



EVALUATION OF FIRE SAFETY PREPAREDNESS IN SHIRORO HYDROPOWER STATION, NIGER STATE, NIGERIA.

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ABSTRACT

Fire has been a blessing and a curse to humanity. Over time, fire has caused unimaginable destruction to lives, properties and the environment. The study evaluates fire safety preparedness in Shiroro Hydropower Station in Niger State, Nigeria. The study used both primary and secondary data, with a checklist of fire safety preparedness

Introduction

Ensuring a safe working condition for workers and their families is a cardinal objectives that must be achieve to ensure economic growth, welfare and comfortability of the general population.

Fire is a form of a chemical reaction that involves the rapid oxidation of combustible fuel (material) with the subsequent liberation of heat and light (fire safety lecture, 2015). Fire is one of the greatest threats to buildings, facilities, people and the environment because of its ability to cause wide range of damage. Fire is a dominant hazard in the workplace (Ogbonna and Nwaogozie, 2015) Fire safety is an essential component and requirement in building infrastructure plans and provision of fire safety system is mandatory (Sravan, Annapurani, Chandrashekan, Joe and Kalyana, 2016)

Fire safety preparedness is one of the four phases of fire emergency management which is aimed at fire disaster risk reduction. It is a continuous cycle of planning, organizing, training, equipping, exercising, evaluating and improving strategies to



improve effective coordination and enhancement of capabilities to respond to fire disasters (FEMA, 2007).

Fire safety preparedness is an essential aspect in both environmental and occupational safety. Fires being an example of physical hazards have affected many work places and most of them are mainly caused by inadequate strategies in fire prevention, detection and fire control. Effective preparedness entails a good grasp of knowledge and awareness on fire safety issues.

Fire outbreak in constructed facility present risks to humans and their properties (Geraldine, 2015). In recent times, fire disasters has led to destruction of lives, properties and obstruction to production and

equipments to ascertain their availability. 178 structured questionnaires were administered using stratified random sampling of the staff in each section. Descriptive statistics using percentages and frequencies was used to present the results. The findings revealed that the fire safety preparedness level within the station is on a good stand although there is need for improvement. The result shows that the distribution of the preparedness equipments were disproportionate with the power house and administrative blocks having the automated fire safety equipments (98%) while the schools, hospital and the store complex was only provided with portable and motorable (trolley) type of the fire extinguishers (54%), the fire safety vehicles were also kept within the power house complex far away from the schools, hospital and store areas which will delay prompt response to fire emergency in those areas difficult. The study concluded by recommending the Hydropower station management to provide automated heat and smoke detectors in the schools, hospital and store complex. Fire safety truck should also be put on standby close to the school and hospital for prompt response to fire incidents.

Keywords: Preparedness, Fire safety, Fire extinguisher, Hydropower Station, Shiroro



manufacturing processes. Residential fires alone constituted 39.7% of all building fires causing direct damage to properties worth about \$ 48,936,330, about 347 civilian injuries and 853 civilian deaths annually in China (Xing and Huang 2013).

Report released by the United States Fire Protection Agency (NFPA) shows that from 2011 to 2015 the US fire department has responded to an estimated average 358,500 home structure fires per year. The fire also caused an average of 2,510 civilian deaths, 12,300 civilian injuries and \$6.7b in direct property damage per year. These figures show the need for fire safety preparedness and awareness among the users of facilities. The Nigerian story also shows a steady disturbing trend. In the first half of 2018 alone, the country has witnessed series of fire disasters from offices, markets and residential areas. Among them is the Jos main market fire in June, 2017 which leads to the destruction of more than 200 shops. The office complex of Kaduna state independent electoral commission office was also destroyed by fire on 21st of April 2018. The Magodo gas fire explosion on 18th April 2018 killed two with several others injured. The university of Jos library was gutted by fire on 10th October 2016 destroying the entire library complex. On March 1st 2017 fire destroyed part of the Federal College of Education in Gusau, Zamfara state destroying academic materials worth millions of naira. The President of Fire Disaster Prevention and Safety Awareness Association of Nigeria Badanga Ahmed Lamidi said Nigeria has lost more than 6 trillion naira worth of goods to fire from 2013 to 2017. The Kantin Kwari market in Kano was estimated to engulf about 2 trillion naira. This is a serious issue for a developing country like Nigeria.

