

APPLICATION OF CAUSE-AND-EFFECT-ANALYSIS FOR EVALUATING CAUSES OF FIRE DISASTERS IN PUBLIC AND PRIVATE SECONDARY SCHOOLS IN ILORIN METROPOLIS, NIGERIA

ABSTRACT

The contributions of fire disaster to the varying degrees of students', staff's and schools' property and/or lives lost in secondary schools in Nigeria is recently alarming. The study assessed causes of fire disaster in public and private secondary schools in Ilorin metropolis, Kwara State, Nigeria. The objectives were to identify latent causes of fire disaster, use fishbone diagram to illustrate and analyze root cause of fire disaster in secondary schools. Exploratory research design was used. The target population was 18 senior public and private secondary schools, Ilorin having 18 principals, 965 teachers and 3765 Senior Secondary 2 students. From these population, simple random sampling technique through a pick and not-return balloting was applied to sample 72.22% of the principals, 14.8% each of the teachers and students. Data were collected through in-depth interview, questionnaire, participatory observation checklist, and were analyzed using cause-effects-analysis. The findings reveals that fire disasters in public and private secondary schools in Ilorin metropolis are caused by arson, bush/waste burning, electrical fault/wiring, carelessness, and alcohol, smoking and drugs. It was concluded that open wiring and sparks from wrong connections, setting undergrowths on fire, cultism rivalry, use of combustible materials for decoration, and lack of proper fencing of school compound are root-causes of fire disasters in PPSSs in Ilorin metropolis. The study recommends that schools should prepare and anticipate future fire tragedy, and since there are several factors responsible for fire incidents, further studies should investigate to clarify the sequence or magnitude of each causes of fire because these factors magnitude may not be the same.

28 **Keywords:** Fire disaster, Fishbone-analysis, Ilorin metropolis, Secondary school.

29

30 **INTRODUCTION**

31 Fire disaster has become a global prevalent disaster experienced in most public and private
32 secondary schools and other learning institutions with likely no country is exempted whether
33 developed or developing. Lending credence to this, not fewer than 43% of 938 secondary schools
34 surveyed by the Arson Control Forum ACF (2006) in United Kingdom (a developed country)
35 recorded large numbers of fires incidents between years 2003 and 2006 alone. Kenya, a
36 developing country in Africa has fire disaster as most common disaster experienced in secondary
37 schools and other learning institutions (Kirui, 2009; Akumu, 2013; Shibusse, Omuterema, and
38 China, 2014b). National Fire Data Center NFDC, (2007) reported that, Africa continent where
39 Nigeria belongs is one of the continents at the verge of most of these school fires deaths related
40 due to different reasons such as lack of preparedness.

41 The incidents of fires in Nigeria are grossly increasing every year ranging in different locations
42 like residential buildings, warehouses, learning institutions, etc. Fire disasters situation in learning
43 institutions precisely secondary schools is worrisome in the country because it continuing without
44 cessation. The incidents are so incessant in the country to the extent that they occur on a daily
45 basis (Adamu, 2013), with enormous contributions to the toll of varying degree of losses from
46 property losses to students and staff lives losses in public and private secondary schools (PPSSs).
47 Notable among these incidents in secondary schools in Nigeria include the year 2001 fire disaster
48 at a Government Girls Secondary School in Bwalbong-Gindiri village, Plateau State, where 23
49 students died and 40 injured. In the incident, students were trapped in the dormitory because it
50 was locked and fortified with iron bars and a chain (The Independent Newspaper, March, 8 2001).

51 In a similar event, Government Girls College, Jogana, Kano State was on the night of 30th
52 November, 2015 experienced fire disaster incident. The incident took 7 lives of female students
53 and left 21 others injured (Mohammed, 2015). Similarly, important documents including class
54 register, records of students, books, some learning aids were reduced to ashes by fire in year 2016
55 in a section of Ogbe Secondary School, Benin City, Edo State (Ibileke, 2016). Fire wiped entire
56 block of two female hostels at Federal Government College, Keffi, Nasarawa State in 2017.
57 Books and other students' property were destroyed in the incident (Premium Times, November,
58 27 2017). Punch Newspaper gathers that in December, 2017 fire burn down a student hostel at
59 Government Science Secondary School, Kware, Sokoto State. The same source added that, 80
60 students escape fire at Government Girls Secondary School, Mabera, Sokoto State on January 21,
61 2018. The inferno suspected to be caused from electrical sparks completely destroyed the four-
62 room A'isha hostel and valuables but no student was hurt (Punch Newspaper January 22nd, 2018).

