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The Efficiency of Fire Protection Systems in Major Public Buildings in Ghana: A Case Study of Selected Major Public Buildings in the Sunyani Municipality, Ghana

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Abstract:
The numerous fire outbreaks in recent times which has claimed many innocent lives and destroyed several properties worth billions of cedis confirms the assertion that fire is a good servant but a bad master. The huge loss of lives and properties from fire outbreaks has been attributed to the ineffective fire protection systems in public buildings. This thesis scrutinised the state of emergency routes and efficiency of fire protection systems in public buildings. To achieve this, a purposive sampling technique was used to sample 130 respondents made up of Fire Officers, workers in public buildings and building inspectors. Questionnaires, interview and field survey were basically used to collate data from the respondents. Tables and figures were generated to analyse and present the findings. From the findings, the research identified several factors which greatly contributed to the inefficiencies of fire protection systems in public buildings. These include lack of fire safety measures, limited emergency routes and exit points, inadequate fire fighting equipment, lack of fire alert systems and inadequate knowledge of fire protection systems by users. The study therefore recommended the installation of modern fire protection systems, provision of enough emergency route and exit points and regular inspection of electrical installation in public buildings.

Keywords: *Public buildings, accidents, fire safety, emergency routes and firefighting equipment*

1. Introduction

Human interests in fire safety probably dated back from the discovery and employment of fire. Primitive man used heat for cooking, warming and lighting his dwelling with the inherent risk that misuse or accident in his control of fuel might precipitate disaster. The obvious benefits of numerous friendly uses of heat energy are often overshadowed by the enormous destructive power of fires. Today as in primitive society, that risk has not been eliminated despite the apparent sophistication of modern living. Fire is a potentially life altering threat in any public building and can create an even worse situation if there is no prior preparation or control systems for such an event.

Recently, Ghana has recorded serious major fire outbreaks in public buildings. Statistics available at the Ghana National Fire Service (G.N.F.S.) indicates that property worth GH¢6,898,750.00 were destroyed by 967 fire outbreaks in 2012 in Ashanti Region alone with twenty-six people losing their lives. Brong-Ahafo Region alone recorded 586 fire outbreaks destroying properties estimated at GH¢1,163,635.00 with forty-four lives lost in the same year. Eastern Region has also recorded 441 fire outbreaks destroying properties worth GH¢662,473.00 with one hundred and five (105) losing their lives in 2012. There were similar fire outbreaks in the other regions (G.N.F.S. Brong Ahafo Regional Command, 2014).

According to the Brong Ahafo Regional Fire Safety Officer, very little fire fighting equipments are provided at most public buildings. Most workers at these places had no knowledge about the few existing fire protection systems at their work places.

2. Purpose of the Study

The purpose of this study is to assess fire protection systems in some selected public buildings in the Sunyani Municipality.

3. Objectives of the Study

1. To identify the fire protection systems in use in public buildings.
2. To assess the challenges in the operational reliability of the systems.
3. To devise policies to improve the efficiency of fire protection systems in public buildings.

4. Research Questions

The study seeks to answer the following research questions:

a. What are the fire protection systems in public buildings in Ghana?
b. What are the challenges involved in the operation of the fire systems?
c. What policies and strategies can help ensure efficiency of the fire system?

5. Significance of the Study

The study is significant with the following reasons:

1. Knowledge acquired will inform authorities and stakeholders on fire safety design systems.
2. Authorities and stakeholders could identify areas for improvement in fire protection systems.
3. Lives and properties would be saved from rampant fire outbreaks due to the creation of safety awareness.
4. Money used by way of offsetting medical bills and reconstruction of damaged buildings would be saved because fire outbreaks at public buildings would be reduced.

6. Scope of the Study

This study is limited to the Brong-Ahafo Regional Capital, Sunyani Municipality and covers some selected public buildings such as the Regional Hospital, the Cocoa House and the Sunyani Central Market. The study also focused on the following issues: The concept of fire, causes of fire, Building regulation strategies and fire, Fire Grading/Load, Fire prevention and Consequences of fire.

7. Literature Review

7.1. The Concept of Fire

According to Brett (1985), fire is the visible effect of the process of combustion. It is a chemical reaction between a substance and oxygen, during which heat is produced and the original form of the substance is destroyed. The dangerous thing about the chemical reactions in fire is the fact that they are self-perpetuating. The heat of the flame itself keeps the fuel at the ignition temperature, so it continues to burn as long as there is fuel and oxygen around it. The flame heats any surrounding fuel so it releases gases as well. When the flame ignites the gases, the fire spreads.

