



AN INVESTIGATION INTO THE SAFETY PERFORMANCE OF PUBLIC BUILDINGS IN RELATION TO COMPLIANCE OF FIRE SAFETY REGULATIONS: A CASE STUDY OF ASHANTI AND GREATER ACCRA REGIONS OF GHANA

Samuel Asumadu Roberts¹ and Humphrey Danso²

¹*Department of Building and Construction, Cape Coast Technical Institute, P.O Box DL155, Cape Coast, Ghana.*

²*Department of Construction and Wood Technology Education, Akyem Appiah-Menka University of Skills Training and Entrepreneurial Development, P. O. Box 1277, Kumasi, Ghana*

Ghana has experienced various forms of fire outbreaks emanating from domestic buildings, public buildings, industrial activities, and forests. It has become almost impossible to end a year in Ghana without recording incident of fire outbreaks that result in the deaths of individuals and loss of property. This study therefore aims at investigating the safety performance of public buildings concerning compliance with fire safety regulations in the Ashanti and Greater Accra regions of Ghana. A descriptive survey research design was adopted. The targeted population consisted of housemasters in public Senior High Schools and fueling station managers in Accra and Kumasi. Convenient and purposive sampling techniques were employed in selecting 72 housemasters and 384 filling station managers, and a questionnaire was used as a data collection instrument. The study found that the occupants of public buildings in Ashanti and the Greater Accra Region do not comply with safety regulations. It was also revealed that fire has caused many negative effects in Ghana from an economic perspective, population, safety, and security. A positive and significant relationship was found between compliance with fire safety regulation and safety performance of the public building ($F=127.293$, $df=308$, $p<0.01$). It was recommended that building owners should ensure that their buildings are well equipped with active and passive firefighting equipment. Also, training on fire safety, first aid, use of firefighting equipment, and evacuation procedure should be made compulsory for all building occupants and at regular intervals. This implies that compulsory compliance of fire safety regulation will give a positive effect on public building structures in performing their required purposes.

Keywords: compliance, fire outbreak, public building, safety performance

INTRODUCTION

Fire is one of the major hazards which may occur due to natural or man-made causes (Karake & Kulkarni, 2013). Fire posed great risk and challenges to early

¹ samuelasumaduroberts@yahoo.com

² hdanso@aamusted.edu.gh

people, including the challenge of setting and controlling fires and grappling with the threat of burn and wildfires. Fire continues to be a basic everyday element of most people's lives. However, improper handling and usage can lead to several accidents in homes, offices, schools, other public places with very serious repercussions (Ayarkwa, Danso & Adinyira, 2010). In 2019, Ghana recorded 5,673 fire outbreaks, 1,698 incidents were domestic fires as at the end of the third quarter as compared to 1,622 figures recorded in 2018. Commercial fires followed with 631 cases recorded, 606 for Bush fires, 502 for electrical fires, and 480 cases for vehicular fires. The report by GNFS in 2019 on fire outbreaks from January to September recorded a total number of 4,287 compared to 4,531 cases recorded in the third quarter of 2018. Figures from the Ghana National Fire Service (GNFS) have revealed that as of December 21, 2020, the country recorded 5,966 fire outbreaks. GNFS further noted that the recorded fire outbreaks represent a 4.9% increase compared to a figure of 5,673 in the same period in 2019. GNFS (2020) disclosed Ashanti Region recorded the highest number of cases and North East Region recorded the lowest. The report revealed that, although the significant rise can be attributed to the increase in domestic activities during the lockdown period, it also shows the citizenry has still not given fire safety protocols the urgency and attention it deserves.

According to Addai, Tulashie, Joe-Steve, and Yeboah (2016), Ghana happens to be losing a lot of money and resources due to numerous fire outbreak cases. There has been great emphasis on the provision of fire-fighting equipments for the fire service offices in the country. Millions of money are spent to train fire-men in fire combat, but little has been done to look at fire safety practices in buildings where there is likely to be the occurrence of fire. In most times, fire-fighters are being blamed for fire incident in a public building, and all this possible loopholes has been seriously explored (Addai et al., 2016) but little has been said or explored about the activity of the other stakeholders in the construction industry and usage of public buildings, who oftentimes responsible for the causes of fire outbreak. Fire safety regulation is an aspect that has suffered great neglect among designers and users of public buildings, this may be due to uncared attitudes and ignorance on the part of building owners and users. It has become almost impossible to end a year in Ghana without recording an incident of fire outbreak which results in the deaths of individuals and loss of property worth millions of Ghana cedis. From Kumasi to Accra, Wa, and the rest of the country, there has been a series of reports of deadly fire outbreaks. It is against this backdrop that an investigation of the relationship between the compliance of fire safety regulations and safety performance of public building is explored. The implementation of the findings and recommendations can be the foundation of a structured approach to safety management and minimizing the occurrences of fire outbreak in Ghana while ensuring buildings perform their required purposes.

