Full paper

International Journal of Real Estate Studies

INTREST

Adequacy of Fire Safety Measures of Residential Buildings in Peri-Urban Neighbourhoods of Ibadan, Oyo State, Nigeria

Olayinka Clement Oloke[1]*, Afolashade O. Oluwatobi[1], Lekan M. Amusan[2]

[1]*Department of Estate Management, College of Science and Technology, Covenant University, Canaanland, Ota, Nigeria*
[2]*Department of Building Technology, College of Science and Technology, Covenant University, Canaanland, Ota, Nigeria*

*Corresponding author's email: yinka.oloke@covenantuniversity.edu.ng

Article history: Received: *15 September 2021* Received in revised form: *30 November 2021*
Accepted: *10 March 2022* Published online: *29 June 2022*

Abstract

The spate of fire outbreaks and the lack of capacity to mitigate the incidence in most urban areas reflect the violation of physical planning regulations and relevant building codes. In the past two decades, the peri-urban neighbourhoods have witnessed rapid developments as a result of the growing population in these areas. However, the level of compliance of various developments with the provisions of the existing National Fire Safety Code remains unclear. Consequently, an assessment of the adequacy of fire safety provisions vis-à-vis the effectiveness of the fire safety standards in rapidly urbanising communities became imperative. This study examined the adequacy of fire safety measures of residential buildings in peri-urban neighbourhoods of Ibadan, Oyo State, Nigeria. Relevant studies were reviewed while structured questionnaires were administered to 320 respondents across four towns in Lagelu West Local Council Development Area (LCDA). A total 296 questionnaires were retrieved representing 92.5% rate of response. Responses were analysed with basic descriptive statistic tools. The mean scores were interpreted using cut-off points and results presented in tables and charts. The study found that human activities and attitudes constituted the principal causes of fire incidence and that there is good compliance with passive fire control guidelines in the study area. However, the active fire control systems were grossly deficient in residential buildings. Moreover, lack of active fire control equipment, lack of community fire safety apparatus, and lack of reliable water supply constituted the principal challenges against effective fire control measures facing the neighbourhoods. Whilst filling the gap in literature especially on fire hazards in peri-urban areas, the study recommended the strict compliance with extant fire safety codes by property owners, provision of community fire safety apparatus by the government, residents' awareness programs on fire safety measures, subsidized active firefighting equipment and improvement of road and water infrastructure, amongst others.

Keywords: Fire safety, peri-urban, residential, building codes, passive fire control

1.0 INTRODUCTION

Usually, for all categories of building projects, the common approach to incorporate safety measures is by executing the construction according to the prescribed safety regulations and standard (Kurniawan et al., 2018). The study further revealed that each element of building is designed according to specifications defined by the rule, then checked for compliance to assess whether the required level of safety has been met. Building projects, regardless of the type, size, shape, use and location are required by extant planning laws and safety guidelines to observe and adhere to certain safety standards during the design and construction. David et al. (2019) affirmed that the National Building Codes was issued by the Federal Government of Nigeria to set minimum standard on buildings, pre-design, design, construction and post construction stages. As pointed out in the study, these codes were aimed at ensuring safety and proficiency in the building industry caused by incessant collapse, infernos, environmental abuses and other disasters. It thus implied that the developers, owners or relevant authorities are expected to engage the prescriptive-based evaluation procedure to determine the level of compliance of a building with the stated safety design objectives. The incessant building failure and fire incidence in built-up urban centres have shown a gap in compliance with relevant safety prescriptions or rather, the prescriptions are already outdated. In developing countries, such as Nigeria, what was observed was primarily low level of compliance. David et al. (2019) have observed that professionals are often constrained to efficiently apply fire safety codes due to bulkiness of the codes, accessibility, weak law enforcement and client demands/affordability. In advanced countries also, regulatory failure has also been observed in building fire safety regulations. Across Europe, Osácar et al. (2021) concluded that the analysis of legal and regulatory framework, the expected level of fire risk/safety of buildings and actual fire safety achieved or implemented constitutes the basic framework for determining the appropriateness of fire safety regulations. While fire continue to raze buildings in the congested urban areas of both developed and developing nations, practically nothing is known about the peri-urban neighbourhoods that have been witnessing rapid physical transformation in the past two to three

decades with regard to the level of compliance with safety standards or the appropriateness of the safety codes in recent times. In 2017 alone, there were 160 cases of fire outbreak across Nigeria, out of which 61.8 percent affected public buildings (Leadership News, 2017).

Different studies have been carried out to ascertain the causes of fire outbreak in homes and other places over the years and quite a number of factors were identified. Popoola et al. (2016) listed human activities such as bush/refuse burning, improper electrical works, high voltage electricity, as well as fireworks as some of the causes of fire disaster. Asigri et al. (2017) compiled the list of causes of fire in student hostels to include, cooking, arson, open flame, electrical appliances, mechanical faults and above all, carelessness. Lawal et al. (2018) identified and classified causes of fire in public building into natural, accidental and incendiary causes. Natural causes include lightening, thunder, earthquake, tremor, landslide and gale. Accidental causes could result from arcing, sparking or overheating while incendiary causes are fire outbreaks that originated from malicious, deliberate intentions or gross carelessness. Adekunle et al. (2018) identified different causes of fire outbreak at home as electrical fault, heat, sparks, gas cylinder, arson, carelessness, naked flame and power surge. Other causes of fire catastrophe in residential and any other property include use of adulterated electrical materials, faulty electrical design, wrong installation of electrical materials and circuit system, lack of safety measures and lack of fire safety precautions during building construction. Apart from natural causes which are most times occasional, the most significant cause of fire hazards have been human being, by reason of carelessness, willful act or accident.

