IOSR Journal of Humanities and Social Science (IOSR-JHSS)
Volume 29, Issue 11, Series 6 (November, 2024) 31-42
e-ISSN: 2279-0837, p-ISSN: 2279-0845.
www.iosrjournals.org

Estimate of Fire Safety Management in Residential Buildings: A Structural Equation Modeling (SEM) Approach

Ayobami Dele Jembola
Federal Fire Service, Oyo State Command, Federal Secretariat, Ikolaba G.R.A., Ibadan, Oyo State, Nigeria.

Abstract
The devastating consequences of fire incidents have brought global attention to the need for a thorough understanding of the factors responsible for this menace in order to provide a lasting solution. Poor fire safety management in buildings contributes to our societies' increasing susceptibility to fire disasters. Nigeria, like every other nation in the world, has experienced a number of fire incidents over the years, most of them occurring in residential buildings. Thus, the study aimed to estimate fire safety management in buildings that provide accommodation and sleeping facilities for individuals and/or households, such as apartments, hotels, and hostels, which are referred to as residential buildings. The study was conducted to fill the gaps in the existing literature and provide relevant policy recommendations to address the challenges in fire safety management.
The study employed a cross-sectional research design. Primary data were collected from a random selection of one hundred and eighty respondents, including one hundred and twenty (120) building occupants, twelve (12) hostellers, and forty-eight (48) hoteliers, using a well-structured questionnaire. Descriptive statistics and structural equation modeling (SEM) were used to analyze the dataset collected.
The study's findings indicate that fire safety awareness, households/management commitment to fire safety policies and standards, and fire safety practices have significant positive impacts on fire safety management in residential buildings. Conversely, the cause of fire incidents has a significant negative impact on fire safety management in residential buildings, with P-values less than 0.05 under the regression weights. Additionally, the study revealed that the majority of fire incidents in residential buildings stem from human carelessness, errors, poor human behaviors, and malfunctioning mechanical and electrical equipment. Furthermore, the study showed that achieving fire safety management objectives in residential buildings requires a greater awareness of fire safety, a commitment to fire safety policies and standards, and the implementation of fire safety practices among residents, hoteliers, and hostellers.
The study thus recommends that residents, hostellers, and hoteliers should adopt a positive attitude towards fire safety management; prioritize fire safety training, fire risk assessment, and routine maintenance of fire safety equipment; ensure the use of surge protectors for electrical equipment; and establish a well-planned and organized emergency action plan and evacuation procedure, complete with proper documentation, to create a standardized system for preventing, mitigating, preparing for, and responding to fire emergencies. Similarly, the fire service should intensify public enlightenment on fire safety management with strict enforcement of fire safety policies and standards to ensure uncompromised fire safety practices and effective fire safety management in buildings.
Keywords: *Fire, Disaster, Fire Safety Management, Buildings, Structural Equation Modeling (SEM).*

Date of Submission: 06-11-2024 Date of Acceptance: 16-11-2024

I. Introduction

The devastating consequences of fire incidents have brought global attention to the need for a thorough understanding of the factors responsible for this threat in order to provide a lasting solution. Fire safety management is crucial in ensuring, maintaining, and enhancing safety in buildings. Fire safety management aims to educate building owners and occupants to be proactive, responsible, and responsive towards fire safety through the application of policies, standards, tools, information, and practices directed towards the analysis, evaluation, and control of fire safety (Howarth and Kara-Zaitri, 1999; Abdul Rahim et al., 2014). Fire safety management creates awareness about fire safety, assures safe practices by the occupants to reduce fire incidents, promotes compliance to fire safety standards and policies, and encourages first-hand fire safety prevention, preparedness, mitigation, and response in order to avert fire disasters.

Fire disasters are one of the world's most prevalent and damaging calamities that have proven difficult to address, especially in developing countries (Agbola and Falola, 2021; Salazar et al., 2021). Fire disasters can be due to natural events, human activities, and technological, electrical, or mechanical factors. Nigeria, like every other nation in the world, has experienced a number of fire incidents over the years. According to the National Fire Statistics (2020-2023), a total of 11,006 fire incidents resulted in 403 fatalities, with property losses worth about 12.9 million dollars (at a ₦1,500 (naira) per USD ($) conversion rate) reported in Nigeria in the last four years. Residential building fires are a major concern, as about forty percent (40%) of the total fire incidences reported occur in residential buildings.

Residential building fire is an everyday hazard that can start without warning and, if not promptly put out when it starts, can turn into a raging inferno with widespread human, material, economic, or environmental losses and impacts. Residential building fires are largely man-made (Cvetkovic et al., 2022), usually accidental (Anand et al., 2022), and normally begin with an incipient phase during the early stages (IFE, 2017). Residential buildings are the types of buildings that provide accommodation and sleeping facilities for individuals and/or households, which include apartments, convents, lodging houses, dormitories, dwelling houses, hotels, guest houses, barracks, motels, multi-family houses, and boarding houses (NFSC, 2013).

Fire will start when any of the building contents (referred to as fuel) in combination with a sufficient quantity of oxygen is exposed to a source of heat above a certain temperature, which in turn produces a self-sustaining chemical chain reaction, generating heat, smoke, and other combustion products. Fire makes use of the available oxygen and fuel for its development, generating a high amount of heat and smoke, which makes evacuating from the building difficult for the occupants and users. Cooling, smothering, starvation, or inhibiting the chain chemical reaction of the fire pyramid can extinguish the fire. Therefore, it is crucial to regularly assess the location of fuel in relation to ignition sources for fire prevention, as most building contents can ignite when exposed to an ignition source.

The increasing level of susceptibility to fire disasters in our societies is a result of haphazardly planned and organized fire safety management in buildings (Kazeem et al., 2021). Fire incidents will be frequent and severe in buildings with poor fire safety management or when the approach is not holistic and/or properly coordinated. Relevant stakeholders must therefore make concerted efforts to ensure effective fire safety management in buildings and a safe environment from fire disasters for all.