7.2. Causes of Fire

Ansah (2003) outlines the causes of fire outbreak as carelessness of occupants of buildings. Carelessness is the most serious cause of fires in most buildings. Putting kettle on a gas stove to boil water and forgetting to put it off can be very disastrous. Forgetting to remove the plug of an iron from the socket after ironing can also start fire when it gets into contact with combustible a material. Fuel leakages (eg Liquefied Petroleum Gas (LPG)) are also dangerous. If the fuel and air mixes in the right proportion and a heat source is introduced, an explosion can occur. Cigarette smokers carelessly throw lit butts of cigarettes indiscriminately causing destructive fire. Some smokers sleep whilst smoking in their beds or sofas culminating in fires. He also outlined the following as causes of fire: the use of sub-standard electrical appliances, use of unqualified electricians to wire buildings or service appliances, poor storage of fuel such as petrol, poor storage of cellulose thinner and other volatile fuels in cans as well as other containers, poor housekeeping practices like failing to put combustible waste in approved areas, or failure to clean spillage from flammable materials, ageing electrical fittings and cables due to their inability to contain imposed electrical loads etc. (Ansah, 2003).

7.3. Building Regulation Strategies

Building design and construction is regulated throughout the world by building codes. These are administered by Local, Municipal, and Government whose codes are based on one of the major model codes. The codes are virtually important to the entire design community because they establish a benchmark for minimum standards. In this regard, the minimum standard for life, safety, public health, welfare and protection of property are drawn and continually updated as social needs. They are used as a base for the development of a basic fire safety during the design of any building (Ghana Building Code, 1989).

Part six (6) of the Ghana Building Code (1989) makes provision for compartment walls and floors; fire resistance doors; exceptions permitted use of certain doors in lift shafts; limiting the spread of flame over surface of walls, ceiling and roofs; garage or workshops separating building; and means of escape.

According to Foster (1994), the means of ensuring fire safety in public buildings is based on its categories. The two broad ways are passive and active fire protection.

i. Passive Fire Protection falls under structural fire protection and fire safety in a building. It attempts to contain fires or slow the spread of fire through the use of fire-resistant walls, floors and doors etc. for a limited period of time.
   Some types are the intumescent fire protection and vermiculite fire protection. The intumescent fire protection is a layer of paint which is applied along with the coating system on the structural members whilst the vermiculite fire protection is where the structural members are covered with vermiculite materials, compartmentation and emergency exits.

ii. Active fire protection is an integral part of fire protection. It is characterized by items or systems which require a certain amount of motion and response in order to work, contrary to passive fire protection. Categories of Active fire protection are fire suppression and fire detection.

Fire suppression can be controlled or extinguished, either manually (fighting) or automatically. Manually includes the use of fire extinguisher, standpipe system, hose reels. Automatic means can include fire sprinklers, automatic flooding system. Early fire detection and warning of an impending fire are vital to life safety.

7.4. Fire Grading/Load

Buildings can be graded by the amount of overall fire resistance required by taking into account the size of building, use of building and fire load.

The fire load is an assessment of the severity of fire due to the combustible materials within the building. This load is expressed as the amount of heat which would be generated per unit area by the complete combustion of its contents and combustible members. It is measured in Joules per square meter (Forster, 1994).

Grade 1- Low fire load, not more than 1150MJ/m^2

Typical buildings within this grade are flats, offices, restaurants, hotels, hospitals, schools, museums and public libraries.

Grade 2-Moderate fire load 1150 to 2300MJ/m^2

Typical examples are retail shop, factories and workshops.

Grade 3-High fire load, 2300 to 4600 MJ/m^2

Typical examples are certain types of workshops and warehouses.

When deciding on the grade, no account is taken of the effect of any permanent fire protection installation such as sprinkler systems.

7.5. Fire Prevention

According to Bongard, 1996, fire prevention are measures put in place to prevent the outbreak of fire by controlling potential fire hazards such as heating installations and electrical equipment. He stated that the intensity of fire can be reduced by controlling the quantity of combustible materials employed, whiles the magnitude of fire can be reduced by the choice of suitable materials in the design of a building. He therefore outlined the following measures for fire prevention:

7.5.1. Fire Hydrant

Fire hydrants are specified by the type and nature of construction, size and number of connections, size of hub for connection to the water pipe and depth of bury. It is basically used to fight fire by connecting lengths of hoses to the fire scene or by supplying water to either overhead tank or appliance on the fire ground.

7.5.2. Means of Escape

It has been established that the death of people almost always occurs through either the collapse of the structural component blocking means of escape or obstruction of the available means of escape. This has necessitated the provision of means of escape to ensure rescue of people, protection of the rescuers and ensuring efficient fire fighting services.

7.5.3. Warning Systems

This is provided to inform occupants of buildings as early as possible to enable them find refuge in the event of fire. It is generally recommended as a safety measure for larger buildings with many occupants to have an alarm system or at least public address system to inform all occupant of any emergency situation.

7.5.4. Directional Sign in Buildings

Buildings are to have directional signage to the means of escape or emergency exit. The signs should be fixed low down because smoke rises and it might obstruct visibility of fire victims. The signs are to help victims of fire incidents leave the building within the first four minutes with ease.