63 Ilorin being the Kwara State capital has continued to attract migrants from various part of the
64 country, particularly due to its strategic location as a gateway between the northern and southern
65 parts of the country (Usman, Malik and Alausa, 2015). The religious intolerance experienced in
66 the northern parts of Nigeria in the late 90s (Ahmed, 2005), the insurgency in northern eastern
67 parts of the country (Ibrahim, Adetona and Olawoyin, 2014; Usman et al., 2015), and the recent
68 herdsmen activities has contributed to these influx of people to the city. Based on these, one of the
69 challenges people recently faced is fire disaster from human errors as a result of demand and
70 careless use of facilities and utilities such as cooking gas, electrical appliances, etc in public and
71 private secondary schools (PPSSs) and houses near them.

72 However, losses accompanying these fire incidents in PPSSs in Ilorin metropolis are very
73 alarming. For instance, in only 3 fire disaster events purported from sparks from a working

74 generator and setting undergrowth on fire by unknown person, properties worth ₦ 6,600,000
75 million were destroyed in year 2012 at St. Mary International School, and Cherubim and
76 Seraphim College, Ilorin in the year 2015 and 2019 (Kwara State Fire Service Headquarters
77 KSFSH, 2019). These huge losses are clear evidence of lack of what fire is and how it can be
78 prevented (Pascal, 2006).

79 Nevertheless the fire incidents and losses incurred, over the years researchers have been working
80 vigorously to provide different models and analysis tools to explain and find solution to fire
81 disaster problems, for instance, Oladokun and Emmanuel (2014) invoke fuzzy logic model to
82 analyzed urban market fire disasters management in Nigeria while Oladokun and Ishola (2010)
83 used a risk analysis model to explained fire disasters situation in commercial complexes in
84 Nigeria. Meanwhile, the purpose of providing such tool(s) is/are to assists in unveiling the key
85 causes of fire disaster, take corrective actions for management and continuous improvement on
86 fire situations (Balanced Scorecard Institute, 2007; Tarun, 2012). Therefore, this study is about
87 “The Cause-and-Effect-Analysis (fishbone-analysis)” and its application to analysis latent causes,
88 root causes and as well as providing solutions to fire disaster problems and cost of property loss in
89 it in PPSSs in Ilorin metropolis.

90 **MATERIALS AND METHODS**

91 Ilorin Metropolis is located between latitude $8^{\circ} 24' 0''$ N and $8^{\circ} 56' 0''$ N of the Equator and
92 between longitude $4^{\circ} 32' 0''$ E and $4^{\circ} 56' 0''$ E of the Greenwich Meridian with an elevation of
93 290m above the sea level. It lies on the southern fringes of savanna region and north of the forest
94 zone of Nigeria. The city is situated in the North central geo-political zone with a land mass of
95 approximately 100km^2 (Adediji, Ajayi and Olawole, 2009; Usman et al., 2015). The metropolis

96 has about 20 political wards, and comprises part of three Local Government Areas (L.G.As):
97 Ilorin East, Ilorin South, and Ilorin West.

98 Ilorin is one of the fast growing cities in Nigeria with relatively high growth rate. The city is a
99 confluence of cultures, dominated by Yoruba, Hausa/Fulani, Nupe, Baruba, Igbo while the minors
100 are other Nigerian languages, and foreigners. The indigenous people's religion is predominately
101 Islam and Christianity is majorly practiced by non-indigenes and few indigenes. The population
102 according to the 1991 census put Ilorin's population at 532,088 (NPC, 2006), and was projected
103 to be 1,049,168 by 2013 (Ibrahim, Bako, Raheem, and Abduldykeen, 2014). The population
104 explosions has greatly contributed to different human errors such as careless use of gas cooker
105 and electrical appliances in schools and houses closed to schools, and uprising establishment of
106 new secondary schools leading to inferior use of building materials that can easily catch fire.
107 Ilorin is a fast growing in educational wise with different learning institutions from primary to
108 university level. Ilorin metropolis has 64 public and 45 registered private senior secondary
109 schools with a population of 47,568 students, 5010 teachers, and 109 principals/head teacher
110 (MOEHCD, 2017).

