ASSESSMENT OF FIRE SAFETY MEASURES IN THE DESIGN OF CONFLUENCE SHOPPING MALL LOKOJA, KOGI STATE

BY

AUDU, Francis Eleojo
MTech/SET/2017/7002

DEPARTMENT OF ARCHITECTURE
FEDERAL UNIVERSITY OF TECHNOLOGY,
MINNA

APRIL, 2021

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ABSTRACT

Shopping malls are fundamentally large complex buildings occupied by considerable numbers of the general public and shop staff. These buildings must be planned to be safe and in the event of an emergency or fire outbreak, allow for fast and safe evacuation from the building by all its occupants. In designs, fire safety is one of the most .important and Complex considerations. Fire safety requirements will be more onerous for enclosed and covered shopping malls than for open street based schemes. Shopping malls are approached by people from different walk of life. These buildings are marked by their diversity in activities. The aim of this research. is to assess fire safety measures in case of emergency in shopping malls with the view to secure lives and properties. Interview and a checklist survey were used for data collection in this research. The findings from the checklist of assessment of case studies carried out shows that fire safety measures is insufficient and among of these present safety features, some of them are adequate for the purpose they were provided while others were not. The facilities were assessed were passive and active fire safety features, the analysis shows that 75% of the passive features assessed were present at the shopping mall below average. It also shows in that half of the active for safety features were present above 50%. For the purpose of this research, Ten case studies were carried out both locally and internationally which are; Silverbird Galleria, Abuja, Ceddi Plaza, Abuja, Jabbi lake mall jabi, area 1 shopping mall, Shoprite lugbe/lugbe mall, Hebron plaza, gudu district, Shagari Plaza, Bannex Plaza, zone 2, Willow shopping mall, Townsville, Autralia, and Bullring shopping mall, Birmingham. The findings from the case studies carried out shows that fire safety is prerequisite for any shopping mall design. The finding also shows that both passive and active fire safety measures should be employed in shopping mall design. The interview reveals that regular routine check of fire safety element is paramount. Some of the recommendations include; building in compliance with national building code (NBC) and providing a simple evacuation plan in each floor of the building,

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Background of the Study

Shopping malls are approached by people who have different Jobs or position in the society. These buildings are marked by their diversity in activities and vast flow of employees and customer alike. For that reason, the provision of satisfactory or acceptable safety measures demands great attention. Fire incidence in a public building post a threat or endangers humans and their properties. They have been determined attempt to solve fire risk in public buildings. (Alexander, 2002) has identified and managed potential issues or problems for fire incidence in huge store in Nigeria. Daily, the demand for arrange shopping mall is becoming essential in the society. These buildings must be protected and in the case of unforeseen event or fire disaster, take into account quick and secure relocation from the building by the people who lives or work there (Peter, 2006).

In the architectural design or pattern of the public buildings such as shopping malls, fire safety is very essential with serious concern. Shopping malls; like any retail centre, confront with damages cost for a whole host of hazard, from tragedy to fire death bow. Shopping malls are commonly the most complicated of retail structures, requiring a fire alarm system needed without being in excess to give messages or signal for the active system (David, 2006).

In Nigeria, factors such as location, administrative and economic having added towards a substantial increase in shopping activities. Climbing on the rear of population, prompt urbanization, changing the shopping ways of life and an increasing middle class. The growth passing through the open based schemes in Nigeria.

Advancement in the Nigerian market is an indication of the growth in the middle class whose shopping importance has improved from the primitive shopping in an open based scheme to a more arranged and comfortable shopping experience proffered by retail mall (Odinaka, 2014). In order to achieve a convenient shopping experience, there is need for the shoppers to feel safe in case of fire accident. This can be achieved only by providing both preventive and control safety measures in the event of fire outbreak in shopping malls and commercial centre.

1.2 Problem Statement

Inspite of the fact that acceptable safety are important for enjoying a threat free shopping surrounding, it has been observed that they do not accommodate even the basic practice of design principles (Martin & Andrew, 2005). As public facility, every shopping mall needs to be safe for human use. Fire safety measures must be considered right from the preliminary shopping mall design stage to finish. In Nigeria, shopping malls rely on fire fighters to extinguish fire rather than extinguishing from the fire safety instruments in the shopping mall. This trend has been a problem to the society and as such, the need for providing system that require some amount of action to work and system that compartmentalize a building through the use of resistant rated walls and floors (Odinaka, 2014).

1.3 Aim and Objectives

1.3.1 Aim

The aim of this research is to assess the fire safety measures in case of emergency with the view to secure lives and properties.

1.3.2 Objectives

i. To identify fire safety measures in the existing shopping malls in Abuja
ii. To determine the fundamental fire safety features.
iii. To design a shopping mall building where the safety of its users is enhanced through the incorporation of fire safety design features.

1.4 Justification of the Study

The study we go in search of locating the key issues that can be used in laying out a secured shopping background through the application of fire safety measures. This will act as steers towards accomplishing or attaining a pleasurable and danger free shopping surrounding in the North central part of Nigeria. This research will also aid in increasing the shopping activities in shopping malls than in open air market because of adequate safety that will be achieved.

1.5 Scope of Study

The research is restricted to findings of fire safety measures in shopping malls, especially in Abuja. There by assisting architects and other designers in providing the best passive and active fire safety measures that could be used in protecting lives and properties.

1.6 Limitation of the Study

A major limitation capable of affecting the success and execution of this research work is identifying the application of fire safety measures in the design of the available facilities as they are not duly incorporated in their initial designs.

1.7 Study Area

Abuja is Nigerian Headquarter sited at the middle of the nation. It is designed and constructed to take over the position of Lagos in the 80s. It is enclosed in the eastern part by Nasarawa State, northern area by Kaduna State, western part by Niger State and Southern area by Kogi. These Locations were selected due to their constant exposure to the modern trend of architectural form aided by the resultant effect of urbanization and industrialization engulfing the globe.