Statement of Research Problems

Cases of fire outbreaks with severe aftermaths are basically an indication of how unacquainted, unprepared, and/or indifferent people are with fire safety management. Nigeria's experience highlights the importance of effective fire safety management in buildings, particularly in the light of the limited implementation and consideration of lessons learned from previous occurrences (Agbola and Falola, 2021).

While it is important to improve the response capacities of the fire emergency responders, members of households and the management of organizations are in the best position to prevent fires from starting or getting out of control. By committing to effective fire safety management in buildings, both household members and organization management can optimally minimize the frequency and impacts of fire incidents. Thus, the study aims to estimate fire safety management in residential buildings to proffer solutions that can bring about real-time and comprehensive fire emergency prevention, control, and management.

The study has the following objectives:

1. Identify the causes of fire incidents in residential buildings within the study area.
2. Find out the level of fire safety awareness within the study area.
3. Assess the fire safety practices within the study area.
4. Determine the commitment to fire safety policies and standards within the study area.
5. Examine the fire safety management within the study area.
6. Interrogate the challenges facing fire safety management within the study area.

Justification of the Study

Many empirical studies have been conducted on fire safety, disaster preparedness, mitigation, and management in different parts of Nigeria (Osunsanmi et al., 2017; Adegboro and Ojoye, 2019; Adeleye et al., 2020; Alao et al., 2020; Daramola and Ibrahim, 2021; Oloke et al., 2022; Ukegbu et al., 2022; Dankani et al., 2022; Nwaichi et al., 2023; Ekong et al., 2024), etc. However, there is a paucity of studies specifically on fire safety management in residential buildings within the Federal Capital Territory (FCT), Nigeria, using the structural equation modeling (SEM) approach. This study, therefore, will help in bridging the gap in the existing literature.

In addition, the study set out to provide relevant recommendations to policymakers, the government, and the general public at large in order to avert and abate fire disasters.

Review of Past Empirical Studies

Sun and Luo (2014) posited that fire safety management is essential to reduce the likelihood of a fire outbreak and to mitigate its consequences in buildings. Kazeem et al. (2021) reinforced this assertion, stating that fire safety management plays a crucial role in guaranteeing the complete safety of buildings, their occupants, and their contents. Similarly, Arewa et al. (2021) highlighted structural fire resistance; automatic fire detection, suppression, and extinguishing systems; accessible emergency exits to allow for evacuation; water provision for firefighting purposes; passive protection measures; and voice communications between building occupants and the firefighters as the six (6) fundamental pillars of fire safety in buildings.

However, most buildings have been perceived to neglect fire safety management, despite its significant importance. Adeleye et al. (2020) found that building occupants face significant fire risk and potential chaos during fire outbreaks, primarily due to their lack of preparedness for managing fire incidents and their ignorance of evacuation plans. In a similar vein, Ogbanna and Nwaogazie (2015) opined that most occupants of buildings are not even aware of the fire safety regulations or legislation guiding them, resulting in a lack of knowledge about fire safety preparedness. Agbonkhese et al. (2017) further confirmed that a significant proportion of residential buildings lacked fire detection and firefighting equipment, and those that did either lacked proper usage instructions or neglected to maintain the equipment for optimal functionality.

In addressing these shortcomings, Daramola and Ibrahim (2021) suggested educating building residents on fire safety protocols and insurance, enacting laws for fire safety equipment to increase mitigation facilities, and integrating safety devices in all buildings. Also, Oloke et al. (2022) recommended improving household fire preventive and control capacity through fire safety awareness and sensitization, subsidizing the cost of active fire equipment, and enforcing compliance with the various building safety codes during the design, construction, and before occupying buildings. Ekong et al. (2024) asserted that fire safety regulations and standards must be enforced in all buildings to guarantee sufficient provision, efficacy, consistent maintenance, uninterrupted operation of the fire safety management system, and to encourage occupants to create a fire escape plan for sufficient fire safety readiness and reaction.

II. Research Methodology

The study employed a cross-sectional research design. The technique was adopted because it is straightforward, not expensive, and allows for the easy collection of data from a large pool of subjects without undue pressure to probe physical inquiries from respondents.

Sources of Data Collection

The primary data used for the study were collected through the administration of well-structured questionnaires to residents, hostellers, and hoteliers in the Federal Capital Territory (FCT), Nigeria. Also, key informant interviews, in-depth interviews, and focused group discussions (FGD) were conducted to gather all the necessary information for the study.

Sampling Procedure and Sampling Size

The study employed a multistage sampling technique to ensure that the selected respondents fit the purpose of the study under review. The sample size for the study was one hundred and eighty (180).

The Nigeria Federal Capital Territory (FCT) has six (6) local government areas, namely Abaji, Abuja Municipal Area Council (AMAC), Bwari, Gwagwalada, Kuje, and Kwali. Abuja Municipal Area Council (AMAC) has twelve (12) wards, while the remaining five (5) local government areas have ten (10) wards each, to make a total of one hundred and twenty (120) wards available in the study area.

Two (2) wards each were purposefully selected from each of the six local government areas, taking into account the availability of the different categories of residential buildings within these ward areas, resulting in a total sample of twelve (12) wards for the study. This includes Abaji Central and Yaba Gurdi in Abaji Local Government Area; Garki and Karshi in Abuja Municipal Council Area (AMAC); Bwari Central and Dutse-Alhaji in Bwari Local Government Area; Gwagwalada Centre and Tunga Maje in Gwagwalada Local Government Area; Kuje and Rubochi in Kuje Local Government Area; and lastly, Kwali and Yangoji in Kwali Local Government Area.

In the final stage, fifteen (15) respondents were randomly selected, each consisting of ten (10) residents, four (4) hoteliers, and one (1) hosteller, from each of the twelve (12) selected wards. This makes a total of one hundred and twenty (120) apartments/flats; twelve (12) students' dormitories/hostels; and forty-eight (48) hotels/inns/guest houses selected for the study. In all, one hundred and eighty (180) questionnaires were administered to respondents in various residential buildings.