7.5.5. Escape Stairs

Stairs are one of the principal means of escape to the outside in case of fires in buildings. Stairs should be constructed of materials that are capable of maintaining strength and stability for a period of time sufficient for those in a building to escape to place of safety. The size of the steps and width of the stairs should be adequate for the safe escape of those in the building.

7.5.6. Fire Fighting Equipment/System

Fire fighting equipment/systems hinder the outbreak and spread of large fires brought about by the manual or automatic release of extinguishing media. For instance, sprinklers detect and combat fire at its very onset. These internal fire protection measures often lead to a relaxation of the fire protection regulations by allowing larger compartments and reducing the requirement for the fire resistance of structural components.

Increasing the size of the compartment can be an important concession in multi-storey building such as departmental stores, buildings containing large assembly hall and office buildings.

7.5.7. Fire Detector System

Chudley, 1983, also stated that numerous number of fire detector systems are available for use in fire detection in buildings, each with a special advantage suitable for a special use. The performance of these systems depends on the class of fire anticipated and the use of the building. Heat detectors, smoke detectors and infra-red scanning radiation detectors are the main detector systems available, under these, a variety of types also exist.

8. The Consequences of Fire

According to Chudley, 1983, a building in its working life may be exposed to force of gravity, wind, earthquakes, temperature variations, noise, dampness, chemical and electrical phenomena. However, when fire occurs, it leads to destruction of the combustible material, creation of excessive heat and noxious gases. For that matter, the building and its structural components must be designed so that they can resist these consequences for the duration of the fire. These consequences should therefore be investigated before reconstructing the affected structure.

In Ghana, a number of fire cases causing massive destruction and huge economic loss were recorded within the last two years. For instance, a publication made by modern Ghana news revealed that Fifty-seven people lost their lives in 3,077 fire incidents recorded across the country between January to June, 2014. The figures represent an average of four deaths and 522 fires monthly with financial loss amounting to GH¢2.83 million monthly. Among some of the fires recorded were old Parliament House, Winneba Government Hospital, 13 shops in Swedru, Abuja Slum, Aboadze Plant, LETAP Jewellery, Suame magazine, 49 shops at Makola, 400 shops in Makola No. 2, Kantamanto, Kumasi central market etc.

Source: *http://www.modernghana.com/news/258330/1/intensify-fire-outbreak-campaigns.html , Published: Friday, January 08, 2010*

9. Research Methodology

The population for the study was made up of Sunyani Central market, Regional Hospital, Cocoa House, and their occupants; estate officers; Building inspectors and Fire officers at the Regional Headquarters in the Sunyani Brong Ahafo Region. The researcher employed qualitative and quantity research design for the study. The design relied basically on questionnaire, field observation and structured interview to gather data for the analysis.

Purposive sampling technique was used to determine the sample size for the study. This type of sample technique was chosen because the researcher only went to those in his opinion are likely to have the required information and willing to share it. The sample size distribution is shown below

	Sample Frame	Sample size
1.	Public Building users	
	a. Cocoa House	- 20
	b. Regional Hospital	- 20
	c. Central Market	- 20
2.	Fire Personnel	- 20
3.	Building Inspectors	- 20
	TOTAL	100

100 questionnaires were administered to the public building users, fire personnel and the building inspectors. The questionnaire focuses on issues such as operational reliability of fire systems and policies put in place to improve the efficiency of fire protection system in public buildings. This part of the questionnaire was specifically given to those who could read and write.

A structured interview, guided by an interview schedule, was also developed and administered to 30 users of public buildings. The content of the questionnaire covering awareness and causes of fire outbreak, fire prevention systems and operational reliability of fire protection systems was explained to all participants using local dialect for them to respond accordingly by writing their opinions. This method was used to create a conducive atmosphere for all categories of personnel to have a chance of participating in the study.

Tables and figures were generated to analyse and present the findings.

10. Results and Discussion

10.1. Results of Questionnaires

This section discusses the results of the questionnaires, field survey, observations and interviews.

10.1.1. Use of Public Buildings

Table 1.0 shows how often user's use major selected public buildings within the municipality. The respondents were required to indicate how often they use the buildings.

Times of usage	Frequency	Percentage (%)
Daily	49	82
Weekly	5	8
Monthly	5	8
Annually	1	2

Table 1: Major use of public buildings
N = 60

The results indicate that more than three-fourth (82%) of the responding users of the buildings used the building every day. These users were probably the workers who have their businesses in these public buildings. Less than one –fourth, (16%) of the users also reported to use the building either weekly or monthly. These users could be visitors who visits workers in these buildings or customers who come to transact business or hawkers who sell their wares in these buildings.

10.1.2. Capacity as a User

To find out in which capacity the users use the buildings, the researcher asked the respondents to indicate their capacity as in conformity to their use of the buildings.

