



# **Examination of the Causes and Frequency of Fire Hazard in Communities Housing Refinery Flammable Facilities: A Case Study of PHRC**

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## **Authors' contributions**

*This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.*

## **Article Information**

DOI: 10.9734/ACRI/2021/v21i830262

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(2) Dr. Wang Mingyu, Central South University, China.

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Complete Peer review History, details of the editor(s), Reviewers and additional Reviewers are available here:  
<https://www.sdiarticle5.com/review-history/84070>

**Short Research Article**

**Received 20 October 2021**  
**Accepted 25 December 2021**  
**Published 27 December 2021**

## **ABSTRACT**

Fire hazards regardless of their immediate or remote cause(s), always have very serious consequences whenever they occur. This paper examines the causes and frequency of fire hazards in the host communities of Port Harcourt Refinery Company (PHRC) flammable materials, to establish the causes and frequency of fire outbreaks in such facilities as the Crudeoil tanks, Crude Distillation Unit (CDU), Fluid Catalytic Cracking Unit (FCCU), Naphtha Hydrotreating Unit (NHU), and suggesting measures to reduce such practices. The research was sorted via an intensive literature review alongside the administration of a well-structured questionnaire. A total of seventy questionnaires with sixty returned adequately filled giving a percentage response of 85.7%. The responses were analyzed using computer-based software (SPSS) and the result was presented in percentages and Relative Importance Indices (RII). The result showed among others that the reoccurring communal practice around PHRC that lead to fire hazard is bush burning (RII=0.91). Other common practices that lead to fire hazards are; Arson and incineration of refuse at proximity to combustible elements. The result also shows that there is no fire enlightenment within this

environment. Thus, based on the findings the following are recommended; regulation and supervisory committees be set up and empowered to guide against the act of bush burning around PHRC flammable facilities. Fire prevention measures and enlightenment should be organized within the communities surrounding PHRC, and also the point where PHRC flammable facilities are stored or located within the communities should be well designated so that people can easily see and consequently avoid any activity that can instigate the eruption of fire outbreak.

*Keywords: Causes; frequency; and fire hazard.*

## 1. INTRODUCTION

Fire is a chemical reaction where the atom of oxygen combined with other atoms such as carbon and hydrogen etc. in the form of heat which generates flames [1]. Fire is not a respecter of person or place, it breaks out in all forms of the building because almost all buildings contain some combustible material such as furniture kerosene, clothing, and every machine, especially in industrial buildings. Fire is one of the earliest innovations of civilization and an essential part of our existence on the earth. Still, it is the name of a dreaded demon that burns everything into ashes when it gets out of control. Fire can cause widespread destruction within no time and is one of the most feared scourges of modern civilization. Although fire hazards cannot be fully eliminated, corresponding risk can be minimized by better preparedness and well-planned mitigation strategies developed based on comprehensive analysis based on its spatial, temporal, and causal pattern [2,3].

Every year, industrial accidents resulting from fire hazard of petroleum activities causes several deaths, injuries, and property losses due to petroleum refining operations. Even if the accident is minor, it may lead to millions of dollars worth of property loss and several days of production interruption [4]. That is why; fire-oriented industrial accidents are considered a threat to human safety.

Inherently, no building material is perfectly fireproof. Every building contains some materials (such as furniture, clothing, eatables e.t.c) which can either easily catch fire or which are vulnerable to fire (Punmia et al, 2005). However, the endeavor of the architects and builders should be to plan, design, and construct the building in such a way that the safety of occupants may be ensured to the maximum possible extent in the event of an outbreak of fire in the building due to any reason whatsoever. The technical interpretation of fire safety of buildings is to convey the fire resistance of

buildings in terms of hours when subjected to fire known intensity. It should have a structural time interval so that adequate protection to the occupant is afforded [1].