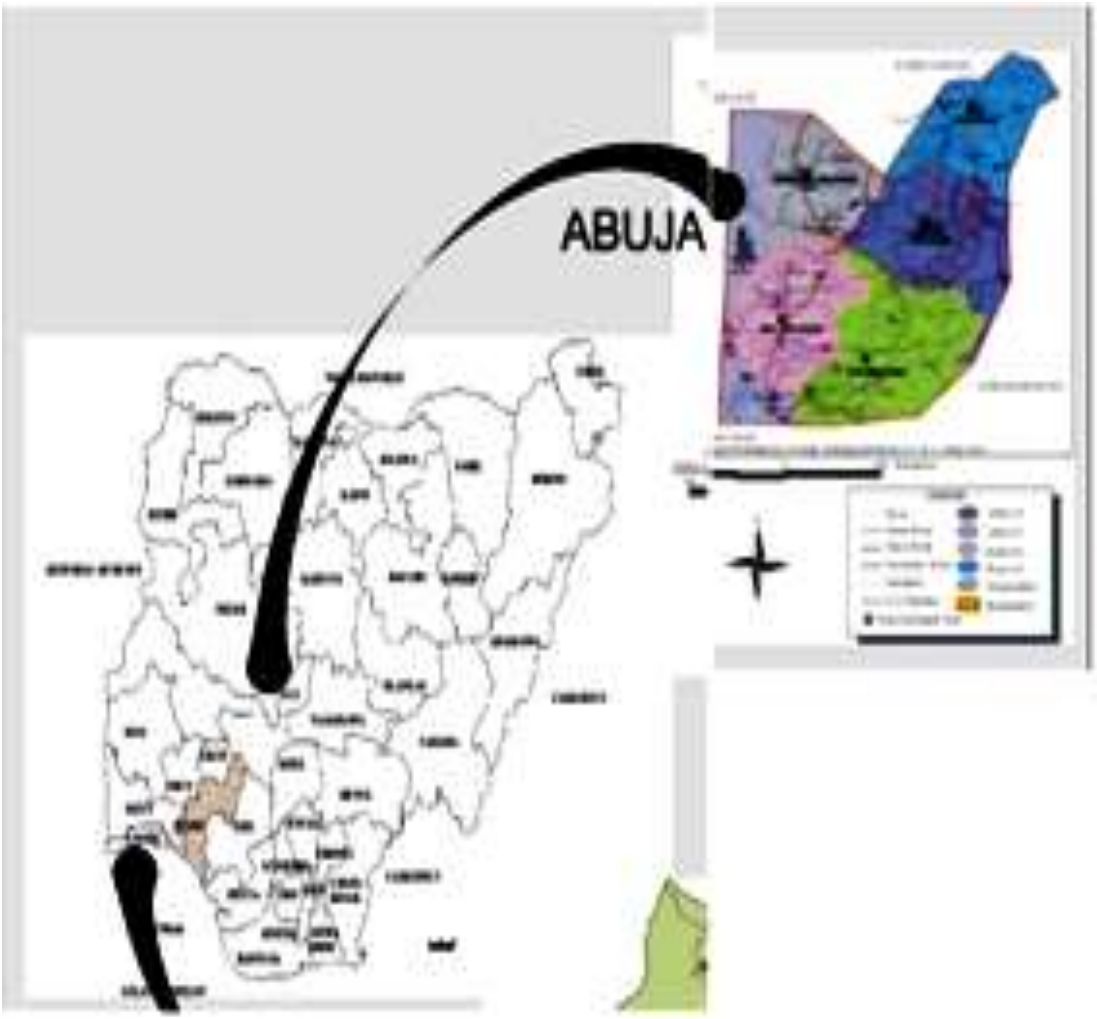


Figure 1.1: The Study Area
(Source: Adapted from www.motherlandnigeria.com/geography.html, 2018)

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Overview of Shopping Mall

A shopping mall is an up to date or current construction of shopping centre in which separate buildings figures a multiple of shop's standing from merchandisers with interrelating path that enable customer to work for one section to another (Persner, 2004). They are recommended shopping place for tourist. Shopping is the major project that happens in shopping centres. Shopping is to check consumables with determination to buy, to hurt rough a market on ransack of the best to buy. However, shopping could be pleasant or an unfortunate occurrence as a result of the condition and equipment in place. The suggested mall is an approach to making shopping complex a pleasant experience with the aid of a conductive environment and satisfactory equipment or comfort in terms of fire safety (Prior, 1999).

All over the world, shopping for consumption which is done either by exchange of money or goods has constantly of maximum significant to the routine of humanity. These manner or process changes from a place to another. No matter how these methods vary, the underlying and basic desire in all these settings is to bring into being a conducive surrounding for the purpose of buying goods and services but also to satisfy social needs (Cohen, 2003). In primitive market where people walk many kilometers from the outlying isolated areas carrying their produce and goods, the social aspect is the most important part of the persons experience. It becomes a festival day and the market assumes the role of community get together and it was pleasurable culmination of the weeks work. This important social aspect of the market place gradually lots its role, when urban pattern gave way to the sophistication and subsequent detachment

characteristics of city life. In large cities, shopping centers we created as what we can central business district. These were close to the administrative and recreational faculties forming the dynamic of city life pattern.

In large cities, shopping centers we created aw what we can central business district. These were close to the administrative and recreational facilities forming the dynamic of city life pattern. Though the primary function of a shop is to sell goods or services to the public at an accepted profit (Lee, 2005). However, retailing methods and shopping patterns are changing rapidly to meet new social conditions. These changes are emphasized in shop planning and selling methods with new development must be kept in check.

2.2 Shopping Mall Classification

For several years, the concept of shopping center has occupied on an uncertainty display of sameness which includes, Lifestyle Centers, Shops, Mega malls, Hybrids, Outlets, Squares, Super Centres, Town Centers, Vertical, Mixed-Use, Villages Urban Retail, Promenades, Strips, Centres and Plazas. Regrettably, there is lack of understanding regarding many kind of shopping center formats. The manner individual centres should be allocated to several groups. Add on to the uncertainty is that shopping centers can be set apart by severe of marketing and management strategies including: Luxury, Entertainment, Ethnicity and Festival. In addressing the feasible connection of these kind of distinguishing facts, it is obvious that people contemplate the retail sector basically complicated to comprehend (James, 2005).

Table 2.1: The ICSC types of malls and shopping centers.

Type of Malls	Concept	Size range, No. of stores Sqm
Regional centre	General merchandise, fashion	50-100,000 (150-250)
Super Regional centre	Same as regional: more variety & Assortment	Over 100,000 (250 above)
Open-air centres		
Neighborhood centre	Convenience	5000-12,000 (25-50)
Community centre	General merchandise, convenience	12000-25,000 (50-100)
Lifestyle centre	Upscale, national specialty, entertainment, outdoor	15-50,000
Power centre	Category-dominant anchors, few small tenants	25-60,000
Theme/festival centre	Leisure, tourist-oriented: retail & service	8-25,000

(Source: Runstad Centre, ICSC, 2005).

2.2.1 Regional centre

A shopping center typically incorporating one full line department store, a full line discount department store, one or more supermarkets and around 100 or more specialty shops. Total GLAR typically ranges between 30,000 and 50,000 square meters. (www.icsc.org) In some instances, all other characteristics being equal, a centre with two full discount department stores, without a department store, can serve as a regional centre. Key features:

I. Extensive coverage of a broad range of retail needs (including specialized retail), however, not as exhaustive as major regional centres;

II. Contain a combination of full line department stores, full line discount department stores, supermarkets, banks, chain and other specialty retailers; as shown in plate I

III. Provide a broad range of shopper facilities and amenities.

Plate I: Regional Toronto Eaton Center, California
(Source: James, 2005)

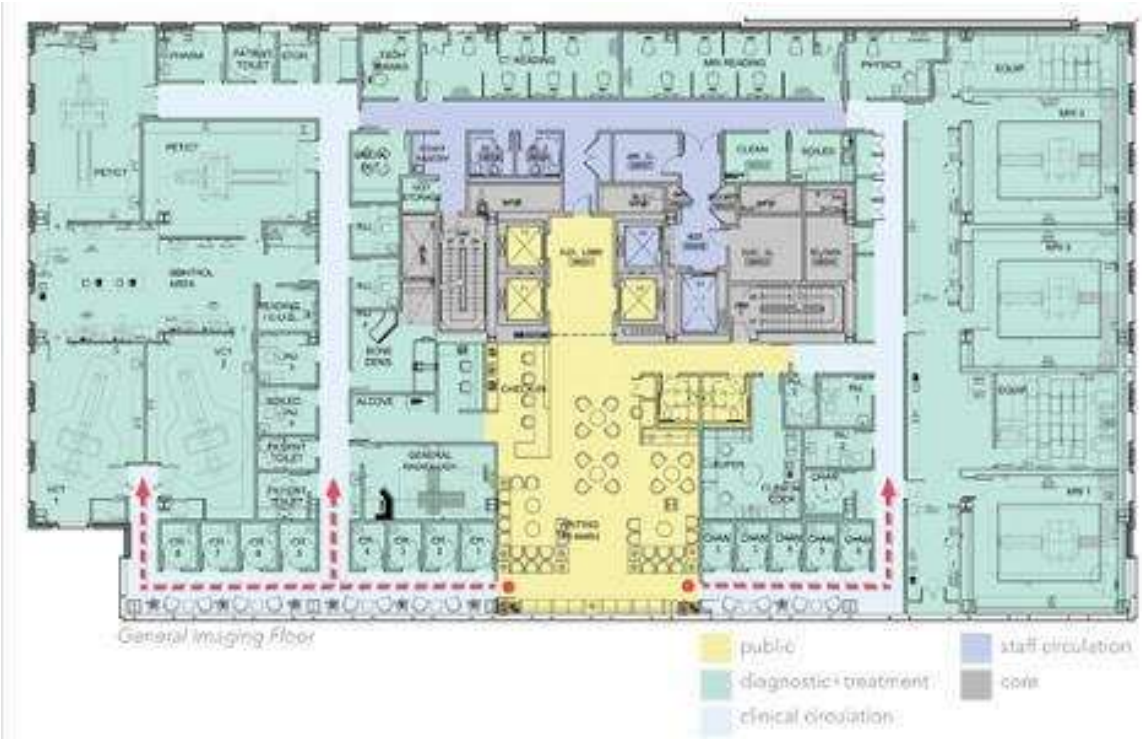


Figure 2.1: A floor plan of regional shopping mall
Source: James, (2005)

2.2.2 Super regional centre

According to the International Council of Shopping Centers (ICSC), a major shopping center typically incorporating two full line department stores, one or more full line discount department stores, two supermarkets and around 250 or more specialty shops.