Capacity	Frequency	Percentage (%)
Visitor	15	25%
Worker	44	73%
Owner	1	2%

Table 2: Occupancy rate of public buildings
N=60

The results revealed that majority (73%) of the users of these public buildings were workers who have their business in these buildings confirming the earlier discussion in Table 1. One – fourth (25%) were visitors who comes to either transact business or for their personal issues. This therefore indicates that preponderance of the responses was gathered from workers who actually are the perpetual users of these buildings and therefore can ascertain what exactly the states of fire safety systems are in the buildings.

10.1.3. Years of Working in these Public Buildings

To find out from the users if really they have been using these buildings, the researcher sought to find out how long they have been using the building.

Period	Frequency	Percentage (%)
Less than 1 year	9	17%
1-4 years	16	30%
5-9 years	21	40%
10 years and above	7	13%
Total	**53**	**100%**

Table 3: Years of working in public buildings

The outcome showed that more than half (53%) of the respondents had been using the buildings for 5 years and above. This was probably their company or place where their business had been located ever since they were employed. A few (17%) reported to have used these buildings less than one year even though they used these buildings every day. This revealed that longer service personnels are the most users of those buildings.

10.1.4. Users knowledge on Fire Safety Systems

Users of public buildings knowledge about fire safety systems would help the assessment of the efficiency of fire protection systems and reduce the recent rampant fire outbreaks in the country. The researcher therefore sought to find out the knowledge of users of public buildings on fire safety systems in the buildings. The results revealed that more than half (59%) of the users of these buildings have been informed on fire safety measures. Users and for that matter, workers were aware of the fire safety measures in the building in which they work to earn their daily bread. A little more than two-fifth (41%) were either ignorant about safety measures or they simply don't know of any fire safety systems in these public buildings.

A further investigation was made by the researcher to find out users understanding about fire safety. Respondents were therefore required to indicate the meaning of fire safety. The results show that majority (93%) of the respondents reported that fire safety means "the state of a worker being safe from harm and danger" confirming (Patterson, 1993) and (Foster, 1994) findings. The users of these buildings of which majority are workers therefore had knowledge about fire safety systems in these buildings.

In spite of the respondent's awareness and understanding of fire safety, the researcher further investigated to unmask if accidents do occur while working as a user of these buildings. Majority of the respondents (70%) reported that indeed accidents do occur in these

buildings while carrying out their duties as workers. The respondents further reported that those accidents were as a result of fire outbreak from wall sockets, shocks from electricity, uncontrolled high power supply, carelessness on the part of users, putting combustible materials near fire and wrong use of matches to light Liquefied petroleum gas (LPG) among others. This view of the respondents as causes of the fire accidents in the public buildings confirms Ansah's (2003) assertion of fire outbreak.

The researcher again sought to find out the existence of emergency exits in these buildings. The respondents were asked to indicate if those buildings have enough emergency exit points where victims could use if accidents occur. Majority (62%) disagreed to the assertion that public buildings have adequate emergency exit points where workers and victims could use in case of any fire outbreak. Workers and victims are therefore sometimes trap in the building and become suffocated and eventually die as a result of smoke intake. Sometimes, many people may also use the limited exit points at the same time in case of fire outbreak causing stampede.

Respondents were further asked about their knowledge of fire prevention systems in place. The responses indicate that more than half (58%) said they have knowledge about fire prevention systems in place at these buildings. Further investigation revealed that respondents' knowledge about fire prevention systems was limited to fire hydrants, areas of escape, having system and fire fighting equipments as shown below:

Fire Prevention Systems	Frequency	Percentages %
Fire hydrants	9	27%
Area of escape	3	9 %
Having systems	11	32%
Fire fighting equipment	11	32%
Total	**34**	**100%**

Table 4: Knowledge of fire preventing systems

Table 4, further indicates that more than half of the respondents (64%) either have knowledge about having systems such as alarms and public address systems and fire fighting equipment such as fire extinguishers. 27% had knowledge about fire hydrants followed by 9% in area of escape. Respondents were deficient in the area of exit points probably due to inadequate exit point available at the various selected buildings. Again even though respondents had knowledge about fire fighting equipment's, they hardly know how to operate it.

In an attempt to assess the efficiency of fire protection systems, the researcher sought to find out from the users whether the fire officers' visits the buildings to ascertain the conditions of fire protection systems. The outcome shows that 28% of the respondents actually admitted positively that fire officers do visit the buildings. Majority (72%) reported that fire officers do not visit the buildings. Further assessment revealed that of those who reported that fire officers visit the building, 70% reported that the officers visit the buildings once in three years. A few (20%) said the officers visit annually. This suggests that even though fire officers visit public buildings, they didn't have a well-planned time limit to do that. Whenever they feel fit they pay visit to these buildings. When it comes to combating fire outbreak, almost all (97%) of respondents reported to having a fair knowledge on how to combat fire. In spite of respondent's fair knowledge on how to combat fire, the researcher wanted to know which methods respondents are familiar with. The result is shown in Table 5 below:

Fire Combat Methods	Frequency	Percentages%
Use of gravels	4	7%
Use of fresh palm fronds	1	2%
Use of damp sand	10	18%
Use of wet blankets	8	14%
Use of fire extinguishers	33	59%
Total	**56**	**100%**

Table 5: Knowledge of fire combat methods

The results indicate that more than half (59%) of the respondents reported to be familiar with using fire extinguishers in combating fire. Furthermore, 32% reported that they are either familiar with using damp sand or wet blankets to combat fire. The respondents might have fair knowledge on how to combat fire, however their knowledge in these methods might not necessary mean they know how to use these methods.