The injuries, loss of life and properties that accompany fire outbreaks are not only inimical to the progress of persons concerned but have constituted a great hindrance to socio-economic growth and development of the society at large. Incidence of fire has always resulted in major disruption to the finances and spending of affected persons and a leak or wastage of limited economic resources. The National Bureau of Statistics (NBS) (2012) reported that an estimated 3.8billion Naira worth of goods were lost in the industrial fires while loss estimates for the domestic fires was put at 14.6billion Naira. Moreover, the Director, Lagos State Fire Service stated that in 2017, the fire service in the state responded to 1,659 calls, out of which 1,273 were fire calls, with about ₦16.5 billion worth of property destroyed (The Guardian, 2018). A statement credited to the President of Fire Disaster Prevention and Safety Awareness Association of Nigeria, Badanga Ahmed Lamidi disclosed that incessant fire outbreaks have cost the national economy about 6 trillion Naira in the last five years (Leadership News, 2017). It was further revealed that the country lacks operational fire statistics database. As much as the incidence of fire knows no bound when it occurs, different accounts have shown that fire outbreaks have consumed different kinds of property, be it public, corporate or private properties, residential, commercial, offices, administrative etc. buildings. As a matter of fact, urban market centres have emerged hotspot of fire pandemic in recent times across the globe. Popoola et al. (2016) showed that market fire account for 92% of total fire occurrence in Lagos State between 2007 and 2014. While the spate of fire outbreak continues unabated and becoming worrisome, enough has not been done on proper documentation of the statistics of property affected. More emphasis is often put on the economic and financial consequence than the record of type, number and magnitude of impact of the fire hazard.

Furthermore, more than any other part of the country or territory, apparently because of its economic, administrative and development significance, studies on environmental hazards including fire incidences have focused more on urban settlements than rural and peri-urban neighbourhoods in most countries. In addition, due to some administrative constraints such as insufficient personnel, fund and logistics, the monitoring and enforcement of building safety regulations become ineffective at the fringe communities and rural areas. However, considering the rising population and fast pace of physical development of peri-urban communities in the past two decades, as well as the importance of housing to man, being next to food in the hierarchy of human needs, it becomes imperative to bring the attention of the authorities and stakeholders to the pattern and nature of developments in these areas and undertake the assessment of the level of compliance with safety guidelines or the appropriateness of same considering the nature of modern developments. Compared to the Brazilian model that has different fire safety regulations for each state, it might be expedient to evaluate the appropriateness of the existing fire safety codes in Nigeria to suit recent developments in peri-urban neighbourhood so as to maintain a unified fire safety regulation in the country. The multiplicity of fire safety regulation in Brazil, according to Rodrigues et al. (2017), has resulted in administrative disarray among fire safety agents as well as extravagant building design and construction. Thus, the focus of this study is on the causes and adequacy of fire safety measures in residential buildings in Lagelu West Local Council Development Area, Ibadan, Oyo State. Basic provisions for active and passive fire safety measures in residential buildings as contained in the Nigeria National Building Codes were discussed in order to relate the outcome of field work with existing regulatory provisions or expectations in terms of fire safety compliance. The challenges facing fire incidence curtailment in the study area were also examined.

2.0 LITERATURE REVIEW

2.1 Peri-Urban Housing Development

Housing is among the critical primary need of man, others being food and clothing. The physical and spiritual well-being as well as the economic and financial progress of man so much depend on the housing condition. Housing, no matter how simple or sophisticated, has been a source of peace and stability, centre for planning and coordination as well as symbol of status and prestige to the owner. House ownership is desired by every man and despite the fact that it requires huge financial commitment, majority of urban populace that are classified as poor, low or medium income group, often brave the odds to acquire a home (Oloke et al., 2013). The demand for housing in urban centre is huge while the supply has not been commensurate. Government intervention in the supply of housing for the masses has been minimal while private sector interventions have always produced houses that are not affordable by the masses (Henshaw, 2010). The pressure of urbanization coupled with the growing population of urban centres has invariably resulted in the need for more houses (Adedeji & Olotuah, 2012). The stiff competition of urban land use which has culminated in the high cost of urban land, uncontrolled conversion of residential buildings to commercial, offices and other economic uses as well as the rate of obsolescence being experienced among the existing housing stock have not only made housing unaffordable in city centres, but also compelled majority of urban dwellers to take

responsibility for procuring their homes. Thus urban housing supply has largely been augmented through informal private sector intervention, principal of which is individual housing development, co-operative societies' provision and faith-based sponsored housing projects (Oloke, 2015). Since fire hazards know no class, taste or bounds, it is imperative and expected that houses developed in this context meet the prescribed fire safety requirements to avert disaster in the event of fire incidence.

The peri-urban neighbourhoods of major cities in Nigeria such as Lagos, Ibadan and Abuja are undergoing tremendous transformation in the last two to three decades due to the increasing influx of human population from the city centre and towns and villages of other states in the country. According to Adelekan (2020), the expansion recorded in Ibadan, beginning from 2000 was 75 percent atomistic settlement and 25 percent informal land subdivision. This was a change from what obtained between 1984 to 2000 where 36 percent of the additional built-up area was from atomistic settlements, 56 percent from informal land subdivision and only 8 percent from formal land subdivisions and housing projects. The pace and trend of physical development of these fringe neighbourhood require that precautionary measures are ensured to protect buildings from environmental hazards such as fire incidence. The apparent lack, deficiency or non-compliance of old buildings in towns and cities with fire safety requirements which often lead to huge loss when there is fire outbreak should be guarded against for structures in peri-urban areas. Ali et al. (2018) observed that most old and aged buildings are at unacceptable levels of compliance with fire safety standards while Hassanain et al. (2017) concluded that fire protection systems installed in the old and existing building are often different from present requirements as the codes and standards changes from time to time.