Total GLAR exceeds 85,000 square meters. Key features:

I. one-stop shopping for all needs'

II. comprehensive coverage of the full range of retail needs (including specialized retail), containing a combination of full line department stores, supermarkets, services, chain another specialty retailers;

III. typically include a number of entertainment and leisure attractions such as cinemas, game arcades and soft play centers; as shown in plate ii

IV. Provide a broad range of shopper facilities (car parking, food court) and amenities (restrooms, seating).

Plate II: Showing pond ok Indah super regional mall, Jakarta, Indonesia (Source: Peter, 2006)

2.2.3 Neighborhood center

A local shopping center comprising a supermarket and approximately 35 specialty shops.

Total GLAR will typically be less than 10,000 square meters. Key features:

I. Typically located in residential areas;

II. Service immediate residential neighborhood;

III. Usually have extended trading hours; and

IV. Cater for basic day-to-day retail needs.

Plate III: A neighborhood center in the form of strip mall, Cornelius, Orego (Source: Peter, 2006)

2.2.4 Outlet center

An outlet mall (or outlet centre) is a type of shopping mall in which manufacturers sell their products directly to the public through their own stores. Other stores in outlet malls are operated by retailers selling returned goods and discontinued products, often at heavily reduced prices. Outlet stores were found as early as 1936, but the first multi-store outlet mall, Vanity Fair, located in Reading, PA did not open until 1974.

Belz 28 Enterprises opened the first enclosed factory outlet mall in 1979, in Lakeland, TN, a suburb of Memphis (Schoenherr, 2006).

2.2.5 Lifestyle centers

Lifestyle centers are targeted at a specific sector of the market – the young urban professional, with a tendency towards up market retailing, providing shops and facilities for those with ambition and the desire to succeed. Lifestyle centers are composed of selective elements found at the mall but arranged in an external and attractive environment. As such they attract those customers from the mall and those who would not normally select the mall for shopping. Lifestyle centres are made up from a carefully selected mix of aspirational retailers (plate IV). These retailers are a mixture of comparison fashion brands, leisure and sportswear, which reflect a hobby or interest, and household goods providing good quality furniture and housewares. All the shops contain certain products which the shopper would aspire to and reflect their ideals. Combined with these retailers there will be a variety of cafés and restaurants allowing a visit to the center to be combined with relaxed refreshment or a meal (Peter, 2006).

Plate IV: Lifestyle shopping mall, Alabama
(Source: Peter, 2006)

2.3 Shopping Mall Design Criteria

2.3.1 Optimum size

Figure 2.2 shows how idea volume of a shopping centre is set up as at total of retail floor space that a shop tenants leased. It is known as the gross leasable area (GLA). The retail brief to the architect is usually expressed as an amount of GLA. It is important, for the purposes of the early site planning exercises, for the architect to convert the GLA into the potential overall gross area. To achieve this conversion simply, an additional area needs to be added to the GLA to allow for means of escape, structure, external wall, service access, supporting accommodation. As a general rule the GLA should represent about 80 per cent of the gross area. It should be noted that the GLA also excludes the public circulation space, service yards and car parking areas which will need to be allowed for. The public circulation space will need to be considered for each project and is influenced by individual site conditions. The inclusion of public circulation space in the gross area will differ between enclosed and open schemes.

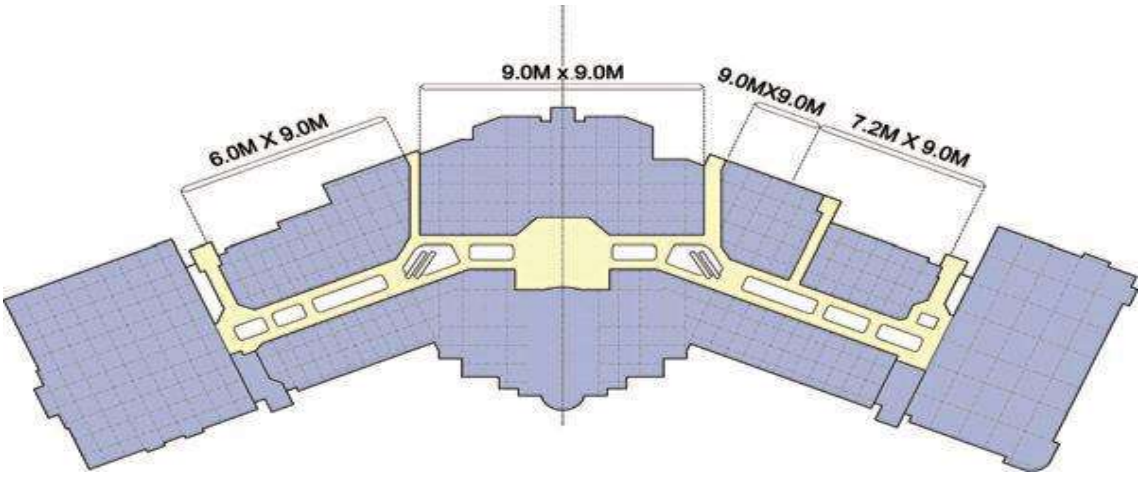


Figure 2.2: Showing Plan layout of the Mall at Cribbs Causeway, Bristol, UK showing variable grids providing different shop unit sizes.
Source: (Peter, 2006)

2.3.2 Site accessibility

Site availability has been shown as one of the major problem of concern when valuing the site of a shopping mall. It makes buyer to easily visit and moved to return how adequate product can be delivered to provide to the shop a means of protection of the occupants. Figure 2.15 identifies how Understanding a site location provides for public transport, private cars and service vehicles is essential to establishing the brief for the new facilities in the development.

Accessibility includes an understanding of all modes of transport and access to the site which includes pedestrian and cycle-ways.

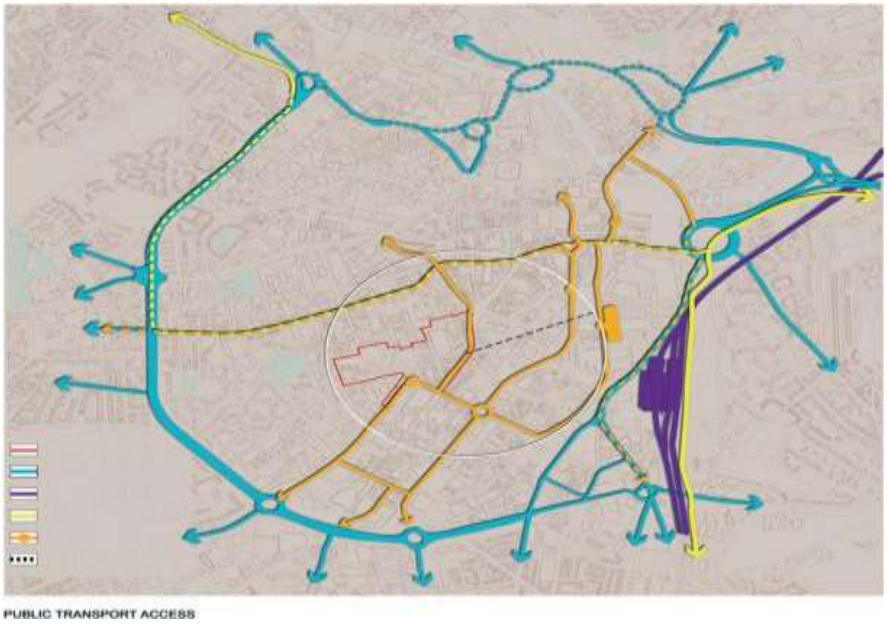


Figure 2.3: A typical immediate transport and access assessment diagram prepared for the New Retail Quarter, Sheffield, UK (planned 2010) (Source: Peter, 2006).