Fires, regardless of their immediate or remote cause(s), always have very serious consequences whenever they occur. The consequences of fire outbreaks are damage to the environment, loss of lives and properties, disruption of the work process resulting in a decrease in productivity and profitability. To a very large extent also, the corporate image of the company is affected. Though it would seem extremely impossible to eliminate bush fires, for example, the next best thing would be to suppress them while they are still small or strategically manage the forest fuel to minimize the intensity of the fire. And beyond endangering the flammable facilities, they can also destroy valuable infrastructure, cause widespread damage to vegetation and even cause the death of trees [5-8]. Exposure of facilities to fire often results in explosions, this often occurs in flammable facilities. Such materials include petroleum, petroleum products such as petrochemicals, and natural gas. PHRC flammable facilities all belong to these categories and more. It processes flammable substances at very high temperatures and pressure making the hazards event more severe [9,10].

Recent development shows that modern cities have adopted laws to protect its citizen from fires hazards such low specifying the maximum number of people who may occupy a public building at one time and the minimum number of exits, fire extinguishers, and fire experts or fire starts, the building must have the installation of an automatic sprinkler system in .large building is required by many manic, panties, fire roof construction in many cities [11]. The most advanced fire codes now require smoke alarms in all new housing most city building codes include regulations covering both design and material fire-safe-resistant walls, floor, doors, and partitions, all vertical components, such as

elevators shaft and stairwell must insulate from the main body of the building hollow walls which can act like flues during a fire contain fire stops. (Refining and Petrochemical plant such as Port Harcourt Refining Company Limited (PHRC) is a very complex system, composed of various equipment such as compressors, pumps, soot blowers, electric motors, generators (diesel/oil) power cranes, etc. The system works under severe conditions such as exposure to chemicals, high temperature, or corrosive conditions. Thus they have a very high discharge of combustible chemicals which can initiate fire outbreaks within the surrounding environment of the refinery.

Thus, an examination of the causes and frequencies of fire hazards within and around the communities surrounding Port Harcourt Refining and Petrochemical Company Limited will provide a good fire hazard pattern within the study area which will inform the disaster preparedness in the communities (Okirika, Abuloma, Onne and Alese) capable of endangering or exposing flammable facilities belonging to the refinery to fire accidents. PHRC, being primarily a chemical process plant made up of process units, storage facilities-both crude oil and finished products, building facilities, warehouses for storing general goods, as well as chemicals and catalysts, etc.

The surrounding communities, namely Okirka, Abuloma, Onne, and Alese are rural settlements that are engaged in farming and low-level industrial activities such as bakeries, packaged water plants, grinding machines of various kinds and capacities. But, gas plants have also been established in the communities because of the ease of gas supplies from the refinery. As a result of these activities, it is easy to deduce that fires could result from industrial accidents, bush burning, particularly during dry seasons in preparation of the land for farming activities. Even fireworks are common, especially during festivities, which are known to be a common cause of fires. Bush burning in particular is a very common phenomenon among the communities and therefore poses very serious threats of fire to the PHRC flammable facilities. Local hunters equally engage in bush burning activities in their efforts to catch wild animals.

The communities are also serving as hosts to many gas plants due primarily to the ease with which they can source their feed, as well as cheap lands upon which such plants are sited. As of today, there are eight (8) gas plants spread

across the communities. This obviously, poses a very serious fire hazard to PHRC flammable facilities. The findings of this paper further add insight to the available knowledge of fire prevention measures particularly in safeguarding PHRC flammable facilities within the host communities.

## **2. LITERATURE REVIEW**

### **2.1 The Phenomenon of Fire**

Fire is a phenomenon with which everyone is familiar. Fire is used daily to heat homes and cook meals. When harnessed, the power and energy from fire serve us well; however, when it is uncontrolled, a fire can quickly consume and destroy whatever lies in its path. Few people are aware of its nature and the complex processes of fire. This Section examines the phenomena and various mechanisms at work within fire and is intended to provide a better understanding of the requirements in fire-fighting scenarios [12].

Fire is a chemical reaction in which certain percentages of oxygen are needed to make it effective. Fire starts when a flammable, combustible material with an adequate supply of oxygen or another oxidizer is subjected to enough heat and it can sustain reaction [13]. Fire starts when a flammable and combustible material with an adequate supply of oxygen or another oxidizer is subjected to enough heat and can sustain a chain reaction. This is commonly called the fire tetrahedron. Fire cannot exist without all of these elements being in place though as previously stated, another strong oxidizer can replace oxygen. Once ignited, a chain reaction must take place whereby fires can sustain their heat by the further release of heat energy in the process of combustion and may propagate, provided there is a continuous supply of an oxidizer and fuel [14].