Data Analytical Technique

The study used IBM Statistical Package for Social Sciences (SPSS) software version 23 to code the collected dataset. Descriptive analysis in the form of frequency tables, percentages, and mean scores was first conducted to determine the demography of survey respondents. Also, a psychometric scale was used to measure the non-numeric information about the perceptions of the respondents. The respondents selected their choices on a 1 to 5 rating scale, which included strongly disagree (SD), disagree (D), undecided (U), agree (A), and strongly agree (SA), in that order. The four (4) independent variables constructed for the study include causes of fire incidents, awareness of fire safety, commitment to fire safety policies, and fire safety practices, while the dependent variable for the study is the overall fire safety management.

The preliminary tests were performed on the dataset to check for redundant respondents who selected the same option for every question, outliers whose responses did not correlate with others, variable commonalities, reliability, and validity using Cronbach's alpha based on standardized items and principal component analysis (PCA), which produced a Kaiser-Meyer-Olkin (KMO) value. The result was considered satisfactory for the subsequent statistical procedure with the Cronbach's alpha and KMO threshold values above 0.7 and 0.6, respectively (Achoba et al., 2021; Aule et al., 2022).

The psychometric scale dataset saved on the IBM Statistical Package for Social Sciences (SPSS) was loaded on the IBM SPSS Analysis of Moment of Structures (AMOS) software version 26 for the structural equation modeling (SEM) and analysis conducted. Structural equation modeling (SEM) consists of two orders, which include the first-order confirmatory factor analysis (CFA) and the second-order SEM. The first-order CFA requires generating path diagrams of the constructs and the links between the respective independent variables and the dependent variable before loading the observed or measured variables, called factors for the data analysis (Nwaichi et al., 2023). The first-order CFA is completed once the model goodness-of-fit is attained and the conditions for reliability and validity are met. The recommended thresholds for acceptance are the standard regression weight (SRW) and square multiple correlation (SMC) values above 0.5 and 0.25, respectively (Kline, 2016; Malhorta, 2020).

The second-order SEM creates a comprehensive model using the results of the first-order CFA, which generates a series of dependent relationships between a group of generated constructs, each represented by several quantifiable variables (Malhorta, 2020). However, this study will not conduct a second-order SEM, as its objectives do not include formulating a hypothesis for statistical testing relationships.

III. Results And Discussions

Demography of Survey Respondents

Table 1 below shows the demographic attributes of the respondents for the study. The result shows that 53.9% of the respondents are males, while 46.1% are females, and above two-thirds (69.4%) of the total respondents are married. This suggests that the study largely sampled both the male and female gender opinions

Table 1: Demography of Survey Respondents

Demography of Respondents		Frequency	Percentage (%)
Gender	Male	97	53.9
	Female	83	46.1
	Total	**180**	**100.0**
Age distribution	18-30	25	13.9
	31-40	50	27.8
	41-50	55	30.6
	51-60	33	18.3
	61 and above	17	9.4
	Total	**180**	**100.0**
Educational attainment	Secondary/High School	23	12.8
	Graduate/College	106	58.9
	Postgraduate	51	28.3
	Total	**180**	**100.0**
Marital status	Single	48	26.7
	Married	125	69.4
	Widow(er)	7	3.9
	Total	**180**	**100.0**
Year(s) of stay or work in the building (year)	Less than 1	11	6.1
	1-5	29	16.1
	6-10	76	42.2
	11-15	43	23.9
	16-20	12	6.7
	Above 20	9	5.0
	Total	**180**	**100.0**

Source: Field Survey, 2024

without any form of bias. The mean age of the distribution of respondents is forty-three (43) years, and a very high proportion of the respondents (90.6%) are mature, agile, economically active, and responsible enough to make important decisions about life as well as provide needed responses for the study. Additionally, 87.2% of the respondents possess post-secondary education, demonstrating their literacy and potential to understand and provide pertinent responses to the issue raised in the study. Similarly, more than three-quarters (77.8%) of the respondents have resided or worked for more than five years in the buildings sampled for the study. Therefore, the respondents will provide crucial information in achieving the objectives of the study.

Reliability and Validity Test

The data collected for the study achieved a Cronbach's alpha of 0.960, surpassing the 0.7 minimum threshold for suitability for using the data set in the subsequent statistical procedure, as indicated in Table 2 below. As well, the Principal Component Analysis (PCA) gave a Kaiser-Mayer-Olkin (KMO) sampling adequacy value of 0.879, which is higher than the 0.6 minimum requirement. The Bartlett's Test of Sphericity also gave a significant 0.000 value, which shows the data was suitable for SEM.

Table 2: Reliability and Validity Statistics for Collected Data

Reliability Statistics			
Cronbach's Alpha	Cronbach's Alpha Based on Standardized Items	N of Items	
0.960	0.962	62	
Case Processing Summary			
		N	%
Cases	Valid	180	100.0
	Excluded[a]	0	0.0
	Total	180	100.0

Listwise deletion based on all variables in the procedure.

Source: Author's Computation, 2024

Structural Equation Modeling (SEM) for Fire Safety Management in Residential Buildings

Figure 1 below presents the first-order confirmatory factor analysis (CFA) path diagram of the SEM for fire safety management in residential buildings in Nigeria. The SEM comprises five (5) constructs: causes, awareness, policies, practices, and management. These constructs represent the causes of fire incidents, the awareness of fire safety, the commitment of households/management to fire safety policies and standards, the fire safety practices, and the management of fire safety in residential buildings, respectively. The path diagram shows that fire safety awareness, fire safety policies and standards, fire safety practices, and causes of fire incidents have 0.16, 0.18, 0.23, and -0.50 regression coefficients (i.e., β-coefficients), respectively, for the standardized estimates. Also, awareness of fire safety, causes of fire incidents, households/management commitment to fire safety policies and standards, and fire safety practices have 0.035, 0.003, 0.031, and 0.012 regression weight P-values, respectively, which all meet the less than 0.05 standard for level of significance. This implies that awareness of fire safety, households/management commitment to fire safety policies and standards, and fire safety practices have significant positive impacts on fire safety management of residential buildings in Nigeria, while the cause of fire incidents has a significant negative impact on fire safety management of residential buildings in Nigeria.

