INTEGRATION OF FIRE SAFETY PERFORMANCE IN MARKET DESIGN; 
CASE STUDY OF ABUBAKAR RIMI MARKET, KANO STATE, NIGERIA

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ABSTRACT

The importance of fire safety in market building design process has been the subject of a recent study to identify the factors within the design process, which influence the integration of fire safety objectives into the process of architectural design. Fire outbreaks in markets have led to a wanton loss of lives and properties worth billions of naira across Nigeria, this ugly sinister isn't mostly due to natural causes but man-made as well. Most markets designs do not put into consideration fire prevention and control strategies that could minimize fire spread in cases of emergencies. The aim of this study is to evaluate fire prevention and control strategies in markets design in Nigeria. For this purpose, market evaluation on fire prevention and control strategies, a case study of Abubakar Rimi Market, Kano State was conducted and data was collected through interview, Focus group discussion, observation and also the use of a checklist. The results obtained from this study showed that the market is not properly designed with regards to fire outbreak. Furthermore, this study shows how fire could easily be spread in a public place with no provision for adequate space/flexibility in a case of an outbreak.

KEYWORDS: Holistic design, buildings, fires prevention, safety, standard
1. INTRODUCTION

Fire safety management in markets is a worldwide challenge, millions of people have lost their lives and others permanently maimed (Adekunle A et al., 2018), properties worth trillions of dollars have been damaged in fire, this has led to serious psychological and economic implications to victims, their relatives and the nation at large. Markets are public places where people meet for business transactions (Adekunle A et al., 2020). In Africa, markets developed as open-air places where people met for business transactions in strategic areas (Ngugi, 2015; Onyango et al., 2013). After some time, markets took diverse forms such as street markets and regional built-up markets. These transformations are as a result of numerous factors which are economic (A Adekunle et al., 2016), political and social factors, cultural behavior in humans, urban informality, demographic changes, and urban land policies for countries of Africa that were colonized (Ngugi, 2015; Onyango et al., 2013). In Nigeria, markets are very important to people in one way or the other and their importance cannot be over emphasized. They serve as an avenue for people to earn living. Man being a social primate needs companionship for entertainment, interaction and other activities; to this end, it was noted that market places serve as an avenue for the interaction of people (Ngugi, 2015; Kamarudin et al., 2015; Raipat).

Fire mostly in Nigerian markets is one of the most destructive, disruptive and costly causes of damage to any building and yet fire doesn’t just happen, it is caused by a human based factor. Fire has been seen as the leading cause of loss of lives and properties at commercial and industrial facilities worldwide. The records of losses from fire incidences in Nigeria are so numerous and this indicates that more work needs to be done by researchers to find more prevention techniques. The market is a commercial place where buying and selling take place. In the past many markets both in and outside Nigeria have recorded significant losses from fire; The case of the Abubakar Rimi central market fire in Kano, the Kure central market in Mina, we have the mile one market fire in port Harcourt, the Ariaria market fire in Aba and so on. The rate at which fire is destroying markets in Nigeria is becoming alarming, owing to the fact that since the beginning of the 2018/2019 Harmattan season, a week does not pass without news of fire incidence in different markets around the country (Ozioma O., 2020). This is painful because, in all these recent cases, affected shop owners barely escaped with their properties. And most importantly. It is quite unfortunate that the incidents of fire outbreak in markets have not taught other market unions and local government authorities in other parts of the country any lesson of any kind. This is obvious from the fact that market unionists and local government agents are more interested in revenue collections than in putting in place, measures that will ensure that fire accidents are prevented or handled swiftly when they happen (Adekunle A et al., 2016).

For example, The Abubakar Rimi Market in Kano state has experienced a myriad of fire outbreaks in almost every year leaving catastrophic damages behind. On 26\textsuperscript{th} march 2016, according to the Daily Trust, a fire outbreak at the Muhammadu Abubakar Rimi market, popularly known as the Sabon Gari market in Kano State destroyed over 500 shops and goods worth billions of naira. The issue of concern is “if fire is caused by human beings”, then what are the factors responsible and how can we control these factors when designing markets in Nigeria. Past studies on market fire have considered human factors that cause fire such as reckless use of electrical appliances, smoking/careless disposal of cigarette stumps, gases from gas cylinders, improper storing of fuel, overloading of electrical
sockets, faulty electrical wiring, illegal connections of electricity and lack of general safety awareness. They are of the view that the most common causes of fire are electrical related.