## **3. CAUSES OF FIRE IN BUILDINGS**

According to Kodur & Rafi [15], fire can occur by broadly three causes. They include;

1. Natural causes
2. Accidental causes
3. Incendiary causes

### **3.1 Natural Causes of Fire in Building**

- a. Lighting: This is caused by connective current occurring in the thunder clouds

dense cold air at the top and warm moist at the bottom. This results in the long updraft, and a positive change in the upper portion of the thunder cloud with the lower portion developing a negative charge on the cloud, and also a charge from the earth to the cloud will occur. Lightning strikes will result in fire only if sufficient heat is produced to ignite combustible materials. Lightning can either occur as the hot bolt which has a longer duration igniting combustibles or the short bolt with a shorter duration which shatters and splinter the building materials and in some cases may result in major damage to the building.

- b. Rays of the sun: Fires can also be caused by the rays of the sun, mostly as the result of the sun shining through older window panels containing 'bubbles'. More recently, there have been reports of the sun's rays coming through a window and hitting a concave mirror concentrating the light on combustible materials and igniting them.
- c. Rain: Rain is known for leaking into buildings, shooting electrical wire, and causing fires. Rain can penetrate containers that contain water-reactive chemicals and thus result in exothermic reactions-reactions that release heat to the surroundings-causing combustible materials to ignite.
- d. Flood: This is a common cause of fire. It can also cause sewers to block up until they short out electrical circuits.
- e. Wind: Among the natural cause of the fire is the action of the wind, which can blow a building apart, shorting out an electrical wire, which in turn may start a fire. Wind can also sway electrical lines causing them to oscillate until they make contacts, shorting them out and causing a fire. Unattended fires can also be blown out by stray winds currents.
- f. Animal causes: Animals have been known to cause a fire in buildings by chewing the insulations of electrical wires, especially those with only one layer insulations. The animals themselves short circuit the connection by setting on the wire they chewed while chewing the other one. The animal's body is used as a conductor and therefore is used as a fuel to ignite other materials nearby.
- g. Building settlement: Differential settlements in building due to varying bearing capacity of the subsoil below the building may cause pipe carrying crack; as

a result of which leaks may occur causing a fire.

### **3.2 Accidental Causes of Fire**

The term 'accident causes of fire' has been framed to cover several causes which are electrical faults causes, malfunctioning, explosion, and miscellaneous causes.

- A. Electrical fire causes: The sources of almost all electrical fires can be classified as originating from three conditions:
  - i. Arcing
  - ii. Sparking
  - iii. Overheating

Arcing: if a short circuit or break in an electrical conductor occurs, the electrical current tries to continue to flow in the open space. It creates an arc. The intensity of the arc depends upon the voltage and current flowing.

Arcing on small scale occurs every time an electric switch is opened. Its intensity again depends upon the amount of current flowing. If the atmosphere in which the switch is opened contains flammable vapors, flammable gases, or combustible dust and the moisture is within the flammable range, an explosion or fire can occur when the switch is opened.

Sparking: Sparks most commonly occur as a result of electric (arc) welding operations or from the arcing of short circuits. The tremendous heat created during the electrical welding process creates a bond between the electrode and the material being bonded.

This also creates many sparks and glowing globules of hot metal. If combustible materials are in the vicinity, sparks and molten can cause a fire.

Overheating: Damage to electrical conductors can result from heat exposing them in two ways: The fire that heats the conductors from the outside and overheating from an internal source. External heating can result from a fire that begins to melt a copper conductor by the constant applications of heat. When the wires have reached their melting point (approximately 2000<sup>0</sup> F) blistering will occur at the surface of the wire shortly thereafter, the wire will begin to distort, usually by elongating or thinning and this can result in the fire outbreak.

