

AN EVALUATION OF FIRE DISASTER SAFETY MEASURE IN SOKOTO METROPOLIS

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ABSTRACT

Fire has been quite critical in the daily life of mankind from time immemorial with its positive and negative impacts. This study is design to evaluate fire disaster safety measures in Sokoto Metropolis. The specific objectives were to determine the major causes of fire outbreak, to assess the level preparedness of the Fire Service Department in fighting fire and to examine the trend of recorded cases of fire disasters. Primary and secondary was used to source data. A Total of 72 questionnaires were distributed to firefighting personnel using purposive sampling technique. Recorded of cases of fire incidents were collected from Sokoto State Fire Service Department from 2000-2017. The result shows that electrical fault account for 96% fire disasters. The major challenges facing firefighters are traffic congestion and road inaccessibility. Data analysis shows that trend of fire disaster is increase on monthly and annual basis at the rate of $Y_t = 20.93 + 0.653 * t$ and $Y_t = 240.2 + 10.1 * t$. The fire service department has adequate fire fighting materials (dry chemical extinguisher) and (Carbon dioxide extinguishers) exist in stations. Moreover public enlightenment is frequently carryout through radio program particularly during dry season. The study recommended that residents should engaged experts in electrical wiring when building house, increases, also public participate more in fire safety training and how to install fire equipment in buildings. The study concludes that disasters are preventable.

Keywords: Level of Fire Preparedness, Fire Safety, Fire Protection Measure, Percentage of Connectivity, Road Network Analysis

1. Introduction

Rapid increase in population and urbanisation with no commensurate improvement and expansion in public infrastructures, have no doubt contributed to the increase in fire incidents and fire-related fatalities in many cities in Nigeria (Johnson, 2011). Thus, the frequency of and severity of fire incidents in Nigeria is becoming worrisome. Chike (2107) reported that incessant fire outbreaks have cost the national economy about #6 trillion in the last five years, with major cities like Lagos, Kano, Port Harcourt, Sokoto and Abuja

seriously suffering the consequences of the scourge. In view of this revelation, the safety of lives and properties, especially from avoidable fire accidents, must now occupy a higher place in the risk management priorities of authority in Sokoto Metropolis. This is the concern of this study.

Basically fire disaster can be broadly categorized in to two; natural and man-made. Fires can be classified into: forest fires, grassland fires, residential fires stash, building fires, industrial fires and mine fires based on

the places where they occur. Urban fire patterns are mainly influenced by the distribution of fuels, weather conditions (temperature and humidity) Liu *et al* (2012), and topography (Falk 2013 *et al* , and Perez *et al*). Human activities have a close relationship with the factors mention above with both positive and negative effects on fire.

According to Swetnam(1993), all fire can be occur either due to natural or man-made reasons, all residential and non-residential structural fires are largely man-made , while industrial and chemical fires occur as result of explosion cause by humans and machine failures. Ismaila (2014) has highlighted some examples of causes of natural fires which include: earthquake, volcanic eruption and lightning while man-made fires include Industrial or chemical fires, fires at social gatherings due electrical short circuit and kitchen-fires. There are numerous factors that cause and contribute to the incidents of fire disaster globally. The causes include: ignition from cooking equipment, carelessness, electrical faults, open flame exposure or ember, air condition fault, child play, and heat sources. Other contributory factors are ambient high temperature, wind speed, high air temperature and low relative humidity. In conclusion there are varied factors that may lead to fire incidents in a densely- populated metropolis like Sokoto

According Drabek, (1986) to protect life and properties against consequence fire disasters, there should be a consensus preparation and change behavior to limit the impact of disaster events. Preparedness is continuous cycles which involve planning, managing, organizing, training, equipping, exercising, creating, evaluating, monitoring and improving several activities to ensure an effective coordination to prevent and mitigate the effects of natural and man-made disasters (Falkenrath, 2001).