Table 1. Showing frequency of fire in Abubakar Rimi Market

<table>
<thead>
<tr>
<th>S/N</th>
<th>YEAR</th>
<th>FREQUENCY</th>
<th>PROPERTY LOSS (N)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2000 – 2002</td>
<td>4.00</td>
<td>0.54</td>
</tr>
<tr>
<td>2</td>
<td>2003 – 2005</td>
<td>2.00</td>
<td>1.63</td>
</tr>
<tr>
<td>3</td>
<td>2006 – 2008</td>
<td>3.00</td>
<td>2.83</td>
</tr>
<tr>
<td>4</td>
<td>2009 – 2011</td>
<td>4.00</td>
<td>4.48</td>
</tr>
<tr>
<td>5</td>
<td>2012 – 2014</td>
<td>7.00</td>
<td>5.96</td>
</tr>
<tr>
<td>6</td>
<td>2015 – 2017</td>
<td>5.00</td>
<td>7.62</td>
</tr>
<tr>
<td></td>
<td>TOTAL</td>
<td>26.00</td>
<td>23.06</td>
</tr>
</tbody>
</table>


1.1 Problem Statement

It has been observed that most markets in Nigeria during design and construction do not factor in or integrate fire safety performance in their designs. Architects make numerous design decisions which take into account various functional and aesthetic features needed to satisfy the needs of clients and stakeholders as well as compliance with building codes and regulations. Fire safety is an important need, although it sometimes has a lower priority than other design objectives due to its intrinsic nature and the low level of risk perceived from fire. This study seeks to evaluate some selected Nigerian markets in regards to integration of fire safety performance from the design stage.

1.2 Justification/Significance of the Study

The significance of this study is to expand the understanding of building design features on actual fire safety performance, and explore how fire protection engineers FPE can use this knowledge to increase fire safety in buildings and assist architects to design better and safer buildings.
1.3 Aim and Objectives of the study

The aim of this study is to evaluate fire prevention and control strategies in markets designs in Nigeria. This is hoped to be achieved through the following objectives;

i. Identifying the defect in market design as it relates to fire safety performance.

ii. Identification of access for fire men and fire truck (Ingress/Egress) flexibility within the market.

iii. Design and modelling of market with standard space size measurement for prevention of fire outbreak (Prescriptive-based design)

v. Integration of the objectives of fire safety into the process of architectural design.

1.4 Various design objectives of architects

Some design objectives may cooperate well, contributing to the holistic goals for the building. Generally, architects manage the relationships among the design objectives, prioritizing them and finding the most appropriate design solution with the assistance of the broader design team.

![Diagram of Various Design Objectives of Architects]

Figure 1. Various design objectives of architects
### 2.0 LITERATURE REVIEW

<table>
<thead>
<tr>
<th>S/NO</th>
<th>TOPIC</th>
<th>AUTHORS</th>
<th>FINDINGS</th>
<th>RECOMMENDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A Review on Fire Protection: Architect’s Role during Construction of Buildings</td>
<td>H. Chinna Saidulu</td>
<td>Roles of architects for fire safety while constructing the building.</td>
<td>The study, hereby recommends that in order to achieve the practices of efficient fire management, its proper design from the design stage should be carried out.</td>
</tr>
<tr>
<td>2</td>
<td>Fire Protection Measures in Market Buildings: The Architect’s Design Role</td>
<td>ARC. N. I. OBI</td>
<td>The fire protection codes, laws and standards are as such effectively implemented in advanced countries. Here in Nigeria there seem to be no adequate statutes in place.</td>
<td>Architects’ need to adapt new techniques and new materials and incorporate them in their designs. They also need to liaise with fire professionals and engineers across the globe in order to update their knowledge in fire safety.</td>
</tr>
<tr>
<td>3</td>
<td>Analysis of Active Fire Protection Measures In Garki Model Market of The Federal Capital Territory Of Nigeria</td>
<td>S.N. Zubairu, Odaudu Ugbede Sunday, and A.D. Isah.</td>
<td>The results showed that fire protection devices in the market are not adequate; all the fire hose reels in the market are not in good condition.</td>
<td>The adequacy and functionality of fire protection devices should be ensured by the government of Nigeria and the management authorities of markets in Nigeria</td>
</tr>
</tbody>
</table>
| 4    | Development of Design System for Building Fire Safety                | T. WAKAMATSU                     | 1) low efficiency or overlapping of fire safety measures  
2) low flexibility in architectural design                                                                                                           | The fundamental requirements are essentially the description of the basic fire safety concepts before design.                                                                                              |

Source: [https://www.google.com](https://www.google.com)
3.0 STUDY PROFILE AND METHODOLOGY

3.1 Study Area

The study area for this study is in Kano state, north western Nigeria, which is selected as typical but densely populated cities with high commercial activities in the country. Kano state has a population of over 9,401,288. It lies between latitude 11.75°N and longitude 8.53°E. The presence of a well populated environment has made growth of commercial activities very significant and this has explained the level of buying and selling activities in their markets.

