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Assessment of Fire Risk for Mike Adenuga Library, Bells University, Ota, Nigeria

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Abstract:
This study carries out an assessment of the fire risk of the Mike Adenuga building, Bells University of Technology, with an aim to provide first-hand information on the building, its fire prevention, and safety measures. It serves to raise awareness of the possible causes of fire, the consequences of fire events, and mitigation strategies in the facility with the aim of protecting users' lives, businesses, properties, and the university's equipment against fires.
This research carried out a literature review to understand the causes of fire and other subjects under fire risk assessment. It then proceeded to assess the building by case study and observation analysis to arrive at a result that will enable the researchers to provide new information that will benefit the owners and users. The research showed the areas with higher fire risk in the building. It also showed the group of users of the building that are vulnerable to the negative result of a fire outbreak. The overall results from the assessment found the Mike Adenuga building at a 68.75% risk rate of fire occurrence with only 31.25% readiness against fire outbreak. The researchers found these figures relatively poor when compared to the average of 50%. This study proceeded to recommend both passive and active fire protection measures that will reduce the high-risk rate of the Mike Adenuga building. These recommended measures were those that the building lacked and needed urgently to improve the current state of fire safety, which will indefinitely affect the next fire risk assessment result in a positive manner.

Keywords: *Fire assessment, safety, mitigation, fire, risk assessment, facilities*

1. Introduction

Building services are the services put in place in buildings to make them comfortable, functional, effective, and safe (Designing buildings, the Construction Wiki, 2022). Building services are a key component of a building's design, contributing to such factors as:

- Façade engineering,
- The weights, sizes, and locations of major plants and equipment,
- The placement of vertical service risers,
- The paths taken for the distribution of horizontal services, drainage,
- Energy sources, sustainability, and many other factors

This means that, particularly on complex building projects, building services design must be integrated into the overall building design from a very early stage. One such service includes fire safety, as fire is the major cause of massive destruction to lives and properties of a building at one go. Fire events frequently cause reputational harm to the organizations and people involved, which may intensify into a call for those accountable to be charged with corporate culpability or manslaughter in the event of loss of property or lives. It is undoubtedly the ethical obligation of building owners and operators to ensure that modern structures holding hundreds or even thousands of people are safe for the occupants, regardless of the reputational cost (Vanguard, 2022).

Therefore, this research assesses the Mike Adenuga Library building for its fire risk precautions and countermeasures to provide information that will hinder and decrease any future fire outbreaks resulting in damage to lives and property. For the research aims to be met, certain objectives were outlined to guide the research. These include:

- Assessing the fire hazards in the building,
- Identifying possible victims of unexpected fire accidents in the building, Identifying preventive and counteractive measures installed in the building against fire outbreaks,
- Establishing the level of risk that the hazards pose and
- Suggesting new information to upgrade the existing features

1.1. Background of Study

Among the many different types of disasters, fire poses the greatest threat to human life, property, and the environment. Fire is also crucial for the growth of the nation and civilization (Hassanain et al., 2022). Building fires, especially in public buildings, continue to be a serious concern as the fire outbreak revealed between 2013 and 2018 indicates a significant increase in fire disasters and the number of deaths (NFPA, 2018). According to the report from the fire services department in 2018, there were a total of 51400 fire calls and 934 fire deaths (Emmanuel, Tulasie & Jeboah, 2016).

Despite the existence of building and fire safety regulations designed to safeguard against property damage and ensure the safety of people, mishaps frequently occur, such as fire outbreaks that raze multiple parts of our public structures. Most of the time, things are blamed for the causes, such as electrical issues, sabotage, and unidentified occurrences.

Fire Regulations and practices for safety cover the provision of a safe system that complies with modern fire safety precautions guidelines and ensures that they are routinely tested and maintained. This means that for every piece of fire safety equipment in a structure, regular testing and upkeep of all health and safety records, including employee training and ongoing exercises like fire drills performed frequently, are part of what provides a safe environment for public buildings.