Grant, (2012) demonstrated that fire protection is the study and practice of

mitigating the unwanted effects of potentially destructive fires. It involves the study of the behaviour, compartmentalization, suppression and investigation of fire and its related emergencies, as well as the research and development, production, testing and application of mitigating systems. Similarly, Langdon, (1972) contends that when dealing with dangers of fire in buildings we have to contend with two systems which are complimentary, these are fire protection and fire safety systems. Fire protection incorporates active and passive measures. It aims at protecting human life, goods and activities as well as protecting buildings. Passive measures are thus present and operating all the time in a building such as selection of non-combustible materials, subdivision of buildings and ensuring correct ventilation.

On the other hand, active measures involve necessary additions to the services of a building such as installation of alarms and detectors to give a warning of fire and the installation of equipment for fire extinction (Mugure, 1991). Ogajo (2012) add that fire safety is influenced by the availability of firefighting equipment, awareness of resident's, fire protection and prevention measures as well as mitigation measures adopted by various players. Changes in any of the four necessary independent variables are likely to affect levels of fire safety in any given building. Ogajo's conceptual model highlighting fire protection measures is presented in Figure 1. It is seen that the objectives of the model are to reduce the possibility of outbreaks of fire, to provide adequate facilities for fighting and escape of occupants from the building, to reduce the spread of fire within the building and to adjoining buildings and to protect the occupants from the adverse effects of fire losses. Saleh (2015) argues that fire is perhaps is the most threaten factors for human life. Despite precautionary measures that humans

take to control it, fire still occurs in many residential and public building Sokoto metropolis. Fire in residential buildings are attributed to many factors that include, overloaded or poor electrical wiring system,

carelessly disposed smoking cigarette butts, gas leakages, children playing with flammable object pressing ironing, and cooking appliance (Saleh 2015).

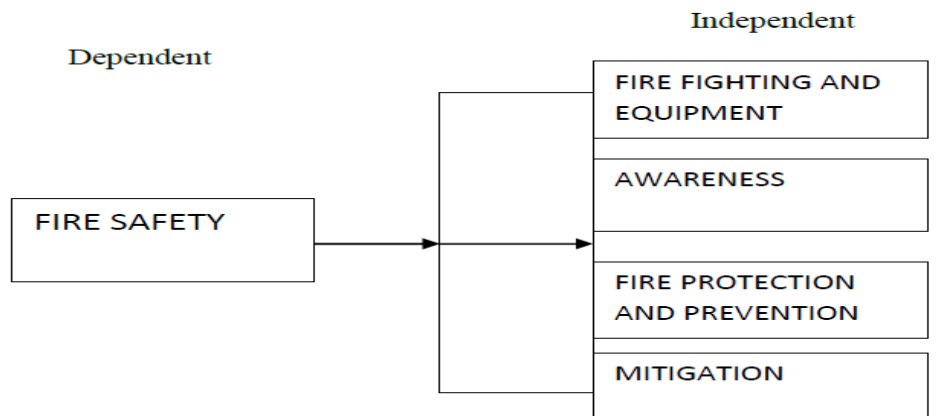


Figure 1 Fire Protection Measure

Source: Ogajo (2012)

According Sale (2015) fire protection should start at the stage of architectural and engineering design phase of any building. A good architectural system can be design to provide the followings, exit way, fire barrier, fire zoning, compartment, and fire-proofing structure. Other mechanical systems that aid in controlling fire include sprinkler, standpipe, horse system, and smoke controlling via ventilation. To protect life existing in residential building it is important provide and maintain the detection system as well as fire alarm warning system. Ogajo's fire protection measure model demonstrated in Figure 1 highlighted that some independent factors determine the status of fire safety in building (residential or otherwise). The first is the availability of fire-fighting equipment ready to be deployed should any case fire erupt, the second is the fire protection and preventive measure that have been installed to prevent fire from starting, the third is the quick awareness of occupants in a building to detect