2.2 Imperative for Effective Fire Management for Peri-Urban Areas

Fire is a blind servant that knows no class, has no taste and ready to operate with full gusto where condition permits. An instance was the deepwater horizon oil rig explosion that occurred in April 2010. The inferno, caused by a surge of natural gas from the ocean floor, blasted through the concrete core and traveled up the rig's riser to the platform and exploded. The conflagration that resulted defied the vast sea environment of the incidence as well as the fireboats dispatched to quench it, to consume the theatre and the master, leading to the death of 11 workers, collapse of the rig and leakage of approximately 4.9 million barrels of oil into the Gulf of Mexico. Inferno could be triggered by a number of natural or human-related factors, but it cannot start unless three important elements are present which are heat, fuel and oxygen (Hassan, 1999; Makanjuola et al., 2009). Fire starts when a combustible material is combined with sufficient quantity of air or oxygen in particular and exposed to heat above the flash point of the fuel material resulting in irreversible combustion/oxidation of the fuel material (Adekunle et al., 2018). The incessant cases of fatal fire incidents in residential buildings are an indication of inadequacy of fire prevention/control measures in the buildings or inadequate awareness of fire safety measures. Fire safety in building is a system of protection that combines fire prevention measures with suppression system at design, construction and post-construction stage (Alao et al., 2020). Thus, effective management of fire in buildings is a tripartite function of active control, management control and passive control of measures (Alao et al., 2020). Ebenehi et al. (2016) averred that building design is an important determinant of the intensity and impact of fire outbreak. The ability of a building to either confine or fast-track the growth and spread of fire depends on how it was designed. The blatant abuse and disregard of planning regulation have increased the risk of fire outbreak and spread with severe consequence for the safety of life and property. In a bid to eradicate or minimize the outbreak and impact of fire hazards, nations continue to evolve and ensure compliance with current fire safety guidelines for different structures. In Malaysia, for example, Ali et al. (2018) examined fire safety provisions for pre-building code shophouses converted into budget hotels with attempt to provide adequate protection of the investment from fire hazards. The study observed that for conversion project, fire safety system is bound to be upgraded to match the new function and structure requirements of the building concerns and that parties involved are to pay close attention to new or revised fire safety policies that supersede standards used for old and existing buildings.

In addition, the trend of fire hazard and the attendant devastating impact on victim's life, especially the vulnerable medium and low income groups of the society do not only create, prolong and spread poverty, but also make cities and human settlement unsafe, broken and practically unsustainable. The spate of fire outbreak coupled with the lack of adequate preparedness and mitigation measures by the concerned parties present vicious threats that are counterproductive to the achievement of some of the Agenda of the United Nations Sustainable Development Goals. Goals #1 and #11 of the sustainable development agenda aim at ending poverty in all its forms everywhere and making cities and human settlement inclusive, safe, resilient and sustainable by 2030. Specifically the SDG target #1.5 anticipate to have built the resilience of the poor and those in vulnerable situations and reduce their exposure and vulnerability to climate-related extreme events and other economic, social and environmental shocks and disaster by 2030. In the same vein, Target #11.5 was directed at significantly reducing the number of deaths and the number of people affected and substantially decreases the direct economic losses relative to global gross domestic product caused by disasters, including water-related disasters, with a focus on protecting the poor and people in vulnerable situations (United Nations, 2015). Regrettably, among the devastating consequences of fire is building collapse (Adelekan, 2020; Oloke et al., 2017). The state of fire prevention and control infrastructure in most developing countries and the devastating physical, economic and financial havoc constitute formidable setback to the achievement of these sustainable development goals in record time. Makanjuola et al. (2009) observed that fire safety culture and practices has been a thing of neglect in most commercial buildings in Nigeria and this has been a contributing factor to incessant fire incidents. According to Adelekan (2020), provisions for fire services for Ibadan is grossly inadequate considering the large population, land mass/spatial coverage of the city. The study noted that there are only seven fire stations, with five located in the metropolis and remaining two in the suburb. This has rendered fire services across the city ineffective and unreliable. Building capacity to combat fire hazards in peri-urban centres has attracted little attention from stakeholders in the society compare to urban centres. Several studies have focused on fire safety for highrise buildings, office/commercial complex and residential buildings mainly in city centres (Osunsanmi et al., 2017). Furthermore, series of catastrophic fire incidents across the globe have claimed thousands of life, caused material loses and afflicted terrible toll, especially in developing countries where these disasters divert attention and resources from development needed desperately to escape poverty (Victoria, 2002).

2.3 Fire Safety Strategies for Residential Buildings

The persistent occurrence of fire hazards in human communities has been a source of concern and media fuss each time it happens. Despite the various fire incidences that occur almost regularly at different places, Makanjuola et al. (2009) observed that little had been done to look at fire safety practices in the building where there is likely to be fire occurrence. The authors further averred that fire safety practices are aspects that have suffered great neglect among designers and users of public buildings. David et al. (2019) observed that the prevalence of fire hazards on building is currently an issue for all stakeholders in construction industry. The study therefore advised that equal consideration should be given to all building types in order to adapt a system of safety approach for both private and public building to salvage the situation. Adelekan (2020) in her study on everyday hazards and disaster risks in Ibadan, observed and averred that fire outbreak is not only classified among those environmental risks that occur on extensive scale, is also the fourth most fatal hazards out of the nineteen environmental risks identified and second in terms of the number of houses damaged in Ibadan, the study area. It is therefore important to examine the cause of fire incidence in homes vis-à-vis the level of compliance of buildings with fire safety regulations in city and suburban neighhbourhoods. Generally, fire control system can be classified into active and passive (McAllister, 2002). Passive fire control system, according to David et al. (2019), deals with the aspect of design and construction of building which put into consideration safety measures such as egress (escape route), firefighter access, compartmentation and materials. Active fire control system, on the other hand, involves the use of sprinkler system, fire hydrant, fire alarm, smoke detector, fire extinguisher and photoluminiscent egress. Obi (2015) reiterated five approaches to ensuring fire protection measures. These are:

i. Prevention of fire initiation (i.e. precautions taken at design and construction stage)
ii. Restriction of the growth and spread of fire (retardation)
iii. containing fire within specified boundaries (compartmentation)
iv. provision of means of escape (egress/rescue route)
v. controlling fire by automatic sprinklers, (extinguishment)

The Nigerian National Building Code spells out the design guidelines for passive fire control measures which include compartmentation, materials, egress, sprinklers, smoke control and alarms. The design guidelines according to the National Building Code of Nigeria are as follow:

a. Compartmentation: Section 7.1.1.3 of the National Building Code directs the separation of occupants in fire resistive construction, either vertically, horizontally or both.
b. Materials: Section 5.3.1.1 of the building code states that steel, iron, concrete or masonry shall be used as type 1 fire resistive building material.
c. Means of Egress: Section 7.3.3.1 of the Building Code states that means of egress are to be provided in every fire resistant structure leading to an open space whose access is directly to a street
d. Sprinkler Systems: Section 5.3.7.2 states that sprinkler systems are to be provided in every fire resistant building, designed and provided for every floor constituting a water floor device and shut off valves
e. Smoke Control: Section 5.21 states that an air system which is mechanically operated to emit air, must be installed, and the opening of the exhaust located in a smoke trap area of an atrium.
f. Alarms: Section 5.3.7.10 states that fire alarms with communication systems must be installed in every floor of all tall buildings

In addition to this, studies have shown that personal characteristics of residents and occupants of buildings such as their level of knowledge, income, exposure and experience significantly determine the management of fire incidences. According to Kobes et al. (2010), the survival of building occupants depend on the nature of the fire, human aspects and building features. The study further averred that occupants' personal characteristics such as knowledge, experience and alertness to fire hazard usually affect how occupants respond and behave during fire incidents. In addition to the human aspect are the building features. According to Akashah et al. (2017), one way to ascertain the fire risk status of a building is through a fire risk assessment. This entails an assessment of both the adequate presence and working conditions of active and passive fire protection systems, usually against relevant guidelines and standards.