As current flows through a conductor, it generates heat in much the same way the water flowing through a fire hose develops a friction loss. The smaller the conductor and the greater the amount of current flowing, the more heat generated. This heat is dissipated through the insulation on the conductor. If the insulated wire is exposed to the air and the heat is not excessive, the wire will not become overheated. But if the insulated wires are covered such as with a rug or carpeting, the heat will be confined and built up. The resultant heat may be sufficient to ignite the covering.

- A. The fire caused by electrical appliances: Fire may result due to faults in electrical appliances which may develop due to overload. Fire may also start due to filament lamp neglect. The heat developed by a low watts lamp will be enough to ignite tissue paper. The heat from high voltage lamps suspended by the least of flexible wires (flex) may also cause the deterioration of the insulations and therefore constitute a fire risk. Danger also arises when electric lamps are placed in showcases or shop windows where heat is confined, especially when highly flammable liquids such as scents and perfumes are present.
- B. Temporary electrical insulation: A temporary installation in addition to a fixed installation may constitute a fire hazard in buildings where it's arranged or just hitched up by the incompetent person who does not know the safety precautions that should be taken under the pretext that is just temporary connections. A temporary electric installation of whatever from must comply with the regulations of the Institution of Electrical Engineers (IEE) the United Kingdom for it to be relatively safe.
- C. Gas fires: Natural gas such as propane, methane, usually causes fire in buildings when they escape from leaking pipe systems. The leak may be due to construction mishaps, appliances malfunctions, building settlements, or numerous other causes.
- D. Appliances malfunctions: Fire can cause in the building due to the breakdown of gas devices, mechanical and electrical appliances. The usual cause of the failure in mechanical devices is due to the frictions which result from the lack of lubrication of the mechanical devices. This causes overheating of parts which in turn

heat other combustible materials around the machines and subsequently ignite them and cause a fire.

- E. Explosion: Explosion is the instantaneous release of gas or heat. Explosives are materials that pose a hazard principally because they are rapidly combustible. Explosive is divided into three; they are Gas explosions, Dust explosion, Explosion, or explosives.
- F. Miscellaneous causes of fire: the miscellaneous causes of fire in buildings include those fires caused by Smoking, Bonfires, and Rubbish fires.
- G. Smoking: Smoking is among the major causes of fire outbreaks in the building. When cigarettes are displaced accidentally or intentionally on combustible materials such as furniture, paper, waste materials, or other similar materials, they ignite causing a fire. The cause of fire outbreaks is usually attributed to smoking where no obvious reason was at hand.
- H. Bonfires and rubbish fires: These are fire that are usually said to be 'burning' under controls, but which from the time don't get out of control. They can be a major source of fire when they get out of control on-site near doors or windows [11].

### **3.3 Incendiary Fires**

The term "incendiary causes of fires" has been coined to cover several causes of fire outbreaks of fire which are either malicious, deliberate, or of such gross carelessness as to be equally capable [11].

This type of fire is usually set by a person falling into one of the following classes:

- A. Fraud fires (Arson): The law definition of arson was traditional "the willful and malicious burning of a building of another including all outbuildings adjoining there to "Abroad (USA) arson results from a desire to fraud insurance companies. But in Nigeria, it is all employed by high-ranking government officials who have misappropriated funds to cover up their offenses. This is one of the major causes of fire in this country, evidence of which abounds in frequent destructions of our public buildings by fire for fraudulent reasons.
- B. The pathological firesetters: These types of fire are set by people with a form of

insanity in which they get a thrill from seeing uncontrolled fire burning. He may have no other reason than to satisfy his physiological feelings.

- C. The emotional firesetters: These types of fire are set by people who destroy property in an act of revenge, hatefulness, or strikes but at the person whom he feels has wronged him. This type of person included mobs and demonstrators. Fire incidents caused by these types of persons occur commonly in this country as can be seen during student demonstrations and also the recent religious crisis in the country where more than one hundred and fifty-two places of worship were destroyed in a single state.

## **4. METHODOLOGY**

This research work was carried out via an extensive literature review of relevant textbooks, journals, and conference proceedings were the source of data for the study. The field survey was using a structured questionnaire and via a physical inspection of the communities under study as well as the interview of individuals where necessary for data collection instrument.