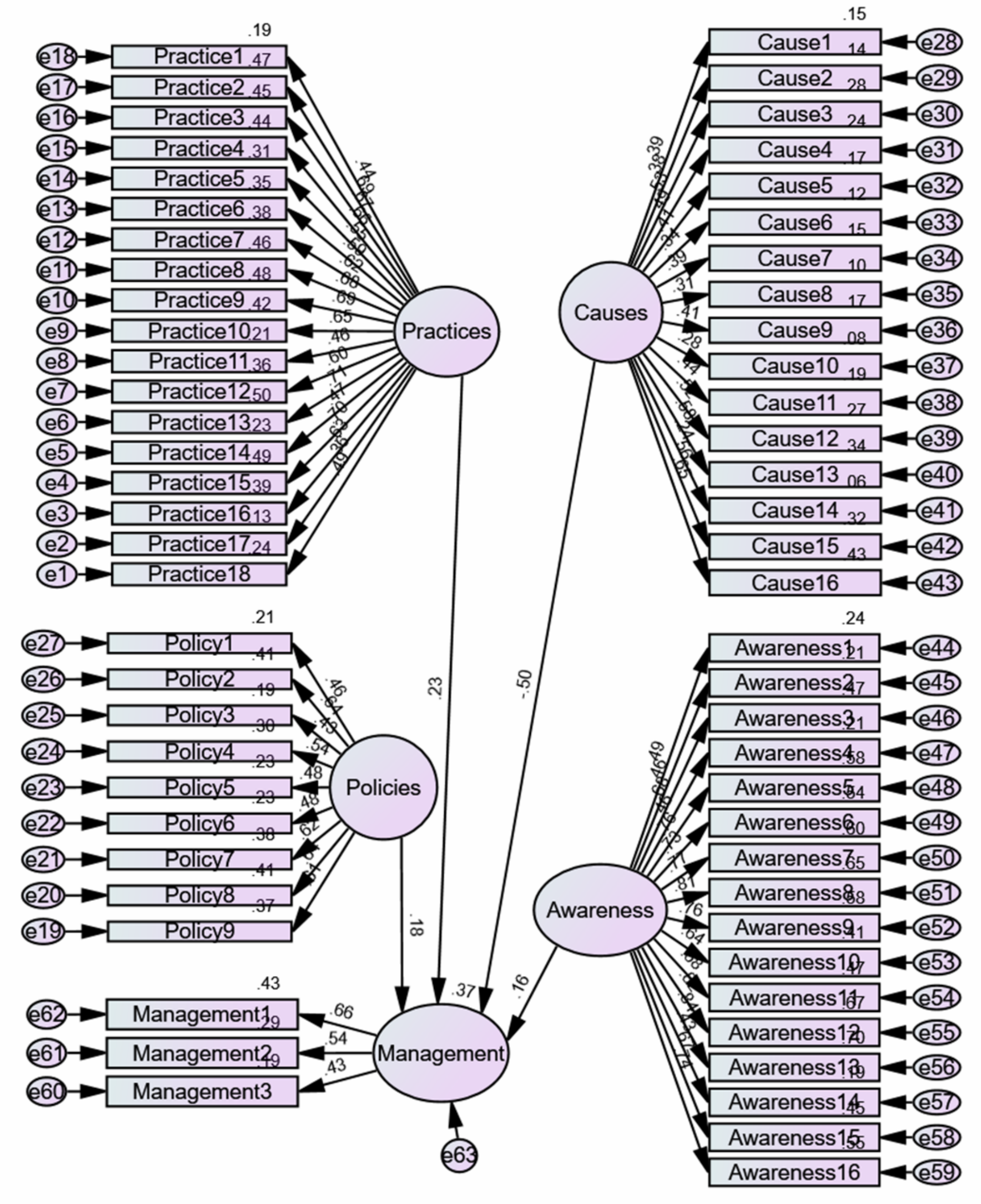

Figure 1: SEM for Fire Safety Management of Residential Buildings in Nigeria

Source: Author's Computation, 2024

Causes of Fire Incidents in Residential Buildings

Table 3 below presents the results of the standardized regression weights (SRW), squared multiple correlations (SMC), internal validity, and reliability for the sixteen (16) variables, coded from 1 to 16, which make up the construct for the causes of fire incidents in residential buildings in Nigeria. The construct's SRW ranges from lowest (0.283) to highest (0.654); consequently, the construct's SMC ranges from lowest (0.080) to highest (0.428). Also, a Cronbach's alpha of 0.786 above the 0.7 minimum limit is obtained, and thirteen (13) out of the variables under the causes of fire incidents construct are significant at a 99 percent confidence level.

Table 3: Causes of Fire Incidents in Residential Buildings

Construct	Code	Variable	SRW	SMC	Validity	Cronbach's Alpha
Causes of Fire Incidents	Cause1	Gas leakage	0.392	0.154	000***	0.786
	Cause2	Poor housekeeping practices	0.379	0.143	000***	
	Cause3	Malfunctioning/faulty electrical and mechanical equipment	0.528	0.279	000***	
	Cause4	Poor wiring, electrical installation, maintenance of electrical and mechanical equipment	0.487	0.237	000***	
	Cause5	Wrong use of mechanical and electrical equipment	0.410	0.168	000***	
	Cause6	Indoor smoking	0.342	0.117	000***	
	Cause7	Wrong use of flame (candles, lighters, and matches)	0.391	0.153	000***	
	Cause8	Poor cultural practices	0.312	0.097	000	
	Cause9	Overloading of electrical sockets leading to overheating of cable and socket	0.414	0.171	000***	
	Cause10	Natural events	0.283	0.080	000	
	Cause11	Poor storage of flammable and combustible substances	0.436	0.190	000***	
	Cause12	High voltage	0.519	0.269	000***	
	Cause13	Unattended cooking	0.580	0.337	000***	
	Cause14	Arson	0.238	0.057	000	
	Cause15	Electrical sparks	0.561	0.315	000***	
	Cause16	Leaving electrical appliances on while away	0.654	0.428	000***	