Map of Nigeria showing studying area

Figure 2. Maps of Nigeria Showing Study Area
Source: https://www.google.com/showing-Kano-State-local-government-areas-
Figure 3: Satellite Image Showing Location of Markets Surveyed in Kano State
Source: https://www.google.com/showing-Kano-State-local-government-areas-sampledinthisassessmebbreviation_fig1_322883137&psig=AOvVaw31VP3-DM9-

Figure 4: Conceptual Design Process
The series of actions taken in the conceptual design process may be described as follows:

- **Formulation** refers to the definition or description of a design problem in broad terms through the synthesis of ideas describing alternative facilities.
- **Analysis** refines the problem definition or description by separating important from peripheral information and by pulling together the essential detail. Interpretation and prediction are usually required as part of the analysis.
- **Search** involves gathering a set of potential solutions for performing the specified functions and satisfying the user requirements.
- **Decision** means that each of the potential solutions is evaluated and compared to the alternatives until the best solution is obtained.
- **Specification** is to describe the chosen solution in a form which contains enough detail for implementation.
- **Modification** refers to the change in the solution or re-design if the solution is found to be wanting or if new information is discovered in the process of design.

### 3.2 Data Collection

The research data collection was done by both primary and secondary means. The primary data comprised information that was collected using interviews, direct observations and key informant interviews focus group discussion (FGD), physical measurement of spaces and setbacks. Secondary data was obtained from Fire Service, relevant journals, books, internet, statistical bulletin, newspaper report etc. Direct observations also accorded the researchers the opportunity to get first-hand information on compliance with fire safety measures. Interviews were used to obtain information from personnel of Fire Service in all our visitations which are considered relevant for fire prevention, firefighting and rescue. This instrument was used to collect in-depth information from officers who were well abreast with issues relating to Fire Management.

### 3.3 Data Analysis

Data collected from Fire Service was analyzed using trend analysis to determine trends and patterns of market fire outbreaks within some periods as well as their relationship to environmental factors.

### 4.0 RESULTS AND DISCUSSION

#### 4.1 Market Design and space

I. The as-built market shows the design has been altered causing planning problems and challenge in traffic especially in the event of fire emergency. Pertinent to note is that many of these structures’ extensions are built with wood/timber which has low resistance to fire and contribute to the spread of flame.

II. It is observed from the design (as-built), there are more number of people buying and selling in a small area thereby causing congestion.
Plates 2 and 3: Apparent disregard for the appropriate access road allowance.

(Source; Author’s visitation, 2020)

Plates 4 and 5: Apparent disregard for allowances and distances between buildings and shops to prevent the spread of fire in case of outbreak.

(Source; Author’s visitation, 2020).
4.2. Problems Faced by Fire Service in the Management of Fire Safety.

Internal Traffic Flows and Congestion

Congestion is often the main factor influencing the need for market improvements. Problems often occur where access is limited and where the market authority uses the gate to control entry in order to maximize revenues. If the lead-in length of the internal access road is also very short and the parking of vehicles is not rigorously controlled, congestion is inevitable. Altering the road pattern to work on the basis of a one-way system and extending or changing market trading hours may solve the problem, but this will not help if the parking of vehicles inside the market is uncontrolled and there is a lack of traffic management.

Plates 6 and 7; Poor access in between shops and Building of attachments on access road.
(Source; Author’s visitation, 2020)
4.3 Development of quantitative model standards.

As shown below, the building fire safety performance is involved with various characteristics of building, people, and fire components and the cause-effect relationships among them. In other words, a holistic perspective accounting for the effects of not only individual characteristics but also the various interactions among both hard and soft characteristics is required in order to properly assess the building fire safety performance. With the holistic understanding as a prerequisite, a quantification method commonly used in analytical hierarchy process is adopted using standards.

Plates 8 and 9: Extension of roof covering without considering access for fire trucks should in case of fire outbreak in the market.
According to National Building code 2006,

the market is design consciously to prevent and control emergency fire out break and to curtail the deteriorating effect of the infrastructure as a result of other negative factors militating against market facilities for instance Waste management systems, circulation patterns both vehicular and pedestrian amongst others. Apart from providing stall/shops it would also provide a conducive atmosphere for both the buyers and sellers.
Plate 5; A 3d architectural design showing a normal standard of 4meter between shop without any alteration or extension of roofs or steps to cause obstructions for a fire truck to pass between.

