Test between Required and Available No. of Fire Extinguishers

Test No.	Variables		Type of Model	Observations						
	X_1	X_2		Mean Values (%	T_{cal}	T_{tab}	P_{value}	LOS	Remark	Action on Hypothesi
2	Required No. of Extinguisher	Available Number of Extinguish-ers	Paired Sample	$X_1 = 10.70$ $X_2 = 6.40$	3.023	2.26	0.014	0.05	SSD	Reject H_0

Source: Researchers' Field Survey (2016)
KEY: SSD: Statistically Significant Difference

The third T – Test shows that there exists a statistically significant difference between the required number of firefighting equipment and the available number of firefighting equipment in the selected public buildings in Minna. The observed mean value of the number of required number of firefighting equipment was 17.30 while that of the number of available number of firefighting equipment was 8.00. The observed T calculated value from the result of the analysis was 4.225 and was greater than the T tabulated value of 2.26, while the P value of 0.002 observed was less than the level of significance of 0.05 which the analysis was based upon. The null hypothesis was therefore rejected based on these. This therefore implies that the standard number of firefighting equipment required is not being complied with in public buildings in Minna. The finding from the study of Shittu *et al.* (2013b) also agrees with this. The results of the third T – Test are summarised in Table 4.3.

Table 4.3: T – Test between No. of Required and Available Fire Fighting Equipments

Test No	Variables		Type of Model	Observations						Action on Hypothesis
	X_1	X_2		Mean Values (%)	T_{cal}	T_{tab}	P_{value}	LOS	Remark	
3	Required No. of Firefighting Equipment	Available No. of Firefighting Equipment	Paired Sample	$X_1 = 17.3$ $X_2 = 8.00$	4.225	2.26	0.002	0.05	SSD	Reject H_0

Source: Researchers' Field Survey (2016)

KEY: SSD: Statistically Significant Difference

Results and discussions for regression analysis

It was observed in the first regression analysis that there exists a weak, negative and non-significant relationship between population of building occupants and the number of escape routes in the selected public buildings in Minna. The coefficient of determination (R^2) value observed was 0.2% implying weak relationship and the correlation coefficient (R) observed was 4.4% indicating weak degree of association between the variables. The negative correlation observed between the variables indicates a tendency that an increase in the population of building occupants will be followed by a decrease in the number of escape routes and vice versa. The value of F calculated of 0.015 observed was less than the value of F tabulated of 5.32 while the probability (P) value of 0.905 observed was greater than 0.05. This led to the acceptance of the null hypothesis in this case. This finding is in line with the findings of Shittu *et al.* (2016) where it was also found that number of escape routes does not significantly relate with the population of building occupants. Table 4.4 summarises the results of the first regression analysis.

Table 4.4: Summary of Regression Results between Population and No. of Escape Routes

Analysis No	Variables		Type of Model	Observations					Inferences		
	X	Y		Regression Equation	R/R^2 (%)	F_{cal}	F_{tab}	P_{value}	Strength of Relationship	Remark	Action on Hypothesis
1	Population	No. of Escape Routes	Linear (Simple)	$Y = 1.115 - 0.005x$	4.4/0.2	0.015	5.32	0.905	Weak	NS	Accept H_0

Source: Researchers' Field Survey (2016)

Key: NS = Not Significant

The second regression analysis also revealed a weak, negative and non-significant relationship between building floor area and the number of escape routes in the selected public buildings in Minna. The R^2 value observed was 3.2% implying weak relationship and the R value observed was 18% indicating weak degree of association between the variables. The negative correlation observed between the variables indicates a tendency that an increase in the building floor area will be followed by a decrease in the number of escape routes and vice versa. The value of F calculated of 0.267 observed was less than the value of F tabulated of 5.32 while the

probability (P) value of 0.619 observed was greater than 0.05. This led to the acceptance of the null hypothesis in this case. This finding also agrees with the findings of Shittu *et al.* (2016) where it was also found that the number of escape routes does not significantly relate with the floor area of building. Table 4.5 summarises the results of the second regression analysis.

Table 4.5: Summary of Regression Results between Floor Area and No. of Escape Routes

Analysis No.	Variables		Type of Model	Observations					Inferences		
	X	Y		Regression Equation	R/R^2 (%)	F_{cal}	F_{tab}	P_{value}	Strength of Relationship	Remark	Action on Hypothesis
2	Building Floor Area	Nr. of Escape Route	Linear (Simple)	Y = 1.397 0.001x	18/3.2	0.267	3.32	0.619	Weak	NS	Accept H_0

Source: Researchers' Field Survey (2016)

Key: NS = Not Significant

CONCLUSIONS AND RECOMMENDATIONS

Findings from the results of the analysis led to the following conclusions:

i. The incidence of fire outbreak in public buildings in Niger State fluctuated from 2006 - 2015 and more properties were being saved than the ones lost to fire outbreak.

ii. Fire safety requirements are not adequately provided or complied with in public buildings in Minna, Niger State. This is because significant differences exist between the required and available numbers of escape routes, fire extinguishers and firefighting equipment.

iii. The relationship between population of building occupants and number of fire escape routes and building floor area is not significant respectively. This also implies that the requirements of fire safety requirements are not being complied with.

