

Planning for Firefighting Service Facilities in Zaria Urban Area, Kaduna State, Nigeria

¹Fidelis C. Duchi and ²Kabiru M. Wadanda

¹Department of Urban and Regional Planning, Ahmadu Bello University, Zaria

²Department of Urban Affairs, Abuja Metropolitan Management Council

Corresponding Author: wadandakabiru@gmail.com

Abstract

Firefighting service is one of the basic necessities in securing urban environment. The idea of this study is to make a planning proposal for firefighting service facilities in Zaria Urban Area with a view to suggesting suitable planning recommendations for improvement of firefighting service facilities. Data were collected through both primary and secondary methods. Analysis of spatial data was carried out using ArcGIS software which help to support planning decision regardless to preparedness, mitigation, response and general management of fire service within the study area. The success of firefighting service depends mainly on the speed of the fire engines reaching the scene of a fire incident and the performance on field to reduce losses to a minimum ratio. The Study suggests a service radius of 2 km to 3km at a speed of 30 km/hr and a response time of 4minutes and 6minutes respectively. Individuals and communities are target audience to be train on how to tackle emergency cases at home and place of work. Findings revealed that there is inadequacy of firefighting service station, water hydrants, basic equipment and manpower, poor access road, low level of private sector participation, poor communication system, inadequacy site coverage and negligence of planning authority in the provision of firefighting service facilities that will support fire service operations. A total of three fire stations were proposed to ensure effective delivery of service. The study also recommends including the provision of water hydrant, establishment of fire service training school, communication gadget/facilities, rehabilitation and construction of roads, provision of watch towers in existing and proposes fire service stations. All these are in view of achieving effective and sustainable firefighting service delivery in Zaria Urban Area.

Keywords: Facilities, Firefighting service, Safety, Station

INTRODUCTION

The frequency of disaster and loss of life and property caused by disaster are rising constantly because of the increase in human population, destruction of nature, unconscious urbanization and technological development (Alaxander and Demir, 2010). Urban fire, a type of disaster, is one of the many problems faced not only by developing countries but also developed countries. This disaster has caused unimaginable loss of lives and property worth billions of dollars worldwide. It has also had negative effect on investment and national economy at large. Fire disaster is to be managed by the fire service so as to reduce its adverse effect. Fire disaster has evolved into one of the greatest human tragedies. Unfortunately, the disaster has unusually claimed high number of lives and property of people around the world. Marchant (2000) pointed out the objectives of fire safety as life safety; the protection of the contents of a building; the protection of the

building fabric and the minimization of threat to the environment. Achieving fire safety in the built environment requires contributions from a number of organizations and during the operational stage building should be maintained and operated in accordance with the effective fire safety planning (Wang, Marden and Kelly, 2011)

The mission of the fire service is to protect life, property, and natural resources from fire and other emergencies. With increasing demands, the fire service must utilize the best tools, techniques, and training methods to meet public expectations. Risk management, preparedness, and mitigation have taken on new importance with challenges facing fire departments today. One emerging tool that is helping the fire service optimize emergency services delivery is geographic information system (GIS) technology. Abbas s. Jaber and Sajad K. Wanas (2018) carried out research on assessment and development of the spatial coverage of fire

service in Nasiriyah city by using geographic information systems (GIS). The recent rapid increment in population growth and in the urban area of cities requires the evaluation of the fire service within cities from time to time as it is concerned with the protection of the population and their private property and the protection of state property. The success of fire service depends mainly on the speed of the fire truck reaching the scene and the performance on field to reduce losses to a minimum ratio.

PROBLEMS AND CHALLENGES OF FIRE SERVICE AGENCIES ACROSS NIGERIA

From time to time, various fire incidents test the capacity of fire service agencies across states of the country. The capacity of these fire service agencies to combat fire disasters basically depends on the funding got from their respective state governments. However, across various states, there are issues of shortage of personnel, inadequate fire fighting vehicles, no insurance for staff, lack of modern firefighting equipment, poor maintenance of facilities, lack of personal protective equipment, lack of training and retraining of personnel. Fire service personnel are also faced with attacks from people who decry that the fire service usually turns up late to scenes of fire disaster. But, fire service personnel have, in defence, pointed to failure of people to quickly inform them of fire outbreaks, clogged roads, poor road network, usual traffic build-up as delaying their movement to fire incident scenes and careless attitude of people to safety. Meanwhile, the readiness of states to respond to fire incidents differs from state to state (Olakunle, 2022). <https://tribuneonline.com/how-several-challenges-affect-states-capacity-to-tackle-fire-disasters/>