The Mike Adenuga Library Building, Bells University of Technology, was constructed by a construction company called Cachez Turnkey Projects Limited in partnership with Arc. Mike Adenuga. This building, located at the center of the campus, is still under construction and is currently being used to house both the College of Environmental Sciences (COLENVS) and College of Engineering (COLENG) studios and classrooms. The building has 4 floors: the ground floor, the first floor, the second floor, and the third floor. The building though originally built to be a Library, has been converted into a University work environment with several departments taking up spaces for studios, laboratories, classrooms, and offices.

Figure 1: Image of Mike Adenuga Building
Source: Author's Fieldwork, 2022

Figure 2: Image Showing Ground Floor, First Floor and Second Floor of Adenuga Building from the Courtyard
Source: Author's Fieldwork, 2022

2. Literature Review

2.1. What Is a Fire Risk Assessment?

It is an evaluation of a building to determine its fire risk and, if necessary, provide recommendations on how to make the facility safer. It is necessary to fully comprehend the potential threats and then improve your fire safety measures, ultimately protecting the users and facilities in the building (Fire risk assessment network, 2022).

- A fire risk assessment must be prepared in two sections, whether it is written down or not:
- The review itself, which takes place in the first section, rates the facilities' fire safety on a number of criteria
- The second section contains a list of conditions that must be met for the construction to comply with fire safety regulations
- Implementing these suggestions is crucial since, in the end, they will ensure the safety of your building. A risk assessment is required to establish whether the building's current safety precautions are adequate and, if not, how to improve them.

Some of the places required to do fire risk assessments include: Offices, retail shops, hospitals, and houses for social care, schools and learning areas, construction site, restaurants, bars, cafes and pubs, worship spaces, sports facilities and public spaces, warehouses and factories, event centers, hotels, and apartment buildings (Burton-Hughes, 2018).

2.2. What Is a Fire Hazard or Risk?

Fire risks are any practices, substances, or circumstances that could amplify the size or impact of a fire or ignite one from scratch. A fuel with a high ignition risk or a heat source like a broken appliance could be the danger.

The word ‘fire risk’ is defined as the likelihood of a fire occurring multiplied by the severity of the fire, or the ‘harm potential’ and repercussions in terms of life loss, fire spread, property damage, and many others. The potential for injury from a fire hazard depends on the risk that a fire may start from the hazard and then the likelihood that it would result in loss of life or property.

The assessor must determine the danger's prospective consequences to determine its potential for harm (National Fire Chiefs Council, 2020).

2.3. Fire Causes in Public Building

Three categories can be used to group the causes of fire in public buildings (Lawal et al., 2018). These groups include:

- An organic cause
- Unintentional cause
- An explosive reason

2.3.1. Natural Cause

2.3.1.1. Lightning

Lightning is brought on by connecting current in a thundercloud that is composed of densely cold air at the top and warm, moist air at the bottom.

2.3.1.2. Wind

The wind's action can cause structures to be torn apart and send electrical wires flying, which could set off a fire.

2.3.1.3. Animals

Especially for electrical cables with only one layer of insulation, animals like rats and bats can gnaw through the insulation.

2.3.1.4. Building Settlements

Differential settlement of the building may lead to a gas pipe cracking, allowing the gas to leak and start a fire.

2.3.2. Fires Caused by Accident

One of the following conditions may lead to an electrical fire:

- Sparking
- Arcing, and
- Overheating

2.3.2.1. Sparking

Sparking frequently results from short circuits or arcing during electric welding operations.

2.3.2.2. Arcing

A short circuit or break in an electrical conductor can result in an electrical current trying to continue flowing in an open area, which results in an arc.

2.3.2.3. Overheating

Overheating can be caused by heat conductors from outside or inside sources such as cooking equipment, broken appliances, explosions, smoking, bonfires, and rubbish fires.