The fire incident that occurred in Shiroro hydropower plant of 16th September 2009 when fire engulfed portion of the Unit 3 generator which led to the destruction of materials worth millions of naira and a loss of about 150MW of electricity to the national grid . The repairs took about six months engulfing additional funds.

In 2013, the Jebba hydropower station was shut down for about a week before isolation and eventual startup of the unaffected units due to a fire breakout at the section of the turbine leading to loss of power and



several million worth of money. This incident has led to increased action in the handling of fire safety issues in power stations in Nigeria

Other similar fire incidences were recorded within the residential quarters. Available records shows that from December 3rd 2009 to July 2015, Shiroro Hydropower Station has witnessed 12 residential fire incidences with 2011 having the highest frequency of 6 fire accidents destroying and entire residential block beyond repair within the Chas T-Main residential quarters. The study area (Shiroro Hydropower Station) is located between latitudes 9°58'N and latitudes 11° 30'N and longitudes 6° 51'E and longitudes 8° 45'E. Politically, it falls under Kuta district of Shiroro Local Government in Niger state, Nigeria. The study area is 63km from Minna by road. It is bordered to the north by Kaduna State, to the east by Munya local government area, to the south by Bosso local government areas while to the east by Rafi and Mariga local government areas (Abdul-Aziz, 2013).

Shiroro Hydroelectric Power Station is one of the ten federally owned Power stations located within Nigeria. It was concessioned to North South Power Company Ltd (NSPCL) in 2013. It is situated in Niger State, Nigeria. The hydropower station has an installed capacity of 600MW and was officially commissioned on 20th June, 1990.

There are about 15 tributaries of the Kaduna River within the Shiroro watershed, the major among them being rivers Dinya, Sarkin-Pawa, Guni, Erena, and Munya, The tributaries flow in the north south direction and few in the northwest to southeast direction. Some surface hydrology has the problem of low base of rivers. The storage areas do not sustain the river during extended dry season. This explains the seasonally characteristics of these rivers, since they depend on rainfall (AbdulAziz 2013).

The local government is made up of six districts (namely, Kuta, Galadimako, Manta, Gurmana, Allawa and Kushaka districts (Figure 1.1)

Shiroro local government covers an area of 48,000 square kilometers with a tropical climate which belong to the AW of the Koppen system of climatic classification depicting tropical wet and dry periods. Rainfall amount vary between 1100mm in the north to 1600mm in the southern part of the area (Compendium of local government, 2014).



Shiroro local Government has an estimated population of 300,000 people (2006 census projection). Gwari language is the major language spoken while other indigenous tribes such as Bassa and Gurmana are also predominant. Other tribes representing the diverse socio-cultural groups are equally found in this area, e.g the Hausa, Fulani, and Igbo.(Salihu, 2013)

The predominant occupation of the people is farming while other inhabitants earn their living through fishing due to the presence of the Shiroro dam along the Kaduna River. The occurrence of commercially viable mineral resources like gold and Columbite have been proved, while it is also ranked as a major producer of rice, yam, maize, cottons, bean seed, groundnut, millet and guinea corn in the state(Salihu,2013).