3.0 EMPIRICAL REVIEW

Alao et al. (2020) examined fire safety protection and prevention measures in Nigeria office buildings. The aim was to investigate the fire safety protection and prevention system in six multi-storey office buildings randomly selected across the north-central region of the country. Physical inspection of the buildings was conducted with a pre-designed checklist extracted from the Nigerian National Building Code (launched in 2006) and Nigerian National Fire Safety Code (approved in 2013). Interview was conducted with professionals who are either state director of fire safety, work and maintenance, occupational health and safety and building and premises managers. Questionnaire was also administered to respondents to each state director where the building was selected. A multi-attribute evaluation model was adopted to determine the collective performance of the fire safety features of each building. The study observed a lack of implementation of the standard fire regulation stipulated in the National Building Code and National Fire Safety Code, of which the fire safety systems provided in the buildings are not working as expected due to poor maintenance. The study further revealed that all the buildings inspected do not have critical fire safety systems such as firefighters' access and emergency lighting. The study, therefore, concluded by recommending strict compliance with the provisions of National Building Code and National Fire Safety Code, along with regular maintenance of the fire safety systems in these buildings. Aside the fact that the study was conducted in the north-central, the building of interest was mainly multi-storey (public) office buildings.

Sunday et al. (2019) conducted an analysis of active fire safety measures in Garki Model Market, Abuja, Nigeria. Questionnaires were administered to respondents from 287 sales points selected via systematic sampling technique in the market. Further information and data were obtained via direct observation of the state of the market, discussion with 20 different focus groups and interview conducted with the market management system of Garki Model Market. The study observed that fire protection devices in the market are not adequate and also not in good condition. Moreover, most people in the market do not know how to operate available firefighting equipment and the evacuation route in the market lacks emergency lighting. The study thus recommended adequate provision, maintenance and functionality of fire-fighting apparatus in the market. It further suggested that market people are trained to operate firefighting equipment in the market and the escape route are provided with emergency lighting. This study only focused on market structures.

Adekunle et al. (2018) carried out statistical analysis of fire outbreaks in homes and public buildings in Lagos State, Nigeria. The study relied on data on fatal fire outbreaks in the state between 2009 and 2014, obtained from relevant fire agencies in the state. Interviews were conducted and structured questionnaires administered to obtain robust responses and necessary data on the number of fatal fire incidences and number of death recorded, fire incidences on objects other than building in the state as well as causes of building inferno. Descriptive statistical tools such as tables, percentage, mean, bar and pie charts as well as pictures were used for data analysis and presentation. The study found amongst others that cases of fire incidence in 2014 was twice the number in 2009 and that 93.7% of fire hazards resulted in the death of at least one person. The study further established that 28.95% of fire incidence between 2009 and 2014 was caused by electrical fault in the building while 61.0% of building affected has no smoke detector. The study further revealed that an alarming proportion of 52% of building fire cases were not attended to by fire brigades and no insurance or compensation was paid thereafter. The study concluded by suggesting that smoke detectors and fire alarm systems are necessary in buildings for early detection of fire, the empowerment of fire fighters to respond swiftly and adequately is crucial, education, awareness creation and training of building occupants/users on fire safety prevention and control measures. The study, which was carried out in Lagos state, only focused on buildings and incidences of fire hazards in the metropolis.

Prior to that, Adekunle et al. (2016) carried out statistical analysis of electrical fire in residential buildings, Lagos State, Nigeria. Data on electrical fire incidence between 2012 and 2014 were obtained from fire services agencies in the state. Also, Lawal et al. (2018) carried out an assessment of implementation of fire safety procedures and regulations in public buildings in Kano, Nigeria. The buildings targeted in the survey include the Kano Electricity Distribution Office Complex, Muritala Mohammed Library Complex and Grand Central Hotel all in Kano. A total of 550 questionnaires were administered to three categories of respondents which are the facility managers, workers and visitors to each building. Mean score and standard deviation were used for data analysis while results were presented with tables. The study concluded that both passive and active fire safety systems are provided adequately in the three buildings under study. Nevertheless, the number of public buildings involved is quite small aside the fact that the study failed to capture residential buildings in the study area.

Makanjuola et al. (2009) carried out an assessment of fire safety practices in public buildings in western Nigeria. The buildings involved include the low, medium and high-rise buildings of public corporations and educational institutions. Ninety questionnaires were administered to occupants and users of the buildings while only 64 were returned and 57 used for the analysis. Frequency, percentages and tables were used for data presentation while mean scores were determined and ranked for the various variables analysed. The study observed amongst others that majority of the public buildings are without adequate fire installation and equipment, many occupants and users of public buildings lack necessary training or awareness on fire prevention, control or evacuation procedure and that weak policy implementation of fire safety codes militates against firefighting efforts in the region. The study therefore recommended the enforcement of fire safety codes by relevant authorities, the adherence to fire safety and building codes, adequate provision and regular maintenance of fire safety measures in public buildings as well as training of building users and occupants on fire safety practices, first aid and evacuation procedure in the event of fire incidence.

Arising from the foregoing, it was observed that majority of studies conducted earlier have focused on public and private buildings which include the low, medium and high-rise in major urban centres such as Lagos State, Kano State, Abuja, Akure and other geopolitical jurisdiction in the country excluding Ibadan. Furthermore, these studies neglect the unfolding scenario of rapid physical development ongoing at the peri-urban neighbhourhoods of these cities and towns in Nigeria. This study therefore attempted to fill this gap in literature by providing an insight into the adequacy of fire safety measures in the rapidly urbanizing peri-urban neighbourhoods of Ibadan, Nigeria.