2.3.3. Incendiary Fire Causes

This term, which refers to various fire-related causes that are either intentional, premeditated or the result of such egregious negligence as to be equally blameworthy, was coined:

- Irrational fire starters,
- Emotional igniters,
- Arson

2.4. Fire Safety Standards and Their Application

For meeting the fire safety performance standards for buildings, whether they are residential or not, many recognized regulations provide recommendations and guidance. In order to lessen the threat to people, property, and business continuity, the Nigerian government is especially pushing for establishing fire risk management systems in buildings. Building fire safety is ensured by these systems' ability to control, protect, and prevent fire effectively (Alao et al., 2020). Even now, the issues with fire safety management remain unresolved despite numerous interventions by the stakeholders, including undertaking an evaluation of fire safety in the existing buildings, particularly office buildings (Chen, Chuang, & Huang, 2012). According to (Service, 2015), evidence has revealed the important elements causing fire outbreaks or disasters (Badger, 2017), with multiple researches demonstrating that most catastrophes were brought on by human mistake. Lower rates, however, appear to be a technical fault. Understanding the elements that cause fires in any specific site is necessary for conducting a fire risk assessment (London Fire Brigade, 2020).

2.5. Building Fire Safety Requirement

These rules are applied to any two- or more-story building (Lawal et al., 2018).

- In addition to the enclosed stairway, there must be at least two other staircases, one on either side of the main staircase.
- Emergency lights must have a backup power system, according to the rule.
- There must be exit signs illuminated on all exit doors.
- Materials that are fire resistant must be used to build the building's circulation sections.
- In case of a fire, fire extinguishers and fire blankets should be available and located in conveniently accessible locations throughout the structure.
- Hose reels, sprinkler systems, and wet or dry risers must be supplied where the building has five stories or more.
- There must be a manual or automatic fire alarm system to alert visitors to the presence of a fire.
- In the case of a fire, a suitable area should be made available inside the building to gather all occupants.
- All doors to the bedrooms in the hotel's circulation spaces must be fitted with fire-resistant doors in high-rise buildings.

The Mike Adenuga building, in this case, has four floors with over 100 users in it at a time due to the many functions it now provides to the university. Asides from people, equipment such as computers, machinery, architectural design studio tables, chairs, audio equipment, and more are installed throughout the building. Therefore, a fire outbreak in this building will result in severe casualties both in lives and finances.

Therefore, the research proceeds to carry out the risk assessment of the building following the necessary steps (Fire risk assessment network, 2022). These steps include:

- Step 1: Determine the fire threats on your property.
- Step 2: Determine the persons who are most at risk.
- Step 3: Assess the situation to determine whether the current fire safety measures are enough or whether they need to be improved.
- Step 4: This is to document the results, create an emergency plan, and
- Step 5: This is to arrange for frequent evaluations of the assessment.

3. Methodology

This research utilized observation analysis and case studies to obtain data on the assessment of fire risk in the building. In accordance with legal regulations, hiring a certified fire risk assessor is not mandatory, as a 'competent' person may perform a fire risk assessment. Taking advantage of this, the authors proceeded to carry out the assessment following the recommended steps, which aligned with the research objectives (London Fire Brigade, 2022).

The objectives of the research are used as key points, and under each point, the assessment steps which fit in will be analyzed.

- Assessing the fire hazards in the building.
- Determine possible victims of unexpected fire accidents.
- Identify preventive and counteractive measures installed in the building against fire outbreaks.
- Assess the level of risk that the hazards pose and suggest new information to upgrade the existing features.

3.1. Assessing the Fire Hazards in the Building

From the research carried out on steps for fire assessment, the following step was chosen for the research (Fire risk assessment network, 2022).

3.1.1. Determine the Fire Threats on Your Property

The authors proceeded with this step by examining each floor to observe three things:

- Source of ignition such as direct flame or commercial activities,
- Source of fuel such as waste products, display materials, textiles, or overstocked goods
- Sources of oxygen such as air from windows, air conditioners, or industrial or medicinal oxygen products.