LITERATURE REVIEW

Building

A building is a structure with a roof and walls standing more or less permanently in one place. Buildings come in a variety of sizes, shapes, and functions, and have been adapted throughout history for a wide number of factors (Economic Times, 2020). Buildings serve several societal needs-primarily as shelter from weather,

security, living space, privacy, to store belongings, and to comfortably live and work. Building can be for residential, or public commercial, industrial or other. Residential buildings are for people to live like house, flat etc. Public buildings are the cinema theatres, community halls, Railway station buildings, fueling stations, hospitals, schools, Aerodrome buildings, government office buildings wherein public persons will be visiting (Economic Times, 2020). Fire disasters experienced at the various residential and public building in Ghana repeatedly caused remarkable damages, which harmed the socio-economic development of the affected communities (Gakpe & Mahama, 2014). Addai, Gabel, and Krause (2016) indicated that fire incidents involving occupied premises often result in injuries, loss of assets, business disruption, and sometimes death.

Concept of building fire

Fire is one of the major hazards which may occur due to natural or man-made causes. Fire is a rapid, self-sustaining oxidation process accompanied by the evolution of heat and light in varying intensities (Addai, et al., 2016). Fire starts in various ways and acts as a destructive force in human livelihoods (Asori, Dogbey & Dumedah, 2020). Building fires occur in buildings as a result of exposure to combusting materials like fuel and other flammable materials. Building fires are also classified based on materials, structures, and the building types (PAROC, 2017). Building occupants 'evacuation in cases of fire incidences depends on the fire resistivity of the material of construction. A building constructed mostly of combustible material will allow only but a limited time for evacuation. Building fire classification based on structure entails the response of the building elements or components (walls, roof, floors, ceiling, and construction systems) to fire. National Building Code of Finland (2011), also classified building fires into three classes (P1, P2, and P3), which are identified by building elements, building materials, and roof coverings. In building fire class P1, there is no restriction on the building height or number of storeys and accommodates more than 50 occupants. On the other hand, building fire class P2 may have either a single storey or two storeys and may accommodate a maximum of 50 people, while P3 building fire class may only have a single storey not having a height above 14 m. In a single building, different parts may belong to separate fire classes as long as fire spread is curtailed by a fire wall.

Fire outbreak is the most serious threat nowadays in Ghana (Asori et al., 2020). Fire outbreaks are generally caused by people through carelessness, ignorance, negligence, malicious ignition among others. This happens when the person handling the fire does not take it seriously and it gets out of hand. According Engel (2020) common causes of fire outbreak are faulty electrical outlets and old, outdated appliances, leaving gas and stove unattended whilst cooking, and careless handling of candles. In addition, Aliyu and Abdulrahman (2016), attributed the causes of fire to accident, faulty electrical equipment, fire spread and carelessness.

Effect of fire outbreaks in Ghana

Fire has caused many negative effects in Ghana cutting from economic perspective, population, safety and security threat in the last decade. In 2015, fire outbreaks consumed the Goil fueling station at the Kwame Nkrumah circle in Accra. Over 150 people including woman and children lost their lives (Gadugah, 2016). Anane (2016) affirmed that between January and September 2016, the country further lost

approximately US \$21 million in property damage, a 50% increase from the total cost of items damaged in 2015. In the first quarter of 2016, the GNFS reported the Ashanti region are the region with the highest reported cases of fire incidence (Anane, 2016). In the latter part of 2016, the country was hit yet another major fire at the Ghana international trade fair center resulting in size deaths (Ibrahim, 2016). The central medical stores of the Ghana health service (GHS) in Tema which houses medical supplies for distributive to medical facilities nationwide was destroyed by fire in the early parts of 2015. An estimated US \$81 million of medical supplies and equipment was lost (Pharmaceutical Society of Ghana, 2016). In March 2016, over 110 shops and stores were totally destroyed during yet another fire outbreak. Figures from the GNFS reveal that 33 people perished while 239 sustained varying degree of injury in fire disaster in 2017(GNFS, 2017).

As indicated by GNFS, 2020, little less than 6,000 fires torched different parts of Ghana destroying properties and lives in 2020. Significant places that were destroyed by fire include Kantamanto Market, GCB Liberty House branch, shops in Koforidua Market, UEW laboratory, shops in Takoradi Market, two halls of Accra academy senior high school and many others. The damage the fire caused to properties was estimated at GH¢28,421,058.18 (GNFS, 2020). In under year review, fire outbreaks have resulted about hundreds of burned shops at Mallam Atta Market, and also properties, livestock destroyed as fire burns down orphanage at West Mamprugu. In the Kumasi Metropolis, fire destroys shops and houses at Bantama leaving families distressed and uncertain about their future (Ghana News Agency, 2021). Also fire engulfs the administration block of the Mampong College of education where academic activities came to holds (Ghana News Agency, 2021). Most of these fires whether domestic, industrial, institutional, commercial, vehicular comes with devastating consequences, including loss of lives and properties.