Note: Cronbach's Alpha > 0.7; * significant at 99% confidence level**
Source: Author's Computation, 2024

Since the cause of fire incidents is a negative construct, it can be deduced that leaving electrical equipment on while away, unattended cooking, electrical sparks, malfunctioning electrical and mechanical equipment, and high voltage from the Power Holding Company of Nigeria (PHCN) are the causes of most fire outbreaks in residential buildings in Nigeria with their SRWs and SMCs scores above the minimum threshold of 0.5 and 0.25, respectively. Other notable causes of fire incidents in residential buildings include poor wiring, electrical installation, maintenance of electrical and mechanical equipment; poor storage of flammable and combustible substances; overloading of electrical sockets; wrong use of mechanical and electrical equipment; gas leakage; wrong use of flame; poor housekeeping practices; and indoor smoking with SRWs scores relative to the minimum threshold limit.

Human carelessness, errors, poor behaviors, and malfunctioning mechanical and electrical equipment can all contribute to these factors. All fire incidents have the potential to cause fatalities, injuries, permanent disabilities, property destruction, and structural defects in buildings. The fire statistics of the fire service listed these factors as causes of fire outbreaks in Nigeria (National Fire Statistics, 2020-2023). Likewise, Anand et al. (2022), in a similar study, identified cooking fires, poor human behaviors, malfunctioning, and poor maintenance of electrical and mechanical systems as the factors responsible for most residential fires.

Awareness of Fire Safety in Residential Buildings

Table 4 below presents the results of the standardized regression weights (SRW), squared multiple correlations (SMC), internal validity, and reliability for the sixteen (16) variables in the fire safety awareness construct, coded from 1 to 16. The construct's SRW values range from lowest (0.434) to highest (0.836); consequently, the construct's SMC values range from lowest (0.188) to highest (0.698). With a Cronbach's alpha of 0.929, above the 0.7 minimum limits, all sixteen (16) variables under the awareness of fire safety construct are significant at a 99 percent confidence level.

The residents, hostellers, and hoteliers demonstrate considerable knowledge of fire safety. However, there is still a need for increased awareness of emergency action plans and evacuation procedures, as five of the SRWs and SMCs are below the minimum threshold levels of 0.5 and 0.25, respectively. This knowledge will assist in guiding residents, hostellers, and hoteliers on the appropriate actions to take during fire emergencies.

When there is an outbreak of fire, occupants or users of buildings should remain calm and act quickly to evacuate everyone from the building as soon as possible. They should never move any object that is on fire within the building to prevent its spread. If they have the necessary training, they should respond promptly to extinguish fire with the use of appropriate fire extinguishing equipment or system. Otherwise, they should close doors and windows behind them while evacuating the building during a fire emergency to impede the rapid fire development. They should also check if a closed door is not hot before opening to prevent sudden explosions, known as backdraft. This finding is consistent with the Institution of Fire Engineers standard on fire safety.

Table 4: Awareness of Fire Safety in Residential Buildings

Construct	Code	Variables	SRW	SMC	Validity	Cronbach's Alpha
Awareness of Fire Safety	Awareness1	One should walk out quickly, smartly, and calmly to evacuate the building during fire emergency	0.489	0.239	000***	0.929
	Awareness2	An object on fire should not be moved out of the building	0.459	0.210	000***	
	Awareness3	The very first things to do when fire breaks out is to alert other occupants of the building	0.685	0.469	000***	
	Awareness4	Doors and windows should be closed as one leaves the building during fire emergency	0.458	0.210	000***	
	Awareness5	One should not pick up any valuables or possessions during a fire emergency	0.764	0.584	000***	
	Awareness6	All fires are not the same and therefore cannot be extinguished using the same extinguishing medium	0.733	0.538	000***	
	Awareness7	Lift/elevator/accelerator should not be used to evacuate the building during fire emergency	0.773	0.598	000***	
	Awareness8	When the room is smoke lugged, one should crawl out of the building	0.807	0.651	000***	
	Awareness9	All occupants must assemble at the designated muster point after evacuating the building and roll call should be made immediately to know if anyone is left behind	0.762	0.581	000***	
	Awareness10	In case of gas leakage, naked flame or spark should not be allowed in the area	0.638	0.407	000***	
	Awareness11	When there is an outbreak of fire, fire service emergency line should be dialed as soon as possible	0.682	0.466	000***	
	Awareness12	Water or foam solution cannot be used to extinguish electrical or oil fires	0.816	0.665	000***	
	Awareness13	I can operate a fire extinguisher without assistance or fear following PASS procedure	0.836	0.698	000***	
	Awareness14	During an outbreak of fire, one must check a closed door if it is not hot before opening it	0.434	0.188	000***	
	Awareness15	One should do stop, drop, and roll when his/her cloth catches fire	0.674	0.455	000***	
	Awareness16	Fire extinguisher cannot be used on fat pan fires	0.744	0.554	000***	

Note: Cronbach's Alpha > 0.7; * significant at 99% confidence level**
Source: Author's Computation, 2024

Fire Safety Practices in Residential Buildings

Table 5 below presents the results of the standardized regression weights (SRW), squared multiple correlations (SMC), internal validity, and reliability. The construct for fire safety practices has eighteen (18) variables coded from 1 to 18. The construct's SRWs for the households and management fire safety practices range from lowest (0.363) to highest (0.707); consequently, the construct's SMCs range from lowest (0.132) to highest (0.501). All the eighteen (18) variables in the fire safety practices construct are significant at a 99 percent confidence level, with a Cronbach's alpha of 0.908 surpassing the 0.7 minimum limit.