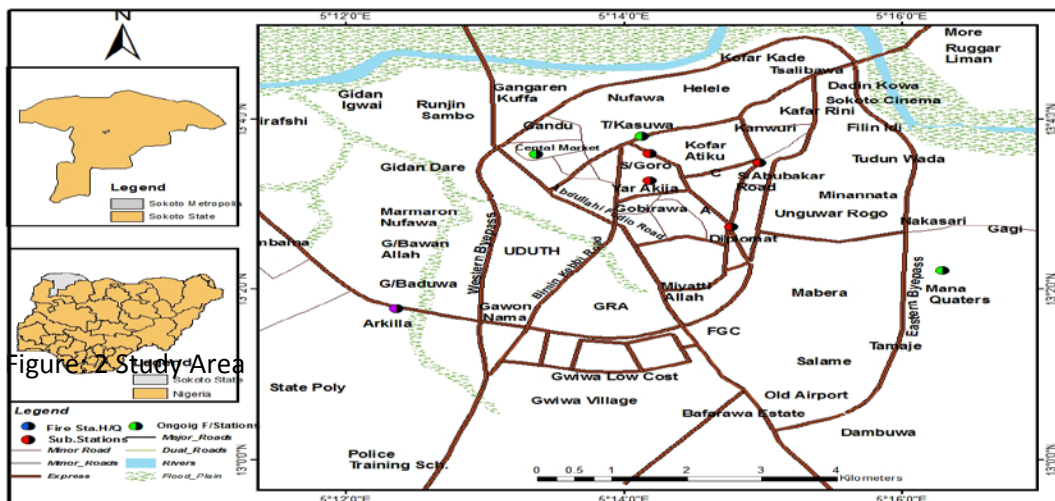
that a nascent fire has started while the fourth is the mitigation measures that fire fighting crew and occupant adopt when fire has started in a building such as occupants running to a muster area.

2. Study Area

Dantuni's (2012) *Appraisal of the Implementation of the Sokoto Master Plan* provides much insight into the Geography of the Sokoto metropolis. The metropolis covers a roughly circular area with a radius of about 16 kilometres beginning from the Shehu Kangiwa Square, Sokoto is located between Latitude 5.13604⁰N to 13.95661⁰ N and Longitude 5.13604⁰E to 5.30231⁰ (See Figure 2). The relief of the metropolis is aproximately 300m above sea level (Ayoade, 1983) The climate of the area is largely Tropical continental north climate influenced by the interactions between two air masses.

The Tropical Maritime air mass originated from the Atlantic Ocean and the Tropical

backup's vehicles each with 30,000 liter capacity and 152 personnels (Muhammed, 2018). The fire stations are spatially distributed across the metropolis in followings areas, Abubakar Road, Shagon Goro, Central Market, Diplomat area, Kofar Rini , Sokoto state Government House and Arkilla the head quarters (SSFSD 2018). Consider the spatial coverage of 16km² radius with population of 552,400 (NPC 2015), one doubts whether 18 fire vehicle are adequate for managing fire outbreaks in Sokoto Metropolis.



Percentage Connectivity (% Connectivity) is determined by the formula:

$$\% \text{ Connectivity} = \frac{\text{Actual (Existing) links of Road}}{\text{Possible (Maximum) links of Road}} \times \frac{100}{1}$$

OR

$$\% \text{ Connectivity} = \frac{A}{P} \times \frac{100}{1}$$

Where $P = n(n-1)/2$, n = number of nodes

4. Presentation of Result

Table 1 shows that majority of respondents 65 (92%) are males while females constitute 7 (8%). The result implies that men are higher in number than female counter part among they fire service personnel in the metropolis this is because the nature of the risk of fire service personnel hindered females from joining the service. Other factors were religion considering the metropolis as seat of caliphate where it is very difficult for most families to allow their daughters to join any paramilitary services. Further analysis Shows 62 (87%) were married while 9 (13%) are single.