Plate 6. Distance Between shops in Market after alterations.

Above is a picture view showing the existing space between shops in Kano market. The actual construction of space left is 3.80mm, which is enough for a fire truck to pass between. But the space left after alteration from extension of roof and steps as shown in the picture is 1.5m.
Plate 7: A 3d architectural design showing the area view in a zone of the market with required setbacks of 6metersand 4meter distance between each shops in an holistic design approach.
Plate 8. Fire Service Outpost in Market with lots of obstructions in front of the fire truck, looking at this plate, it will take a fire man another 30 minute to clear it way before moving of the truck for any fire outbreak.

Plate 9; 3d design view of a holistic design showing a fire truck outpost in the market ready for operations. A fire truck ready for operation should always be free of obstructions.

4.4 Provide access and means of egress.

Access is classified users:

a. Building users

b. Fire fighters
Building users

Building should be designed and constructed so that there are means of escape from the building, accessible to the building users, in case of fire to a place of safety outside the building. The main danger to people in buildings, in early stages of a fire, is the smoke and noxious gases produced which cause most of the casualties and may also obscure the way to escape routes and exits. The regulations are concerned to:

a. Provide a sufficient number and capacity of escape routes to a place of safety.

b. Protect escape routes from the effects of fire by enclosure, where necessary, and to limit the ingress of smoke

c. Ensure the escape routes are adequately lit and exits suitably indicated.

The general principle of means of escape is that any person in a building confronted by an outbreak of fire can turn away from it and make a safe escape. The number of escape routes depends on the number of occupants in the room or building, and the limits on travel distance to the nearest exit depend on the type of occupancy.

Fire fighters

Access is very vital in fire safety this should serve both firefighters and users trapped during emergencies. Access should be designed to accommodate the vehicles and others gadgets of fire firefighters. During fire emergencies means of egress for evacuation is key.

Plate 10 showing an holistic architectural design of market shops with its standard measurement of 3.6meters width and length of 2.8meters.
Plate 11 showing an unobstructed traffic circulation pattern and effective parking control with adequate parking facilities being provided for feasibility of cars and fire truck.

Plate 12; provision and full utilization of support facilities and adequate arrangements for display and sale of produce with adequate spaces within the market, entrance and exit.

The distance between inner and outer turning circle radius is to provide body swing clearance (i.e. vehicle swept path), and not be less than 5 m for general fire appliance access and 7.5m for specialist fire appliance access.
4.5 Market Lay-out

A market lay-out is an organization and components of a typical market, it can be discussed in terms of the suitability of different layouts, the zoning of specialized activities in the market, the market's traffic circulation pattern, its relationship to adjacent uses and the potential conflict with traffic flows. Most Market operations these days are influenced by management methods and by the physical lay-out. They need to achieve. From the market-layout gotten from Abubakar Rimi market, we were able to modify/ re-design an organized market with Integration Fire Safety Performance.
4.6 Utilization of Space in Markets

The optimum use of space in markets is one of the keys to their success. The fundamental design decision relates to determining the “core” space of the market, i.e. the area in which sales occur. This area includes both the area occupied by the traders and the local circulation area needed to reach these stalls or premises. This area may be totally indoors or may be a combination of covered space such as a stall, combined with external gangways or access platforms. The available sales space will have a direct relationship on the rents that can be charged and will affect the market’s throughput. In addition to the sales space, allowance also has to be made for ancillary and supporting services, such as administrative offices and banks.

5.0 CONCLUSION

From this study the following conclusions can also be reached;

- Architects tend to determine building design features in most cases, based on various building design objectives. Fire safety is one of them, but again tends to not draw architects’ attention much.
- Shop owners/traders in Nigeria have low level of awareness and preparedness towards causes of market fire.
- The causes of market fire in Nigeria market can be grouped into 6 categories in ranking which are general storing, electrical installations and related issues, disposal...
and knowledge of market locations, market exit points and muster points, regulations regarding markets, awareness and fire emergency plan

✓ Curbing of market fire effectively in Nigerian markets should start from the design stage.

5.1 RECOMMENDATION

To reduce the rate of fire incidences in Nigerian markets the following are recommended:

✓ The government should take more seriously the design of markets and adopt points laid out in this study for professionals to consider in their design and operation of markets
✓ A safety and quality management team should be instituted to manage every market in Nigeria.
✓ An integration of mechanical suppression systems into the design of markets is required. This can be achieved by providing fire hydrants at 30meters interval each.
✓ Segregation (zoning) of areas that are susceptible to fire from places that are less susceptible.
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