4.0 METHODOLOGY

Ibadan, a city in the southwestern Nigeria, is expanding at a fast pace and the suburban neighbourhoods are not left behind. The city was selected because fire hazards is one of the prominent environment hazards that affect the city, as confirmed by Adelekan (2020). The city was projected to increase to about 5.03 million inhabitants by 2025 based on an average annual growth rate of 4.6% between 2010 and 2020 (UN-DESA, 2012). Out of the eleven local government areas in the city, Lagelu was selected, being one of the rapidly urbanizing peri-urban LGA in Ibadan Metropolis. Lagelu LGA was partitioned into two local council development areas (LCDA) in 2017 namely Lagelu North local council development area with administrative headquarter at Oyedeji, and Lagelu West LCDA with administrative headquarter at Olorunda Abaa. Lagelu West LCDA is the rapidly urbanizing part of Lagelu LGA and is the most populated. Lagelu West LCDA covers approximately a total area of about 260 square kilometres and consists of four (4) political wards of over 30 towns and 278 small and bigger villages. The respondent group was head of households and house owners resident in Lagelu Local Government. Based on NPC (2006), population projection of 208,100 in 2016 for Lagelu LGA, the sample size for the study was determined by linear interpolation of appropriate population size and corresponding sample size on Cochran's table at 95.0% confidence level and 0.05 margin of error. This yielded the sample size of 320. In addition, reliability test was conducted on the questionnaire by calculating the Cronbach's alpha. The computed Cronbach's alpha was 0.917 which is greater than the reference score of 0.7. The Cronbach's alpha gave good level of internal consistency of questions. The four wards in Lagelu West LCDA constituted the sample frame. One town was selected in each

ward, i.e. Alegongo, Olorunda, Monatan and Sagbe/Pabiekun. Eighty questionnaires were subsequently administered via systematic random sampling technique to adult male residents in each town, making a total of 320 questionnaires. A total of 296 valid questionnaires were retrieved, yielding 92.50% response rate. Data were measured on 5-Point likert scale of strongly agreed (5) to strongly disagree (1). Response were analysed with basic tools of mean score, relative importance and interpreted based on cut-off point as devised by Morenikeji (2006). In order to interpret the mean scores from the Likert scale, Morenikeji (2006) devised the following cut-off points. Subsequently, the results were presented in percentages, tables, charts and discussions.

1.00 – 1.50	Strongly disagree
1.51 – 2.49	Disagree
2.50 – 3.49	Undecided
3.50 – 4.49	Agree and
> or = 4.50	Strongly Agree

5.0 DATA ANALYSIS AND DISCUSSION

5.1 Socio-Economic Characteristics of Respondents

The socio-economic characteristics of respondents in the study area are presented in Table 1.

Table 1 Socio-economic characteristics of respondents

Category	Attributes	Respondents	Percentage
Age	21 – 30	33	11%
	31 – 40	74	25%
	41 – 50	143	48%
	Above 51	46	16%
Gender	Male	257	87%
	Female	39	13%
Resident status	Homeowner	160	54%
	Tenant	136	46%
Level of education	Primary school	31	11%
	Junior school	17	6%
	Senior school	67	23%
	Diploma	101	34%
	First/Second degree	90	30%
Occupation	Self-employment	97	33%
	Private sector	86	29%
	Public sector	113	38%
Accommodation	Tenement	119	40%
	Bungalow	77	26%
	Flats	54	18%
	Duplex	27	9%
	Semi-detached	19	6%

The preceding table reveals, amongst others, that majority of people residing in the neighbourhoods are 41 years and above while only 36% of respondents are within the age range of 21 and 40 years. This potentially portends a mixture of migrants and original settlers in the neighbourhood. Moreover, about 87% of the respondents are male, indicating that there are male respondents were more accessible during the survey and also suggest that both males and female residents engaged in secondary occupation to support the family. This was contrary to the findings of Onoyan-usina et al. (2017) that recorded more female respondents because women and children often remain at home while the adult male go to their respective primary occupation. Also, about 54% of respondents indicated that they own their houses while 46% are tenants. This indicates that the neighbhourhood has witnessed gradual influx of urban dwellers, migrants or new settlers in recent times thereby showing that the process of urbanization is underway. The level of educational achievement showed that all the respondents have acquired basic formal education in their lifetime and that 87% of respondents possess minimum of senior school certificate similar to the results in Makanjuola et al. (2009). This implied that respondents are literate enough to understand and provide reasonable opinion as regards the issues raised in the questionnaire. Furthermore, 67% of respondents are either engaged in private or public sector while 37% are self-employed. The distribution of houses covered in the survey showed that tenement (bungalow or storey) buildings are common in the study area compared to other types of residential accommodations. However, other types are also available such as bungalow (26%), flats (18%), duplex (9%) and semi-detached (6%). The predominance of tenement apartment is an indication of a transiting traditional peri-urban settlements or simply, urbanizing area.

5.2 Causes of Fire Outbreak in Residential Buildings in the Study Area

Respondents were requested to indicate the cause of fire incidence in their area in a multiple choice question. The responses, as indicated, were analysed with percentages and presented in Figure 1.