Table 1 Marital Status and Gender

		Marital status		Total
		Married	Single	
Gender	Male	57	8	65
	Female	5	1	6
Total		62	9	71

Source: Field work 2018

Table 2 Indicates that majority 56% of the respondents have acquired tertiary education while 43% has secondary school certificate. The result implies that fire personnel in Sokoto state Fire Service apart from the skill they acquired, also have higher academic qualification (Diploma, NCE, and Degree qualification).

Table 2 Educational Background

Level of Education	Frequency	Percentage (%)
Secondary	31	43
Tertiary	40	56
Others	01	01
Total	72	100

Filed work 2018

Table 3 shows the duration of working experience of fire service personnel, some 74% joined service 16 years ago while 17% spent 11-15years in service. This fact clearly indicates that majority of fire service staff have adequately worked for quite a number of years, and hence are in a better position to have adequate information on fire safety and operation.

Table 3: Working Experience.

Experience	Frequency	Percentage (%)
Less than 5 years	02	2.8
6 -10 years	05	6.6
11 – 15 years	12	17
16 years above	53	74
Total	72	100

Field work 2018

Table 4 indicates that out of 72 fire service personnel 94% consider electrical fault is the major cause of fire incidents for reported cases in the metropolis, while 4% attribute it to accident and only 1 personnel mentioned carelessness as the cause of fire incidents. From this revelation between 2000 to 2017 majority of the fire cases recorded in Sokoto metropolis were related electrical faults, the other causative factors are careless attitude of people using electrical appliances followed by accidental causes.

Table 4: Causes of Fire Outbreak

Causes of fire	Frequency	Percentage (%)
Electrical fault	68	96
Accident	03	4
Careless	01	1
Others	0	-
Total	72	100

Field work 2018

Figure 3 demonstrate the period during which fire service personnel carry out routine maintenance of fire safety equipments in public, residential and commercial and buildings. It is seen that 13% of the respondent agreed that it take place on

weekly basis, 41% said monthly basis while 46% said the inspection is carried out annually. The result implies that it takes a longer period of time for check to be carried out by fire service in the metropolis.

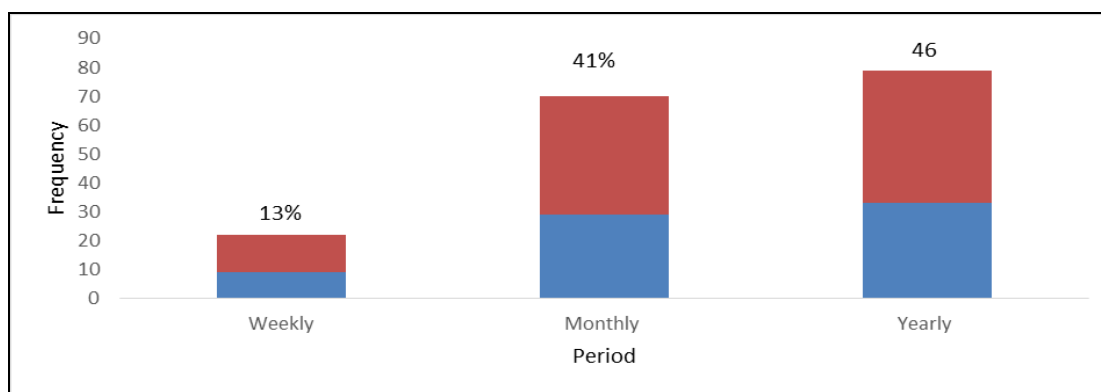


Figure 3 Frequency of Routine Maintenance Check by Fire Service

It is seen Table 5 that 58 (85%) of respondents indicate that fire service communicates through radio for public enlightenment on safety measure, 9% said via television broadcast, 1% said use Newspaper and 4% the use internet on social media platforms as means of information dissemination.