These were categorized in a percentile system of 0-100% where:

- 0-25% - No chance
- 25-50% - Low chance
- 50-75% - Medium chance
- 75-100% - High chance

The findings are stated below:

Floor	Source of Ignition	Source of Fuel	Source of Oxygen	Average Percentage (Sum of All/3)
GROUND FLOOR	25%	75%	75%	58.3%
1ST FLOOR	25%	50%	50%	41.67%
2ND FLOOR	25%	50%	75%	50%
3RD FLOOR	0%	25%	25%	16.67%

Table 1: Table Showing the Rate of Fire Threats in Adenuga Building

From the table above, the rate of fire threats in the building has its highest reading on the ground floor, with a 58.3% chance. This is because this floor has more ongoing activities and more electrical work installed on it. The second highest floor has a 41.66% chance of being susceptible to fire as the materials, equipment, and building features make them a 50% fire threat to the building. The lowest reading is on the 3rd floor, with a 16.67% fire threat chance.

With this result in mind and further observation done, the concluded fire hazards to this building could result from electrical failure or fault. The building manager must take note of this to appropriately protect the building from such an occurrence.

3.2. Determine Possible Victims of Unexpected Fire Accidents

3.2.1. Determine the Persons Who Are Most at Risk

The authors analyzed this step by dividing the possible users of the building into four groups based on the location, type of building, and environment. The groups include:

3.2.1.1. Students

They are users between the ages of 16-30 who utilize the building for receiving lectures and performing school work.

3.2.1.2. Staff

They are users between the ages of 26-50 who utilize the building for giving lectures or/ and have offices within the building.

3.2.1.3. Auxiliary Staff

They include cleaners, security guards, maintenance crew due to the ongoing construction of the building, and more.

3.2.1.4. External Users

They include random people visiting or performing an action in the ICT facility.

These were categorized in a percentile system of 0-100% where:

- 0-25% - No risk
- 25-50% - Low Risk
- 50-75% - Medium Risk
- 75-100% - High Risk

These groups were then classified into the below categories based on the frequency of use of the building. The results are in the table below.

Users	Students	Staff	Auxiliary Staff	External Users
GROUND FLOOR	75%	50%	50%	0%
1ST FLOOR	50%	25%	0%	25%
2ND FLOOR	75%	25%	0%	0%
3RD FLOOR	0%	0%	0%	0%
AVERAGE PERCENTAGE (Sum of floors/4)	50%	25%	12.5%	6.25%

Table 2: Table Showing the Rate of Group of Users at Risk of Fire Dangers

From the analysis above, the group at more risk during a fire outbreak is the student group, with a 50% rate as this group uses the building more frequently than the rest. Conversely, the group with the least risk is the External users, with a 6.25% rate, as this group visits the building occasionally.

- Note: The 3rd floor is inaccessible to all groups. Therefore its result is at Zero.

3.3. Identify Preventive and Counteractive Measures Installed in the Building against Fire Outbreaks

3.3.1. Assess the Situation to Determine Whether the Current Fire Safety Measures Are Enough or Whether They Need to Be Improved

The authors again observed the Adenuga building to determine:

- If the fire safety measures provided on all floors were enough in the likelihood of a fire outbreak and
- If they required improvement

The findings from this point are stated below:

3.3.1.1. Ground Floor

The most occupied floor in the Adenuga buildings is the ground floor, as it contains more spaces accessible to the users of the building. The fire safety measures provided on this floor included:

- One main entrance and exit point, with three other exit points next to the escape stairways
- Fire extinguishers and sand buckets placed at the entrances of the lecture rooms, architecture studios, and office area
- A source of water just beside the building where a firefighting hose can be attached

3.3.1.2. First Floor

This floor is the second most occupied floor in the Adenuga buildings as it contains more spaces accessible to the users of the building, as well as more equipment of value and combustible materials like wood. The fire safety measures provided on this floor included:

- Escape staircases next to 4 exit points.
- Fire extinguishers and sand buckets placed at the entrances of the lecture rooms, architecture studios, and office area

3.3.1.3. Second Floor

This floor is the second last accessible floor in the building to users. It contains fewer open spaces than the other floors. Asides from the studios, offices and laboratories by the courtyard block, the remainder of the floor remain unfinished, and thus, the fire safety measures provided on this floor included:

- Escape staircases next to 4 exit points.
- Fire extinguishers and sand buckets placed at the entrances of the lecture rooms, architecture studios, and office area.