2.3.3 Parking lots

Private motor cars are the preferred means of transport for customers visiting a shopping mall. Cars provide a safe, convenient and reliable means of access and, until public transport becomes more economical and convenient, will remain the life blood of

shopping centres. No doubt the eventual demise of available petrol and diesel sources will force alternative means to be considered. However, for the foreseeable future the design of shopping centres will need to accommodate the motor car as the means of transporting the majority of customers to the centre. Accommodating the motor car first requires a suitable road network to distribute the cars to and from the mall, and secondly a means of parking them on arrival.

Car parking to a shopping centre development can be provided in a variety of ways, or in various combinations of:

a. New car parking provided with the shopping centre
b. Existing car parking adjacent to the development
c. Off-site car parking in a park and ride facility with buses transferring customers from perimeter car parks into the town centre.

Major anchor tenants will have minimum parking requirements for the number of spaces they wish to provided on site. This figure can vary, but can be as many as 1000 parking spaces for some major tenants. The British Council of Shopping Centres provides a general rule of two to four spaces per100m^2 of new accommodation (British Council of Shopping Centres, 2000). For a typical centre of 50 000m^2 this could be as many as 1000 to 2000parking spaces.

2.3.4 Services vehicles

Service vehicles include all the various vehicles that service the shops, catering and leisure facilities of the shopping centre. Stand as major factor of a shopping centre and cannot be seen by the buyers. They are key to the business of the tenant and to the operation of the landlord/owner “premises”. Along with the assessment of the capacity of private cars and public transport, an assessment will need to be made of the capacity

of the road infrastructure to distribute service vehicles to and from the proposed development. Although service vehicles can share the primary road network to the centre their points of access should be kept separate from those for private cars and public transport.

The type of service vehicles to be accommodated range from vehicles for refuse, vehicles for shop delivery and vehicles for firefighting. Of these service parking spaces, there will be required for articulated vehicles or larger grid trucks. Additionally, large stores and major anchors will require their own dedicated service vehicle parking bays. Parking space will also be required in the unloading yard for refuse compactors and skips which accommodate compacted rubbish, along with parking spaces for the refuse vehicles that remove the skips. For an average sized shopping centre of 45 000m^2 (500 000 ft^2) the total number of parking spaces can be as many as 30 spaces, plus space for refuse vehicle accommodation. This can require a considerable amount of space and needs careful planning to remain discreet and accessible to all parts of the shopping centre. In some centres it may be necessary to provide several unloading areas to ensure convenience for all the shops. It is also worth bringing in a specialist highways consultant to determine the exact number of service bays to be provided so as to avoid over-sizing the service yard facilities (Schoenherr, 2006).

2.3.4.1 Firefighting access

The shopping centre will need to be planned to allow for ready access of fire-fighting vehicles to predetermined points around the building or buildings. From these predetermined points of access, hose reels will be required to extend from the fire-fighting vehicles to cover all parts of the shopping centre. Early consultation with the fire service is recommended to establish the permitted maximum lengths of hose reel, to

show the extent of access points for the fire-fighting vehicles. Fire-fighting vehicle access must remain unobstructed and should be of sufficient width to allow for turning if not arranged on a through route. Access routes need to allow for the significant weight of a fire-fighting vehicle. The other fire-fighting facilities required within the building can also be established from early consultation with the fire service (Peter, 2006).

2.3.5 Layout (Organizational framework)

The layout is fundamental towards the progress of the shopping mall and is therefore considered here as part of the primary brief. The primary brief should start with simple objectives which can evolve as the design progresses. The considerations here have been organised into general objectives for the primary brief.

2.3.5.1 General layout objectives

The layout should form a special and existing site that is convenient, protected and pleasant for service

i. It should be legible and easy to understand
ii. The arrangement should establish strong pedestrian flows which will allow customers to pass along all the retail frontages
iii. Anchor stores should be positioned to generate and reinforce pedestrian flow
iv. Medium space user stores should also be located to reinforce pedestrian flow
v. Other major attractions (leisure facilities and catering areas) can be located to assist pedestrian flow
vi. Other generators of footfall which include entranceways from car parks, points of access from public transport, vertical circulation points including stairs, escalators and lifts, should be positioned to assist pedestrian flow

vii. The arrangement of public circulation space should form natural circuits and avoid customers having to retrace steps

2.4 Horizontal Circulation Layout

One of the fundamental ways of establishing strong pedestrian flows is to point the generator of footfall. The stronger retail areas are those perceived as having the most footfall. The most occupied place happened at the entrance to anchor element and the non-survive beyond the anchor, unless a new attraction, or another anchor, is perceived ahead. Hence, putting the generator in a good side for access to all for the volume of footfall to be evenly distributed past all the shop fronts (figure 2.4).

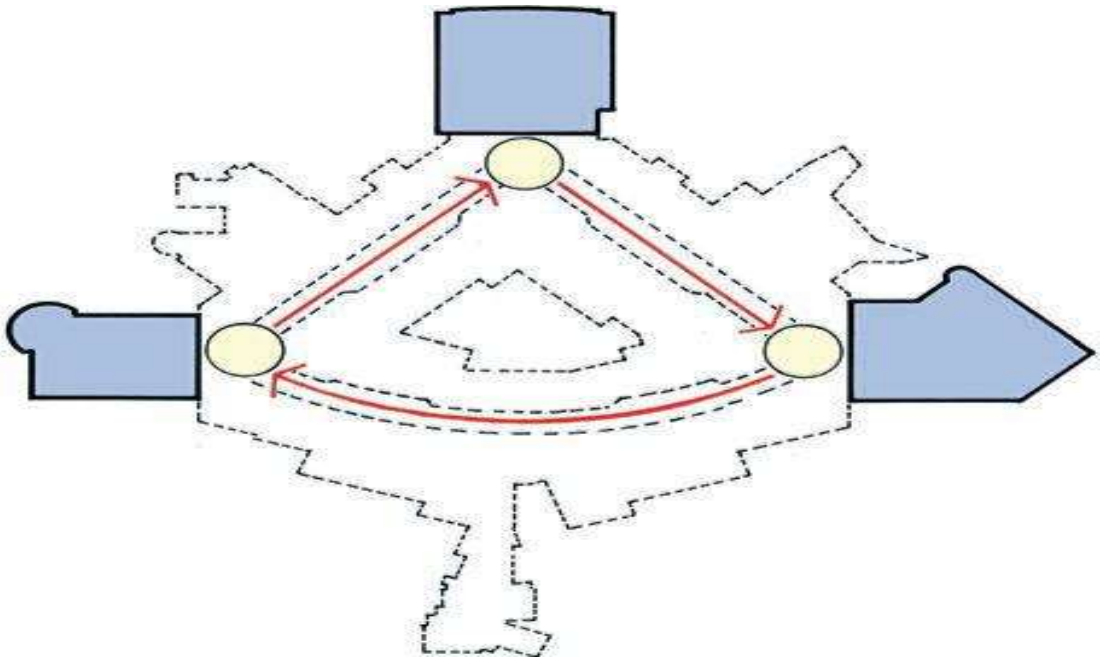


Figure 2.4: Showing the strategic positioning of anchor stores are used to generate footfall around a circuit such as Bluewater, Greenhithe, Kent, UK. (Source: Peter, 2006).