The information implies that of Fire Service major means of public enlightenment is through radio programs. This is because

many people living in both rural and urban areas do listen to radio programmed because it's deeper penetration and ease of access. Further data analysis reveals that the fire awareness campaigns are usually carried annual was revealed by 30 (41%) of respondents, while 29 (40%) them believe that it takes on monthly period. This result could be related with seasonal effect were during dry season the frequency fire cases rises.

Table 5. Mode and Frequency of Public Enlightenment on Fire awareness

Period	Means of public enlightenment				Total
	Radio	Television	Newspaper	Other	
Weekly	9	0	0	0	9
Monthly	23	5	0	1	29
Yearly	26	1	1	2	30
	58	6	1	3	68

Source: Field work 2018

Table 6 demonstrates the challenges fire service personnel face particularly when discharging their duties and responsibly. While 18% attributed the challenges to road accessibility, 51% considered traffic congestion as the hindrance. However, crowd by inquisitive onlooker's and delayed in communication by distressed residents and delay by fire in reaching action areas recorded

14% and 15% respectively. Sokoto metropolis by it location as the meeting point of business men from the surrounding local governments, Kebbi, Zamfara and Niger Republic lead to traffic congestion especially on Fridays. This result implies that when fire service trucks delay in arriving at action area result of traffic congesting and road in accessibility.

Table 6 Challenges Firemen Face During Operation.

Problems encounters	Frequency	Percentage (%)
Road Accessibility (in accessible to action area)	13	18
Traffic Congestion on some specific days	36	51
Poor identification of the action Area	2	2
Crowding by inquisitive onlookers	10	14
Delay in Communication by distressed people	11	15
Total	72	100

Source: Field work 201

Table 7 indicates that 66(92%) of the respondents said dry chemical extinguisher exist, 99% Carbon dioxide extinguishers, 94% of Fire Blankets and 93% agreed the existent of fire hydrant the as part of fire safety equipments. However, the breakdown of non-existing equipment shows that followings were not exist 32% Halon extinguisher, 25% of

sprinklers/house reels and 39% foam cylinders. The respondents confirms the non in existence equipment their stations. From the finding it clearly shows that carbon dioxide, fire blankets and dry chemical extinguisher among other are available in all five functioning fire stations.

Table 7 Fire Fighting Measures

Fire Equipment	Frequency Exist	Percentage (%)	Fire Do Not Exit	Percentage (%)
Dry Chemical extinguisher	66	92		
Halon extinguisher (vaporizing)	05	07	23	32
Foam cylinders	25	35	16	22
Carbon dioxide extinguishers	66	92	01	01
Sprinklers/house reels	17	24	18	25
Wet chemical	25	35	09	13
Fire blankets	68	94		
Any other (specify)	17	24		
Emergency communication system	45	63	13	18
Existence of fire assembly	28	38	06	08
Availability of an emergency fire	38	53		

Existence of Emergency population	27	90	03	40
Existence of a fire hydrant	67	93		
Open spaces for evacuation	49	68		
Existence of a fire Assembly point	40	56		

Field work 2018

Some nine measures were suggested by respondents in order which in order avoid fire disaster: avoid overloading of electrical sockets, avoid smoking at bed time, stop using phones in the kitchen, Provide a thunder arrestor, Keep candles on a candle stand, fuel your generator before not during a football match, put off phones while at the filling stations, people should not be an emergency engineers or electricians when the face malfunctioning of equipment.

The result presented in Figure 4 reveals that the fire cases showing an increasing trend. This implies that, the frequency of the number of fire outbreak in Sokoto Metropolis is generally increasing as reveal by positive trend line equation presented in Figure 4.