111 Data used in this study were obtained from both primary and secondary sources. The primary data
112 were collected from principals/vice-principals through an in-depth interview, teachers and
113 students through questionnaire, and participatory observation. The data include information on
114 causes of fire disaster and the physical outlook of PPSSs surroundings. The secondary data was
115 sourced from Kwara State Ministry of Education and Human Capital Development (MOEHCD)
116 for population of secondary schools in Ilorin metropolis, Kwara State Fire Service Headquarters
117 (KSFSH) for details on secondary school fires, and Kwara State Ministry of Land and Survey for
118 Ilorin map. This study adopted exploratory research design. The target population was 18 senior

119 PPSSs having 18 principals, 965 teachers and 3765 SS 2 students (MOEHCD, 2017). From the
120 target population, simple random sampling technique through a pick and not-return balloting was
121 applied to sample 72.22% of the principals, 14.8% each of the teachers and students that helped in
122 identifying the causes of fire disaster in PPSSs in Ilorin.

123 However, Cause-and-Effect-Analysis (CEA) was used to evaluate the causes of fire disaster and
124 as well its root causes (Balanced Scorecard Institute, 2007). A CEA known as an Ishikawa or
125 “fishbone diagram” is a graphic tool that helps people identify, sort, and display possible causes
126 of a problem or quality characteristic (Institute for Healthcare Improvement IHI, 2016). It is
127 defined as fishbone because of its structural outlook and appearance (Tarun, 2012). Same source
128 added that, in a typical fishbone diagram the main problem which is required to be resolved is put
129 on the head of the diagram and the causes are the bones and then smaller bones are created as the
130 resemblances of the sub-causes.

131 Fishbone diagram or analysis was used to evaluate the causes, sub-causes and assists to uncover
132 the symptoms of fire disaster in PPSSs in Ilorin (American Society for Quality, 2005). In other
133 words it was used to graphically illustrate the relationship between fire disaster and the factors
134 that influence it (IHI, 2004). Henrik (2009) described cause-and-effect-diagram as a simple and
135 pragmatic way of doing root cause analysis. The essence of using this fishbone diagram was to
136 identify the causes in particular the root causes of fire disasters in PPSSs in Ilorin metropolis. This
137 study therefore considered this model very important because as useful as it is, the model has not
138 being explored by researchers in fire disaster incidences and fire safety management. To construct
139 the fishbone diagram, the following steps identified in Ishikawa (1968), Brassard (1988), Vivek
140 (2008) and Tarun (2012) were adapted. The steps were:

- 141 i). Fire disaster (i.e. effect) was written in a box on the right-hand side of the page (fish
142 head).
- 143 ii). A horizontal line (spine) was drawn to the left of the effect.
- 144 iii). Diagonal lines were drawn above and below (these are the fish bones) the horizontal line
145 (spine), and were labeled with the categories chosen in 4 below.
- 146 iv). The main categories of factors (causes) contributing to fire disaster identified were
147 labeled. The major categories typically utilized were electrical fault, arson, carelessness,
148 bush/waste burning, and drugs (including alcohol and smoking).
- 149 v). List of causes for each category was generated, and branch bones off the fish bones
150 connecting the causes to their respective categories were drawn to produce sub-factors.
- 151 vi). Analyzes of the results were done after an adequate amount of detail has been provided
152 under each major category.

153 **RESULTS AND DISCUSSION**

154 The various main causes of fire disaster as well as their root causes identified in PPSSs in Ilorin
155 metropolis are presented in Figure 1. The identified major causes were bush/waste burning, arson,
156 electrical fault/wiring, carelessness, and alcohol, drugs and smoking.