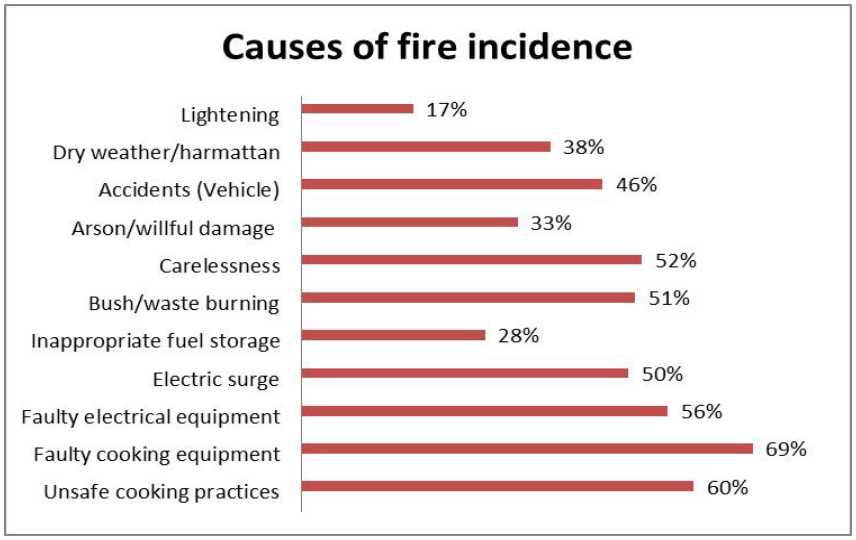

Figure 1 Causes of fire outbreak in residential buildings

The bar chart in Figure 1 shows that majority of fire incidents in the area are traceable to human negligence or activities. Prominent among the various causes are faulty cooking equipment, unsafe cooking practices, faulty electric equipment, negligence, bush/waste burning as well as electrical surge. Similar finding was made in Makanjuola et al. (2009), Adekunle et.al. (2018) and Alao et al. (2020), where majority of fire incidences were traceable to human related activities or factors. It was also noticed that fire outbreak due to natural causes such as harmattan and lightening have occurred in the study area.

5.3 Adequacy of Fire Safety Measures of Residential Buildings in the Study Area

Respondents opinion about the adequacy of fire safety precautions present in residential houses in the study area were obtained and assessed on a 5-point Likert scale ranging from very adequate (5) to not adequate (1). These were obtained with respect to the passive and active fire control systems. The mean scores were interpreted based on cut-off points devised by Morenikeji (2006). Table 2 portrays the opinion of respondents about the adequacy of fire control systems present in residential buildings in the study area. Using the cut-off points to interpret the mean scores of the analysis, it was observed that majority of the respondents agreed with the level of compliance with National Building Code's guidelines and provision of passive fire control systems such as compartmentation, fire resistive materials e.g., steel, concrete, iron, masonry as well as the provision of means of egress or escape route in case of fire occurrence.

Table 2 Adequacy of fire control systems

Passive/Active Fire Control Systems	Total score	Mean score	RII
Compartmentation	1141	3.856	0.771
Materials (steel, iron, concrete, masonry)	1246	4.208	0.842
Means of egress/escape route	1188	4.012	0.803
Sprinklers system	572	1.932	0.386
Smoke control	595	2.011	0.402
Fire alarms	636	2.147	0.430

This is depicted by the mean scores that fall within the 3.51 and 4.49 limits of the cut-off points. However, this is not so with the active fire control systems where general opinion indicates that respondents disagree with the level of compliance with active fire control systems provided in residential buildings in the study area. This is shown by the mean scores that fall within 1.51–2.49 cut-off points. By implication, majority of residential buildings in the study area are deficient or outrightly lacking different items of active fire control systems that could be engaged mechanically or automatically in the event of fire outbreak. This is in consonance with the study by Makanjuola et al. (2009) and Alao et al. (2020), of which they inferred that majority of the fire safety equipment were not available in the buildings under consideration.

5.4 Availability of Fire Control Equipment in the Study Area

In order to ascertain the availability of active fire safety equipment in the study area, respondents were requested to indicate the presence of the listed fire control equipment in their respective houses or within their immediate neighbourhood. Figure 2 presents the result of analysis.

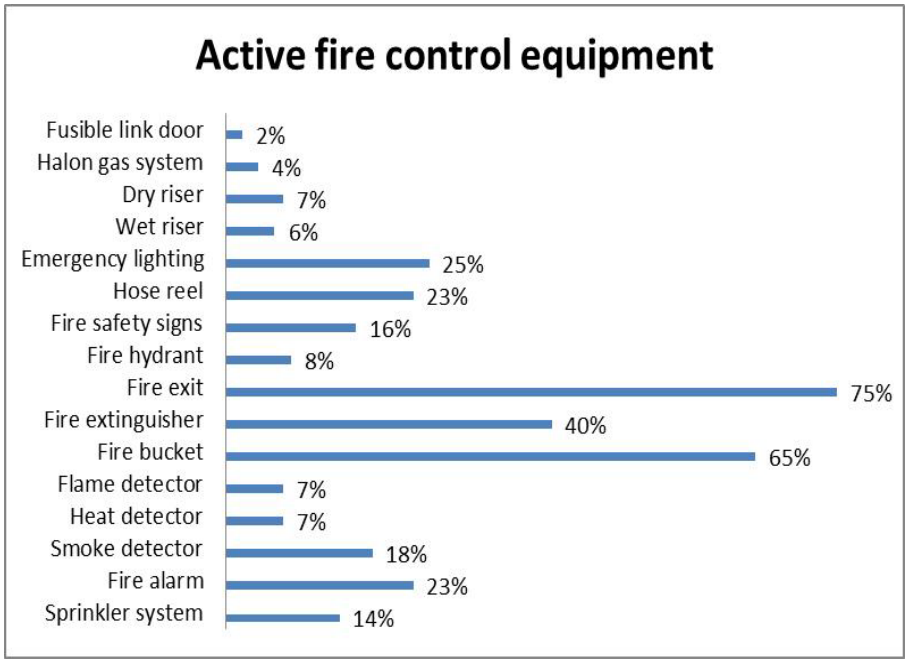

Figure 2 Active Fire Control Equipment

The chart shows that fire buckets and fire exit are the only items that are sufficiently available across the study area while other items of active fire control equipment are grossly insufficient just has found in Makanjuola et al. (2009) and Alao et al. (2020).