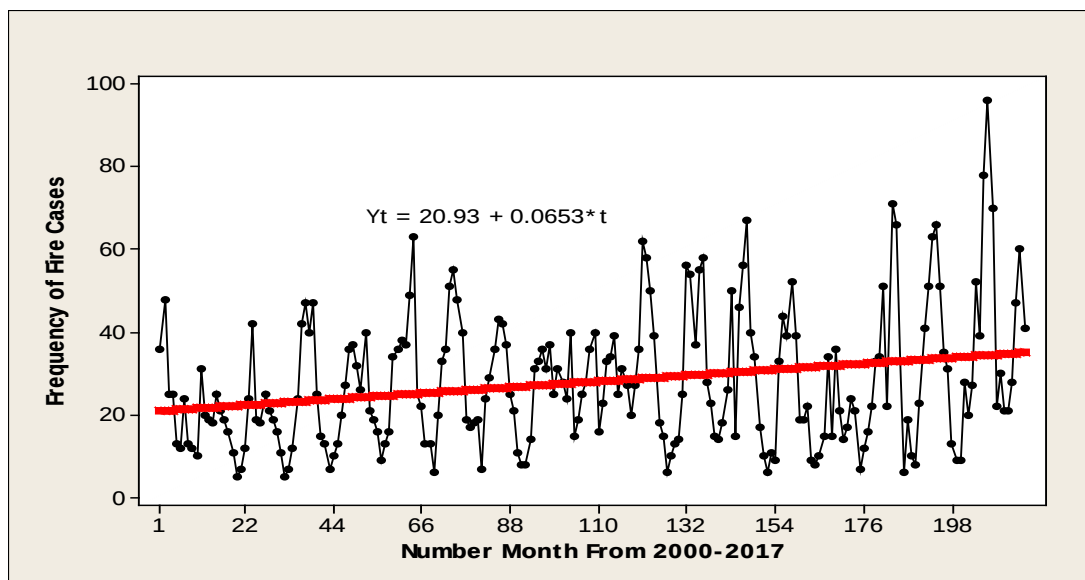


Figure 4 Monthly Trend for reported Fire Outbreaks (2000-2017) in Sokoto Metropolis

Figure 5 shows the annual trend of fire disasters in Sokoto Metropolis. It could be seen from the analysis that the 2013 and 2014 period recorded the lowest number fire outbreak. There was gradual upward movement of the chart particularly in 2015

and 2016 when the outbreak record rose to peak in 2017, obviously the graph show a positive trend over period under study. Thus reveals 2017 recorded highest number fire incidents in Sokoto Metropolis.