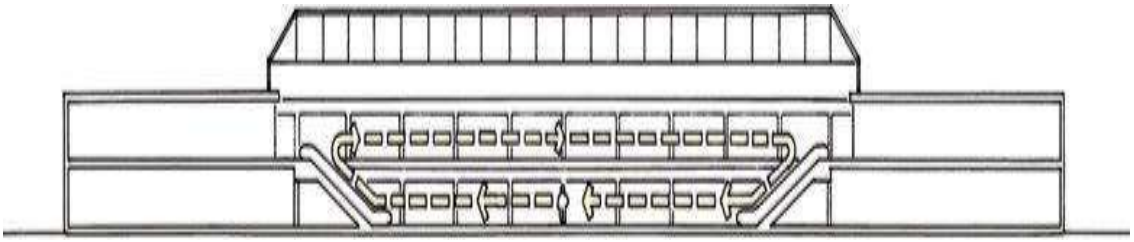


Figure 2.5: Two level dumb-bell arrangements allow circulation past all shop fronts without retracing steps.
(Source: Peter, 2006)

2.5 Vertical Circulation Layout

The successful inclusion of vertical circulation is one of the key enablers to the operation of multi-level shopping layouts and, as such, facilitates shopping development located on 39 high value land. In multi-level schemes, vertical circulation should be considered, equally with horizontal circulation, as the means of structuring the layout and encouraging pedestrians to pass by all the shop units equally. Positioning of vertical circulation has to achieve a balance between facilitating pedestrian footfall and providing a convenient means for visitors to move between different floor levels.

Generally, vertical circulation should be organized to allow visitors to passing front of a recognizable length of shops before changing level and returning past a further length of shop fronts (Figure 2.21). Equally importantly, the vertical circulation should be positioned so that it is clearly visible and understandable, allowing visitors to stop in a leisurely way having foreseen where to change level. The vertical circulation should also be positioned to encourage visitors to move forward and towards the point of changing level. Vertical circulation must be conveniently and strategically located. It should be positioned at regular intervals, which generally should not exceed 80 – 100m (260–325 ft). The interval positioning of vertical circulation is dimensionally similar to the positioning of punctuation spaces in horizontal circulation.

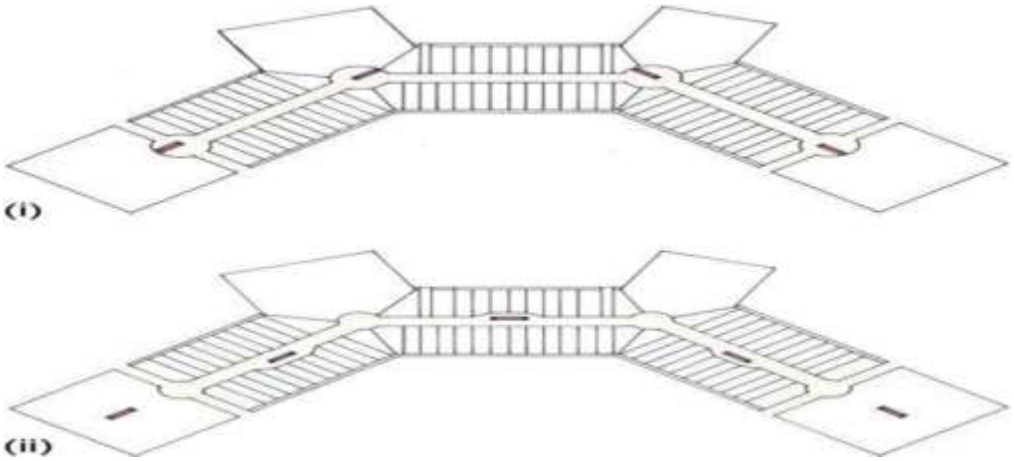


Figure 2.6: Vertical circulation: alternative escalator locations.(i) Escalators located in the node spaces; (ii) escalators located in the malls
(Source: Martine, 2000)

Plate V: Showing the Escalators in the node space, Brent Cross, London, UK.
(Source: Martine, 2000)

2.6 Types of Vertical Circulation

Where vertical circulation is required to provide level changes in the layout, this can be provided by a variety of means. It is usual for a combination of stairs, lifts and escalators to be used to solve the vertical circulation requirements of multi-level shopping facilities. Ramps and sloping the floor are also used readily to accommodate small level changes.

I. Stairs

Stair Character in general space of circulation area are exact and easy manner of transferring strangers vertically between levels and are commonly used and accepted in shopping facilities. Stairs can be sited personally or positioned together with escalators in a variety of combinations. For example, plate V shows stairs is properly located, it can reinforce the total circulation pattern with escalators in node spaces. Alternatively, stairs can be positioned individually midway between the node spaces in the public circulation space or in the node space when the space is kept free of escalators. Stairs are accommodated into the layout more flexibly than escalators and provide a convenient alternative option for allowing visitors to connect between floors.

Plate VI: A generously wide mall accommodates a dog-legfeature stair, Metro centre, Gates head, UK (1984–1987) (Source: Martine, 2000)

Plate VII: Feature stair in the knuckle space at the Sun Court, Bluewater, Greenhithe, Kent, UK (1999). (Source: Martine, 2000)

II. **Ramps**

Independent ramps and sloping the floor of the public space are discreet ways of making up small level differences.

Plate VI shows that Independent ramps can be used to form a deliberate level change and to help reinforce the separation of circulation space from a seating area. Careful consideration will need to be given to all ramp designs to ensure they comply with the regulatory requirements for accommodating less able persons.

III. **Escalators**

Stairs in motion has been used in retail premises. Since their acceptance escalation are mainly used from the period of expansion in 1950s America – with the growth of the out-of-town regional shopping centre. The escalator as a primary means of transferring large size of the shopping public between diverse shopping levels. Escalators are connected and taken up as the primary means of vertical circulation in shopping facilities throughout the world (Plate VII).

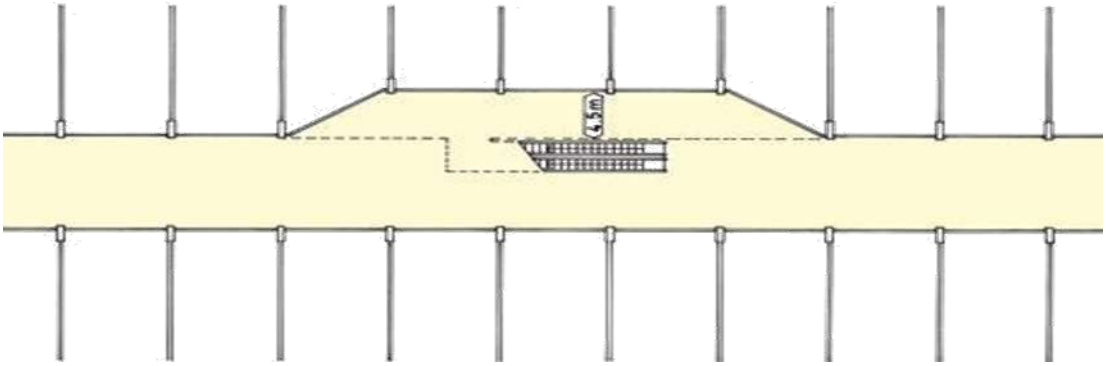


Figure 2.7: The presence of escalators need the mall to form sufficient space between the escalators and shop fronts (Source: Peter, 2006)

Plate VIII: Escalators in the widened mall space Centre West, East Kilbride, Glasgow, UK (Source: Martine, 2000)

IV. **Travelators**

Travelators can be as inclined (as replacement for the escalator) and horizontal. The inclined travelators has an important benefit over the escalator, whether there is no steps on the travelator is of better comfort and not difficult to guide with wheel chair and children. Travelators is largely shared in main shopping malls, transtations, exhibition center and airport.

Plate IX: A pair of travelators span across the water feature, Blanchards Town, Dublin, Ireland. (Source: Peter, 2006).