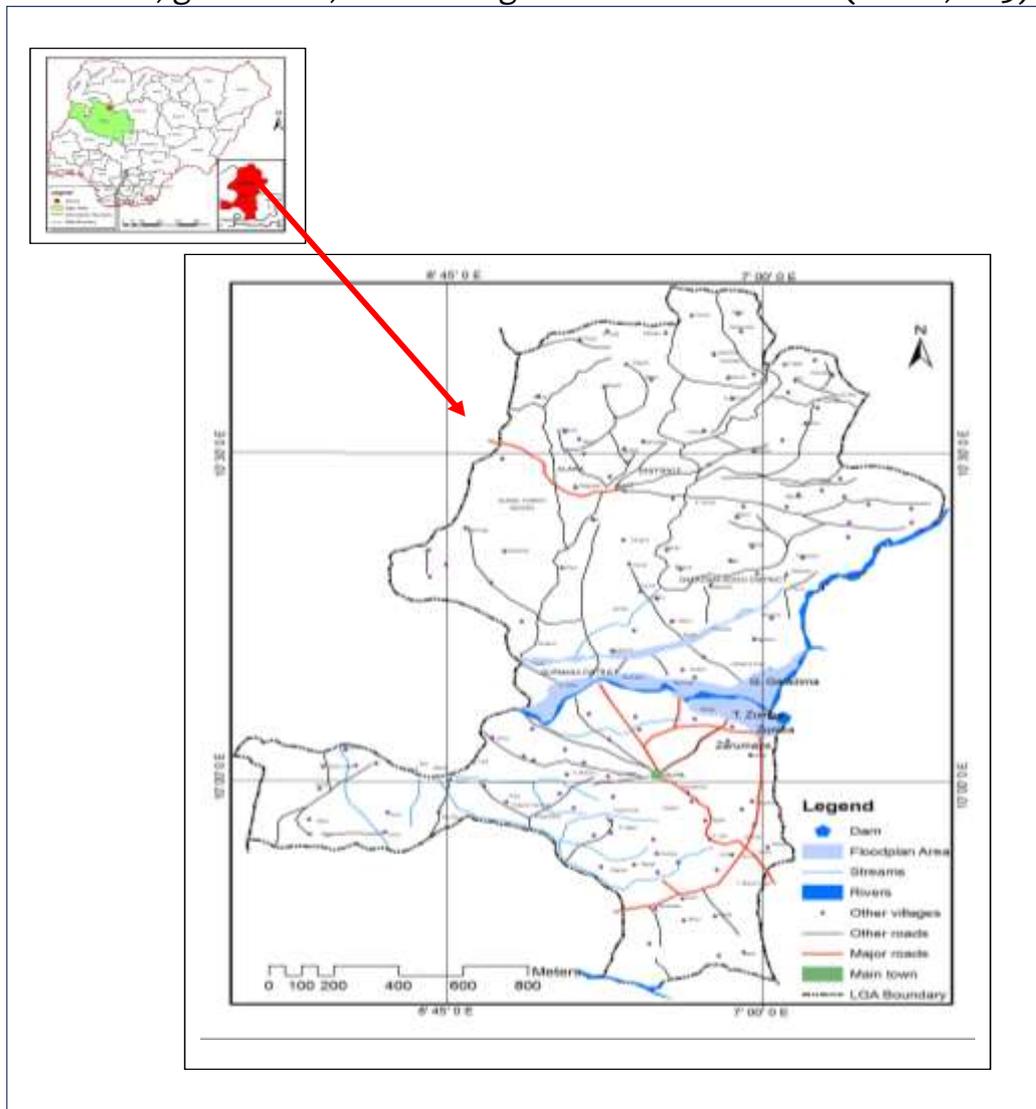


Figure 1.1: Location of Shiroro Local Government Area in Niger State



Source: Niger State Geographic Information System Minna, (2015)

The vegetation of the study area falls under the guinea savannah belt which consists of predominantly tall grasses and trees mostly of economic value such as locust beans and mango trees with shrubs. During the rainy season they are usually green and fresh, but the land is open during the dry season, showing charred trees and the remains of burnt grasses. The mixture of forest and grassland provide habitat for a range of species from large mammals such as African leopard, forest elephants, hippopotamus and antelopes such as the red-flanked duiker to the common tortoise as well as more localized species including patas monkeys and lizards. The wetlands in this region are also rich in birdlife. (Nathaniel 2012)