Zaria Urban Areas is characterized by a number of social, economic and cultural activities. These activities as they existing space have some form of threats as they relate to urban security in Zaria. There have been several fire out breaks in Zaria urban area like fire outbreak timber market (Yan Katako) market fire incident (2014): No fewer than 300 shops were destroyed due to outbreak of fire at Katako market, Sabon gari Zaria, Kaduna. The fire lasted for about five hours before was put out by the fire fighters. The fire was caused by electric spark which subsequently engulfed the market, good worth millions of naira were lost in the

incident. Premium times (2014), Reference laboratory centre fire outbreak (2018): An inferno razed down multi-million naira in Reference laboratory centre at national tuberculosis and leprosy training Centre (NBTL) in Zaria Kaduna state. The burnt reference Centre is one of the best in Africa fully equipped with function facilities for the best of HIV, leprosy and malaria among other diseases. The fire which lasted for about three hours was later brought under control by fire fighters. Vanguard (2018) Dan-Magaji filling station fire outbreak (2013): At least nine people were dead following a fire outbreak at filling station located along Kano-Kaduna express way, Zaria Kaduna state. The fire started when the petrol tanker was off-loading fuel at the station late in the evening, all effort of people around the area to put off fire before it escalated yielded no desire result. The rescue operation involved firemen, the police, Nigerian security and civil defence corps officials as well as Islamic first aid groups. NAN (2013) ABU site II staff quarters fire outbreak (2016): A bursary staff of Ahmadu Bello University (ABU) Zaria was killed alongside his wife and two children in fire disaster. The four family members were burnt by the fire, which broke out in their house at ABU site II staff quarters, along the Zaria-Sokoto Road. The fire was caused by electrical fault.

According to Daily trust (2016) all these fire incidence affect lives and properties and rendering some people homeless. Some reasons that could be responsible for this fire outbreak include inadequate fire service facilities, poor accessibility to some structures, poor firefighting inadequate water supply and host of others. Therefore, this research makes a planning proposal for fire service facilities in Zaria urban area. While this study reviews the concept, principles and standard for the effective provision of fire service facilities in urban areas, the study was guided by the following objectives; to examine the existing fire service facilities in Zaria Urban Area; to examine the challenges of fire service stations in Zaria Urban Area; to make planning proposals and recommendations.

Geographical Location

Zaria Urban area is located between latitude 10°57'36''N and 11°15'32''N and 7°39'00''E and 7°53'02''E. the urban area is made up of it Sabon Gari and Zaria local government

areas and some parts of Giwa Local government area like Shika about from Ahmadu Bello University main campus, Samaru. Zaria Urban Area is bounded by Kudan to the North, Igabi to the

South, Soba to the East and Giwa to the West. Zaria is about 26 km from Kudan, 50 km from Igabi, 40 km from Soba and 29 km from Giwa.

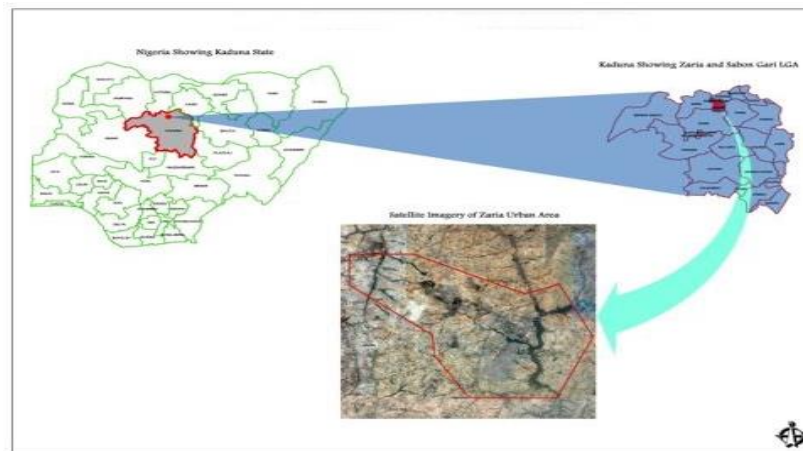


Figure 1 Kaduna Showing Zaria and Sabon Gari Local Government.

MATERIAL AND METHODS

Buffers and network analysis around geographic feature so as have uniform distance or radius from the geographic feature. For the purpose of this research, the Nigerian standard Network analysis uses the road network of the cities, towns or district to solve common network problems, such as finding the best route across the urban area, finding the closest emergency vehicle or facility, identify service area around a location. In this study both spatial and attribute data are required to carry out this research. Spatial data like the satellite image, land use maps are used, and attribute data such as population and road hierarchy. Analysis of spatial data will be carried out using ArcGIS software which will help to support planning decision regardless to preparedness, mitigation, response and general management of fire service within the Urban Area. The study covers service area analysis which was made on the available network data set. These operations are necessary to determine the proximity of the areas or location that fire service can reach a certain time frame travelling at the same speed of their fire trucks.

THE FIRE SERVICE

Fire service is an organization charged with the responsibility of responding to fire incidences and other related emergencies. The fire service dictionary defines fire service as organized fire

prevention, fire protection, and firefighting services. In other words, fire service is defined as an organization for preventing and extinguishing fires. The Oxford dictionary (1980) defines fire service as an organization of people who are trained and employed to put out fires and to rescue people from fires. Fire Service facility is a system that has structure and process. The administration of fire service facilities as a system involves management of such facilities, staff personnel, properties, funds, and environmental relations. Management of fire service facilities is very important aspect of environmental management and therefore a very vital area of fire service administration.