V. **Lift**

It can also be called an Elevator. It will be required for use by disabled persons and those with prams and pushchairs. The same lifts will also be used for the general convenience of the shopping public. The lifts considered here are those operating between the different floor levels of public circulation space and those areas that extend to the car parking located above or below the shopping facilities. Lifts has a direct connection to car parking will be important provision of footfall can be well positioned to help balance and distribute pedestrian footfall between different floor levels of a centre.

Plate X: Square lift in a circular glazed enclosure in the enclosed mall, Smaralind, Reykjavik, Iceland. (Source: Peter, 2006).

2.7 Ventilation

Ventilation in a simple term is a phenomenon that require movement of air to terminate the used air and replace it with new air. Ventilation will also decrease the extent of humidity prevalent in hot-humid zones. Ventilation is gotten by ordinary and man-made means.

a) Artificial Ventilation

This entails the manipulation of the temperature and relative humidity within a space and the movement and composition of the air mass across it (Ernst and Neufert, 2006).

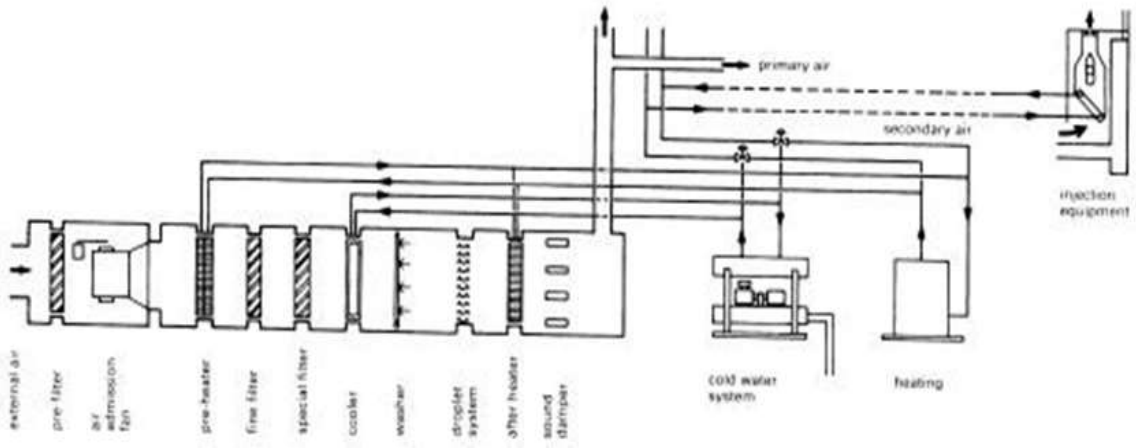


Figure 2.8: Central Air Conditioning System (Source: Ernst and Neufert, 2000)

2.8 Facilities in Shopping Mall

The shopping mall complex shall be aimed at housing the four important sections that are viewed by the (ICSC, 1998) as the contemporary areas that a shopping centre should have to be referred to as a mall. They include

i. Leisure facilities
ii. Entertainment Facilities
iii. Catering Facilities
iv. Retail Facilities.

2.8.1 The Retail Facilities

The unit shop form the focus of the shopping centre and attracts the customers to use the shopping facilities. There are three (3) principal types of shops:

i. Unit shops
ii. Medium space users (MSU‟s)
iii. Anchor store or departmental store.

i. Unit Shops

Unit shops make up the majority of accommodation in a shopping centre. The unit shop is a standard size, which would be readily lettable to a range of potential tenants. A range of different size unit shops would also be provided to meet more closely the generic space requirements of different retailers (Coleman, 2006).

A survey by the BCSC (1998) revealed the unit shop requirement shown below

i. Majority (63%) seek floor space of $95m^2 – 380m^2$
ii. Strong Preference seek floor space of $190m^2 – 325m^2$
iii. Small proportion (19%) require less $95m^2$
iv. A proportion (18%) requires larger than $380m^2$

However, in taking account of this trend a shop unit module of 7.5m wide by 25m deep providing a normal area of $187m^2$ is adequate and the acceptable proportion are within the range of 3:1, 4:1, 2:1 and 5:2 (depth to width). At least 25-30% of the Gross Leasable Area (GLA) should be dedicated for storage.

ii. Medium Space Users (MSU's)

Principles outlined for unit shops apply to medium space users (MSU) shops. They are strategically positioned in the layout to act as attraction points and to lead customer from one area to another.

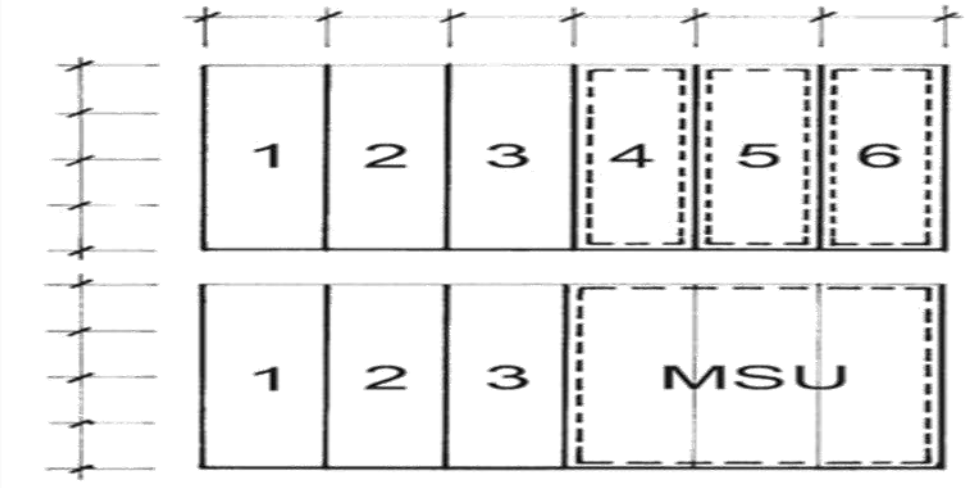


Figure 2.9: Space Requirement for Medium Space Users
(Source: Ernst and Neufert, 2000)

iii. Anchor Store

Anchor store are the third principal types of shop required to be accommodated within the overall layout. Store size can vary from 7000 to 23000m^2. These stores are strategically located and are generally one of the very pedestrian circulation drivers. Typical location for an anchor store would be:

a. At the end of a run of shops, thereby drawing customers past the shop fronts.
b. Located at a change in direction in the layout in a way which is clearly visible and draw customers in from both direction
c. Strategically positioned to form focus point of punctuation in a large complex layout.

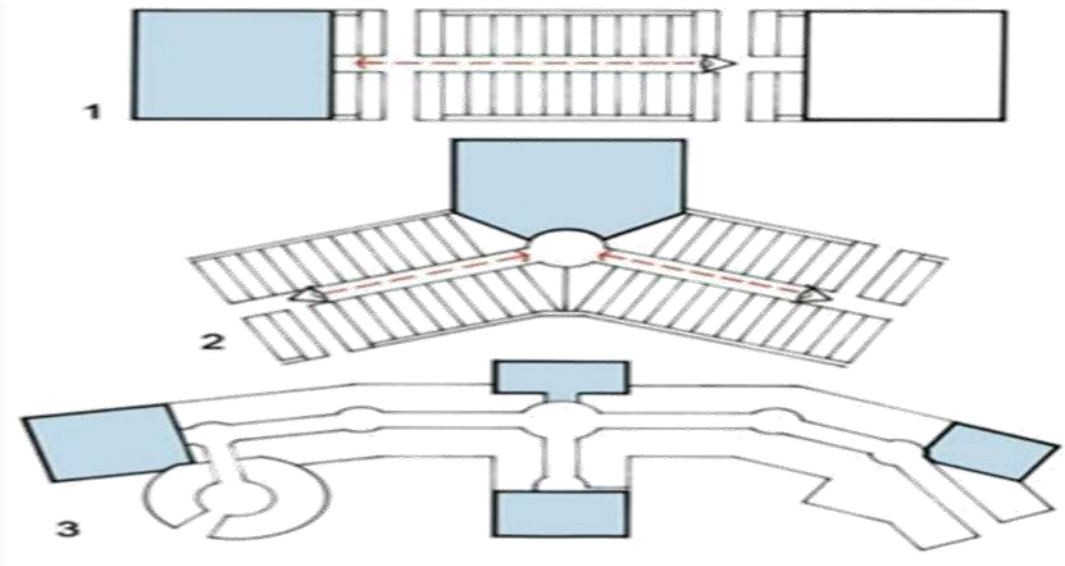


Figure 2.10 Different Positioning of Anchor Store (Source: Peter, 2006)

2.8.2 Catering facilities

Catering is an integral part of visiting a shopping malls and leisure destination and has proven not only to widen the appeal of a particular centre but also to extend the average stay time and amount of spending per customer per visit. The catering facilities make up a proportion of the total accommodation, which can range from 2-25% of the GLA.