The scores for four (4) SRWs, including the availability of fire evacuation procedures (0.363), regular practical fire safety training (0.438), regular fire safety inspection and risk assessment (0.463), consistency in fire safety equipment maintenance (0.475), and the presence of a fire emergency action (0.493), fall below the minimum limit of 0.5. Inference can be drawn that fire safety training, fire safety equipment maintenance, fire safety inspection, and risk assessment are conducted at will rather than following a set plan, while fire evacuation procedures and emergency action plans are poorly set up in most residential buildings. The notable fire safety equipment, systems, and facilities for residential buildings in the study area include fire alarms, portable fire extinguishers, fire balls, fire blankets, fire sand buckets, water sprinkler systems, hose reels, emergency lighting systems, and fire safety signage.

This necessitates the implementation of a fire safety plan that ensures regular fire risk assessment for optimum fire prevention, provides training on fire safety and evacuation procedures for prompt extinguishment of fire and safe building evacuation, and commits to maintaining the functionality of the available fire safety equipment and system. Consistent with this finding are Baker et al. (2013), Aminu et al. (2014), and Kazeem et al. (2021), who opined that educating, training, and creating awareness among the building occupants and general public; regular maintenance of fire safety equipment; a fire emergency plan; and fire safety procedures are among the factors that can positively influence the achievement of fire safety management objectives in buildings.

Table 5: Fire Safety Practices in Residential Buildings

Construct	Code	Variable	SRW	SMC	Validity	Cronbach's Alpha
Safety Practices	Practice1	Have practical fire safety training (simulation, first aid, evacuation drill) regularly	0.438	0.191	000***	0.908
	Practice2	Replace hazards	0.686	0.471	000***	
	Practice3	Remove hazards	0.670	0.448	000***	
	Practice4	Good management/household Practices	0.660	0.436	000***	
	Practice5	Ensure all appliances are switched off while away or when not in use	0.555	0.308	000***	
	Practice6	Investigate hazards, injuries, and near misses	0.588	0.345	000***	
	Practice7	Ensure standard/quality/safe equipment and plant are being installed for use	0.616	0.380	000***	
	Practice8	Ensure regular maintenance/ servicing of electrical and mechanical equipment	0.682	0.464	000***	
	Practice9	Ensure regular check of all gas line, cylinder, and stove or burner	0.693	0.480	000***	
	Practice10	Ensure electrical sockets are not Overloaded	0.648	0.420	000***	
	Practice11	Conduct fire safety inspection and risk assessment regularly	0.463	0.214	000***	
	Practice12	Provide fire signage, muster point, emergency lightening system, first aid kit, fire safety equipment, and water supply for firefighting	0.603	0.363	000***	
	Practice13	Engineering controls/isolation	0.707	0.501	000***	
	Practice14	Regular maintenance of fire safety equipment and systems	0.475	0.225	000***	
	Practice15	Good housekeeping and safe work Environment	0.701	0.492	000***	
	Practice16	Safe system of work	0.628	0.395	000***	
	Practice17	Have fire evacuation procedure	0.363	0.132	000***	
	Practice18	Have developed fire emergency action plan	0.493	0.243	000***	

Note: Cronbach's Alpha > 0.7; * significant at 99% confidence level**
Source: Author's Computation, 2024

Household/Management Commitment to Fire Safety Policies and Standards in Residential Buildings

The results for the construct of fire safety policies and standards are shown below in Table 6. They include the standardized regression weights (SRW), squared multiple correlations (SMC), internal validity, and reliability. The nine (9) variables constructed are coded from 1 to 9.

The SRWs for the fire safety policies and standards construct range from lowest (0.432) to highest (0.643); consequently, the SMCs also range from lowest (0.186) to highest (0.413). A Cronbach's alpha of 0.790, which is above the 0.7 minimum limit, is obtained, and all the nine (9) variables under the fire safety policies and standards construct are statistically significant at a 99 percent confidence level. Four (4) of the SRWs fall below the average 0.5 lower limits. These include the absence of fire safety approval, certification, and insurance for buildings (0.432), the poor implementation of fire safety policies and standards in buildings (0.457), the arbitrary review and revise of fire safety plans for improvement (0.479), and the unsystematic evaluation of the efficacy of fire safety plans and policies (0.480).

The poor responses to critical fire safety policies and standards among residents, hostellers, and hoteliers indicate the need for increased awareness of fire safety policies and their strict enforcement in residential buildings. Engaging the residents and workers to comply with fire safety regulations will enhance fire prevention, preparedness, mitigation, and response capacity in buildings, while susceptibility to fire risk will also become minimal to a large extent. This position is consistent with the findings of Dankani et al. (2023), who stated that culpability is both on the part of residents (for negligence) and government for lack of enforcement of fire safety standards in Nigeria.

Table 6: Commitment to Fire Safety Policies and Standards

Construct	Code	Variable	SRW	SMC	Validity	Cronbach's Alpha
Safety Policies and Standards	Policy1	Implementation of fire safety policies and standards	0.457	0.208	000***	0.790
	Policy2	Communicate/provide relevant information	0.643	0.413	000***	
	Policy3	Fire safety approval, certification, and insurance	0.432	0.186	000***	
	Policy4	Supervise and enforce fire safety standards, policies, and practices	0.543	0.295	000***	
	Policy5	Evaluate the efficacy of fire a safety plan and policy	0.480	0.230	000***	
	Policy6	Review and revise the plan for improvement	0.479	0.229	000***	
	Policy7	Write and develop plan	0.618	0.382	000***	
	Policy8	Have a fire safety plan	0.638	0.407	000***	
	Policy9	Record and keep fire safety inventory	0.606	0.368	000***	

Note: Cronbach's Alpha > 0.7; * significant at 99% confidence level**
Source: Author's Computation, 2024

Fire Safety Management in Residential Buildings

The construct for fire safety management has three (3) variables coded from 1 to 3. Table 7 below presents the results of the standardized regression weights (SRW), square multiple correlations (SMC), internal validity, and reliability.