### **4.1 The Population of the Study**

The population of this study comprises the responses of people living in the surrounding of KPRC in the villages such as Onne (with about 120 residential buildings close to the flammable facilities), Okirka (with about 110 residential buildings nearby), Abuloma (89 residential buildings nearby), and Alese(36, residential buildings), Okrika(53 residential buildings). Although there is a wide range of PHRC facilities, however, the research focuses on buildings near Such facilities as crude oil tanks, product tanks such as PMS, AGO, DPK, asphalt, etc. This is because when a fire breaks out, as they often do, among issues to worry about is its effect on the communities surrounding the PHRC, especially in terms of possible loss of lives and property, air and water pollution, environmental degradation, etc This study will require an assessment of the fire prevention measures among the communities surrounding Port Harcourt Refinery Company as well as the impact on the PHRC.

### **4.2 Sampling Size and Administration of Data Collection Instrument**

The sample size of this study comprise of the sixty (60) respondents residing in the

surrounding of KPRC in the villages such as Onne, Okirka, Abuloma and Alese, Okirka with each town being administered with twenty (20) questionnaires even though an average of fifteen was returned from each town amounting to sixty(60) respondents.

### **4.3 Data Collection Instrument**

The study was designed to sought data using a questionnaire through a field survey as described below

### **4.4 Questionnaire**

The questionnaire was designed to be filled by respondents from the surrounding communities as well as PHRC personnel who resides in such communities to assess their professional opinion on the ways the activities of the communities inhabitant can or has ever led to fire outbreak. The questionnaire sought information on the following aspect of fire prevention measures:

- (i) The kind of activities that the communities are exposed to pose's threat of initiating fire, especially around the PHRC flammable facilities.
- (ii) To identify the extent to which the activities and the measure to limit or eradicate such activities in an attempt to proffer a fire resistance measure

### **4.5 Data Analysis**

The data collected for this study were subjected to various statistical analyses. The questions were analyzed using the Statistical Package for Social Sciences (SPSS) for questions that do not entail ranking. However, for questions that entail ranking, the Relative Importance Index (RII) was used.

The five and four-point scale was transformed to Relative Importance Indices for each of the construction documents. The weighted average items were determined and ranks were assigned to each item representing the perception of the respondents.

The numerical scores for the completed questionnaires indicated the varying degrees of the use of the construction documents. To further analyze the data to establish the significance of the variables considered, the Relative Importance Index (RII) was calculated for each document according to their frequency of use as

suggested for use by Memon et al, (2006) and Othman et al, (2005).

It was calculated using the formulae

$$RII = \frac{4n5 + 3n4 + 2n3 + 1n2 + 0n1}{4N}$$

Where;

- n1= number of respondents for 'never'
- n2 =number of respondents for 'seldom'
- n3=number of respondents for 'sometimes'
- n4=number of respondents for 'often'
- n5=number of respondents for 'always'
- N=total number of respondents

RII ranges between zeros to one. The four-point scale ranking was transformed to relative importance indices (RII) for each of the construction contract documents. The weighted average for each item was determined and ranks were assigned to each item, representing the perception of the respondents.

Results are classified into three categories as follows (Othman et al, 2005) when;

RII<0.60 -it indicates low frequency in use

0.60≤RII<0.80 -it indicates high frequency in use.

RII≥0.80 –it indicates a very high frequency in use.

Data was also presented in graphic form namely pie charts and tabulations. Descriptive analysis of data relating to rating/frequency, simple percentages were used to analyse data.

The results of the analysis are presented in the form of a table for the purposed of easy comparison and clear expression of the findings. Descriptive analysis of data relating to rating/frequency, simple percentages were used to analyze data.

## 5. DATA PRESENTATION, ANALYSIS, AND DISCUSSION

Data for this research was obtained from respondents living within the neighborhood of Port Harcourt Refining Company Limited (PHRC) and the PHRC flammable facilities via a well-structured questionnaire.

### 5.1 Questionnaires Administered

A total of seventy (70) questionnaires were administered, with a total turn of sixty questionnaires giving a percentage response of 85.7% as illustrated in Table 1.