Conceptual framework and Literature Review

Concept of fire

Fire is the rapid oxidation of a material in the exothermic chemical process of combustion (Wahab, 2015). Addai, Tulashe, Annan and Yeboah (2016) also defines fire as the rapid self-sustaining oxidation process accompanied by the evolution of heat and light in various intensities and that for any fire to thrive, the key elements of fuel; ignition source; oxidizing agent; and the mechanism of reaction must all be present. Fire is widely accepted as one of the greatest threats not only to the occupiers of the buildings but also the building fabrics and the contents therein. Angyekum, De-Graft and Kofi (2016) asserts that fire normally takes place without warning and that when such happens, the building occupants are usually restricted in the amount of time they usually have to either extinguish the fire or to escape.

Fire safety

In order to reduce the risk of lives, injuries and property damage, the science of preventing and mitigating undesirable fire outbreak which is also known as fire safety must be embedded in residential and working facilities (Kobes, Margrethe, Helshook, De Vries and Jos 2010). When fires are not effectively controlled, people may suffer injuries and at times death. Many facilities that were investigated for fire safety issues



were found to be either absent or inadequately provided and in case of fire, serious damages are likely to occur. (Rabaratuka, 2013). The importance of fire safety management have been highlighted by many scholars, notably Chen, Chuang, Huang, Lin and Chien (2012) and John, 2012 among others have highlighted the need for proper understanding and application of fire safety measures in curtailing losses through fire disasters.

Fire Safety preparedness in buildings and facilities

Fire safety preparedness is one of the four phases of fire emergency management which is aimed at fire disaster risk reduction. It is a continuous cycle of planning, organizing, training, equipping, exercising, evaluating and improving strategies to ensure effective coordination and enhancement of capabilities to respond to fire disasters (FEMA 2007) Study by Abdulsalam, Kabir and Arafat (2016) on fire safety preparedness in selected hospitals in Niger state Nigeria shows that preparedness level among the hospitals was very low, especially among the primary, secondary health care services and the private hospitals. The study further reveals that none of the hospitals in Niger state has a comprehensive emergency plan in place. This finding shows the extent to which fire disasters when they occur will be difficult to control. It also means that the likelihood of high casualty is imminent as preparedness level is generally low.

Fire Safety Preparedness Installations and Equipments

Preventing fire is definitely an essential safety objective, even though total elimination of hazard may be difficult. An important aspect of preparedness entails the installation of fire safety equipment to warn or alert the occupiers and to prevent the spread of fire when they occur. Companies use different method for developing preparedness plans depending on the size of the facility, the number of employees and the type of operations. Small companies (such as beauty salons or medicine stores) might have relatively simple plans whereby the company owners tells the employees where the exits are located, what the alarms sounds like and which emergency numbers to use. In contrast, employees in



large organizations, with multiple sites, greater variability in operations or large number of employees(as seen in the oil and gas industry) may develop complex preparedness plans that covers all type of facilities.Murage, (2012) stressed that one of the cardinal objective of installing fire prevention equipments in buildings is to alert the people within the premises of an impending fire hazard, and also helps to out rightly fight the fire when it occurs. They added that fire safety measures installed in buildings may incorporate;

- i. Detectors and alarm systems to help notify individuals to evacuate the building due to an impending fire hazards.
- ii. Installing automatic sprinkler systems that help in fighting the fire in the event of its occurrence. This gives the occupants in the facility an added time to help discover the fire place and take necessary action.
- iii. Using flame resilient materials in the floor and walls so as to lessen or stop the spread of fire when they occur.