It is preferable to locate catering facilities nearby or adjacent to the retail units in a secondary or off prime pitch location.

The wide range of different types of catering which can be incorporated into shopping mall can be categorized into three basic physical formats. They are:

a) **Food Court**

This format can be summarized as providing fast food, with a limited chances obtained by self-service and eaten in a communal seating area. Food courts are located as an extension of the shopping centre public circulation space.

A typical arrangement is likely to include six to eight of these offers where each unit is provided with 40-60m^2 of serving a communal dining area with table for 300-400 people.

b) Restaurants Clusters

Restaurants are individual catering offers and are individually located. The size of accommodation required for a restaurant vary depending upon the type. For example, a small restaurant can be accommodated in a unit of 140m^2 GLA, while a themed restaurant will require a large unit up to 560me GLA.

2.8.3 Leisure facilities

Leisure activities associated with shopping development are commercial leisure activities where the public pays the operator for the use or enjoyment of their facilities. These activities ranges from passive to active and from mainstream to the specialist.

The most common types of leisure facilities incorporated in a shopping facility are:

a) Multi-Screen Cinemas

This cinema format is one of the most common leisure activities combined with shopping development. The multi-screen is twofold it gives the visitor a choice of programme and gives he operator the ability to judge business potential of each film. The minimum number of screens ranges between 3-6 screens. The auditorium size will vary to give the operator necessary flexibility with smallest providing 100 seats. The standard space for a 10 screen cinema can be accommodated within approximately 4250m^2 GLA.

b) Bowling Alleys

Bowling alleys are considered as part of a large leisure destination, either a regional shopping and leisure centre or a retail entertainment centre. The amount of floor space will be determined by the number of bowling lanes to be accommodated from a minimum of 4 to upward of 30 lanes. Each lane require

an overall clear area of 26.7m length by 1.7m width which includes the participant's area; the bowling lane and space for pin stacking machinery.

c) Fitness Centres

Fitness centres have grown in popularity in conjunction with the general increase in leisure time and greater public awareness of the importance of physical well-being. A comprehensive facility can typically require up to 4200m^2 or more.

2.8.4 Customer care facilities

Customer care facilities being a facility related to personal hygiene or a personal services have significant influence upon the customer's memory of a particular centre. These facilities include:

a) Public Toilet

The location of public toilets needs to be carefully balanced by being readily accessible, without taking up valuable shop frontages.

b) Crèches

The accommodation for a crèches should be conveniently located in a position which is close to the public circulation space, but which does not occupy prime retail space.

The ideal size of a crèches according to (BCSC, 1998) is one accommodating up to 40 children, with additional staff facilities, storage and toilets an area of approximately 175m^2.

c) Shop mobility

Shop mobility is a term used for the facilities that assist access to a shopping centre for the mobility impaired visitors. These facilities should be located close to a main point of arrival, commonly adjacent to a car parking space.

2.8.5 Back of house

The back of house area of a shopping centre have to be a hidden world, which is generally not accessible to the general public, but its integral to the operation and safety of the building. Although the back of house area tends to be secondary service spaces to the principal accommodation, they are fundamental to the functioning and operation of the mall. The major items of back of house include:

a) Centre Management Facilities

Management suites main reason is to accommodate the administrative and operational management functions of the shopping centre. The management suite has to balance the requirements of being publicly accessible, while retaining the operational aspect in a discrete way. The management facilities include the following:

i. Management Suites (administrative office)
ii. Control rooms
iii. Staff Rooms
iv. Maintenance Facilities

b) Access and Deliveries

Shopping centres contain a multitude of businesses that are represented by different individual shops. Access and deliveries are the means of supplying goods to allow the retail businesses to operate. These facilities include:

i. Service Yards
ii. Service Corridors (Deliveries)
iii. Service Lifts
iv. Interconnecting Stairs

2.9 Fire

According to John, (2014), fire is a rapid chemical reaction that releases great quantities of heat. This chemical reaction always involves the oxidation of some fuel. Fuel is a generic term that refers to anything that can burn (e.g. many gases, many liquids, paper, wood, cloth, plastic and many other materials).

He included that the design of buildings should be to prevent fire from occurring within them. However, because many if not most building fires result from materials brought in to the buildings after occupancy rather from the building assemblies themselves. Designers alone cannot avert the occurrence of fire, which will inevitably happen in some buildings. Therefore the responsibility of the designers to provide building which has the features, reduce the capability of disaster that fire can poses for tenant and belonging.

He also stated that four fundamental goals must be achieve to create buildings that will offer safety and protection against fire. In the presence of a fire, means must be available to ensure that the building occupants can be evacuated or otherwise rendered safe from hazardous condition produced by the fire. The protection of property in the course of a fire event is very important, therefore design efforts must be made to minimize the damage that may result. Buildings must be designed to minimize circumstances whereby buildings adjacent to one in which a fire event occurs might suffer fire related damages. Initial building design work must be directed towards minimizing the amounts of money and time that would otherwise be needed for making repairs after a fire event does happen. Dean further suggested six principal tasks that design must deal with while seeking to create fire safe buildings. Building assemblies should be created – by design and construction that will reduce fire incidence events. If

a fire should occur then the building assemblies should minimize the opportunities for the growth and spread of fire within the fire zone. Fire extinguishing devices should be present to detect the onset of a fire event. Means of evacuating occupants from the fire zone must be well developed. Fire suppression system must be present and should function automatically. Ready accessibility to the fire zone and well functioning devices must be available for the fire fighters.

2.10 Causes of Fire in Shopping Malls

Sroulx, (1997) claimed that building experiencing fire can be as a result of a different factor comprising accidents, carelessness and willful acts. According to Sroulx, (1997). A public building consisting of all class of people with different background and training exposes it to such a hazard. He relayed that accident can be said to be an event that happens without planning which leads into injury, shock, property and damage to life. Accidental fire are contingency or that has no limit to origin of flammable; this origin source of fire can be due to faulty electrical equipment, thunder strike, wiring system and fire spread occurs in the presence of excessive thunderstorm and the building lacks protection with enough lightening protector and fire through this channel is not common electrical equipment power fittings, fan, lighting fittings and air conditioner this is were faulty equipment comes from and result in fire in building when users do not adhere to all important precaution of safety in managing electrical equipment. If there is no adequate assessment in the fire spread from a adjacent buildings can have effect on another that leads to five incidence in building. When there is no proper separation in bushes burning and debris can cause fire outbreak when it is not controlled (Sroulx, 1997).

Richard, (2007) agreed with Sroulx, (1997) by relaying that fires in buildings can be caused by various factors comprising of accidents, carelessness and wilful acts. In the history of building fires, the causes of fire outbreak are usually due to fire ignition, faulty electric cable, smoking, arson, over heated equipment, cooking etc. (Richard, 2001). He stated that the Pioneer International Hotel fire in which twenty-eight people were killed was believed to be arson-initiated. In the process of destroying evidences such as results, incriminating files and documents, arson cannot be ruled out as a factor responsible for fire outbreak in public buildings. Faulty electric cable has also been seen as a major cause of fire outbreak in buildings as a result of the use of substandard materials where thin cables were used to minimize cost. This in turn has sparked off fire disaster. He relayed that careless handling of matches and lighters by children playing with it: they may throw it in a corner and when it comes in contact with other elements of fire results in fire outbreak.