### 5.2 Respondents Profile and Proximity to Refinery Flammable Facilities

From the response of the respondents, it can be established that some of the respondents were PHRC staff and some others were not; the respondents have different educational qualifications; varying duration of abhorred in the area of interest, and their houses were at varying distances from PHRC flammable material. These variations are given Table 2.

From Table. 2 it can be established that 80% of the respondents were both residents of the community in the study area as well as staff of PHRC, this corresponds to a frequency of 48 respondents, while 20% corresponding to a frequency of 12 respondents were only residents of the community of interest and not the staff of the PHRC.

Also, the varying educational qualification of the respondents is presented in the Table. From the table, it can be established that 60% of the respondents possess a post-graduate certificate while 20% have an HND/BSc, and 15% possess an ND or an NCE certificate. This suggests that a greater portion of the respondents have post-secondary education and consequently will be able to read effectively and comprehend the content of the questionnaire to give their candid opinion on the questions asked.

**Table 1. Questionnaire Administered**

Questionnaire Administered	Frequency ( No)	Percentages (%)
Questionnaires Returned	60	85.7%
Questionnaires not Returned	10	14.3%
Total	70	100

Source: Field survey, (2021)

**Table 2. Respondent profile**

S/N	Profile	Option	Frequency (No)	Percentage (%)
1	The staff of PHRC:	a) Yes	48	80.0
		b) No	12	20.0
		<b>Total</b>	<b>60</b>	<b>100</b>
2	Highest educational qualification	a) Secondary Cert	3	5.0
		b) ND/NCE	9	15.0
		c) HND/BSc	12	20.0
		d) Post Graduate	36	60.0
		<b>Total</b>	<b>60</b>	<b>100</b>
3	Proximity of Residence from PHRC Flammable Facilities	a) 0- 50m	12	20.0
		b) 51- 100m	38	63.3
		c) Above 100m	10	16.7
		<b>Total</b>	<b>60</b>	<b>100</b>
4	Duration of Stay in the Community	a) 0-5yrs	3	5.0
		b) 6-10yrs	9	15.0
		c) 11-15yrs	40	66.7
		d) 20 and above	8	13.3
		<b>Total</b>	<b>60</b>	<b>100</b>

Source: Field Survey, (2021)

Also, from the analysis of the opinion of the respondents on the proximity of their house to the PHRC flammable materials, the following can be established as shown in Table 2. From the Table above, 63.3% of the respondents attested that their houses were 0- 50m from PHRC pipe and PHRC flammable facilities, with only 20% considering the distance of their houses from PHRC flammable facilities as just being 51-100m from an underground pipe. Thus it can be gathered that houses are not located in proximity to the PHRC flammable facilities.

With regards to the duration of residency of the respondents in the community of interest, it can be seen a greater majority of the respondent has spent much time in the area as evident in the percentages. From the table, 66.7% of the have spent 11-15yrs in the community and 13.3% have spent over 20yrs in the community. Only 15% of the respondents have spent between 6-10yrs. Thus, from the percentages, it can be established that the respondents have stayed in the community for a reasonable long number of times and thus are on a good footing to give a true view about the happening in the community.

### 5.3 Frequency of Occurrence of Fire Hazard

Table 3 presents the frequency of occurrence of the fire hazard within the host communities of the refinery flammable facilities experience by the respondents as well as the season of the year where the fire hazard is most likely to occur.

With regards to the frequency of the fire hazard in the communities, 75% of the respondent opined that they have experienced fire hazard in their communities about three-time whereas 16.7% was of the view that they have experienced it above three times but about seven times in their communities. Only 8.3 % corresponding to a frequency of five respondents affirmed that they have experienced it above seven times though less than eleven times. This establishes the fact that the communities occasionally experience fire hazards.

With regards to the season of the year that the fire occurrence is predominant, from the analysis of the respondent's opinion, it can be established that 81.7% of the respondent opined that fire occurs more within December to February, followed closely is the 13.3% who thought that fire hazard occurs more within March to May and finally the 5% that was of the view that it occurs more within June to August. Thus going by this opinion as illustrated in Table 3, it can be established that there tend to be more fire occurrence in the winter season of the year.