10.2. Results of Questionnaires from Fire Officers

10.2.1. State of Fire Protection Systems in Public Buildings

In an assessment of efficiency of fire protection systems, it become necessary to assess the state of fire protection systems in selected public buildings. The fire officers were therefore required to indicate if public buildings comply with the National Fire Regulations. The results are shown in Table 6 below

Fire Fighting and Detection	Compliance	Non- compliance
Is appropriate fire fighting equipment provided	14 (70%)	6 (30%)
Is FFE easily accessible and simple to use	14 (70%)	6 (30%)
Suitable means for giving warning when fire is detected	3 (15%)	17 (85%)
Nomination of employees for fire fighting duties	4 (20%)	16 (80%)
Adequate training given	5 (25%)	15 (75%)
Availability of training records	7 (35%)	13 (65%)
Contacts been arranged with emergency services	8 (40%)	12 (60%)

Table 6: Efficiency of fire protection systems

The table above reveals that majority (70%) of the fire officers attested to the fact that appropriate fire fighting equipment's are provided in public buildings. The fire fighting equipment includes fire hydrants, fire extinguishers, water mist systems, fire blankets, fire hoses and connectors, self-breathing apparatus, fireman clothing among others. Furthermore, 70% of the fire officers reported that most of the public buildings comply with accessibility of fire fighting equipment and it usage. These public buildings were supposed to have suitable means of giving warning when fire is detected. This could be fire alarm systems, communication gadgets, public address systems (PAs) and others. However, majority (85%) of the respondents reported that public building did not comply with these regulations. Most people who detect fire in these buildings have no means to alert others either than shouting for help. This has resulted in the death of many victims in such buildings which could have been prevented. Companies and organizations, co-operate bodies in public buildings, as a fire regulation, are supposed to nominate employees for Fire Service training for fire fighting duties. The fire officers were asked to indicate whether or not these regulations are complied with. The outcome shows that these regulations are not complied with. This is because more than three - Fourth (80%) employees have hardly nominated any employees for fire fighting duties. Again, exactly three-forth (75%) reported that adequate training was not given.

Organizations in public building are supposed to keep training records and also arranged contact with emergency services. The researcher in an attempt to assess the state of fire protection in public buildings required from fire officers to indicate if these regulations are being complied with. The results indicate that 65% and 60% of the respondents reported that availability of training records and contact been arranged with emergency services respectively are not complied with. These therefore suggest that even if training were organized, there were no records to confirm that. Again, contacts were not arranged with emergency services such as the Ghana National Fire Services, Police Services, and Ambulance Service among others. This makes it difficult to get in contact with such emergency services when unforeseen circumstances happen.

10.2.2. State of Emergency Routes and Exits in Public Buildings

The assessment of the efficiency of fire protection system in public buildings prompted the researcher to assess the state of emergency routes and exits in public buildings. This, the researcher thought is the very first points of call when victims try to escape from fire outbreak in such buildings. Fire officers were therefore required to indicate whether or not public buildings comply with emergency routes and exit regulations as shown below:

Emergency routes and exits	Compliance	Non-compliance
Emergency routes and exits are kept clear	9 (45%)	11 (55%)
Emergency routes lead directly to place of safety	20 (100%)	-
Employees can evacuate quickly and safely	8 (40%)	12 (60%)
Sufficient escape points for persons present	3 (15%)	17 (85%)
Emergency doors open in direction of escape	17 (85%)	3 (15%)
Sliding and revolving doors are not use as emergency exits	5 (25%)	15 (75%)
Exit doors are easily and immediately open able	5 (25%)	15 (75%)
Exits are indicated by signs	20 (100%)	-
Emergency routes and exits are adequately lit.	14 (70%)	6 (30%)