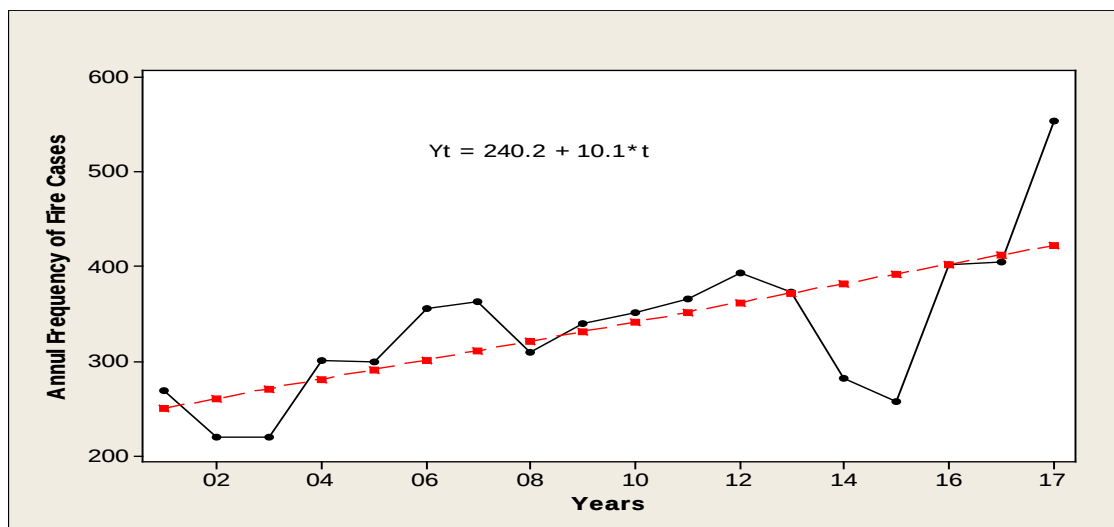


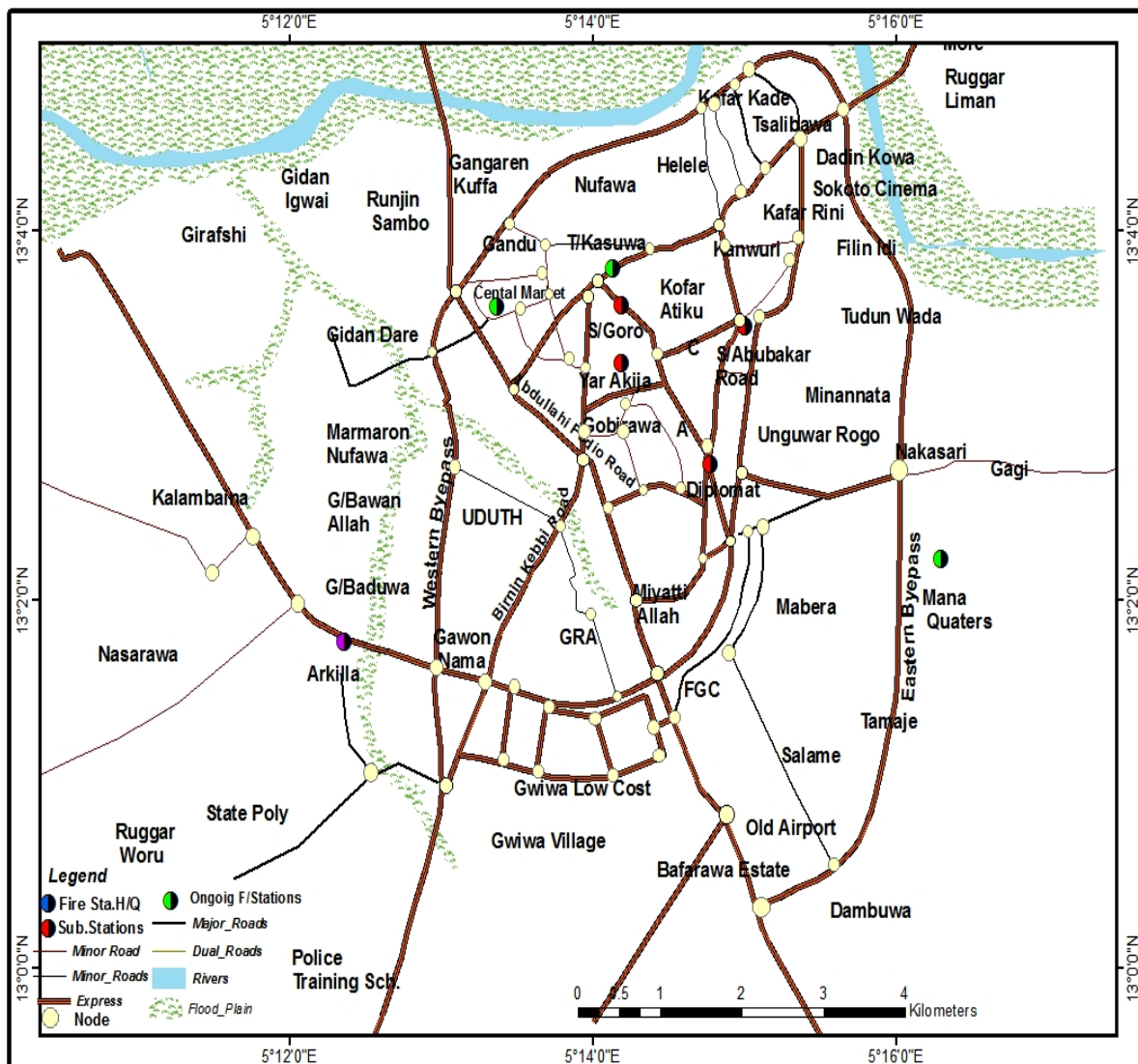
Figure 5 Annual Trend for reported Fire outbreaks 2000-2017 Sokoto Metropolis