### 5.4 Fire Prevention Measure Enlighten Campaign, And Efficiency of the Fire Fighting Services

With regards to the question on the fire prevention measure, enlightenment asked, from Table 4, it can be established that 100% of the respondent affirmed that there is no fire prevention enlightenment measure adopted in their various communities.



### 5.5 The Intervention of PHRC Fire Services in the Communities and their Efficiency

Though there is no existing fire prevention enlightenment measure, existing in the communities, Table 5 gives the opinion of the respondents to the intervention of PHRC fire service in their communities in the event of fire occurrence. From the table, it can be established that a greater majority 83.3% of the respondents thought that the PHRC fire services do intervene in the event of fire outbreak in their community as against only 16.7% of the respondents who were

of the view that the PHRC fire service do not intervene at the event of a fire in their communities.

The respondent also evaluated the efficiency of the fire service, and from Table 5 below it can be established that 36.7% of the respondents thought that the firefighting services were not efficient. Contrary to that 40% of the respondents opined that it was efficient, followed closely by 16.7 % of the view that it was very efficient and a very small percentage of 6.7% opined it was highly efficient. Hence that it can be established that on average the services were efficient.

**Table 3. Frequency of occurrence of fire hazard**

S/N	Questions	Option	Frequency (No)	Percentage (%)
1	Frequency of Fire Hazard	a) 0-3times	45	75.0
		b) 4-7times	10	16.7
		c) 8-11times	5	8.3
		<b>Total</b>	<b>60</b>	<b>100</b>
2	Season of the year with the highest fire occurrence	a) Dec –Feb	49	81.7
		b) March-May	8	13.3
		c) June- August	3	5.0
		d) Sep- Nov	-	-
<b>Total</b>	<b>60</b>	<b>100</b>		

Source: Field Survey, (2021)

**Table 4. Fire prevention enlightenment**

Existing fire prevention measure	Frequency( No)	Percentage (%)
yes	0	0
no	60	100
<b>Total</b>	<b>60</b>	<b>100</b>

Source: Survey, 2021

**Table 5. PHRC fire service intervention at the event of a fire**

S/N	Questions	Option	Frequency (No)	Percentage (%)
1	Intervention in the community	a) Yes	50	83.3
		b) No	10	16.7
		<b>Total</b>	<b>60</b>	<b>100</b>
2	The efficiency of the Fire Fighting Services	a) Not efficient	22	36.7
		b) Efficient	24	40.0
		c) Very efficient	10	16.7
		d) Highly efficient	4	6.6
<b>Total</b>	<b>60</b>	<b>100</b>		

Source: Field Survey, (2021)

**Table 6. Ranking of the causes of fire hazard in the communities**

S/N	Causes Of Fire Hazard	No Of Respondents	Mean	Std. Deviation	Variance	Relative Importance Indices	Ranking
1	Bush burning	60	2.98	0.832	0.692	0.91	1
2	Incineration of refuse at disposal point	60	3.64	1.039	1.079	0.88	2
3	Arson	60	2.65	0.480	0.230	0.81	3
4	Electrical fault	60	3.550	0.951	0.903	0.66	5
5	Unattended stove and gas cookers	60	2.60	0.548	0.300	0.50	8
6	Storage of hazardous chemicals around house place	60	2.66	0.663	0.439	0.69	4
7	Smoking	60	2.43	0.864	0.747	0.53	7
8	Carelessness in handling of combustible substance	60	2.52	1.161	1.348	0.54	6

Source, Survey 2021

**Table 7. Fire detecting devices and type of fire extinguisher used**

S/N	Questions	Option	Frequency (No)	Percentage (%)
1	Fire Detecting Devices	a) Smoke Detector	32	53.3
		b) Heat Detector	28	46.7
		<b>Total</b>	<b>60</b>	<b>100</b>
2	Type of Extinguisher as designated	e) Water fire extinguisher	19	31.7
		f) Fume fire extinguisher	19	31.7
		g) CO <sub>2</sub> fire extinguisher	20	33.3
		h) Dry powder	2	3.3
		<b>Total</b>	<b>60</b>	<b>100</b>

Source: Field Survey, (2021)

## 5.6 Cause of Fire in the Communities

In the respondents' opinion, Table 6 gives the ranking of the causes of fire hazards in the communities studied. From the table, it can be established that bush burning was ranking the highest cause of fire hazard in the communities followed closely by the incineration of refuse at disposal point and then arson. However, the list cause as opined by the respondents was the unattended stove and gas cookers then smoking. These details are given in Table 6 given.