The following recommendations were made based on the findings of this study:

i. Building occupants or owners should always comply with the fire safety regulations on the number of firefighting equipment required for public buildings of different specifications.

ii. Building owners should always use the area of building and population of building occupants as basis in order to make provision for fire safety devices.

iii. Fire sprinkler systems should be provided for public buildings and water hydrants should be installed by the Government in all public areas in cities where water can be easily fetched in case of fire outbreak.

iv. Finally, the Government should set up an agency to constantly inspect the level of compliance of public buildings to the provisions of fire safety regulations.

LIMITATION OF THE STUDY

The study is only applicable to public buildings used for commercial and official purposes. In order to be able to extend its application to other building types, a fresh research should be undertaken adopting the procedures of this research. The following areas are suggested for further research in view of the limitation of this study:

i. A comparative analysis of the level of compliance with the provisions of the fire safety regulations between public and private buildings.

ii. Impact of the level of compliance with the provisions of the fire safety regulations on the number of recorded fire outbreaks in public and private buildings.

REFERENCES

Adeleke, S. (1993). Fire: An Ambivalent Substance. *The Herald*. 25th October. 12.

Ahiamba, E. E. (1985). *Fire Hazard and its Prevention in Buildings (A Case Study of Bendel and Logos States of Nigeria)*. BSc. Thesis, Department of Architecture, Bendel University, Ekpoma.

Aliyu, W. I. and Abdulrahman, M. E. (2016). Assessment of Fire Safety Provisions in Tertiary Institution Hostel Buildings in Niger State Sustainable Built Environment and Climate change; The challenges of Post 2015 Development Agenda. School of Environmental Technology Conference, SETIC, 2016

Anyawata, C.H. (2000). *Analysis of fire outbreak in Niger-Delta, Nigeria*. Unpublished B. Tech Thesis, Department of Quantity Surveying, Federal University of Technology, Minna.

Aqua Group (1984). *Fire and Building*. Granada Publishing, Great Britain.

Clare, J., Garis, L., Plecas, D. and Jennings, C. (2012). Reduced Frequency and Severity of Residential Fires following Delivery of Fire Prevention Education by on-duty Fire Fighters: Cluster Randomized Controlled Study. *Journal of Safety Research*. Volume 43: 123-128.

Encyclopedia Americana (1993). Encyclopedia Americana International Edition. Danbury, Connecticut. (11) 243 – 251.

Hakkarainen, T. (2002). *Studies on Fire Safety Assessment of Construction Products*. Technical Research Centre of Finland. VTT Publications 459. 1 – 109.

Hassan, H. (1999). Fire and Safety Management in Buildings. *The Professional Builders Journal*. June/July. 32 – 35.

Herbert, G. (1999). *Fire safety in hostels*. McGraw-Hill, Inc.

Hussyen, I. and Satyen, L. (2006). Fire safety training: Its importance in enhancing fire safety knowledge and response to fire. *The Australian Journal of Emergency Management*. November 2006. 21(4): 49 – 53.

Klapwijk, J. N. (2012). *The Governance of Fire Safety: Using Networks, Markets, Hierarchy? – Or a form of Anarchy?* Master Thesis. School of Management and Government. University of Twente.

Mekanjuola, S.A. Aiyetan, A. O. and Oke, A.E. (2009). Assessment of *Fire Safety* Practice in Public Buildings in Western Nigeria. *RICS COBRA Research Conference*. University of Cape Town. September 2009. 1-17.

Mallonee, S., Istre, G. R., Rosenberg, M., Reddish- Douglas, M., Jordan, F., Silverstein, P. and Tunell, W. (1996). Surveillance and Prevention of Residential Fire Injuries. *The New England Journal of Medicine*. 335(1): 27-31.

Malven, F. (1997): *Time savers standards for architectural design standards*. seventh edition. McGraw-Hill, Inc.

Marsha, E. Williams, M. E. (2012). Fire Safety Education & Outreach Programs: Memphis, Tennessee: A Qualitative Research Project. Summary Report. Prepared for The National Fire Protection Association. December 2012. Harvest Research Group LLC.

Mogbo, T.C. (1996). Fire Outbreak and the Urban Environment in Nigeria: Implication on Public Policy and Politics. In A. A. Ndamusa (Ed.): *The Quantity Surveyor*. A Journal of the Nigerian Institute of Quantity Surveyors. Lagos. January – March. 31- 38.

Nwabueze, T. M. (2012). *Proposed Nnamdi Azikiwe University/University Postgraduate Hostel, Awka: Enhancing Fire Safety in Hostel Designs*. An unpublished MSc. Thesis. Department of Architecture. Faculty of Environmental Sciences. School of Postgraduate Studies. Nnamdi Azikiwe University, Awka.

Odueme, S. and Ebumomi, V. (2006). Fire on NPA House. In Wole Olugoke (Ed). *Daily Independent*. Lagos. 23rd June. 3(1511). 1.

Oludare, L. (2000). Season of Fire. Shelter Watch. May-June 29-30.