Hashimu (2014) also stressed the need for installation of fire preparedness equipments in structures. The researcher listed some important equipments to include; Sprinkler systems, drenchers, hose reels, hydrants, form installations, gas extinguishers, smoke detectors, heat detectors, smoke extraction and ventilation, portable fire extinguishers and pressurization of escape routes. The importance of using installed fire equipments in buildings has helped tremendously in reducing fire damage within facilities. Research by Makushita (2013) on high rise buildings shows that the buildings have no fire escape route, no proper signs to direct people to safety, no fire hydrants and fire extinguishers and the buildings are not equipped with smoke detectors and fire alarm systems. Geraldine (2015) have stressed the importance of installing heat and smoke detectors, sprinklers and fire alarm systems which serves as early warning and mitigation systems during fire and that lack of smoke detectors in buildings of public use is a major concern as smoke related injuries and deaths far outnumber fire related injuries and deaths in ratio four to one.



Research Methodology.

The methodology of this research was examined under the following subheadings; reconnaissance survey, data types and sources, sampling size and sampling techniques, data analysis and presentation.

Reconnaissance Survey

A reconnaissance survey of the study area was done in order to ascertain the real problems peculiar to the area. This survey provides a framework for identifying fire hazards in the area. Vital and useful information or data on fire safety protection facilities were checked during such visit.

Data Type

The research used two data types; the primary data and the secondary data

Primary Data

The primary data includes data from reconnaissance survey and administration of questionnaire. The reconnaissance survey entails visiting the study area and acquainting oneself with the fire safety preparedness knowledge and awareness measures in Shiroro hydropower station.

Secondary Data

The secondary data entails the use of existing literature related to the topic from journals, textbooks, unpublished studies and other printed media covering the topic of interest.

Data Sources

The research uses data from the fire safety department of Shiroro hydropower station, data from past studies related to fire safety, textbooks, information from journals, pamphlets, magazines, printed researches and online sources. Other data source for the research included data obtained through observation during reconnaissance survey and information obtained through the administration of questionnaires.



Sampling size and sampling techniques

The research populations were the staff of Shiroro hydropower generation managed by NorthSouth Power Company Ltd. The staff strength as at August 31st 2018 was 319.

For convenience, the study used a sampled population from the total population; the sampled size was obtained by using the Yamani (1967) formula

$$n = \frac{N}{1+N(e)^2} \dots\dots\dots (1)$$

Where

n= sample size

N=319 (total population)

e = significance level (put at 0.05%)

$$n = N/1+N(e)^2$$

$$n = 319/1+319(0.05)^2$$

$$n = 319/1+319(0.005)$$

$$n = 319+0.7975$$

$$n = 319/1.7975$$

$$n = 177.5$$

$$n = 178$$

A total of 178 respondents (staff) were sampled and administered with questionnaires. Of the 178 questionnaire 174 were successfully filled and processed while 4 were not submitted giving the total number of respondents to be 174.

The 178 structured questionnaires were administered through stratified random sampling techniques where each of the five sections were assigned base on their population strength. The Power house complex with 138 staff has 79 respondents, the schools with 56 staff has 31 respondents, the administrative block with 39 staff has 20 respondents while store and hospital with 37 and 49 staff has 18 and 26 respondents respectively.

Data Analysis

The information obtained from the administered questionnaires were analyzed using descriptive statistics where charts, simple percentages, graphs and frequencies were used to present the results. The Statistical Package for Social Sciences (SPSS) was used to present the results



Results and Discussion

Evaluation of Fire Safety Preparedness

In evaluating the preparedness level of the station, the necessary preparedness equipments are tabulated and presented in table

The results shows that virtually all the different sections of the station sampled have been equipped with portable fire extinguishers. This can be affirmed during the reconnaissance survey.

The result shows that 46% of the respondents have trolley or mounted fire extinguisher which can be move around during fire emergencies. The trolley or mounted fire extinguisher contains more fire extinguishing reagents and is useful where fire spreads fast with content more than 10kg to more than 150kg or more depending on the need. 56% of the respondents said their workplace doesn't have the trolley fire extinguisher giving an indication that the spread is not even. 1% said they are not sure whether they have it or not. (Table 1.1).