Fire safety regulations in Ghana

To ensure the safety of all public, residential and industrial buildings across the country, the government together with the Ghana Standards Authority (GSA) established the Ghana Building Code. In exercise of the powers conferred on the Minister responsible for Works and Housing by Section 63 of the Local Government Act of 1993 (Act 462), and in consultation with the Minister responsible for Local Government, the national building regulations of 1996 (LI 1630) were enacted on 27th of September, 1996 (Republic of Ghana, 1996). This code determines the standards required for all construction works. In Areas where a naked fire is predominant, it is not recommended to use timber for internal and external walls. In earthquake prone areas, special attention must be given to foundation and superstructure design and construction (Tettey, 2011). Roofs need to be wind/rain storm resistant and concrete foundations are better in flood prone areas. All electrical materials used must be approved by Ghana Standard Board or other competent authority and electrical installations must be carried out by qualified professionals. All buildings must have fire detection, fire alarm and firefighting devices and be protected with a well-grounded lightning arrester. All portable L.P.G bottles shall be located outside the building when in use (Tettey, 2011).

Ghana National Fire Service Legislative Instrument (LI) 1724, Act 53 Fire Precautions Premises Regulations was enacted to ensure fire safety. Fire Precaution (Premises) Regulations, (LI 1724) is a legislative instrument which makes it obligatory for

certain premises to have fire certificates to meet fire safety standards (GNFS, 2016). According to the LI, there is the need to ensure that there are adequate exits within the premises for easy evacuation, serviceable fire-fighting facilities, among other interventions. The LI is applicable to all non-domestic premises and the common parts in some domestic properties. The LI 1724 places greater emphasis on fire prevention in all non-domestic premises, including the voluntary sector and self-employed people with premises separate from their homes. The Ghana National Fire Service (GNFS) has deployed task force to ensure that institutions comply with basic fire rules and regulations to curb the prevalence of domestic fires. This move by the Service has become necessary due to the upsurge in fires at buildings in the country.

METHODOLOGY

Research approach

Quantitative research approach was adopted for this study. The views of the occupants of the public buildings in Ashanti and the Greater Accra Regions were analyzed quantitatively. Quantitative research was employed because it aims to make numerical predictions, establish facts and test hypotheses that have already been stated.

Research design

Descriptive survey research design was employed. A survey research design was used because it is fact finding in nature. This helped the researchers to analyse and interpret the current state of the people involved in the study, provides analyses and helped in the interpretation of data for the guidance of the future course of action. Considering the nature of the study, the descriptive survey design was deemed appropriate in terms of collecting data from a large group of respondents.

Population

For the purpose of the study, the target population consisted of all the 31 and 15 public Senior High Schools in the Greater Accra and Kumasi Metropolis respectively, and 702 and 560 filling stations in the Greater Accra and Kumasi Metropolis respectively. The accessible population consisted all the housemasters in 6 public Senior High Schools, and 384 fueling stations at each Metropolis. The selected population was based on the frequent usage and rate of fire cases on facilities.

Sample size and sampling technique

In determining the sample size for the public schools in the Greater Accra and Kumasi Metropolis, stratified sampling technique was used to select six schools from each Metropolis. The researchers first divided the population into sub groups (strata). The strata included girls 'schools, boys 'schools and mixed schools. After dividing the population, a simple random sampling method was used to select two schools from each sub group. From the target population, a sample of 72 housemasters were selected for the study from the six public schools in each Metropolis using simple random sampling method. In selecting the fueling stations, purposive sampling technique (Judgmental sampling) was used. Since every fuelling station in the Metropolis cannot be reached, this study selected three hundred and eighty-four (384) comprising 192 from each Metropolis using

judgmental sampling. The researchers on the other hand used their value judgment to select managers from each selected fuelling station from the population whose opinions were relevant to make a valuable decision. The determination of sample size was in line with Smith and Albaum (2005) equation for a very large population size.

Data collection instrument

Questionnaire was used for collecting the necessary information from the respondents. The questions developed were adapted from literature, and some were confirmed in a series of interviews with the officials of GNFS. The questionnaire was divided into two (2) sections A and B. Section "A" consisted of personal information of the respondents, whereas Section "B" was made up various questions that answer the developed research questions. The section B reflected the constituents of the 5-Point Likert scale of which the occupants of the public buildings were expected to respond to the statements raised.

Data analysis

The data collected was processed and analysed with the aid of Statistical Package for Social Sciences (SPSS) version 20.0. The following data analysis were used in the study:

- Frequencies, percentages, Mean and standard deviation: This was used to summarize the data.
- Exploratory factor analysis. For the purpose of validating the measurement instrument an exploratory factor analysis was used.
- Correlation analysis. According to the presumption of the proposed impact between fire outbreaks cases (FOC) and public building (PB), the test of measuring the association of variable was Pearson correlation.
- Regression analysis. Regression analysis was used in order to analyze the relationship between the dependent variable and independent or predictor variables.

RESULTS

Compliance of safety regulations in the public building

This section of the paper addresses the extent to which public buildings in Ashanti and the Greater Accra regions comply with fire safety regulations in Ghana. Mean (\bar{X}), and standard deviation (SD) were computed. Table 1 presents the results.