Table 7: Fire Safety Management in Residential Buildings

Construct	Code	Variable	SRW	SMC	Validity	Cronbach's Alpha
Management	Safety Management1	Awareness of fire Safety	0.656	0.430	000***	0.708
	Safety Management2	Fire safety practices	0.537	0.289	000***	
	Safety Management3	Commitment to fire safety policies and standards	0.431	0.185	000***	

Note: Cronbach's Alpha > 0.7; * significant at 99% confidence level**
Source: Author's Computation, 2024

Three (3) SRWs for the fire safety management construct range from the lowest (0.431) to the highest (0.656); consequently, their SMC construct ranges from the lowest (0.185) to the highest (0.430). A Cronbach's alpha of 0.708 above the 0.7 minimum limit is achieved, and all three (3) variables are statistically significant at a 99 percent confidence level. The results show that fire safety awareness, with an SRW score of 0.656, is the most prioritized fire safety management strategy in residential buildings. This is followed by fire safety practices, with an SRW score of 0.537. Commitment to fire safety policies and standards with an SRW value of 0.431 is the least prioritized fire safety management strategy.

In order to achieve effective fire safety management, it is crucial to make concerted efforts to ensure total compliance with fire safety policies and standards in buildings, as outlined in the National Building Code (2006) and National Fire Safety Code (2013). This approach will promote strict fire safety practices, as opposed to the dwindling practices observed among residents, hostellers, and hoteliers. Effective fire safety management in residential buildings will serve as a fire safety net to protect the buildings, their occupants, and contents from fire risk. Kazeem et al. (2021), in a similar study, found out that compliance with fire safety regulations is the least considered factor in fire safety management among the occupants and users of buildings in Nigeria.

IV. Summary, Conclusion, And Recommendations

Summary

The study discovered that fire safety practices, fire safety awareness, and commitment of households and managements to fire safety policies and standards have significant positive impacts on fire safety management, while the cause of fire incidents has a significant negative impact on fire safety management in residential buildings with regression coefficients of 0.16, 0.18, 0.23, and -0.50, respectively, and P-values for regression weights less than 0.05.

The study identified human carelessness, errors, poor human behaviors, and malfunctioning mechanical and electrical equipment as the factors responsible for most fire incidents in apartments, hotels, and hostels. The study also revealed a lack of commitment to fire safety policies and standards, a half-hearted implementation of the fire safety policies and standards, arbitrary reviews and revisions of fire safety plans, a lack of fire safety approval, certification, and insurance, and an unsystematic evaluation of fire safety plans in most buildings. These findings underscore the need for effective fire safety management, prioritizing strict enforcement of fire safety policies and standards in buildings.

Conclusion

In order to achieve fire safety management objectives in buildings, residents, hoteliers, and hostellers must increase their awareness of fire safety, commit to fire safety policies and standards, and implement fire safety practices.

Policy Recommendations

The study's findings lead to the following policy recommendations to accomplish the goals of fire safety management in residential buildings:

1. Building occupants, hoteliers, and hostellers should have the right attitude toward fire safety management and make fire safety training, fire risk assessment, and the maintenance of fire safety equipment routine practices for optimum fire prevention and preparedness.
2. Surge protective devices should be used in buildings to prevent electrical fires.
3. All emergency action plans and evacuation procedures should be well-planned and organized with proper documentation to have a standardized system of fire emergency preparedness and response.
4. The fire service should intensify public enlightenment on fire safety management with strict enforcement of fire safety policies and standards to ensure uncompromised fire safety practices and effective fire safety management in buildings.

References

[1] Abdul Rahim N., Taib M., and Othuman Mydin M.A. (2014): Investigation of Fire Safety Awareness and Management in Mall. MATEC Web of Conferences, 10.06004.doi:10.1051/matecconf/20141006004.

[2] Achoba M.I., Majid R.B.A., and Obiefuna C.O. (2021): Relationship between Window and View Factors in the Workplace: A SEM Approach. International Journal of Built Environment and Sustainability, 8(2): 103-113. https://doi.org/10.11113/ijebs.v8.n2. 667.

[3] Adegboro O. and Ojoye (2019): Assessment of the Preparedness Level of Fire Disaster in Minna, Niger State, Nigeria. Vol. 15, No. 4, African Scholar Publications and Research International.

[4] Adeleye O.I., Ajobiewe T.O., Shaibu S.V., and Oladipo T.O. (2020): Fire Disaster Preparedness of Public Buildings in Ibadan Metropolis, Nigeria. Open Science Journal, May 2020. Pg. 1-14.

[5] Agbola S.B. and Falola O.J. (2021): Seasonal and Locational Variations in Fire Disasters in Ibadan, Nigeria. International Journal of Disaster Risk Reduction, 54 (January), 102035. https://doi.org/10.1016/j.ijdrr.2021.102035.

[6] Agbonkhese O., Yerima A.B., Abba Y.L., and Kawu Y. (2017): Curbing Menace of Urban Fire Outbreak in Residential Buildings: A Case Study of Gombe Metropolis. Scientific Research Journal (SCIRJ), V(VII), Pg. 49-63. http://www.scirj.org/papers-0717/scirj-P0717419.

[7] Alao M.K., Yatim Y.M., and Mahmood W.Y.W. (2020): Model of Fire Safety Management for the Assessment of an Office Building in FCT Abuja, Nigeria. International Journal of Academic Research in Business and Social Sciences, 10(8), 333-340.

[8] Aminu U., Embi M.R., and Yatim Y.M. (2014): Fire Safety Management Evaluation Model for Existing Plastic Factory Buildings in Nigeria, in Applied Mechanics and Materials, Vol. 584, pp. 732-737. Trans Tech Publications Ltd., 2014. https://doi.org/ 10.4028/www.scientific.net/AMM.584586. 732.