Passive Fire Protection Federation (2013). *Gateway to UK Fire Protection*. Gandens Business Park, Kingsley House, Boerton, Hampshire, UK. Retrieved from http://www.propfp1.definition.htm on 13/03/2013.

Patterson, J. (1993). *Simplified design for building fire safety*. John Wiley and sons Inc.

Shuttu, A. A. (2007). A comparative analysis of Fire Outbreak in Domestic and Public Buildings in Niger State during the Military and Civilian Era (1988-1998 and 1997-2004 Respectively). In L. M. Opap (Ed.): *Environmental Technology and Science Journal*. School of Environmental Technology, Federal University of Technology, Minna, Nigeria. 2(2): 139-146.

Shuttu, A. A. (2009). Analysis of Fire Incidences in Domestic and Public Buildings of Some Selected States in North- Central Nigeria. In Z. A. Uji (Ed.): *Journal of Environmental Sciences*. Faculty of Environmental Sciences, University of Jos, Jos, Nigeria. Vol. 13(1/II): 54-61.

Shittu, A. A., Oke, A. A., Adamu, A. D. & Shehu, M. A. (2013a). A Comparative Analysis of Fire Incidences in Domestic and Public Buildings during the Military and Civilian Era in Kwara State, Nigeria (1990 - 1999; 2000 - 2009). In A. S. Abdulkareem, S. A. Abdularahaman, A. A. Amadi & M. Abdullahi (Eds.). *3rd Biennial Engineering Conference. Conference Book of Proceedings*. School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria. Tuesday, 14th – Thursday, 16th May 2013. 255 – 267.

Shittu, A. A., Adamu, A. D., Oke, A. A., Aliyu, S. & Shehu, M. A. (2013b). Appraisal of Fire Safety Provisions in Tertiary Institutions Buildings in Minna. In M. Zubairu (Ed.). *Centre for Human Settlement and Urban Development (CHSUD) Journal*. Federal University of Technology, Minna, Nigeria. December 2013, 4(1): 64 - 72.

Shittu, A. A., Idiake, J. E. and Akanmu, W. P. (2015). Relationship Between Cost of Fire and Capital Expenditure in Kwara State. In A. Nasir, A. S. AbdulRahman and A. S. Kovo (Eds). *Procs: 1st International Engineering Conference (IEC 2015)*. School of Engineering and Engineering Technology, Federal University of Technology, Minna, Nigeria. 1st – 3rd September. 243 – 250.

Shittu, A.A (2001). *An Analysis of Losses due to Fire Incidence in Residential and Public Buildings of Kwara State (1990-1999)*. Unpublished B.Tech. Thesis Quantity Surveying Department, Federal University of Technology Minna, Nigeria.

Shittu, A. A., Idiake, J. E., Oyewobi, L. O., Tsado, A. J., Bilyaminu, B. & Mac-Barango, D. O. (2016). Viability of Fire Escape Routes in the Student Hostels at Selected Katsina State Tertiary Institutions. Sustainable Built Environment and Climate Change: The Challenges of Post 2015 Development Agenda. *In*: Y. A. Sanusi, O. F. Adedayo, R. A. Jimoh & L. O. Oyewobi (Eds.): *Proceedings of School of Environmental Technology International Conference (SETIC 2016)*. School of Environmental Technology, Federal University of Technology, Minna, Nigeria. 10th – 12th May. 66.

APPENDIX

Table A1: Research Data on Fire Statistics from 2006 - 2015

Year	Electric Fault Fire	Gas Fault Fire	Bush Burning Fire	Public Building Fire	Fire Losses (N Million	Fire salvages (N Million)
2006	100	30	20	32	412	400
2007	97	27	13	40	150	250
2008	86	22	9	30	80	200
2009	80	18	6	44	275	80
2010	58	15	1	34	250	550
2011	53	19	1s	45	500	240
2012	44	13	20	52	270	580
2013	30	7	18	28	150	600
2014	22	4	25	45	360	580
2015	20	2	25	32	280	440

Source: Niger State Fire Service, Minna (2016)

Table A2: Research Data on Fire Safety Provision

Buildings	Standar No of Escape Route	Available Escape Route	No of Required Fire Extinguishe s	No of Available Fire Extinguisher s	Floor Area (sqm²)	No of Required Fire Fightin Equipment	No of Available Fire Fighting Equipment	Population
House 1	4	2	14	1	250	18	1	15
House 2 (Hospital Complex)	4	3	25	15	600	32	15	34
House 3 (Church Hall)	2	0	10	4	300	14	6	17
House 4(Balls Hall)	2	1	8	8	600	10	8	30
House 5 (Lecture Hall)	2	0	4	1	200	6	1	9
House 6 (Event Center)	2	2	8	10	270	12	10	15
House 7(Shop Mall)	2	0	6	4	900	35	14	42
House 8 (Office Complex)	2	0	12	7	900	10	8	38
House 9 (Library)	2	2	10	8	800	18	8	27
House 10 (Show Room)	2	0	10	6	400	18	9	24

Source: Researchers' Field Survey (2016)