From Table 1, the respondents agreed that they avoid overloading of electrical circuits ($\bar{x}=3.97$, $SD=1.064$). Moreover, the respondents also agreed that the means of escape is provided at the public buildings ($\bar{x}= 3.95$, $SD=1.018$). Concerning whether physical accessibility to building is provided, majority of the respondents agreed to that ($\bar{x}= 3.95$, $SD=1.034$). On whether more ventilation point is created in public buildings, the respondents agreed to the statement ($\bar{x}=3.92$, $SD=1.041$). Whether the occupants are cautious when using naked flames, the respondents agreed to that effect with a score of ($\bar{x}=3.90$, $SD=0.994$).

On the other hand, the respondents disagreed to the provision of fire hydrant, provision of emergency lightening system, availability of fire buckets, availability

of fire blanket, availability of wet riser and provision of fusible link door at the various public buildings. The respondents further disagreed to availability of fire hose reel, provision of smoke detectors, availability of sprinkler, provision of halon gas system, and provision of heat detector, at the various public buildings. These statements failed to meet the cut-off point of 3.0. The result shows that the majority of occupants of the public building do not comply with fire safety regulation in Ghana.

Table 1: Responses on compliance of fire safety regulations in the public buildings

S/N	Compliance of fire safety regulations	Mean	Std. Dev.	Decision
1.	Avoid overloading of electrical circuits are obeyed	3.97	1.064	Agreed
2.	Means of escape is provided	3.95	1.018	Agreed
3.	Physical accessibility to building is provided	3.95	1.034	Agreed
4.	Creation of more ventilation point	3.92	1.041	Agreed
5.	Cautious when using naked flames are complied with	3.90	.994	Agreed
6.	Perimeter vehicle access for emergency vehicles are complied with	3.89	1.078	Agreed
7.	Cautious switching-off all un-used electrical outlets	3.87	1.028	Agreed
8.	Fire exits are provided	3.77	1.125	Agreed
9.	Fire safety regulations on the provision of signs and notices are adhered to	3.72	1.166	Agreed
10.	Fire alarm is available	3.53	1.226	Agreed
11.	Portable fire extinguishers are available	3.44	1.314	Agreed
12.	Fire hydrant is provided	2.36	1.177	Disagreed
13.	Emergency lightning system is provided	2.26	1.145	Disagreed
14.	Fire buckets are available	2.26	1.136	Disagreed
15.	Fire blankets are available	2.24	1.177	Disagreed
16.	Wet riser is available	2.19	1.116	Disagreed
17.	Fusible link door is provided	2.14	1.000	Disagreed
18.	Fire hose reel is available	2.10	1.041	Disagreed
19.	Smoke detectors are provided	2.09	.982	Disagreed
20.	Sprinkler system is available	2.07	.954	Disagreed
21.	Provision of halon gas system is adhered to	2.02	.933	Disagreed
22.	Heat detector is provided	2.00	.964	Disagreed

Note: $X < 3.0 = \text{Disagreed}$; $X > 3.0 = \text{Agreed}$

Principal factor analysis on compliance of fire safety regulations

An exploratory factor analysis was performed on all the 22 variables. The tests were required for the appropriateness of the factor analysis for the factor extraction, including the Kaiser-Meyer-Olkin (KMO) measure of sampling accuracy, anti-image correlation, measure of sampling activities (MSA) and Barlett test of Sphericity. The results of the KMO test showed a coefficient value of 0.915. The factor loading is presented in Table 2.

After the Varimax Rotation converged in 22 iterations with a Kaiser Normalization, all three factors were named (Table 2). The naming of the factors was done by the researchers based on the variables association with literature. The main projections of the statements offered in the questionnaire on the first factor (F1) are those related to compliance of fire safety management. This encompasses motives such

as means of escape is provided, cautious when using naked flames are comply, perimeter vehicle access for emergency vehicles are complied with, cautious switching-off all un-used electrical outlet, fire exits are provided, fire alarm is available, fire hose reel is available, and emergency lightning system is provided.

Table 2: Factor loadings of compliance of safety regulations in the public buildings

Item	Factor	Variables included in the factor	Factor Loading	Eigen value	Variance explained %	Cumulative variance %
1	Compliance of fires safety management	Means of escape is provided	.709	7.637	34.713	34.713
		Cautious when using naked flames	.671			
		Perimeter vehicle access for emergency vehicles are complied with	.825			
		Cautious switching-off all un-used electrical outlet	.873			
		Fire exits are provided	.883			
		Fire alarm is available	.713			
		Fire hose reel is available				
		Emergency lightning system is provided	.839			
		Avoid overloading of electrical circuits are obeyed	.872			
2	Compliance of emergency communication systems	Physical accessibility to building is provided	.848	7.172	32.599	67.312
		Creation of more ventilation point	.857			
		Fire safety regulations on the provision of signs and notices are adhered to	.769			
		Provision of halon gas system is adhered to	.705			
		Fusible link door is provided	.936			
		Fire hydrant is provided	.747			
		Fire buckets are available	.736			
		Fire Blankets are available	.786			
		Wet riser is available	.776			
3	Compliance of firefighting equipment	Portable Fire Extinguishers are available	.867	1.083	4.922	72.234
		Smoke detectors are provided	.632			
		Sprinkler system is available	.872			
		Heat detector is provided	.778			