Fire Safety

Fire safety refers to fire prevention, limiting the spread of fire and smoke, extinguishing a fire and the chance of a quick and safe exit (Kobesetal., 2010). As described by Hassana in (2006), fire safety is the reduction of the potential for harm to life as a result of fire in buildings (CWC, 2000 cited Hassanain, 2006). Hence, fire hazards with numerous casualties generally raise questions about the safety requirements in buildings with the type of occupancy levels that there were in the property wherein the fatal fire occurred (Kobesetal., 2010). Moreover, Porter (1990) stated that in order to achieve the highest fire safety level in a building, it is necessary to have a greater reliance on what are

known as active fire safety systems such as automatic sprinkler systems, smoke detection systems and smoke control systems.

The consequences of poor fire safety practices and a lack of emergency planning are especially serious in properties where processes or quantities of stored materials could pose a serious threat to the community and environment in the event of fire hazardous

RESULT AND DISCUSSION

Fire Service Station in Zaria Urban Area

ABU fire Service Station Samara Campus: it is an institutional fire service station and it is located within the premises of ABU, main campus samara. It is expected to serve the entire university community and the environs, but it is not mandatory for it to expand its service operation outside the university community.

Federal Airport Authority of Nigeria (FAAN) Fire Service Station: it is an institutional fire service station and it is located within the premises of the Nigerian collage of aviation technology (NCAT) located at Pallada. It is also under national emergency management agency

(NEMA). Its function is to maximize security and safety for aircrafts taking off and landing

ABU fire Service Station Congo Campus: it is also an institutional fire service station and it is located within the premises of ABU, Congo campus. It serves the entire Congo campus and environs. Although, it is not mandated to expand its services outside the university community.

Zaria fire service station: it was located at Tudun-wada district along Kaduna Road and bounded by Zaria walled city and Tudun-wada settlement. It also characterized by traffic running from Jos Road to Kaduna Road. It is the only public fire service station in Zaria and is expected to serve the entire urban area.

Zaria fire service station is charged to reduce loss of life, injury and property damage caused by fire and other emergencies; reduce the number and chance of fire outbreak by providing public enlightenment on the need to be conscious and careful in relation to fire and other emergencies; minimize impact on environment in case of fire and other emergencies; and ensure a safe system of work at all time.

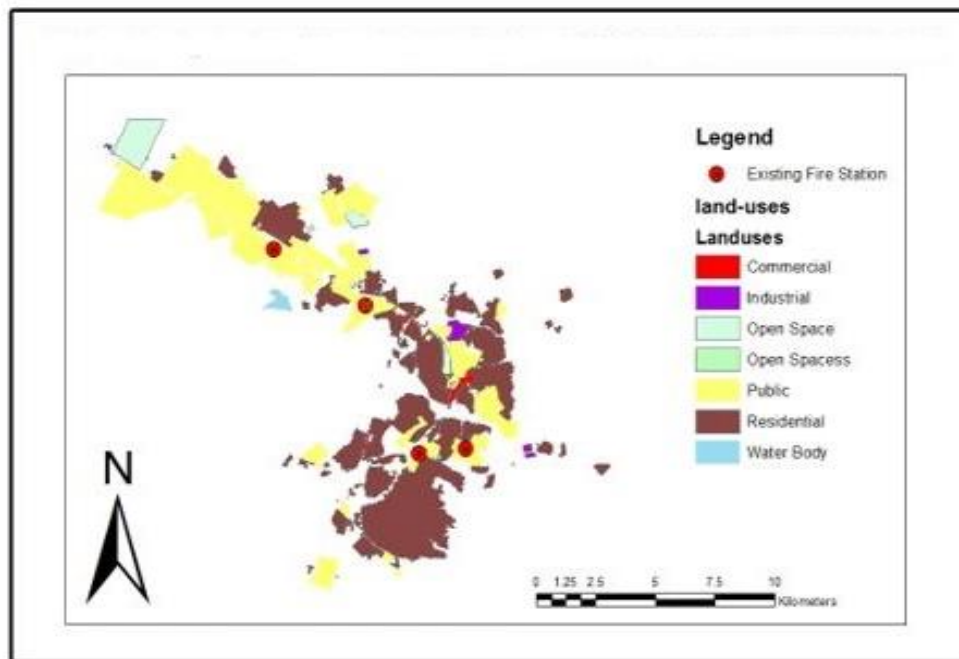


Figure 2 Existing Fire Stations.
Source: Field Survey

Table 1 Fire service station, type, and their location

S/N	NAME OF FIRE SERVICE STATION	TYPE OF FIRE SERVICE STATION	LOCATION OF FIRE SERVICE STATION
1	ABU Fire Service Station	Institutional	Samaru
2	FAAN Fire Service Station	Institutional	Palladan
3	ABU Fire Service Station	Institutional	Congo
4	Zaria Fire Service Station	State/public	Tudun-wada

Facilities at Existing Fire Service Stations in Zaria Urban Area

Tables 2 Shows the Detail of Equipment/Facilities Required by Standard and Shortfall where by it depict that more fire personal and equipment are required to fill in the gap by the said study areas, Ahmadu Bello University Main Campus Fire

Service Station, Federal Airport Authority of Nigeria Fire Service Station, Ahmadu Bello University Fire Service Station Congo Campus, Zaria Fire Service Station so as to cocktail any fire incidence that might arise within and outside the environment.