Table 1.1 Availability of Fire fighting Installations in the Station

Fire Safety Preparedness Variable	Available(% Yes)	Not Available(% No)	Not sure(% unsure)
Portable fire extinguishers	100	0	0
Trolley mountedextinguishers	46	53	1
Smoke detectors	38	60	2
Heat detectors	32	60	8
Sprinkler systems	2	38	60
Hose reel	32	63	5
Escape route/ exit	76	13	11
Functionality of escape route	68	6	26

The result on the availability or otherwise of smoke detectors shows that a larger percentage of the respondents (60%) don't have smoke detectors in their workplace (Table 1.1). Only 38% affirmed the installation in their workplace.



Smoke detectors are very important in detecting fire onset usually at the initial period before it spreads or becomes larger and destructive. Places with smoke detectors have the added advantage of responding immediately to fire curtailing damages that it may cause if allowed to degenerate.

The results also shows that majority of the respondents don't have heat detectors in their workplace. Only 32% of the respondents have heat detectors as against 60% and 8% that don't have it or are not sure respectively.

Heat detectors usually alert building occupiers and users of high temperatures that may lead to ignition and has been a very important preparedness installation especially in electrical and mechanical areas where machines are electrically powered.

Results on sprinkler systems shows that only 2% said it's available in their workplace with the majority (60%) saying they are not sure while 38% said they don't have sprinkler system in their workplaces. The sprinkler systems are usually pipes with nozzles that spray water and chemical in fire emergency situations. They are usually equipped with automated sensors that detect ignition temperatures. They automatically start sprinkling water on the surfaces to deter the spread of fire within the area.

Results on the availability or otherwise of hose reel shows that only 32% of the respondents have hose reel systems in their workplaces. 63% of the respondents said hose reel systems are not available in their workplaces while 5% said they are not sure whether available or not. The hose reel system usually consists of pumps, water supply, pipes and hose reels located strategically within a building complex. It is usually manually operated and activated by opening a valve enabling the water to flow in to the hose that is typically 30m away.

Result on the availability of escape route within the workplaces shows an encouraging figure of 76% saying they have escape routes or exit routes in their working places with only 13% saying they don't have while 11% said they are unsure of its availability. Escape routes must be available in workplaces to provide alternate routes for people to evacuate safely during emergency situations. A visit to the station store revealed that only one entrance is available which will be very difficult for people to evacuate during emergency situations. On the functionality of the escape routes, 76% of the respondents said their workplaces have functional escape routes while 16% said their escape is not functional



while 16% said they are not sure whether its functional or not. Similar visit to the school shows an abandoned exit route outgrown by bushes that cannot allow the gate to open. The exit gate is also locked and when a staff was asked on where such keys are kept, he replied on the negative meaning he doesn't know who is in possession of the key.

The functionality of escape routes are also important, most a times the escape routes may be provided in the workplace but its functionality may be a problem. This can be as a result of obstruction with other materials or it may be locked or improperly labeled. Escape routes must be functional and accessible at all times within the working hours.

Conclusion

The study examines the level of fire safety preparedness in Shiroro Hydropower station in Niger state. The findings of the research showed that fire safety preparedness within the hydropower station is adequate although there is room for further improvement. The availability of fire preparedness installation was not evenly distributed. The hydropower complex (Power house) has more preparedness installations followed by the site office, hospital, the schools and then the store complex. This can be attributed to the importance of the power house as the main engine room of electricity generation and the site office as the administrative headquarters that controls the activities of the station.

The study further revealed that the hospital, school and store complex were not equipped with detectors and sensors either as heat detector, smoke detector or fire alarm systems which will help during fire emergency. The school, due to the high number of pupils and students will require such facilities to help control and reduce risk associated with fire when it occurs.