Table 7: Emergency routes and exits in public buildings
N=20

Responding to emergency routes and exits kept clear, more than half (55%) reported that public buildings do not comply with that. This suggests that emergency exits which are supposed to lead victims to a place of safety are not clear of obstruction such as materials, dust bins among others. However, in spites of the unclear nature of emergency routes and exit, the results revealed that 100% of public buildings comply with emergency routes leading directly to place of safety. This means that obstructed emergency routes and exit actually lead to place of safety. A further investigation brought to light that in case of fire outbreak, employees cannot be evacuated quickly and safely. This comes to light when 60% of the respondents attested to the fact that public buildings do not comply to quick safety evacuation of employees in case of fire outbreak. This is because of narrow emergency routes and probably the unclear nature of these emergency routes and exit. Employees and other victims are sometimes seriously injured and even pass away. Again, the outcome revealed that more than three forth (85%) reported that escape points for persons present in case of fire outbreak

were insufficient. A whole building might have one or two escape points making it difficult for large number of people to exit through these points at the same time. This sometimes causes stampede leading to loss of lives. However, in spite of the insufficient escape points, 85% reported that the few emergency doors available open in direction of escape. As a fire protection regulation, sliding and revolving doors are not used as emergency exits. However, a further assessment by the researcher showed that three forth (75%) of the respondents said that public buildings do not comply with these regulations. This suggests that most of the emergency exit doors are either sliding or a revolving one. Again, majority (75%) also reported that doors are not easily immediately open-able. This suggest that even when victims are able to reach the doors which is mostly either sliding or revolving door, it becomes very difficult to open the door to escape from danger after passing through all the husk and hurdles to come that far. However, (100%) of the respondents admitted that in spite of the inefficiencies, exits are indicated by directional signs which when followed should led victims to place of safety.

10.2.3. State of Maintenance Culture in Public Buildings

The previous discussion revealed that appropriate fire fighting equipments were provided in the selected public building under study. The researcher therefore sought to find out how these equipments are maintained. The results indicate that majority (70%) of the fire safety equipment were in good working condition. Furthermore, more than half (60%) reported that there was suitable system of maintenance. To justify whether there were available records to support the maintenance culture on fire safety equipment in these public buildings, the researcher recorded split responses (i.e. 50% each). This suggest that fire safety equipment might be in good working condition because there exists a suitable system of maintenance but unavailable. This probably may be as result of bad record keeping or because there was no planned review for maintenance.

10.2.4. Management Regulations

As part of effort to assess the efficiency of fire protection systems in public buildings, the researcher wanted to find out the compliance of management regulations on fire risk assessments. The result is presented in Table 8 below.

Fire Risk Assessment	Compliance Frequency (%)	Non- Compliance Frequency (%)
Fire risk assessment are carried out	10 (50)	10 (50)
Emergency plan are prepared	7 (35)	13(65)
Existence of effective system for planning	7 (35)	13 (65)
Existence of effective system for organization	19 (95)	1(5)
Existence of effective system for control	7 (35)	13 (65)
Existence of effective system for monitoring	8 (40)	12 (60)
Existence of planned review	4 (20)	16 (80)
Appointment of competent persons	7 (35)	13 (65)
Appropriate procedures for serious imminent danger	9 (45)	11(55)
Employees are provided with relevant information	6 (30)	14 (70)
Adequate cooperation and co-ordination between employers	11(55)	9 (45)
Adequate information is given to host workers	1(5)	19 (95)
Appropriate training is given all employees	5 (25)	15 (75)
Responsibilities are clearly defined	4 (20)	16 (80)

Table 8: Regulations on fire risk assessment

The results indicate that regulation of fire risk assessment in public buildings is not encouraging even though there is 50% compliance on the practice of fire risk assessment. This is because apart from, existence of effective system for organization and adequate co-operation and co-ordination between employee which recorded compliance level of 95% and 55% respectively, all the other management regulations were not complied with. For instance, effective system for organization policy was not complied with. Again, most of the management regulations were not regarded or complied with. This suggests that there was no effective system for control, monitoring and planned review. In all instances majority (60%) and above reported that public buildings do not complied with these regulations. The results further revealed that more than half (65%) and above reported that management regulations such as appointing competent persons for fire risk assessment, providing employees with recent information and putting in appropriate procedures for serious imminent danger were not conformed to. Again, adequate information was not given to host workers as well as clearly defined responsibilities regarding fire safety.

10.3. Results of Questionnaires from Building Inspectors

10.3.1. Building Inspectors

In assessing the efficiency of fire protection systems in major selected public building in Ghana, the researcher thought it wise to inquire some answers from building inspectors who were supposed to inspect these building before, during and after building. The building inspectors were asked whether they have a policy framework that reflects comment on fire protection systems for public

buildings. The outcome from the building inspectors indicated that indeed there was a policy framework that reflects comments on fire protection systems (i.e. 90% responded positively). A further assessment revealed that occupants of these buildings were not aware of such regulations. This was ascertained when 83% of these building inspectors responded negatively to occupant's awareness of the regulations. Again, since the occupants were not aware of the regulations, it was also evident that users of these public buildings do not adhere to fire protection systems put in place. More than half (65%) of the building inspectors admitted that users of public buildings do not comply with the fire protection systems in such places. When quizzed further, all (100%) of these building inspectors strongly agreed to the fact that the Government should institute a fire protection system campaign programme for public building. This the researcher thought it was because users of public buildings were not aware and for that matter do not comply with fire protection system regulations. This might be due to little or no educational programme for users on strict regulations. Majority (90%) of the respondents reported that they were aware of fire protection programme for Government public buildings.