5.5 Challenges of Fire Control in the Study Area

Table 3 Challenges confronting firefighting efforts

Challenges of firefighting	Total	Mean Score	RII	Ranking
Lack of active fire equipment in buildings	1431	4.833	0.967	1st
Lack of community fire apparatus	1364	4.609	0.922	2nd
Lack of reliable source of water	1336	4.512	0.903	3rd
Unplanned/unrestricted developments	1254	4.236	0.847	4th
Poor neighbourhood road network	1254	4.236	0.847	4th
Lack of fire safety education of residents	1152	3.892	0.778	5th
Poor/Lack of access/egress route	1011	3.415	0.683	6th
Distance to fire station	944	3.189	0.638	7th
Inadequate fire brigade	886	2.992	0.597	8th
Unfavourable weather	831	2.807	0.562	9th
Poor maintenance	814	2.751	0.550	10th
Age of building	743	2.510	0.502	11th

Respondents were requested to assess the significance of the challenges confronting firefighting efforts in the study area on a 5-point likert scale. Responses were collated, analysed and the summary was presented in Table 3. The Table showed the mean scores of the identified challenges as well as the relative importance index and subsequently the ranking of the challenges. It was observed that lack of active fire equipment in residential buildings ranked 1st, followed by lack of community fire apparatus, lack of reliable water source, unplanned/unrestricted access and poor neighbourhood road network which ranked 2nd, 3rd, 4th and 4th respectively. By implication, the residents of the study area are greatly incapacitated to effectively curtail fire disaster when it occurs. Furthermore, lack of fire safety education, poor/lack of access route, distance to fire station, inadequate fire brigade and insufficient fire truck ranked 5th, 6th, 7th, 8th and 8th and are considered significant challenges to mitigating fire incidents in the study area. The remaining factors are considered less significant and these include unfavourable weather, poor maintenance and age of building, ranking 9th, 10th and 11th respectively. The result derived from the analysis is corroborated in the study by Onoyan-usina et al. (2017) where lack of water and fire hydrants, lack of active fire equipment, poor fire safety education by residents amongst others were identified as prominent challenges confronting the fight against fire hazards.

6.0 CONCLUSION

This study has examined the vulnerability of residential buildings in rapidly urbanizing neighbourhoods of Lagelu West Local Development Council of Ibadan, Oyo state with respect to the causes of fire hazards in the area, adequacy of fire safety measures in the

buildings as well as the challenges confronting effective firefighting efforts by the residents. Amongst the findings is the prevalence of bungalow and storey tenement buildings, signifying that the study area is more of traditional/core peri-urban settlements undergoing transition into modern urban neighbourhoods. It was also observed that 6(55%) of the causes of fire outbreak received above average responses indicating those causes are major causes of fire trouble that need to be addressed with alacrity among the residents whilst not leaving others out. Furthermore, most houses in the study area did well in their compliance with precautions for passive fire control systems but are grossly deficient in the areas of active fire control systems. The study further revealed that majority of respondents indicated the preponderance of fire buckets and fire exits as the available active fire control equipment while several others and more convenient, effective means are grossly lacking or inadequate. By and large, it became conspicuous that there is a huge gap between fire safety codes prescribed and fire safety systems found in most of the buildings in the study area. It is also a pointer to weak enforcement of safety codes. The study therefore conclude by recommending improvement of household fire preventive and control capacity through proper education, subsidizing costs of active fire equipment and enforcing compliance with the various building safety codes during the design, construction and occupation of buildings. Furthermore, government needs to consider the provision of community based fire apparatus, educate the people on appropriate attitude toward handling or usage of naked flame and electrical appliances. Government can also procure and distribute firefighting equipment to the residents and ensure that property owners provide active firefighting tools such as fire extinguishers in the houses. Also, there is need for government to work and improve on pipe-borne water supply as well as the neighbourhood network of roads so as to provide easy access and reliable supply of water for fire-fighting brigades in case of fire incidents. These suggestions have the potential to facilitate the achievement of sustainable development agenda as spelt out in goals #1, #6, #10, and #11. As such, the recommendations of this study engenders end to extreme poverty, availability and sustainable management of water and sanitation, reduction of inequality of within and among countries and make cities and human settlements inclusive, safe, resilient and sustainable. This study is largely delimited by reason of location and building use. Further study could explore the adequacy of fire safety measures of properties in other states of Nigeria and other categories of building use.

Acknowledgement

The authors wish to acknowledge the painstaking efforts of all reviewers of the manuscript for the various constructive contributions. The Centre for Research, Innovation and Development of Covenant University is also appreciated for providing the platform and enablers to undertake the research.

References

Adedeji, Y. M. D., & Olotuah, A. O. (2012). An evaluation of accessibility of low-income earners to housing finance in Nigeria. *European Scientific Journal, 8*(12), 80-95.

Adekunle, A., Asuquo, A., Essang, N., Umanah, I. I., Ibe, K. E., & Alo, A. B. (2016). Statistical analysis of electrical fire outbreaks in buildings: Case study of Lagos State, Nigeria. *Journal of Sustainable Development Studies, 9*(1), 76-92.

Adekunle, A., Umanah, I. I., Ibe, K. I., & Imonikosaye, M. R. (2018). Statistical analysis of fire outbreaks in homes and public buildings in Nigeria: A case study of Lagos State. *International Journal of Engineering Research and Advanced Technology, 4*(8), 21-30.

Adelekan, I. O. (2020). Urban dynamics, everyday hazards and disaster risks in Ibadan, Nigeria. *Environment and Urbanization, 32*(1), 213-232.

Akashah, F. W., Baaki, T. K., & Lee, S. P. (2017). Fire risk assessment of low cost high rise residential buildings in Kuala Lumpur: A case study. *Journal of Design and Built Environment, 17*(Special Issue), 124-139.

Alao, M. K., Yatim, Y. B. M., Mahmood, W. Y. B. W., & Aliu, I. U. (2020). Fire safety protection and prevention measures in Nigeria office buildings. *International Journal of Management and Humanities, 4*(5), 109-115.

Ali, D. B. A., Akashah, F. W., & Sulaiman, R. (2018). Fire protection provisions for pre-building codes shophouses repurposed into budget hotel: A Malaysian perspective. *Journal of Building Performance, 9*(2), 198-203.

Asigri, E. O., Afram, S. O., & Oppong, R. A. (2017, April 12-14). Assessment of the adequacy of fire safety measures in student housing facilities at KNUST, Kumasi. In J. Ayarkwa, D. K. Ahadzie, E. Adinyira, T. Kwofie, & D. Owusu-Manu (Eds.), *ICIDA 2017. Proceedings of the 6th International Conference on Infrastructure Development in Africa* (pp. 492-504). Kumasi: KNUST.