References

- Abdul-Aziz, D. (2013). Description of Shiroro Power Station and plant Status as at 2013. Unpublished paper. Public Relations Office, Shiroro Dam.
- Abdulsalam, A. Kabiru, R. & Arafat, S.M.Y. (2016). Assessment of Fire Safety Preparedness in Selected Health Institutions in Niger State. *International Journal of Perceptions in Public Health*1(1)50-58
- Addai, E.K., Tulashie,I..S., Annan,J. &Yeboah,I.(2016). The Trends of Fire Outbreaks in Ghana and ways to Prevent these Incidences. *Safety, health and Work Journal*. Available at www.e-shaw.org
- Angyekum, K. Joshua, A & De-Graft, J.O. (2016). Fire Safety Awareness and Management in Multi-Storey Students Hostels. *Asian Journal of Applied Sciences*. 4(02). 112-119/ 2016



- Chen, Y.Y., Chuang, Y.J., Huang, C.H., Lin, C.Y. & Chen, S.W. (2012). The Adoption of Fire Safety Management for Upgrading the Fire Safety Level of Existing Hotel Buildings. *Journal of Building and Environment*. 51,311-319,2012
- Compendium of Local Governments in Niger State (2014). Sonic Printers Ltd.
- Federal Emergency Management Agency, FEMA (2007). National Preparedness Guidelines. Washington DC. Department of Homeland Security.
- Fire Safety Lecture, (2015). Downloaded at www.kau.sa/subjects
- Geraldine, J.K. (2015). A Study on the Awareness of Fire Safety of Shopping Malls: The Case of Mlimani City and Quality Centre in Dar es Salaam. *Journal of Engineering and Architecture* 9(2015)1415-1422.
- Hashimu, G. (2015). Fire Safety Awareness and Preparedness among Market Traders in Engr. A.A. Kure Market and Gwari Market, Minna. Niger State, Nigeria. Unpublished project, Federal University of Technology, Minna.
- John, M. (2012). Assessment of Fire Safety and Evacuation in Nursing Homes. *Journal of Food Science and Environmental Health*.
- Kobes, M. Helshoot, I. De Vries, B. and Jos, J.P. (2010). Building Safety and Human Behaviour in Fire: A literature review. *Fire Safety Journal*, 45,1-11.
- Makushita, Y.D. (2013) A study of the Awareness regarding Fire Safety Measures among 20 Residents lives in High-Rise Buildings of Anand City. GUJ; *International Multidisciplinary Journal of Applied Research* 1(4):8-48
- Murage, J.G. (2012). Factors Influencing Fire Disaster Preparedness in Central Business District of Nyeri Town, Nyeri County, Kenya. Unpublished Thesis, University of Nairobi, Kenya
- Nathaniel, O. A. (2012). "Spatio-Temporal Analysis of Land Use/Cover of Lokoja – A Confluence Town". *Journal of Geography and Geology*, 41. Retrieved on 4th July 2014 from <http://dx.doi.org/10.5539/jgg.v4n4p40>
- Ogbonna, C.I & Nwagozie, I.L. (2015). Fire Safety Preparedness in Work Places in Portharcourt, Nigeria. *International Research Journal of Public and Environmental Health*. 2(8),112-121.
- Rabaratuka, I.A., (2013). Investigation of Provision of Fire Safety Measures in Building in Dar-es Salaam. *International Journal of Engineering and Applied Sciences*. 4 (4)40-5
- Salisu, I. (2012). Nigeria; Evening Fire Destroys Textile Materials at Kano Kantin Kwari Market. Leadership Newspapers at www.leadership.ng/17/10/2012
- Sravan, K.Y. Annapuri, R, Chandrashekhar, J. Joe, J. & Kalyana C.P. (2016). Assessment of Knowledge and Attitudes of Fire Safety- An Institution Based Study. *Journal of Pharmaceutical Sciences and Research*. 8(11)321-325.
- Wahab, A.B. (2015) Evaluation of Fire Management Practices in Selected Restaurant Buildings in Oshogbo, Nigeria. *Journal of Multi-disciplinary Engineering, Science and Technology*. 2(9), 2391-2396.
- Xing & Huang C. F. (2013), Fire Risk Assessment of Residential Buildings Base on Fire Statistics from China. *Fire Technology* 50_1147-1161 (2014). DOI: <https://doi.org/10.1007/510694-013-0327-8>