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization

*a. Rotation converged in 5 iterations

Note. Factor loadings < .30 are suppressed

The compliance of fire safety management factor explains 34.713% of the total variance among the 22 fire safety regulation compliance by occupants of public buildings. The second factor (FII), named compliance of emergency communication

systems, is defined by statements such as avoid overloading of electrical circuits are obeyed, physical accessibility to building is provided, creation of more ventilation point, fire safety regulations on the provision of signs and notices are adhered to, provision of halon gas system is adhered to, fusible link door is provided, and fire hydrant is provided. Compliance of emergency communication system accounted for 32.599% of the total variance among the 22 fire safety regulation. The third factor (FIII), determined by fire safety regulation is named compliance of firefighting equipment (fire buckets are available, fire blankets are available, wet riser is available, portable fire extinguishers are available, smoke detectors are provided, sprinkler system is available, and heat detector is provided). As depicted in Table 2, compliance of firefighting equipment explained about 4.922% of the total variance among the items. On the variance-covariance matrix, all the three extracted factors with an eigenvalue were greater than 1.0.

Safety performance of public buildings

The safety performance of public buildings in Ashanti and the Greater Accra regions of Ghana were assessed. The mean (\bar{X}), and standard deviation (SD) were computed. Table 3 presents the results.

Table 3: Responses on safety performance of public buildings

S/N	Safety performance	Mean	Std. Dev.	Decision
1.	Good condition without obvious defects of public buildings	4.20	1.069	Agreed
2.	Non-destruction of public building property	4.10	.943	Agreed
3.	Reduces insurance premium of public buildings	4.00	1.006	Agreed
4.	Employee feels secured of public buildings usage	3.87	1.021	Agreed
5.	Reduction in public building disaster risk	3.72	1.272	Agreed
6.	Increases the prestige attached to the public buildings	3.62	1.272	Agreed
7.	Safety and security of workers on the usage of public buildings	3.54	1.386	Agreed
8.	Minimize property loss of public buildings	3.24	1.329	Agreed
9.	Ensures standardization of public buildings	3.13	1.335	Agreed
10.	Reduces cost in maintenance and purchasing new equipment during fire outbreak	3.12	1.318	Agreed
11.	Continuous running of business in the public buildings	2.73	1.307	Disagreed
12.	Permanent usage of public buildings	2.72	1.299	Disagreed
13.	Increase profit margin generated from the public buildings	2.71	1.375	Disagreed
14.	Increase in the employee performance	2.34	1.445	Disagreed
15.	Increase the goodwill of the public buildings	2.29	1.068	Disagreed
16.	Produces more efficient organizational structure	2.22	1.139	Disagreed

Note: $X < 3.0$ =Disagreed; $X > 3.0$ = Agreed

As depicted in Table 3, the respondents agreed that fire safety compliance leads to good condition without obvious defect of public buildings with a scores (\bar{x} =4.20, SD =1.069). Moreover, the respondents agreed that fire safety compliance ensures non-destruction of public buildings property with a scores(\bar{x} =4.10, SD =.943). In addition, a scores (\bar{x} =4.00, SD =1.006) the respondents agreed that fire safety compliance reduces insurance premium of public building. Furthermore, the respondents agreed that the fire safety compliance makes employee feels secured of public buildings usage(\bar{x} =3.87, SD =1.021). Furthermore, the respondents agreed

fire safety compliance reduces public buildings disaster risk with a scores (\bar{x} =3.72, SD=1.272). On whether fire safety compliance increases the prestige attached to the public buildings, the respondents agreed to the statement (\bar{x} =3.62, SD=1.272).

However, the respondents disagreed to continuous running of business in the public buildings (\bar{x} =2.73, SD=1.307), permanent usage of public buildings (\bar{x} =2.72, SD=1.299), increase profit margin generated from the public buildings (\bar{x} =2.71, SD=1.375), increase in the employee performance (\bar{x} =2.34, SD=1.445), increase the goodwill of the public buildings (\bar{x} =2.29, SD=1.068), and produces more efficient organizational structure (\bar{x} =2.22, SD=1.139) as safety performance of public buildings. These statements failed to meet the predetermined cut-off point of 3.0.

Principal factor analysis on safety performance of public buildings

Factor analysis was performed on the safety performance of public buildings variables. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was found to be .739. Factor loadings of 16 variables are depicted in Table 4.

Table 4 summarizes the varimax-rotated factor matrix with Kaiser Normalization, which extracts three factors. Variables with loading <0.30 were dropped and items with higher loadings were considered to be important and to have influence on the label selected to present a factor.

Naming of the factors was original contribution of the researcher. The variables; non-destruction of public buildings property, reduces insurance premium of public buildings, employee feels secured of public buildings usage, ensures standardization of public buildings, reduces cost in maintenance and purchasing new equipment during fire outbreak, increase the goodwill of the public buildings, produces more efficient organizational structure, permanent usage of public buildings, and increase in the employee performance belong to the first factor (F1), named reduce of cost of rebuilding and maintenance of public buildings. The reduction of cost of rebuilding and maintenance of public building explained about 19.727% of the total variance among the items. Moreover, good condition without obvious defects of public buildings, reduction in public buildings disaster risk, increases the prestige attached to the public buildings, minimize property loss of public buildings, and increase profit margin generated from the public buildings belongs to the second factor (F2) and are described as ensure good condition of public building.