10.3.2. Attributes of Fire Safety Management that would Influence Fire Safety of Public Buildings

Fire safety management was considered by the researcher to have influence on fire safety of public buildings. The researcher therefore sought to find out the attributes of fire safety management that would influence fire safety of public buildings. The building inspectors were required to indicate how often they embark on educational training. 79% of the respondents reported that they annually embark on educational training on public buildings. Most fire outbreaks in public buildings could be as a result of electrical faults. The building inspectors were quizzed to find out if as part of their work, electrical installation works are inspected. Majority (95%) attested to the fact that inspection of electrical installation works is carried out annually. These revelations suggest that if fire outbreaks are attributed to faulty electrical installation then it might be that inferior materials were used for the installation work or less competent workers were employed to do the work. The users of these public buildings were found not to practice good housekeeping. 70% of the building inspectors reported that inhabitants of public building do not practice good house-keeping.

10.3.3. Critical Attributes of Fire Safety Management that would Influence fire Safety in Public Buildings

In assessing the efficiency of fire protection systems in public buildings, the researcher investigated into some critical attributes of fire safety management that would influence fire safety of public buildings. Respondents were required to indicate attributes they consider critical that could influence fire safety. The results are presented in Table 9

Fire Safety Management	Mean	SD	Rank
Conducting inspection, operation and maintenance of fire equipment	4.90	.308	**1**
Provide clear signage indication exit routes	4.90	.308	**2**
Education and training of public building users on fire life safety	4.90	.308	**3**
Conducting inspection of electrical installation works	4.85	.489	**4**
Implementing fire and evacuation drill procedures	4.65	.745	**5**
Implementing good housekeeping practices	4.50	.946	**6**
Taking renovation work precautions and inspections	4.45	.759	**7**
Taking periodic pest control practices	4.15	1.089	**8**

Table 9: Attributes of fire safety Management

N=20 response scale 1= least critical, 2 =less critical 3 =neutral, 4 = more critical 5 = most critical. Source: field survey 2014

Using a scale of 1-5 with 1 being least critical and 5 being the most critical, the outcome reveals that almost all the attributes were considered by the respondents as being most critical that could influence fire safety in public buildings. This is because all the attributes were rated above 4. However, some attributes were considered as most critical to influence fire safety than others. For instances, conducting inspection, operation and maintenance of fire equipment (M=4.90), providing clear signage indication exit routes (M=4.90) and educating and training of public building users on fire safety (M=4.90) were the three fire management attributes respondents considered as most critical to influence fire safety of public buildings. Again, implementing good housekeeping practices and taking periodic pest control practices (M= 4.15), taking renovation work precautions and inspections (M= 4.45) and implementation of good housing keeping practices (M= 4.50) were also the attributes considered as less most critical to influence fire safety of public buildings. These suggest that all the attributes of fire safety management if taken into consideration would influence fire safety in public buildings. Fire officers, building inspectors and users should therefore consider these attributes so as to have efficient fire safety systems in public building.

10.3.4. Methods to Improve Fire Safety Knowledge of Public Building Users

Public building user's knowledge on fire safety was an issue the researcher thought would help in the quest to assess the efficiency of fire protection systems in public buildings. The researcher therefore sought to find out from the respondents some methods they think would improve knowledge on fire safety. Respondents were required to indicate whether they agree or disagree to the methods to improve fire safety knowledge on public buildings. The results are presented in Table 10

Methods	Mean	SD	Rank
Conduct regular inspection of all electrical installation works	1.00	.000	1
Areas under renovation are regularly inspected	1.00	.000	2
Exit routes and location of fire safety should be cleared	1.00	.000	3
Old electrical cables, socket fittings should be changed	1.00	.000	4
Fire and evacuation drills should be conducted at regular interval	1.00	.000	5
Leaflets containing emergency procedures should be distributed to users	1.00	.000	6
Flammable materials should be stored in safe area	1.00	.000	7
Law enforcement has to ensure users complies with statutory requirement	1.00	.000	8
Notices leading to fire safety equipment should be clearly positioned	1.00	.000	9
Assign specific personnel as emergency response staff	1.05	.224	10
Installment of high-tech fire safety equipment in public building	1.05	.224	11
Increase awareness to react to fire emergencies	1.80	.410	12

Table 10: Methods to improve user's knowledge on fire safety

N= 20 response scale 1 = agree, 2 =disagree SD = Standard deviation, source (field survey, 2014)

The results show that all the methods were considered by respondents to improve fire safety knowledge of public building users. This suggests that the respondents agreed to all the methods as a way to improve users of public building's knowledge on fire safety. Even though, respondents agreed to the fact that these methods could improve fire safety knowledge of public building users, they agreed with preferences. For instances, conducting regular inspection of all electrical installation works (M=1.00, SD=0.000), regular inspection of areas under renovation (M=1.00, SD=0.000) and having a clear exit routes and location of fire safety (M=1.00, SD= 0.000) were among the nine methods respondents considered as most appropriate methods to improve fire safety knowledge of public building users. However, increase awareness to react to fire emergencies (M=1.80, SD=0.410) was a method respondents disagreed would improve user's knowledge on fire safety. The overwhelming agreement to all those methods as would improve fire safety knowledge on users of public buildings suggest that urgent attention should be given if stakeholders wants to improve on the knowledge level of users of public buildings about fire safety.