Table 2 Facilities at Fire Stations in Zaria

EQP/FCL	F/S ABU ZARIA			F/S FA A			F/S ABU CONGO			F/S Zaria		
	RQ	STD	SHF	RQ	STD	SHF	RQ	STD	SHF	RQ	STD	SHF
Fire engine	2	6	4	2	2	0	2	2	0	6	6	0
Water tanker	0	2	2	0	1	1	0	1	1	0	2	2
Ambulance	0	2	2	0	1	1	0	1	1	0	2	2
Chemical powder truck	0	1	1	1	1	0	-	-	-	0	1	1
Personal	16	64	48	19	15	0	26	15	0	30	64	34
Hydraulic ladder	2	0	2	0	2	2	0	2	2	0	2	2
Hydrants	3	18	15	10	25	15	4	12	8	2	40	38
Fire blanket	12	3	9	2	12	10	5	12	7	3	12	9
Towing van	0	2	2	0	2	2	0	2	2	1	2	1
Host	5	36	31	10	12	2	8	12	4	27	36	9
Watch tower	0	1	1	0	1	1	0	1	1	1	1	0

Table 2 presents details of equipment/facilities Required (RQ) by Standard (STD) and Shortfall (SHF) for any fire incidence that might arise within and outside the environment.

Population Analysis

According to the Nigerian standards on population, a fire station should be available for every 50,000 inhabitants. However, by exploiting the population

characteristics, the population of Zaria urban area is 698348 according to 2006 National Population Commission and by applying the equation below (the formula for computing the population growth rate), the current population (for 2020) can be estimated for Zaria urban area as follow:

$$Po = PT (1+r)^n \tag{1}$$

Where:

PT: The population's approximate number in the study year (2020).

Po: The population's actual number in the latest census year (2006).

r: The population growth rate.

n: Number of years between PT and Po

Nigeria and especially Zaria Urban Area, $Po = 962673$. Thus, the number of the fire stations should be provided in Zaria urban area for year 2020 is 19, and this number is also large. On the other hand, the spatial coverage criteria that are mentioned in Nigerian standards, assume a service radius 2km from residential areas and 1.6km from office and commercial areas.

By adopting the expected population growth rate (2.5%) for the years after the previous census of

Table 6 Population analyses in placement of fire station in Zaria urban area

NO	LOCAL GOVERNMENT	POPULATION	PROJECTED POPULATION	FIRE STATION BASED ON POPULATION STANDARD	SHORTFALL OF FIRE STATION
1.	ZARIA	406,990	561,040	11	9
2.	SABON GARI	291,358	401,637	8	6
	TOTAL	698,348	962,677	19	15

Buffer Analysis

Buffers are zones of influence around geographic features; usually buffers have uniform distance or radius from the geographic feature. For the purpose

of this research, the Nigerian standard proposed by Uloko and ogbonna (2005) of locating a fire service station within the 2km radius in residential areas and 1.6km for commercial areas is adopted.

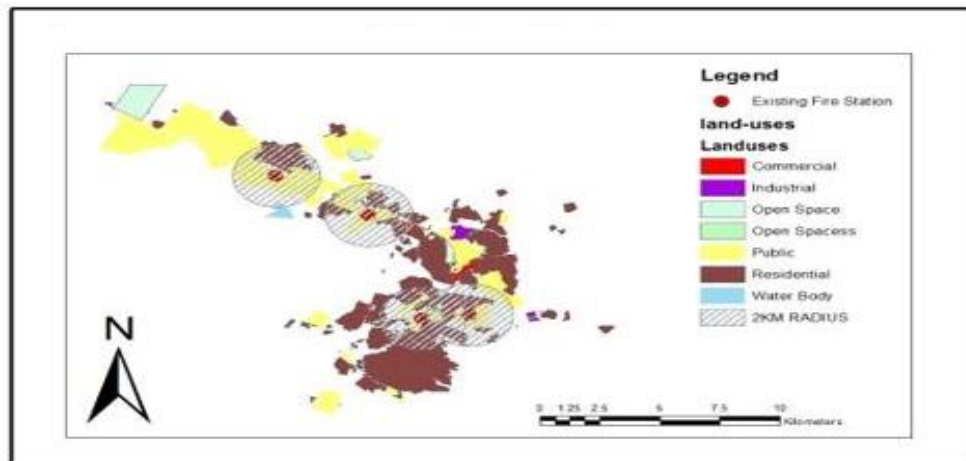


Figure 3 Existing fire stations served at 2km radius

Source. Field survey

The implication and consequences of poor fire safety practices have inadequate and emergency planning response especially in respect to low quantities of stored materials which could pose a serious threat to the community and environment in the event of hazardous fire outbreak , there supposed to be Buffers zones in other to achieve

fire safety in the built environment requires contributions from a number of organizations and during the operational stage building should be maintained and operated in accordance with the effective fire safety Planning

Network Analysis

Network analysis uses the road network of the cities, towns or district to solve common network problems, such as finding the best route across the urban area, finding the closest emergency vehicle or facility, identify service area around a location, servicing a set of orders with a fleet of vehicles or choosing the best facilities to open or close.