The road network accessibility analysis of Sokoto metropolis is presented in Figure 6 . The number nodes and available link of roads were counted and the result is 42 and 72 respectively. The calculation were demonstrated below. The percentage of connectivity within the metropolis was determined using the stated formula in

equation 1, 8.36 % was observed as the connectivity percentage. By implication reveals that the road network connectivity in the study area is very poor. This result is corroborated with the finding in Table 6 were about 18% of respondent attributed to road accessibility as part of the challenges in discharging their duty.

$$= \frac{42(42-1)}{2} \quad p = \frac{42(41)}{2} \quad p = 861 \quad \% \text{ of Road connectivity} \quad \% = \frac{72 \times 100}{861 \times 1}$$

$$\% = 8.36 \approx 8.4\%$$



5. Discussion of Result

The study reveals that Sokoto State Fire Service is equipped with the state of art firefighting equipment as well experienced personnel. The study also reveals that electrical fault is the major cause of fire outbreaks in Sokoto Metropolis, this facts has been highlighted by Ejikeme *et al* (2012) and Ismaila (2014). Globally fire disasters could be either naturally or human activities UN/ISDR (2004). The study observes that most of the recorded cases of fire in Sokoto Metropolis are

human induced and this has been confirm by (Wahab *et at* 2013) that man-induced fires include electrical short circuit accident, kitchen fire, as well as improper storage of fuel and other combustible materials.

In order to reduce the frequency and impact of fire incidents periodic maintenance of fire equipments at residential and public buildings shall carried out. The study confirms that public awareness as part of safety measures against the occurrence of fire as Ogajo (2013) and Brillian *et al* (2016) have

outline. Road congestion emerged as a major challenge to fire men in the study area. This situation could be as result of the city expansion. This findings is in line with John's (2011) observation that incidents of fire are related to increase in population and urbanization. Despite the level public awareness and available equipment the study reveals that between 2000 and 2017 fire outbreaks have been increasing both in monthly and annually. This situation seriously affected means of livelihoods and economy of the state. This finding confirms what Chike (2017) has reported that an increase in fire cases across Nigeria has negatively affected the economy to about ₦6trillion. Finally, the study reveals the problem of poor road network in Sokoto metropolis. This development hinders the movement of firefighting vehicles; information available from SSFSD (2018) indicated that there are only 18 functioning fire tenders and two back up trucks of 30,000 liter capacity. The delay in arrival at the scene increases the catastrophe of fire disaster. These vehicles are inadequate for effective fire-fighting in the age-old metropolis.

6. Conclusion and Recommendations

The study evaluated the fire safety measures present in Sokoto metropolis. The findings show that fire disaster or outbreak in the study area is human-induced not natural. This scenario could be avoided by adhering to the fire safety measures. These measures include: possessing firefighting equipment in homes, public awareness and installing fire protection and prevention measures in home. The study concludes that the duration time taken by the fire service men to respond for any fire incidents is directly related to how quick fire personnel could locate the possible shortest route of the fire scene which depends on accessibility to the affected area. The study recommended that, there is need to inspect the firefighting infrastructure in existence in all the five fire stations in study area. Fire safety measures should be enhanced through fire safety programs, such as emergency procedures/evacuation drills, regular fire safety inspection, maintenance and servicing of fire fighting equipment in order to reduce the frequency of fire outbreaks. There is also need for the increase in the number of firefighting personnel and vehicles in the study area. Finally, the study recommends the government improve the road network within the metropolis for effective management of fire outbreaks particularly in areas that are not accessible.

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