3.3.2. Document the Results and Create an Emergency Plan

From the overall observation of the building, it was discovered that the fire safety measures mostly engaged in protecting the building were majorly active measures for fire suppression. These were highlighted in a table showing the percentage of preventive to counteractive measures provided in the entire facility.

Floor	Preventive	Counteractive	Fire Safety
GROUND FLOOR	0	50	50
1ST FLOOR	0	50	50
2ND FLOOR	0	25	25
3RD FLOOR	0	0	0
Average Fire Safety (125/4) = 31.25%			

Table 3: Table Showing the Rate of Safety Measures in the Building

The results of the above table show that the average fire safety rate of the Mike Adenuga building is 31.25%. This figure is far below the acceptable rate of 50%. Therefore, the authors have concluded that the current fire safety measures are not enough for the size and function of the facility; hence, they need to be improved upon.

Below are some images that show the fire safety measures placed in the building.

Figure 3: Image Showing Sand Bucket and Fire Extinguisher Positioned in Front of a Studio
Source: Author's Fieldwork, 2022

Figure 4: Image Showing Fire Extinguisher Close to the Fire Escape Staircase
Source: Author's Fieldwork, 2022

Figure 5: Images Showing Fire Extinguishers Positioned in Front of the Laboratories in the Courtyard Space of the Building
Source: Author's Fieldwork, 2022

Figure 6: Images Showing Fire Extinguishers Positioned in Front of the Laboratories in the Courtyard Space of the Building
Source: Author's Fieldwork, 2022

Figure 7: Images Showing Blocked Exit Points in the Building
Source: Author's Fieldwork, 2022

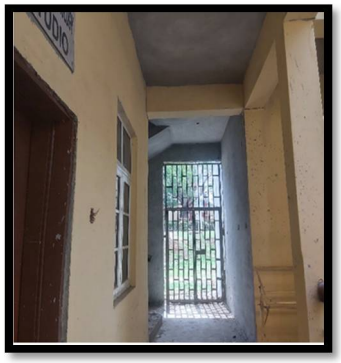

Figure 8: Images Showing an Exit Point Leading from Escape Staircase in the Building
Source: Author's Fieldwork, 2022

Figure 9: Images Showing the Escape Staircase in the Building.
Source: Author's Fieldwork, 2022

3.4. Assess the Level of Risk That the Hazards Pose and Suggest New Information to Upgrade the Existing Features

3.4.1. Arrange Frequent Evaluations of the Assessment

The main cause of the fire to the building might be the electrical failures or deliberate efforts known as arson. This is because there is no direct fire source in the building, like open flames from a kitchen or workshop, but there are a lot of exposed electrical fittings throughout the building.

Figure 10: Image Showing One of the Many Exposed Sockets in the Building
Source: Author's Fieldwork, 2022

Figure 11: Image Showing an Electrical Distribution Board with Some Exposed Wiring
Source: Author's Fieldwork, 202

3.4.1.1. Electrical Hazard

Fires are commonly started by electrical issues. Nearly all buildings have electrical service. However, if it is correctly designed, built, and managed, electrical systems may be both practical and secure, and if not, they run the risk of causing a fire or injuring people. Arcing or heating occurs when a current-carrying electric circuit is accidentally or purposely broken. Arcing, heating, and unintentional contact that could result in electric shock are all things fire protection standards try to prevent. Three categories can be used to classify electrical fires.

- Fires that were ignited by outdated electrical equipment fall under the first category. The majority of electrical fires are brought on by them. Two examples are:
- Electric motors that are filthy or worn out and
- Damaged insulation
- Inappropriate usage of authorized equipment is the cause of the second category of electrical fires. Some of the most frequently mishandled electrical devices include:
- Electric motors,
- Cords that are too heavily loaded, and
- Improper use of heating appliances
- Accidental occurrences or operator errors, such as clothing left in touch with lamps, objects dropped into electrical equipment, heaters left on, or improper installation, is the third cause of electrical fires.

Therefore, in the case of an electrical fire outbreak or any other cause of a fire outbreak, it will take more than a fire extinguisher and a sand bucket to contain it.