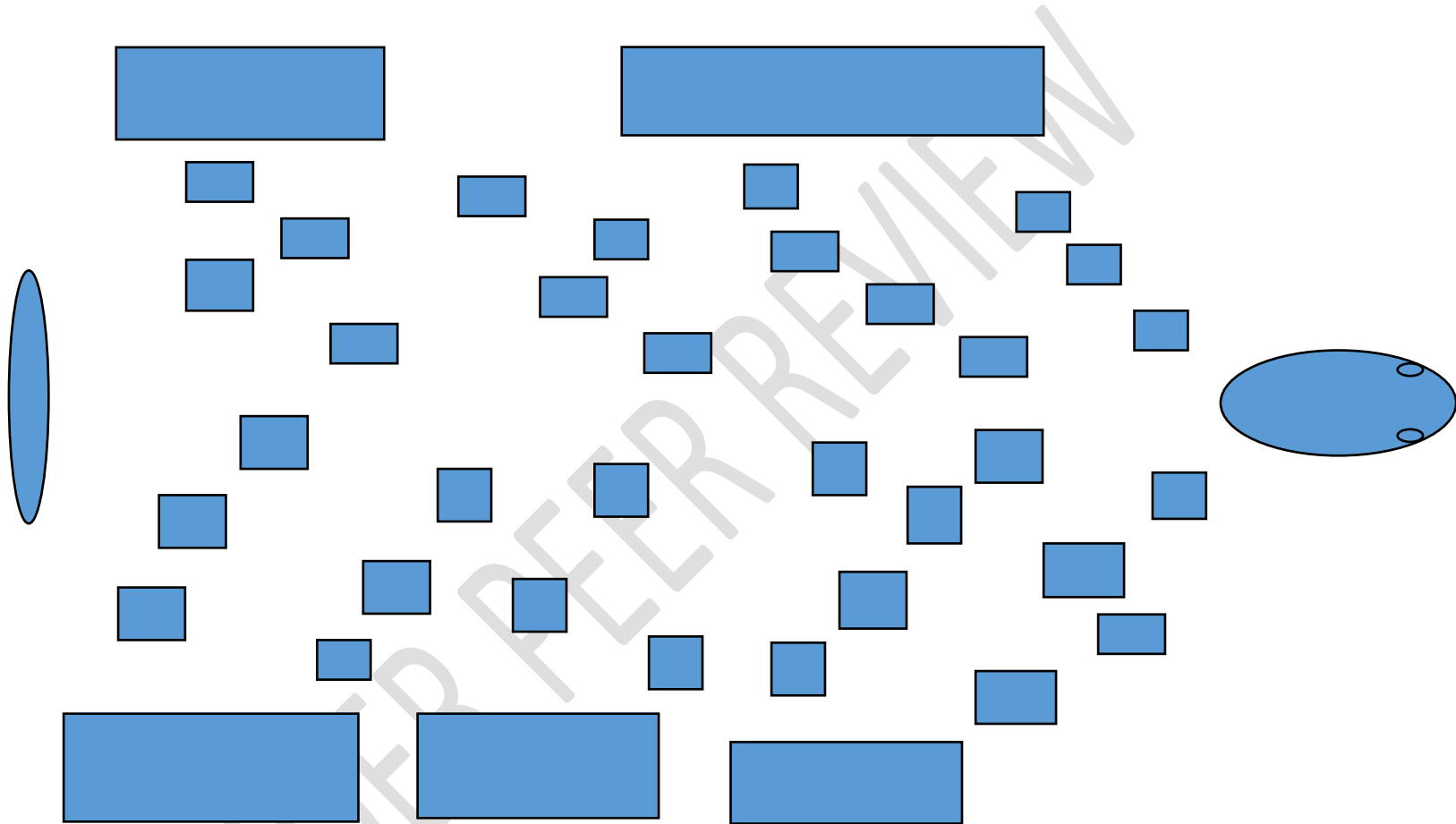


Figure 1: Fishbone Diagram for Causes of Fire Disasters in Public and Private Secondary Schools in Ilorin Metropolis

Source: Adapted from Institute for Healthcare Improvement IHI, (2016)

Keys	Interpretation
A	High voltage.
B	Negligence or failure to put out light after school hours.
C	Abuse and misuse of electronic gadgets such as overloading of sockets and extension boxes.
D	Improper handling of electrical appliances in the school or nearby houses.
E	Improper and illegal connection of wires from the nation grid, in the laboratory e.g. Physics, Chemistry laboratories and other places within the school.
F	Lose wire or open connections
G	Sparks from electrical gadgets due to fallen electrical poles during rainy season.
H	Political reasons.
I	Psychological reasons
Ia	Drugs and hard substances.
J	Emotional reasons
Ja	Cultism rivalry.
K	School policy
Ka	School fees
Kb	School prefects.
L	Setting undergrowths on fire by hunters and other persons.
M	Improper disposal of refuses within the school and dung hill near school.
N	Indiscriminate waste burning in houses near the school.
O	Bushy school surrounding especially during dry season before holidays.