The ensuring good condition of public building factor explains 17.695% of the total variance among the 16 safety performance of public buildings variables. The third factor (F3) named ensure safety and security of occupants; safety and security of workers on the usage of public buildings, ensures standardization of public buildings, reduces cost in maintenance and purchasing new equipment during fire outbreak, continuous running of business in the public buildings, permanent usage of public buildings, increase the goodwill of the public buildings. Ensuring of safety and security of occupants accounted for 11.267% of the total variance among the 16 safety performance of public buildings.

Table 4: Factor loadings of overall performance measurement

Item	Factor	Variables included in the factor	Factor Loading	Eigenvalue	Variance explained %	Cumulative variance %
1	Reduce cost of rebuilding and maintenance of public buildings	Non-destruction of public buildings property	.862	3.156	19.727	19.727
		Reduces insurance premium of public buildings	.920			
		Employee feels secured of public buildings usage	.905			
		Ensures standardization of public buildings	.557			
		Reduces cost in maintenance and purchasing new equipment during fire outbreak	.479			
		Increase the goodwill of the public buildings	.408			
		Produces more efficient organizational structure	.532			
		Permanent usage of public buildings	.663			
		Increase in the employee performance	.130			
		Good condition without obvious defects of public buildings	.493			
2	Ensure good condition of public buildings	Reduction in public buildings disaster risk	.787	2.831	17.693	37.420
		Increases the prestige attached to the public buildings	.824			
		Minimize property loss of public buildings	.853			
		Increase profit margin generated from the public buildings	.712			
		Safety and security of workers on the usage of public buildings	.915			
		Ensures standardization of public buildings	.359			
3	Ensure safety and security of occupants	Reduces cost in maintenance and purchasing new equipment during fire outbreak	.364	2.194	13.711	51.131
		Continuous running of business in the public buildings	.224			
		Permanent usage of public buildings	.524			
		Increase the goodwill of the public buildings	.613			

Extraction Method: Principal Component Analysis.

Rotation Method: Varimax with Kaiser Normalization

*a. Rotation converged in 5 iterations

Note. Factor loadings < .30 are suppressed

Relationship between fire safety compliance and safety performance of public buildings

Correlation analysis

Correlation analysis was used to find out the relationship between the compliance of safety regulation and safety performance of public buildings. Table 5 shows the relationship that exists between the variables.

Table 5: Correlation matrix of fire safety compliance against safety performance

	Construct	1	2	3	4	5	6
1	Compliance of fires safety management	1					
2	Compliance of emergency communication systems	.706**	1				
3	Compliance of firefighting equipment	.894**	.817**	1			
4	Reduces the cost of rebuilding and maintenance of public building	-.035	.041	.026	1		
5	Ensure good condition of public building	.669**	.695**	.711**	.056	1	
6	Ensures safety and security of occupants	.754**	.945**	.853**	.050	.724**	1

** . Correlation is significant at the 0.01 level (2-tailed).

* . Correlation is significant at the 0.05 level (2-tailed).

Statistically, the study found a positive significant correlation between compliance of fire safety management and good condition of public buildings ($r = .669$, $p < 0.001$), and safety and security of occupants of public buildings ($r = .754$, $p < 0.001$). The results of Pearson's correlation coefficient further show a positive relationship between compliance of emergency communication system and good condition of public buildings ($r = .695$, $p < 0.001$), and safety and security of occupants of public buildings ($r = .945$, $p < 0.001$). Again, positive significant correlation was found between compliance of firefighting equipment and good condition of public buildings ($r = .711$, $p < 0.001$) and safety and security of occupants ($r = .853$, $p < 0.001$).

Regression analysis

In order to address the relationship between the compliance of safety regulation and safety performance of public building, regression analysis was conducted. The study analysed the variations of safety performance of public building due to compliance of fire safety regulation. The findings are shown in Table 6.

Table 6: Model summary

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.744 ^a	.554	.549	.633

a. Predicators: (Constant), compliance of fires safety management, compliance of emergency communication systems, compliance of firefighting equipment

According to the model summary output, the variables were significantly correlated where R (coefficient of correlation) was a positive correlation of 0.744 indicating that the compliance of fire safety regulation were highly related to safety

performance of public buildings. The identified independent variables (compliance of fires safety management, compliance of emergency communication systems, compliance of firefighting equipment), explains only 55.4% variation in the dependent variable (safety performance of public buildings). Analysis of variance was carried out and the findings are presented in Table 7.

Table 7: Analysis of variance

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	153.176	3	51.059	127.293	.000 ^b
	Residual	123.542	308	.401		
	Total	276.718	311			

a. Dependent Variable: safety performance of public building

b. Predictors: (Constant), compliance of fires safety management, compliance of emergency communication systems, compliance of firefighting equipment

The relationship was significant at critical value (0.001) since the reported p-value ($0.000 < 0.01$) was less than the critical value. This means that the safety performance of public buildings was significant at 95%. This implies that there is a positive significant relationship between compliance of fire safety regulation and safety performance of public buildings in Ashanti and the Greater Accra regions ($F=127.293$, $df=308$, $p=000 < 0.01$). The evaluation of a building performance in terms of fire safety is always aimed at assessing its compliance with certain safety standards.