The fire would have done considerable damage before someone became alert to it and utilized the available suppression systems. This is because this building lacks adequate fire detection systems that will automatically alert the managers of the building of any possible outbreak. These systems include fire alarm systems, sprinkler systems, and many more.

4. Findings and Recommendations

From the research carried out, the findings show that the floor with the highest fire threats hazard was the ground floor with a 58.3% chance due to the materials, equipment, and building features found in them, and the floor with the lowest was the 3rd floor with a 16.67%. It also shows that the group at more risk during a fire outbreak is the student group, with a 50% rate, as this group uses the building more frequently than the rest. The group with the least risk is the External users, with a 6.25% rate, as this group visits the building occasionally. This research also shows that the average fire safety rate of the Mike Adenuga building was 31.25%, which is far below the acceptable rate of 50%.

The authors have therefore found that the current fire safety measures are not enough for the size and function of the facility; and that they need to be improved upon.

The researchers, in conclusion, found the result of the fire assessment of the Mike Adenuga building to be poor. However, the reason for an assessment initially was to show the owners and managers of the building the fire safety failures and problems to provide room for improvement.

Therefore, the authors have outlined a list of recommendations for the owners to work on before another fire assessment can be carried out to provide a better result for the building. These suggestions are listed as follows:

4.1. Passive Fire Protection

- The construction and planning of the building should be concluded as soon as possible to ensure that the new fire safety measures can be installed properly and working at their full potential before the next fire assessment is done.
- The gates for the escape stairs leading out of the building should be unlocked as they are not currently serving their intended purpose by being locked.
- Electrical fittings and wires left exposed should be repaired to prevent the action of animals, humans, and weather from resulting in a fire outbreak.
- Combustible materials such as wood and plastic, especially on the ground and first floors, should either be replaced with fire-resistant materials or treated with fire retarders.
- The areas with more users, which are the ground and second floor, should have more fire protective features installed in them to protect human life. An example includes fire blankets provided bat such areas.
- Intumescent paints and cementitious coatings should be used on the building to provide fire resistance and ample time to evacuate occupants.
- Fire-rated doors and windows can be installed in areas without providing some resistance to fire spread.
- The abandoned elevator shaft must be resolved to prevent the easy spread of fire from one floor to another.
- There must be a fire safety training course provided by qualified individuals to the users of the building, especially to the students who are the group in more danger in the case of a fire outbreak.
- A muster point should be created for the building and must be clearly defined for every user to know where to go in the case of a fire outbreak.
- Firefighting measures must be easy to see and have the directions of use clearly positioned at their various locations throughout the building.
- Exit points must be boldly highlighted by direction signs and symbols to provide assistance to users in case of fire panic.
- Firefighting service must be a call away, with their contact information bolding put on walls along with fire safety rules and regulations.
- Improved emergency lighting should be provided to enable safe exit in the event of failure of the normal supply. These include equipment that provides illumination in the event of failure of supply to the normal lighting.

4.2. Active Fire Protection

- Heat extractors should be installed in areas with high fire risk, like computer laboratories, to remove air from a space engulfed in the fire to kill off the fire.
- Fire detection systems must be installed throughout the building to alert the users and managers of any fire outbreak in the building. These include:
- Smoke detectors,
- Fire Alarm system – automatic alarm system,
- Heat detectors,
- Pull boxes to notify people of fire

Fire suppression systems must be installed to suppress the act of fire spread in the case of a fire outbreak. These systems include:

- Fire sprinkler system - Automatic sprinkler system
- Updated fire extinguishers
- Sand buckets should be positioned all through the building and must be left undisturbed by users of the building. One of the things noticed was that the sand buckets were used as trash disposal bins and worse.
- Fire hoses must be located close to areas with water supply into the building.

5. Conclusion

The fire assessment carried out on the Mike Adenuga building proved to help unmask the deficiencies the building had in terms of fire protection and safety. This has assisted the researchers in providing recommendations that will go a long way in improving the result of the assessment positively. This research has filled up the paucity of documentation work for the fire assessment of the Mike Adenuga building. The information will thus be made available for the building manager's immediate effect.

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