Keys	Interpretation
P	Mishandling of chemicals in pre-room and science laboratories in practical.
Q	Overturn and careless use of gas cooker and other cooking materials in Home Economics laboratories and kitchens in boarding schools.
R	Mistakenly and careless drop of cigarette stub in waste bin within or near the school.
S	Careless use of combustible materials in the school buildings
Sa	Playing with candle or using it to read in boarding schools' hostels
Sb	Use of glossy paints and other combustible materials for decoration and beautification of offices, classes, rooms in the hostels etc.
T	Refilling of explosive materials
Ta	Refilling of lighted kerosene lamp and cooking stoves while is still on
U	Lack of proper fencing of the school compound.
V	Smoking by gardeners at night.
W	Smoking of cigarette, India helm and other dangerous substance by hoodlums.
X	Accident from drunkard school drivers while filling school bus with petrol.
Y	Improper disposal of cigarette stub.
Z	Psychological disturbance from drugs addicts.

161 **Electrical fault/wiring Problem:**

162 Usage of electrical appliances for a school day-to-day activity is good but its consequence when
163 not properly used is dangerous. Findings as regard this shows that faulty electrical appliances,
164 wrong connections, overloading of electrical outlets etc have been weighing different assault on
165 lives and especially property of students, teachers and school valuables in PPSSs Ilorin
166 metropolis. For example, properties worth over ₦2million were destroyed in an incident of fire
167 in one of the private secondary schools in Ilorin (St Mary International College, Ilorin) in the
168 year 2012 as a result of sparks from a working generator (KSFSH, 2019). An inside look at the
169 case electrical problems in PPSSs in Ilorin through observation reveals that, some of the root
170 causes of these problem are non-insulated wiring system, overloading of junction boxes in some
171 classes, computer rooms in schools, and leaving classrooms and offices light on even after school
172 hours. Sparks happened from high voltage leading to fire disaster when bulbs were not put off
173 and when overloaded boxes are heated and could no longer bear the pressures.

174 **Bush/waste burning Problem**

175 Bush/waste burning has been one of the problems faced in PPSSs in Ilorin from indiscriminate
176 waste burning in nearby houses to school environment and bushy school surroundings
177 particularly during dried season. Setting undergrowth on fire by hunters and other persons on fire
178 on the other hand is another root cause of some fire disaster in PPSSs in Ilorin which has caused
179 a lot of losses and destructions to school buildings and property. An example of huge loss from
180 bush/waste burning in secondary schools in Ilorin were fire incidences in year 2015 and 2019 at
181 Cherubim and Seraphim College, Ilorin alone with property worth ₦4, 100, 000 loss (KSFSH,

182 2019). Bush/waste burning challenges has been faced by many PPSSs in Ilorin and lot of
183 properties has lost from this.

184 **Arson Problem**

185 Arson (intentional fires) is fires deliberately set by an individual, a person or group of persons on
186 ones or others properties as a form of protest or vengeance against others or government (Ilori,
187 2017). Some fire outbreaks in PPSSs in Ilorin are caused by some human beings with evil intent
188 (Tolofari, 2010). Public and private secondary schools in Ilorin are not free from arson set fires
189 which are engineered politically or psychologically e.g. drugs, hard substances and or
190 psychological depressed. Some arson fire root cause is emotionally caused from cultism rivalry
191 among male teachers and students over girlfriend within and outside the school. Other root factor
192 is school policies/laws with sub-causes such as school fees and bully prefect etc. On arson
193 caused fires, KSFSH (2019) documented that arson suspected individuals gutted Government
194 High School, Ilorin on fire on 25th Nov. 2012. The culprits could probably do that to show
195 dissatisfaction due to one or some of the early defined reasons.

196 **Carelessness Problem:**

197 Some public and private secondary schools in Ilorin has experienced some form of destruction
198 from carelessness. Carelessness is as result of different reasons which include mishandling of
199 chemicals in the science laboratories before and during practical, overturn and careless use of gas
200 cooker and other cooking materials in Home Economics laboratories and kitchens in boarding
201 schools. Careless use of combustible materials like, the use of candle in boarding schools hostels,
202 glossy paints and other combustible materials for decoration and beautification of offices,
203 classes, hostel's rooms etc. For instance, during visitations to schools to collect data, some

204 students at Cherubim and Seraphim College, Ilorin were jokingly discussing between themselves
205 how one of them played with fire which later escalates beyond his expectation. Careless playing
206 with fire and other forms of carelessness has been troubling many PPSSs and putting them in
207 serious debts.