Table 8: Regression coefficient

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	1.218	.153		7.981	.000
	Compliance of fires safety management	.188	.076	.212	2.489	.013
	Compliance of emergency communication systems	.333	.061	.359	5.419	.000
	Compliance of firefighting equipment	.208	.096	.228	2.173	.031

a. Dependent Variable: safety performance of public building

From Table 8, the results indicated that a unit increase in average compliance of fire safety management increases the average safety performance of public buildings by 0.188 ($\beta=0.188$, $t=2.489$, $p=0.013 < 0.05$). This implies that occupant compliance of fire safety management is a significant predictors of safety performance of public buildings (p -value < 0.05). The findings as shown on the table reveal that a unit increase in average compliance of emergency communication system positively and significantly increases the average safety performance of public buildings ($\beta=.333$, $t=5.419$, $p=0.000 < 0.01$). This implies that occupant compliance of emergency communication system influences the safety performance of public buildings. The finding also reveals that a unit increase in average of compliance of firefighting equipment positively and significantly increases the safety performance of public buildings ($\beta=0.208$, $t=2.173$, $p=$

0.031<0.05). This implies that occupant compliance of firefighting equipment could influence the safety performance of public buildings.

DISCUSSION

The result shows that fire hydrant, sprinkler system, halon gas system, heat detector, emergency lightning system, fire buckets, and fire blankets are not available at most of the public buildings in the Greater Accra and Ashanti regions of Ghana. At the various public buildings, firefighting equipment are either not available or where available they are not functional or that the occupants of the buildings are not even sure of their availability and functionality. This finding aligns with the report by GNFS (2020) which disclosed the citizenry has still not given fire safety protocols the urgency and attention it deserves. The finding explains the observation by Kahwa (2009) that there had been a trend of increasing incidences of fires and their consequences in public institutions in Ghana between 1999 and 2006. This showed that, fire incidences in educational and commercial buildings in Ghana resulted from negligence and non-compliance of fire safety regulation. The finding is also a true reflection with physical observations made by the researchers in some of the buildings visited in the course of the study. Fire hose reel, oftentimes when available are mostly not functional, while most of the passive firefighting equipment like sprinkler system, fire hydrant, risers, fusible link door and halon gas system are mostly not available in public buildings occupied by the respondents. This was also confirmed during the physical observation by the researchers. Apart from portable fire extinguishers and fire alarm systems, all other fire equipment was found to be below average rating of respondents in terms of availability and functionality.

A positive significant relationship was found between compliance of fire safety regulation and safety performance of public buildings in Ashanti and the Greater Accra regions of Ghana. The coefficient of compliance of fire safety regulation was positive and significant, meaning that it was a major variable that determined reduction in the cost of rebuilding and maintenance of public buildings, good condition of public buildings, and safety and security of occupants of public buildings. The results of this study were in agreement with the findings of a study by Taylor (2010). According to Taylor, it is reasonable for owners and managers of buildings to comply with fire safety regulations, because it helps ensure good condition of buildings, safety and security of workers. Windapo and Oladapo (2012) affirmed that compliance of fire safety regulation eliminates or reduces injuries, loss of materials and time, payment of compensation and payments to injured staff when off duty, hence reducing the cost of production and affecting the profit margin of the organisation. As such, to prevent destruction to buildings, reduce the cost of production, improve productivity and maximize profits, many firms seek to improve safety in their organisations and this includes compliance with fire safety regulations (Windapo & Oladapo, 2012). This explains why Nzuve and Lawrence (2012) posit that good condition without obvious defects of public buildings, and prevention of destruction of public buildings often reflect on the level of compliance with fire safety regulations. The finding also supports Idubor and Osiamoje (2013), that organization compliance with fire safety regulation improves safety performance of buildings.

CONCLUSION AND RECOMMENDATIONS

Fire safety practices is an aspect that has suffered great neglect among designers and users of public buildings, this may be due to uncared attitudes and ignorance on the part of building owner and users. The present study found that the occupants of public buildings in Ashanti and the Greater Accra regions do not comply with safety regulation. At the various public building, firefighting equipment is either not available or where available they are not functional or that the occupant of the buildings is not even sure of their availability and functionality. The study found a positive and significant relationship between compliance with fire safety regulation and safety performance of public buildings in Ashanti and the Greater Accra regions of Ghana. Fire safety practices and awareness is very necessary as it is anonymously said "to be forewarned is to be forearmed" adequate knowledge of fire, cause, prevention and suppression are very important to all building occupants, also provision of adequate firefighting equipment is very important.

The study recommends that building owners should ensure that their buildings are well equipped with active and passive firefighting equipment. Also, training on fire safety, first aid, use of firefighting equipment, and evacuation procedure should be made compulsory for all building occupants and at regular intervals. Government of Ghana should revisit the fire code and resuscitate its administration and implementation, compliance with fire code regulation should be made compulsory for building owners, users, and occupiers of public buildings and any defaulters are brought to book. Also, compliance with the fire code and issuance of fire certificate should be approached right from the inception of the construction and appropriate follow up ensured after completion and throughout the building's life span. It is recommended that Ghana National Fire Service (GNFS) and National Disaster Management Organization (NADMO) should do the proper inspection of public buildings to ensure compliance with fire safety regulation in the country.