David, A. I., Mlanga, V., Kyauta, M., & Dickson, P. (2019). Building design practice and fire codes for buildings in Nigeria (Issues, effects and solutions). *International Journal of Innovative Research & Development, 8*(8), 321-326.

Hassan, H. (1999). Fire and safety management in buildings. *The Professional Builders – Journal of the Nigerian Institute of Building,* (June/July), 32-35.

Hassanain, M. A., Hafeez, M. A., & Sanni-Anibire, M. O. (2017). A ranking system for fire safety performance of student housing facilities. *Safety Science, 92*, 116-127.

Henshaw, G. (2010). *The role of private sector in the provision of affordable housing to the public*. Lecture presented at the workshop for the Nigerian Society of Engineers, Lagos, Nigeria.

Ebenehi, I., Ruikar, K., Thorpe, T., & Wilkinson, P. (2016, March 21-24). Fire safety education and training in architecture: An exploratory study. In O. J. Ebohon, D. A. Ayeni, C. O. Egbu, & F. K. Omole (Eds.), *JIC 2016. Proceedings of the Joint International Conference on 21st Century Habitat: Issues, Sustainability and Development* (pp. 105-114). Akure: Joint International Conference Editorial Committee.

Kurniawan, T. A., Tambunan, L., & Imaniar, L. N. (2018). Fire safety parameters of high-rise residential building: A literature review of performance-based analysis method. *IOP Conference Series: Earth and Environmental Science, 152*, 012030.

Kobes, M., Helsloot, I., de Vries, B., & Post, J. G. (2010). Building safety and human behaviour in fire: A literature review. *Fire Safety Journal, 45*(1), 1-11.

Lawal, N. M., Chandra, I., & Bichi, N. M. (2018). Assessment of implementation of fire safety procedures and regulation in public buildings. *International Journal of Advance Research and Innovation, 6*(2), 84-87.

Leadership News. (2017, September 10). Fire outbreak costs Nigeria N6trn in 5 years. Retrieved from https://leadership.ng/2017/09/10/fire-outbreak-costs-nigeria-n6trn-5-years/

Makanjuola, S. A., Aiyetan, A. O., & Oke, A. E. (2009, September 10-11). *Assessment of fire safety practices in public buildings in western Nigeria*. Paper presented at the Construction and Building Research Conference of the Royal Institution of Chartered Surveyors (COBRA 2009), Cape Town, South Africa,

McAllister, T. (Ed.). (2002). *World Trade Center building performance study: Data collection, preliminary observations, and recommendations*. Washington, DC: FEMA.

Morenikeji, W. (2006). *Research and analytical methods: For social scientists, planners and environmentalists*. Jos: Jos University Press.

National Bureau of Statistics (NBS). (2012). Annual abstract of statistics, 2012. Retrieved 6 June 2021 from https://www.nigerianstat.gov.ng/pdfuploads/annual_abstract_2012.pdf

National Population Commission (NPC). (2006). Nigeria national census: Population distribution by sex, state, LGAs and senatorial district: 2006 census priority tables (vol. 3). Retrieved from http://www.population.gov.ng/index.php/publication/140-popn-distri-by-sex-state-jgas-and-senatorial-distr-2006

Obi, N. I. (2015). Fire protection measures in buildings: The architect's design role. *Civil and Environmental Research, 7*(7), 27-30.

Oloke, O. C. (2015). *Performance evaluation of co-operative societies' housing provision in Lagos State, Nigeria* (Unpublished doctoral dissertation). Covenant University, Ota, Nigeria.

Oloke, O. C., Ajibola, M. O., & Iroham, O. C. (2013). Cost of urban rental housing and its implications on home ownership drive of middle and low-income earners in Lagos State, Nigeria. *International Journal of Arts and Commerce, 2*(8), 65-75.

Oloke, O. C., Oni, A. S., Ogunde, A., Joshua, O., & Babalola, D. O. (2017). Incessant building collapse in Nigeria: A framework for post-development management control. *Developing Country Studies, 7*(3), 114-127.

Onoyan-usina, A., Baba, Y. A., Ladkiwa, A. Y., & Yakubu, K. (2017). Curbing menace of urban fire outbreak in residential buildings: A case study of Gombe Metropolis. *Scientific Research Journal, 5*(7), 49-63.

Osácar, A., Trueba, J. B. E., & Meacham, B. (2021). Evaluation of the legal framework for building fire safety regulations in Spain. *Buildings*, *11*(2), 51.

Osunsanmi, T., Ajayi, O., & Afolayan A. S. (2017). User's perspective of fire safety in high rise buildings in Lagos, Nigeria. *Journal of Sustainable Human Settlement and Housing, 1*(1), 77-90.

Popoola, A. A., Adekalu, O. B., Audu, A. A., Adeleye, B. M., & Jiyah F. (2016). Analysis of causes and characteristics of market fires in Lagos State, Nigeria. *International Journal of Agriculture and Rural Development, 19*(1), 2407-2421

Rodrigues, E. E. C., Rodrigues, J. P. C., & da Silva Filho, L. C. P. (2017). Comparative study of building fire safety regulations in different Brazilian states. *Journal of Building Engineering, 10*, 102-108.

Sunday, O. U., Zubairu, S. N., & Isah, A. D. (2019). Analysis of active fire protection measures in Garki Model Market of the Federal Capital Territory of Nigeria. *British Journal of Earth Sciences Research*, *4*(1), 1-8.

The Guardian. (2018, March 3). Lagos recorded 1,273 fire calls in 2017, says Fire Service boss. Retrieved from https://guardian.ng/news/lagos-recorded-1-273-fire-calls-in-2017-says-fire-service-boss/

United Nations. (2015). A/RES/70/1 - Transforming our world: The 2030 Agenda for Sustainable Development. Retrieved from https://sdgs.un.org/2030agenda

United Nations - Department of Economic and Social Affairs (UN-DESA). (2012). *World urbanization prospects: The 2011 revision.* New York, NY: United Nations.

Victoria, L. P. (2002, September 24-26). Community based approaches to disaster mitigation. In *Proceedings of the Regional Workshop on Best Practices in Disaster Mitigation: Lessons learned from the Asian Urban Disaster Mitigation Program and Other Initiatives* (pp. 269-314). Bangkok: Asian Disaster Preparedness Center.