Service area analysis was done to determine the area that a fire truck can reach travelling at

45km/hr on major roads and 30km /hr on minor roads within 4, 6, and 8-minute response time. This is in line with the National Fire Protection Association Standard of 4-6-minute response time from the fire department receives the distress call to the time they arrive at the scene. The travelling speed takes into account that vehicles need to slow down to take turns and moderate traffic along the routes.

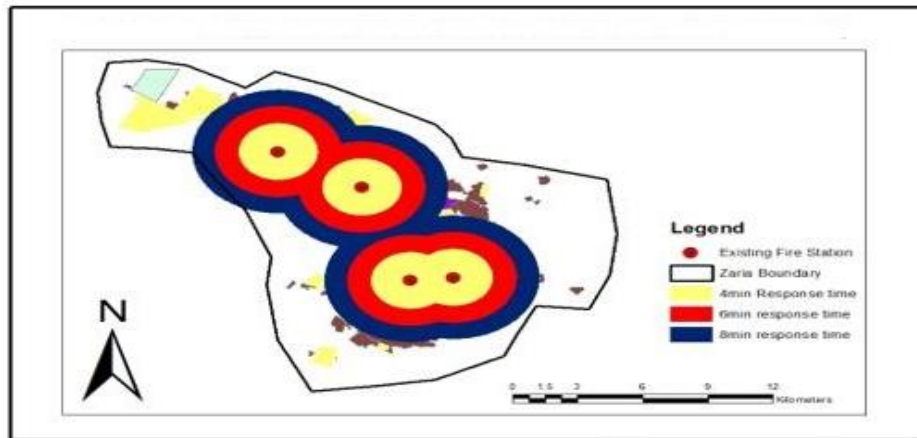


Figure 4 Response Time Analysis from Existing Fire Stations at (30km/hr)
Source. Field Survey

The above map shows that at the speed of 30km/hr at four-minute, six-minute, and eight-minute response time in study area, the distance are 2km, 3km and 4km respectively using the formula:

$$\text{Distance} = \text{Speed} * \text{Time} \quad (2)$$

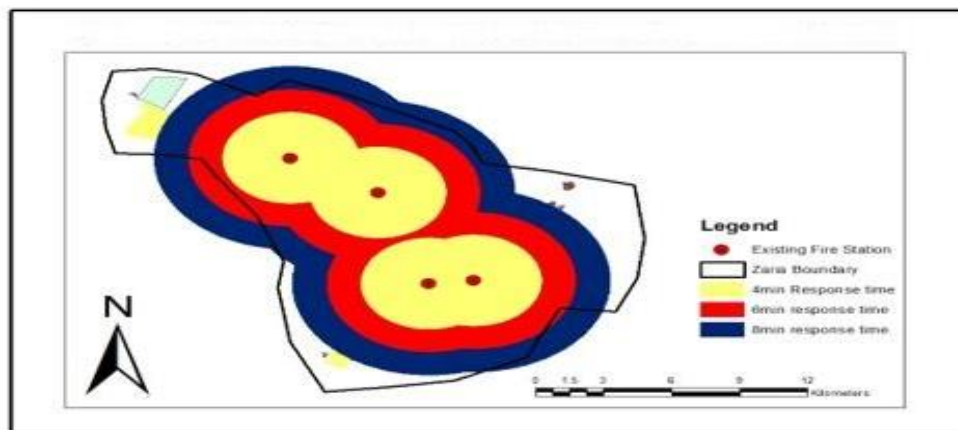


Figure 5 Response Time Analysis From Existing Fire Stations at 45km/hr
Source. Field Survey

Figure 5 shows that at the speed of 45km/hr at four-minute, six-minute, and eight-minute response times the distance are 3km, 2.5km and 6km respectively.

Summary of Findings

Zaria urban area is faced with a lot of problems when it comes to fire service, ranging from inadequacy of fire station, management and availability of facilities. Among the problems are:

1. *Inadequacy of fire station*: there is only one public fire station serving the entire urban area with the aid of three institutional fire service stations (ABU Samaru, Kongo and FAAN); this is completely inadequate when compared to any standard worldwide. This inadequacy has resulted to the inefficient operations of the fire services as a result of poor implantation. Also, the lack of qualified and inadequate of manpower is one of the major problems facing Zaria urban area
2. *Hydrant*: water hydrant which provides the source of water supply from the public water supply networks pipes for fire extinguishing operations have a very limited coverage within the urban area. Hydrant location cannot be spotted because of uncontrolled nature of development in the urban area and also most functional hydrant are either dry or abandoned for other uses.
3. *Inadequate of Basic Equipment and manpower*: there are shortage of personal and inadequate equipment in all the fire service station, such as Fire engines, Water tanker, hydraulic ladder, Ambulance etc. to provide quick response in terms of any disaster
4. *Administrative challenge*: apart from the public fire service which render services to the general public, other act base on the authority of the management when called upon for emergency. eg ABU main campus, Nigerian Collage of Aviation Technology (NCAT) Congo campus fire service. According to the fire service crew, they said that their services are restrict to the collages or campus alone, but only by the order from senate or Captain that they can assist outside the campus or collage. This is because they established to provide maximum safety and security to their organizations. This also makes contributions of other fire service stations to the public minimal.
5. *Poor Access roads*: there is also a problem of poor access roads to the scene of an outbreak. this slow down emergency response time, because time is the critical element when an emergency is reported for the rescue of the occupants and application of extinguishing agents to minimize or curb to fire outbreaks areas like traditional neighborhoods, the market areas have the poorest accessibility which makes difficult of firemen to intervene
6. *Low level of private sector participation*: private sector participation is very minimal and ineffective. Majority of the industries in urban areas such as BATC, Sun seed company, San yoghurt etc. are owned and managed by private organization that are supposed to help the public in the provision of fire service facilities but it is unfortunate that they are silent in this aspect, leaving Government with full responsibility.
7. *Poor communication system*: there is poor communication system between the public and the agencies. In terms of communication there is absence of a ground satellite station that will aid determine where there is fire outbreak within the urban area.
8. *Site coverage*: as observed from the survey most of the fire service stations do not meet the required standard for site of 0.6-0.8 hectares. This is because majority of the stations were not to standard.
9. *Negligence*: Also, there is negligence on the part of planning authorities to enforce the provision of the facilities that will support fire service operation. Development control authorities are silence in the area fire service facilities provision in the urban areas, they give little or no attention to the installation of firefighting equipment in residential, commercial and public buildings.

PLANNING FOR ADEQUATE AND EFFECTIVE FIRE SERVICE

The rapid increase in population has led to the development and redevelopment of settlement within and the outskirts of Zaria urban, these

developments are in most cases not planned and the provision of urban infrastructure such as the fire service are not given consideration. This has led to increase in the fire disaster risk of Zaria urban area, based on location allocation model of network analysis a number of fire service station are proposed and the categorization of the stations as first order or second order will service radius, population and land uses within each station service area. The service area of each station will be based on the response time analysis of approximately 4

and 6minute from time of distress call to arrival at the point of incident.

Locating New Fire Stations

The locations are determined based on the service area analysis of response time 4-6-minute driving time from a station to a point of incident. After running the analysis, a series of buffer some overlapping were produced to show the extent of which each service station can cover within the specified time. The result of the analysis is shown in the map below.

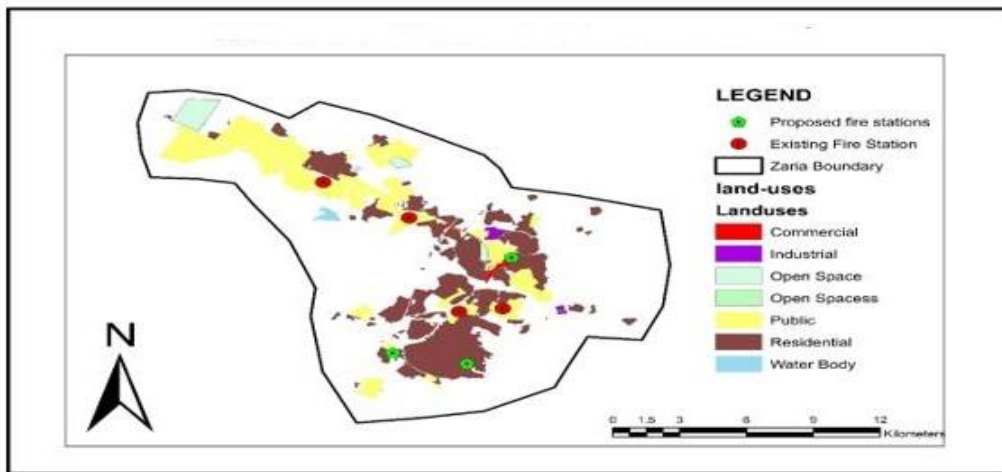


Figure 6 Existing and Proposed Location of Fire Service Stations in Zaria Source. Field Survey, 2020.

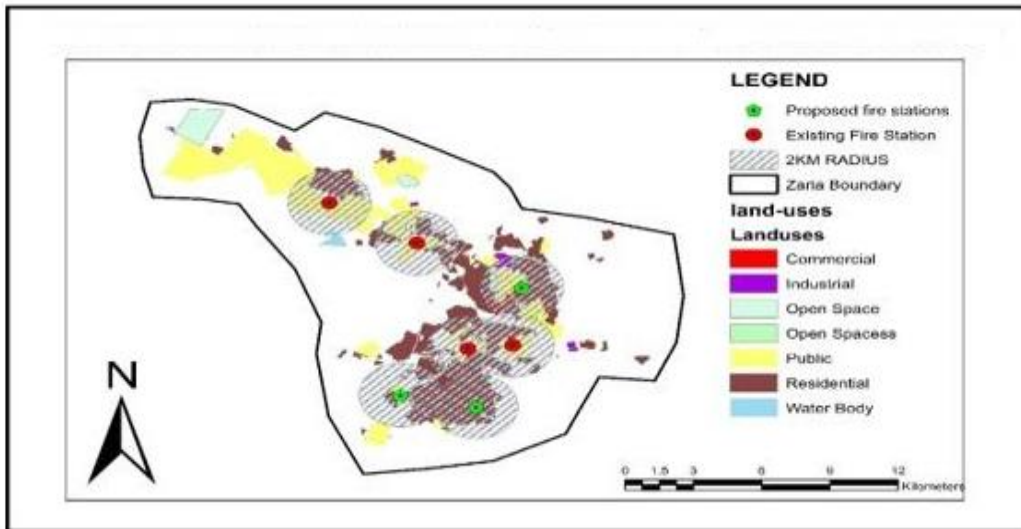


Figure 7 Proposed and Existing Fire Service Stations With Their Service Radius(2 km service radius) Source. Field survey 2020.