[9] Anand S., Chitra A., and Vijaykumar (2022): A Study on Fire Safety Knowledge and Practices among Residents of an Apartment Complex in Chennai City. Tamil Nadu Journal of Public Health and Medical Research. Vol. 2, Issue 3. July–September 2022. Pg. 36-41.

[10] Arewa A.O., Ahmed A., Edwards D.J., and Nwankwo C. (2021): Fire Safety in High-Rise Buildings: Is the Stay-Put Tactic a Misjudgment or Magnificent Strategy? Buildings, 1-16. doi.org/10.3390/buildings11080330.

[11] Aule T.T., Majid R.B.A., and Jusan M.B.M. (2022): Exploring Cultural Values Sustainability Preferences in Housing Development: A Structural Equation Modeling Approach. Scientific Review Engineering and Environmental Studies, 31(3): 149-160. https://doi.org/10.22630/ srees.2971.

[12] Baker J., Dino B., and Stephen E. (2013): Categorization of Fire Safety Management: Results of a Delphi Panel. Fire Safety Journal 59, pp. 37-46. https://doi.org/10.1016/J.firesaf.2013.03.005

[13] Cvetkovic V.M., Dragasevie A., Protic D., Jankovic B., and Nikolic N. (2022): Fire Safety Behavioral Model for Residential Buildings: Implications for Disaster Risk Reduction. International Journal of Disaster Risk Reduction 76, 102981.

[14] Dankani I.M., Ismaila A., and Dankani H.H. (2022): Assessment of Household Fire Safety Devices and Preparedness in Sokoto Metropolis, Nigeria. Journal of Disaster Risk Reduction Vol. 1, No. 2, May 2022. Pg. 284-299.

[15] Daramola A.O. and Ibrahim L. (2021): Analysis of Fire Safety Measures in Residential Buildings in Yaba LCDA, Lagos State, Nigeria. Journal of Disaster and Risk 4(2), 2021, (135-144). e-ISSN:2636-8390. DOI:10.35341/afet.949030.

[16] Ekong A.E., Ogunbanwo B.M., Okeke G.N., and Esitikot E.L. (2024): Disaster Preparedness and Response Capacity to Incidents of Fire among Residential Buildings in Selected Areas in Lagos and Akwa-Ibom. Asian Journal of Advanced Research and Reports. Volume 18, Issue 7, Page 135-158, 2024.

[17] Howarth D.J. and Kara-Zaitri C. (1999): Fire Safety Management at Passenger Terminals. Disaster Prevention and Management: An International Journal, 8(5), 362-369.doi:10.1108/ 09653569910298288

[18] Institution of Fire Engineers (2017): Elementary Fire Engineering Handbook. Amended and Published in 2017 by the Institution of Fire Engineers. ISBN 978-0-903345-23-1

[19] Kaseem A.M., Yatim Y.M., Mahmood W.Y.W. (2021): Examine the Practice of Fire Safety Management in Buildings. Journal of Advance Research in Business and Management Studies 23, Issue 1 (2021) 1-7.

[20] Kline R.B. (2016): Principles and Practices of Structural Equation Modeling. New York. The Guilford Press.

[21] Malhotra N.K. (2020): Marketing Research: An Applied Orientation. Harlow: Pearson Education.

[22] Monisola B.M. (2023): A Review of the Causes, Effects, and Management of Fire Disasters in Nigeria. International Journal of Environmental Research and Earth Science, Vol. 27, No. 4, Pg. 179-186, March 2023. Published by Cambridge Research and Publications.

[23] National Building Code (2006): Federal Republic of Nigeria Standards for Building Construction in Nigeria.

[24] National Fire Safety Code (2013): Fire Service Act, Cap F29, Laws of the Federal Republic of Nigeria, 2004.

[25] National Fire Statistics (2020-2023): National Fire Headquarters Data Collation Centre, Abuja. Fire Report for the Period: January 1st, 2020 to December 31st, 2023.

[26] Nwaichi P.I., Ali M.W., Aule T.T., Aja A.A., and Nwaichi E. (2023): Framework for Fire Safety Management of Hotels in Nigeria: A Structural Equation Modeling Approach. International Journal of Built Environment and Sustainability. Published by Penerbit UTM Press, UniversitiTeknologi Malaysia. IJBES 10(2)/2023, 39-51.

[27] Ogbonna C.I. and Nwaogazie I.I. (2015): Fire Safety Preparedness in Workplaces in Port Harcourt, Nigeria. International Research Journal of Public and Environmental Health, Vol. 2(8), pp. 112-121, August 2015.

[28] Oloke O.A., Oluwatobi A.O., and Amusan L.M. (2022): Adequacy of Fire Safety Measures of Residential Buildings in Peri-Urban Neighborhoods of Ibadan, Oyo State, Nigeria. INTREST-International Journal of Real Estate Studies 16:1 (2022), 14-23.

[29] Osunsanmi T., Ajayi O., and Afolayan A.S. (2017): User's Perspective of Fire Safety in High-Rise Buildings in Lagos, Nigeria. Journal of Sustainable Human Settlement and Housing 2017, 1(1): 77-90.

[30] Salazar L.G.F., Ramao X., and Pauperio E. (2021): Review of Vulnerability Indicators for Fire Risk Assessment in Cultural Heritage. International Journal of Disaster Risk Reduction, 60 (December 2020). https://doi.or/10.1016/j.ijdrr.2021.102286.

[31] Sun X.Q. and Luo M.C. (2014): Fire Risk Assessment for Super High-Rise Buildings. Procedia Engineering, 71: 492-501. https://doi.org/10.1016/j.proeng.2014.04.071.

[32] Ukegbu A.U., Njoku P.U. Metu K.C., Onyeonoro U.U., Obiechina O.C., Ozurumba C.C., and Ebidan C.N. (2022). Workplace Fire Safety: Knowledge and Preparedness in a Public Tertiary Healthcare Facility in Abia State, South East Nigeria. Journal of Community Medicine and Primary Health Care, 34(2), 94-108. https://dx.doi.org/10.4314/jcmphc.v34i2.7