208 **Alcohol, drugs and smoking Problem:**

209 Lack of proper fencing of the school compound, smoking by gardeners at night, improper
210 disposal of cigarette stub, accident from drunken school drivers while filling school bus with
211 petrol were parts of root causes of fire disaster in PPSSs in Ilorin from alcohol, drugs and
212 smoking. From observation one of the authors found that, some hoodlums frequently do their
213 smoking activities in the evening after the school hours in secondary schools since more than
214 61.11% of PPSSs in Ilorin are partially or not fenced. This made it so easy for those guys to do
215 their activities and by virtue some pieces of paper which are viable fuel of fire disaster were in
216 some classrooms being used by these gangs.

217 **Problems and Solutions:**

218 Several factors are responsible for fire disasters in PPSSs in Ilorin metropolis. It is ideal that
219 quick action is taken to avert these incidents so as to mitigate the future occurrence and emerging
220 losses even though the occurrence is few but the cost of property loss in these events were
221 brilliantly in millions of naira. Therefore, for the safety of lives and property of students,
222 teachers, principals, the school itself and other users some solutions are provided for the five
223 main categories of causes of fire disasters in PPSSs in Ilorin.

224

225 **Solutions of Electrical fault/wiring Problem:**

226 To get rid of these electrical fire problems in PPSSs in Ilorin, conscientious actions must be
227 taken such as putting off all electrical appliances like computer systems, fans, electric kettle,
228 cookers, socket and air-conditioning systems when not in use in the laboratory, kitchen, hostel
229 and offices even for a short moment. By so doing sudden sparks from high voltage that causes
230 alarming destruction to lives and property will be prevented. Replacing burnt fuses with cables
231 of higher melting point personally may result into a great fire disaster hence; trained
232 engineers/qualified electrician(s) should be employed by each school to fix electrical problems.

233 **Solutions of Bush/waste burning Problem:**

234 The remedy to this may include; clearing of school compound against bushy environment, strict
235 punishment on any student and even teacher who littered the school compound, provision of
236 waste bin in all classes, staffrooms, and strict restriction of hunters and herders getting access to
237 school compound.

238 **Solutions of Arson Problem:**

239 To curb arson problems, proper and full fencing of school compound with secure gates and
240 placement of security men at the entrances would help schools in reducing such crime and also
241 help to bring culprits to book.

242 **Solutions of Carelessness Problem:**

243 As the case may be carelessness can be prevented among other methods by making matches
244 sticks available to light gas burner in kitchens in the boarding schools, in home economics and
245 science laboratories before turning on the burner. Adding to this, keeping gas cylinder outside

246 kitchens and laboratories would help the flow and leakage into the air outside the laboratory and
247 kitchen to prevent risk of sudden fire explosion from careless use of this equipment.
248 Furthermore, combustible materials should not be used for decoration, and in any circumstance if
249 petrol must be used, it should be kept far away from kitchen, lantern or candle light. All these
250 and many others will help in preventing unexpected losses in PPSSs in Ilorin.

251 **Solutions of Alcohol, drugs and smoking Problem:**

252 To tackle this act in or around PPSSs in Ilorin, proper and full fencing of school compound with
253 secure gates and security men at the entrances would help schools in reducing fire disaster
254 eventualities from the perpetrators. Prohibition of smoking within and around the school
255 premises especially during school hours by school users should viscosly enforced. School
256 management should consistently monitor a school driver that engaged in smoking or that takes
257 alcohol.

258 **CONCLUSION**

259 The study has established from it analyses that fire disaster situations in public and private
260 secondary schools in Ilorin metropolis are major caused by bush/waste burning, electrical faults,
261 arson, carelessness, and alcohol, drugs and smoking. From these major factors, setting
262 undergrowth on fire, open wiring and sparks from wrong connections, cultism rivalry, use of
263 combustible materials for decoration, and lack of proper fencing of school compound are root-
264 causes of fire disasters. This study therefore, recommends that schools should prepare and
265 anticipate future fire tragedy, and since there are several factors responsible for fire incidents
266 further studies should investigate to clarify the sequence or magnitude of each causes of fire
267 because these factors magnitude may not be the same.

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