## 5.7 Fire Detection Measures Around the Flammable Facilities

Table 7 shows the opinion of the respondents with regards to the fire detectors employed.

53.3% of the respondents opined that the fire detectors used were smoke detectors whereas 46.7% of the respondents were of the view that it was heat detectors.

Apart from the fire detecting device employed, the opinion of the respondents was also sorted with regards to the fire extinguishers used within the PHRC flammable facilities. The opinion of the respondents is shown in table 7 shown below. From the table, it can be established that an equal percentage of 31.7% of the respondents opined that the fire extinguisher employed were water fire extinguishers and fume extinguishers respectively. However, a greater percentage of 33.3% of the respondents thought that the fire extinguishers available were CO<sub>2</sub> fire extinguishers.

## **6. SUMMARY OF FINDINGS**

The primary essence of this research paper is to examine the major causes and frequency of fire hazards around the flammable facilities of PHRC in the host communities. Given this four communities surrounding PHRC flammable facilities were studied. The following can be established:

- (i) Fire hazards are more often within December to February of the year
- (ii) Careless is a major cause of fire hazard in the communities studies as opined by the respondents
- (iii) There is no fire prevention measure enlightenment done in that communities
- (iv) The PHRC fire service occasionally attend to the fire hazard demand of these communities for the safety of their facilities
- (v) it can be established that bush burning was ranking the highest cause of fire hazard in the communities followed closely by the incineration of refuse at disposal point and then arson. However, the list cause as opined by the respondents was the unattended stove and gas cookers then smoking
- (vi) smoke detectors were more in use though not located at strategic points in the PHRC flammable facilities
- (vii) the fire services response at the event of any fire hazard was not efficient as such there tend to be great losses already recorded before the intervention of the Fire service

## **7. CONCLUSION**

From the ongoing the following conclusions can be reached;

- i) Bush burning is the most reoccurring cultural practice in the areas studied that is a major cause of fire outbreaks around PHRC flammable facilities like the PHRC pipe networks. Other practices that possess fire hazard threats include; incineration of refuse close to the PHRC pipe network, electrical fault resulting from illegal electrical connections, and Arson.
- ii) There is a pressing need for PHRC at intervals to sensitize the member of the fire prevention measure and the danger of some practice around the PHRC pipe networks and other flammable facilities.

- iii) There is a need for PHRC to position some indicators to show the position of its pipe network to help the people of the communities identify and consequently guide against fire at such points.

## **8. RECOMMENDATION**

Based on the finding of this research study in the areas of study, the following are recommended:

- i) There should be fire prevention measures enlightenment in those communities as this will help reduces the occurrence of fire hazards as well as combat fire even if it occurs to reduces damages to the minimum before the intervention of the fire service agents
- ii) Because the PHRC employs more of the smoke detector as identified from the respondents it is recommended that such devices be placed as strategic points that fire outbreak or any malfunction that can lead to fire outbreak can easily be sense and guided against
- iii) From the finding it is discovered that bush burning is a major cause of fire hazards in such communities, thus it is recommended that regulations and supervisory committees be set up and empowered to guide against bush burning activities within the communities and around PHRC flammable facilities.
- iv) It was also discovered that incineration of refuse at disposal points was also a great cause of fire hazard, thus it is recommended that such disposal points should be located very far from PHRC flammable facilities or spots that can intercept the flow of combustible pollutants from the PHRC

## **CONSENT**

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

## **DISCLAIMER**

The products used for this research are commonly and predominantly used products in our area of research and country. There is no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but the advancement of knowledge.

Also, the research was not funded by the producing company rather it was funded by the personal efforts of the authors.

### COMPETING INTERESTS

Authors have declared that no competing interests exist.

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