10.4. Observation and Field Survey

To gather information on real situation, the researcher together with a team from Fire Service conducted observation and field survey on the selected buildings. A checklist for the observation covered the passive and active fire protection system.

10.4.1. Central Market

In the central market, there are a lot of escape routes but unauthorized structures made of wood are closely linked to each other blocking the escape routes hence can trap victims of fire incidents. Apart from these, the structures can also easily help in the spread of fire in case it occurs. Besides, some shops were also filled with combustibles which are potential materials for fire outbreak.

There was only one fire hydrant located in the market. However, the traders have erected a wooden structure on it. Users of the market have no fire extinguishers in their shops due to lack of knowledge on its importance and fire outbreak. There were no fire alarms, detectors, sprinklers, risers installed in the market.

Figure 1: Obstruction of the main entrance

Figure 2: Stores selling combustibles

10.4.2. Cocoa House

The escape routes are not enough on the building which is currently the tallest in Sunyani. Most of the fire safety systems are broken down and cannot be maintained due to lack of expertise, spare parts and fund.

Old electrical sockets are well maintained to standard. There is a technician in charge of the systems and has contacts with a response unit of Fire and Ghana Police Service. The technician also acts as an emergency response staff.

Figure 3: Six storey cocoa house building

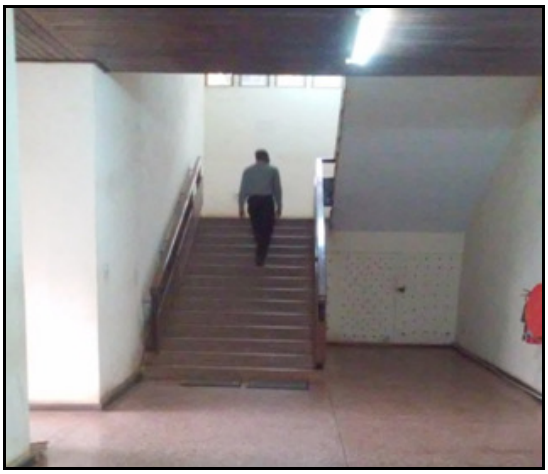

Figure 4: The only escape route

Figure 5: The main entrance

10.4.3. Regional Hospital

The Regional Hospital has modern fire-fighting equipment with a trained technician in charge of it. Some electrical installations such as sockets, switch board and waving fans were broken down and others missing. Further investigations and interview with some of the management members revealed that getting experts to maintain the facility is a problem coupled with lack of spare parts and funds.

There were number of escape routes with good lighting systems. However, the occupants were not given enough education on how these systems function. In general, the fire-fighting system in the hospital was good.

Figure 6: Brong Ahafo Regional hospital building, Sunyani

Figure 7: Central control system for hydrants

Figure 8: Fire hydrants

Figure 9: Fire door

10.5. Conclusion

The study which aimed at assessing the efficiency of fire protection systems in public buildings has revealed the inefficiencies in public buildings as far as fire protection system is concerned. Most of the numerous fire outbreaks in public buildings in recent times may be attributed to the fact that there exist inefficient fire protection systems to help protect humans and properties. Lack of knowledge on how to use these fire protection systems if they are available has also compounded the inefficiencies. Most recent fire outbreaks in public buildings could have been prevented if there exist proper chain of communications and reliable fire alert systems.

10.6. Recommendations

The following recommendations are made based on the researcher's findings:

1. The researcher recommends that efforts should be made by Ghana National Fire Service to periodically inspect all fire protection systems in public buildings.
2. Building inspectors should make sure that any new public building has clear adequate emergency routes and exits put in place before building permit is issued.
3. Furthermore, all public buildings should have reliable fire protection systems at vantage points.
4. Again the researcher recommends that users of public buildings must be educated periodically on how to use available fire protection systems
5. Moreover, regular inspection must be conducted on operation and maintenance of fire equipment.
6. Serious education and training on fire safety should be given to users of public buildings regularly
7. Regular inspection of electrical installations should be conducted to ascertain faulty electrical gadgets
8. Moreover, fire and evacuation drill must be implemented in all public buildings and carried out at least once a year
9. Furthermore, the law enforcement agencies should ensure that users comply with statutory requirement of fire safety equipment's with notices leading to fire safety equipment's clearly positioned.
10. Lastly the researcher recommends that all stakeholders should increase the awareness to react to fire emergencies. Contact numbers should be arranged with emergency services for immediate and rapid response to any fire emergencies in public buildings.

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