REFERENCES

- Addai E. K, Gabel D., & Krause, U. (2015). Explosion characteristics of three component hybrid mixtures. *Process Safety Environment Protect*, 9(3), 72-81.
- Addai, E. K. Tulashie, S. K., Joe-Steve A., & Yeboah, I. (2016). Trend of Fire Outbreaks in Ghana and ways to prevent these Incidents. *Safety and Health at Work*, 30(3), 1-9
- Aliyu, A., & Abdulrahman, L. I. (2016). Renewable materials to reduce building heat loss: Characterization of date palm wood. *Energy and buildings* 43 (2-3):491-497.
- Anane, S. (2016). Exposure assessment, a preventive process in managing workplace safety and health, challenges in Ghana. *Safety of Science*. 84:210–215.
- Asori, M., Dogbey, E., & Dumedah, G. (2020). Wildfire hazard and Risk modelling in the Northern regions of Ghana using GIS-based Multi-Criteria Decision Making Analysis. *Journal of Environment and Earth Science*, 10(1), 5-11.
- Ayarkwa J., Danso, A. K., & Adinyira, E. (2010). Incidence of domestic fire outbreaks in Ghana: causes and prevention. *Ghana Surveyor*; 4(1):1-13
- Ayarkwa, J., Danso, K. A., & Adinyira, E. (2011). Incidence of Domestic fire outbreaks in three cities in Ghana.

- Economic Times (2020). Types of buildings as categorised by government and how infrastructure development can shape India's future. Retrieved from <https://economictimes.indiatimes.com>. Accessed: May, 18, 2021.
- Engel, R. (2020). Common causes of electrical fires. Retrieved from <https://www.firerescue1.com>. Accessed: May, 18, 2021.
- Gakpe B. K., & Mahama, P. Y. (2014). Reportage of stories on fire outbreaks in Ghana: an analysis of the Daily Graphic and the Chronicle. *New Media Mass Communication* 14;24:1-11.
- Ghana National Fire Service (GNFS) (2018). Ghana National Fire Service Act, 1997. Retrieved from: [http://www.epa.gov.gh/Ghanalex/Acts/GhanaNationalFireService Act,1997](http://www.epa.gov.gh/Ghanalex/Acts/GhanaNationalFireServiceAct,1997). January 6, 2019.
- Ghana National Fire Service Act - 1997 (Act 537). Fire Precaution (Premises) Regulation LI 1724
- Hassan, H. (1999). Fire and Safety Management in Buildings, *The Professional Builders Journal*. June/July. 32-35.
- Idubor, G., & Osiamoje, S. M. (2013). Smoke alarms and prevention of house-fire-related deaths and injuries. *Western journal of medicine* 173 (2):92.
- Karake, P. M., & Kulkarni, G. S. (2013). Fire Safety Assessment for Educational Building in India. *International Journal of Science and Research (IJSR)*, 4 (8), 1-4
- National Building Code of Finland (2011). Fire safety of buildings; Regulations and guidelines. Decree of the Ministry of the Environment on Fire Safety of Buildings.
- Nzuve, S. N. M., & Lawrence, B. A. (2012). The extent of compliance with occupational safety and health regulations at registered workplaces in Nairobi. *International Journal of Business, Humanities and Technology*, Vol. 2 (2) 115-120.
- PAROC (2017). Fire classification. Retrieved www.paroc.com. Accessed: 9 July 2019
- Pharmaceutical Society of Ghana (2016). Central Medical Store to be Rebuilt. Retrieved from <http://www.psg.org/news/267632/Central-Medical-Store-to-be-Rebuilt.htm>
- Robinson, F. I. (2014). "Risk Analysis: A Systematic Method for Hazard Identification and Assessment". *Journal of Industrial Pollution Control*. 9(2):88-96.
- Sam-Okyere, M. (2010). Fire Outbreaks: the causes are staring us in the face. Retrieved September 11, 2014: <http://www.modernghana.com/news/467788/50/fire-outbreaks-the-causes-are-stari.html>
- Shittu, S. A. (2007). "Risk Analysis of a Typical Chemical Industry using ORA Procedure". *Journal of Loss Prevention in the Process Industries*. 14:43-59.
- Taylor, D. (2010). "Fire and Innocence," *Texas Observer*, November 27, 2010.
- Tettey, J. (2011). National building guide for lightly loaded structures in disaster prone areas in Ghana. Retrieved from [http://nadmo.gov.gh/images/NADMO documents/2015_documents/BUILDING%20GUIDE.pdf](http://nadmo.gov.gh/images/NADMO_documents/2015_documents/BUILDING%20GUIDE.pdf). Accessed: December, 21, 2018
- Windapo, H., & Oladapo, P. (2012). Legislative safeguards needed to protect college students from fire. *Firehouse*: 31(9), 22.