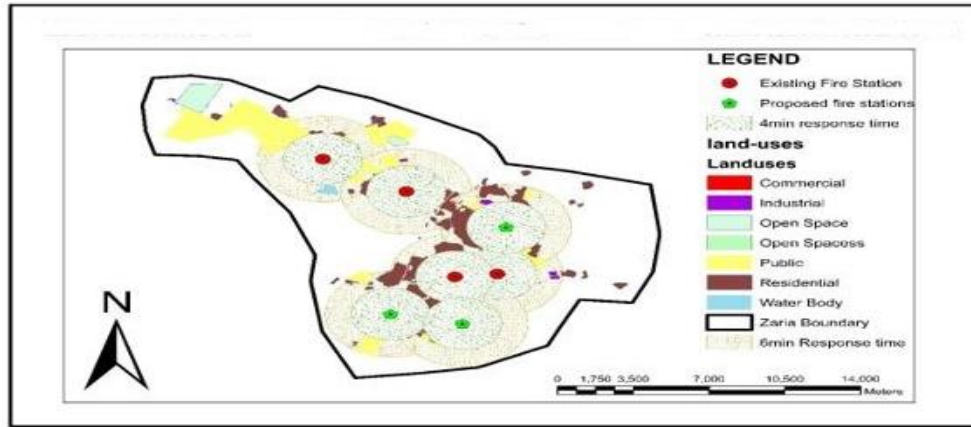


Figure 8 Proposed and Existing Fire Service Station and Their Response Times (4 and 6 minute) at Speed of 30 Km/Hr (Service Radii are 2km and 3km, respectively)
Source. Field Survey 2020

Proposed Areas of Responsibility

The service area of each stations is determined, to avoid the duplication of responsibility and wastage

of resources. Each station has an area of jurisdiction and responsibility to serve.

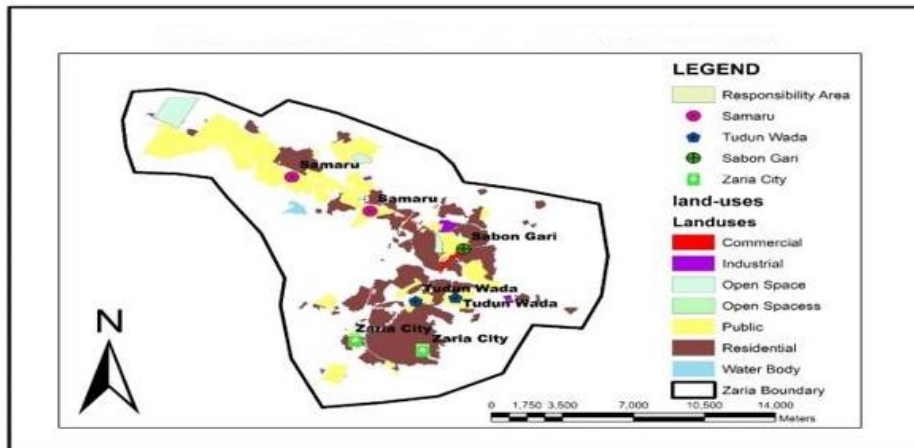


Figure 9 Proposed Fire Stations Responsibility Area.
Source. Field Survey 2020

FIRE STATION CATEGORIZATION

The proposed are categorized based on the type and intensity of interaction of land uses surrounding them, population, building density and history of fire occurrences within their area off. Based on the

aforementioned criteria, the fire stations are categorized into first and second order station. The categorization has to do with the number and type of facilities to be located in the station.

Table 7 Equipment associated with categories of fire service stations

Station Hierarchy	Equipment
First order	6 fire engines, 2 water tankers, 2 fire trucks, 2 ambulance, 1 dry chemical powder truck, 64 personal and site area of 0.6-0.8 hectare
Second order	2 fire engine, 1 water tanker, 1 ambulance, 15 personal and a site area of 0.3-0.4 hectare

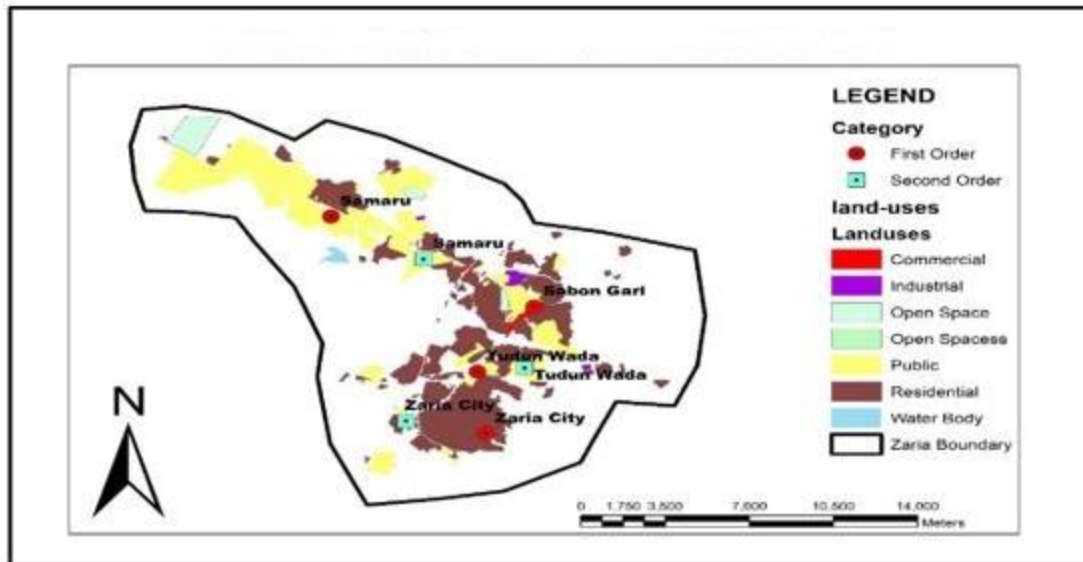


Figure 10 Fire Stations Categorization
Source. Field Survey 2020

Provision of Hydrant

Zaria urban area is having a 105 fire hydrant out of which 18.1% are functional and also found grossly inadequate. Therefore, more hydrants need to be provided along street with 200m-300m apart, while the existing ones need to be upgraded and rehabilitated to compliment for the facilities require in the area.

Provision of Fire Service in our Urban Design

Planning design has been silent in the provision of fire service, that is, most layout design in urban areas has not been provided with fire service examples, like Gaskiya layout design, Kabama one, Kabama two and three layout, Hanwa layout etc. therefore every layout should be provided with fire service facilities to provide protection and safety to both residential lines and properties against fire outbreaks.

Establishment of Fire Service Training School

Kaduna state has no fire service training school in Zaria urban area; therefore, one need to be provided for training and retraining of staff and members of the public for enlightenment on safety and protection measures against fire disaster.

Provision of Communication Gadget/ Facilities

Communication is the fastest means of linking people and passing information. Therefore, more

communication gadgets need to be provided and also a ground satellite station that will be monitoring all the activities within the urban areas should be provided.

Rehabilitation and Construction of Road

There is need to rehabilitate old roads and construction of new ones, access roads should be tarred or graded on areas with poor access road such as market areas, Sabon Gari, Samaru and Zaria walled city in order to enable fire service operation to be carried out effectively and efficiently.

Watch Towers

Watch towers should be provided in all the proposed stations that will enable fire fighters view the area within their jurisdiction. That will enable them to detect where there is fire outbreaks.

CONCLUSION

The mission of the fire service is to assist the public in the protection of life and property by minimizing the impact of fire, medical emergencies, and potential disasters or event that affect communities and the environment. Analysis of spatial data was carried out using ArcGIS software which will help to support planning decision regardless to preparedness, mitigation, response and general management of fire service within the Urban Area Buffer Network analysis was used to solve common

network problems, such as finding the best route across the urban area, finding the closest emergency vehicle or facility, identify service area around a location. The need to improve firefighting services in Zaria urban areas is very important so as to have a functional and efficient firefighting service that ensure security and safety of lives and properties of people on which survival of any urban area depends on. The urban infrastructures are liable to unforeseen situations like fire outbreaks etc. the need for fire service facilities cannot be underestimated in the urban areas for preventing and combating fire menace in the city.

Therefore, adequate training, seminars and workshops should be provided to both people and the fire service personals on the ways and best practice on curbing fire incidence and response time of disasters as well as mitigation measures.

The existing fire service stations owned by state and institutions need to be improved and also new ones should be provided to meet with the needs of the people. City development plans should be prepared to include all the necessary and important urban infrastructure such as fire service stations, the implementation of these plans should also be given more emphasis. Government should enforce the implementation of development control laws so as to check the uncontrolled development of various land use which increases the fire hazard risk of the dwellers

Adequate facilities and equipment should be provided at each station and routine maintenance of these facilities should be given emphasis. Government should rehabilitate the already deteriorating road within the urban area. This will enhance and fasten the movement of fire truck in case there is an emergency. Also, the construction of new roads reduced traffic on the existing roads should be done. The use of advanced traffic management technique should be employed so as to have a firsthand control over the ever-increasing traffic problems.

Government should establish firefighting school to train and retrain fire fighters, individual and the general at large. To enhance performance of fire service, they should keep track of the enormous amount of information processed every day, before, during and after any emergency. This ensures that

they keep up with the growing demands for any emergency that may occur.

The general public should be enlightened on the need and importance of the fire service. There should be training and retraining of fire fighters and other relevant personnel in fire department. Fire safety and general safety should be introduced in school curriculum at all level of leaning, so that people could have knowledge on how to tackle emergency cases at home and place of work

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