From these various studies claims made by these authors established the fact that, fire outbreaks in a building is totally unavoidable. But when it happens, adequate measures should be put in place to reduce fire spread in the building. To reduce fire spread in building one has to understand the principles of fire.

2.11 Principles of Fire Behaviour

Sroulx, (1999) often said that fire is a good servant but a bad master, a good friend but a better enemy. He describes fire as a chemical reaction of three elements. The rapid combination of the three elements oxygen, heat and fuel results in the production of fire and light. Before fire can occur, there must be a presence of the three basic element or ingredients of fire, which is referred to as ‘fire’s own eternal triangle’; Oxygen, Heat, Combustible material (Fuel).

Figure 2.11: Fire tetrahedron
Source: www.nfpa.org

Figure 2.12: Fire triangle
Source: www.nfpa.org

Proulx (2006) posited that fire is the result of combustible material, oxygen and ignition temperature being combined; there is always a risk of fire since buildings contain sufficient combustible material and oxygen. Fire gives off heat and the total heat that can be released by a burning substance is referred to as the specific latent heat. This energy is measured in J/kg.

Proulx (2006) examined the types of fuel determinant and how much energy is initially required to initiate combustion and argued that combustible gases usually require only a slight source of ignition to cause a combustion reaction with oxygen. Solids like wood first have to form combustible gases before they can start burning. The spread of the fuel throughout the room determines how the fire will develop further. Porous and wooden materials in furniture contribute to fast fire development. Plastics sometimes cause a fire to spread fast: they start dripping and thus lead to fire on the floor. The speed of the flame spread is governed to a considerable degree by the types of substances that are mixed together. The position of fuels relative to the initial fire is of great influence as well. For example, flames spread much faster along a vertical surface

than along a horizontal surface. Once a fire has started, it will continue as long as the right amounts and ratio of fuel and oxygen are present and the temperature remains sufficiently high. If no human intervention follows, the temperature in the burning room will become ever higher as heat is released in the combustion process. These results in: - more materials releasing gases - more gases igniting - the flame front increasing in size - heat radiation increasing and accelerating the fire development.

They also examined combustion products and posited that when a material burns, its combustible substances assume a gaseous state and react with oxygen, converting the material into combustion products. This reaction with oxygen causes the combustible substance carbon, the main element of combustible material, to be converted into the combustion product carbon dioxide or carbon monoxide. The increase in temperature during the combustion process causes the combustion products to expand and rise into the air. The combustible products found in smoke and fire gases are the result of the pyrolysis (decomposition) of substances that do not come into contact with the actual seat of the fire or of incomplete combustion of the seat of the fire. Since the temperature is often high at ceiling level, combustible ceiling material will often release gases. The following combustion products develop when a material burns: - Flames; the visible appearance of burning gases. - Energy; the molecules in the burning material become more active during the combustion process producing a lot of thermal energy. The temperature is an indication of the amount of energy that is released. High temperatures are also referred to as heat. - Smoke; the aggregate of fire gases and unburnt carbon particles (soot).

The composition of the air changes drastically during the combustion process. The oxygen content decreases because the air expands (as the air is heated its volume

increases) and oxygen is converted into carbon dioxide (the result of the combustion reaction). However, there is a continuous increase in the content of combustion products in the air, such as: - carbon- carbon dioxide (CO_2)- carbon monoxide (CO)- water vapour- other gases and vapours. Combustion products may be harmful; the same goes for a decrease in the oxygen content in the air. Furthermore, a lack of oxygen frustrates breathing and adversely affects vital bodily functions. A shortage of oxygen during a fire slows down the combustion process; the fire will change into a smouldering fire. A smouldering fire is characterised by incomplete combustion, resulting in more smoke that contains more unburnt combustible gases. Besides this, the temperature of the fire gases and the oxygen endangers people, since their bronchial tubes will already be affected at a relatively low temperature.

2.12 Stages of Fire Development

Proulx (2006) relayed that fire in a closed room or space goes through three stages:

i. A growth stage (Incipient Phase)
ii. A fully developed stage (Free Burning Phase)
iii. A smouldering stage (Decay Phase).

Every stage has its own specific temperature range. The fire curve shows the relationships between temperature and time for a fire in a closed room. As this is a model, it is a simplification of the real situation.

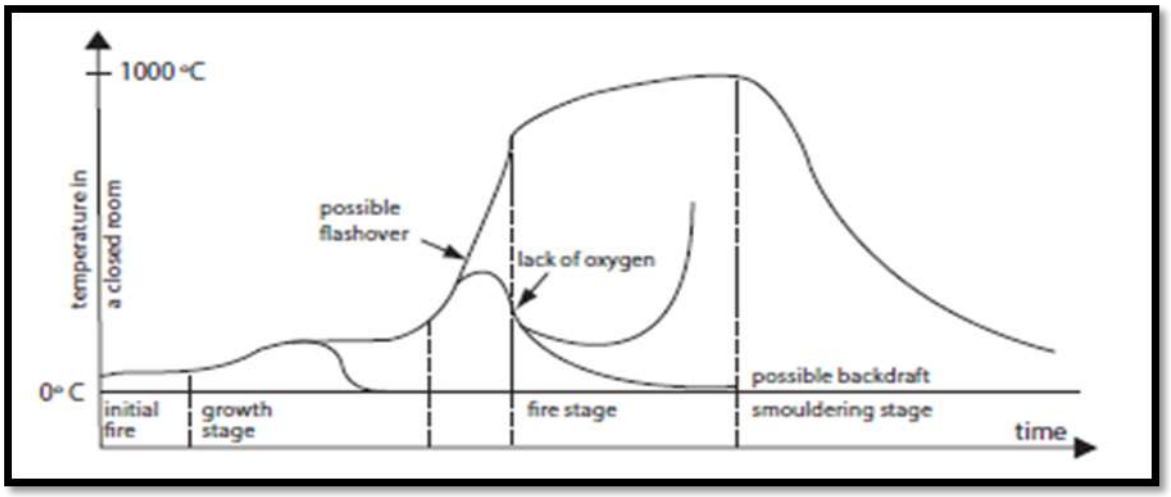


Figure 2.13: Fire curve (Source: Proulx, 2006)

2.12.1 The growth stage

The growth stage starts with an incipient fire. This is the stage where the fire slowly grows, e.g. due to a burning candle on a sofa, setting fire to the seat of the sofa. The burning upholstery of the sofa is then the start of the fire in the room. The combustibility of solids is determined on the basis of the time that elapses until the material ignites. The thermal inertia of a material is an indication of the speeds at which it heats up and cools down. Thermal inertia is expressed as kρc. The surface of a material with a low kρc heats up fast, whereas a material with a high kρc heats up slowly. An incident fire raises the temperature in the room causing other fuels to start to decompose.

This pyrolysis starts immediately upon the inception of the fire and intensifies as the temperature rises. Fire gases are released as part of the pyrolysis process. These fire gases are much lighter than air and rise up into the air, creating a very hot gas cloud at the ceiling. The heat is stored in the carbon particles of the smoke layer. The hot gas cloud radiates heat to other objects in the room, causing them to decompose. This creates even more fire gases that rise up, making the gas cloud even hotter, more

combustible and more concentrated. At a temperature between 200 °C and 300 °C so many combustible gases will have collected that a combustible gas/air mixture may occur. The fire may progress from this stage, depending on various factors. The availability of sufficient oxygen is an important factor. There are situations where a fire goes out during its growth phase. There will be a lot of smoke in the room then, but no fire. This may be due to a shortage of oxygen or it may be due to the fact that the incipient fire had insufficient 'energy content' to cause the adjacent combustible substances to decompose (releasing combustible gases). (Billington, Ferguson & Copping, 2002).

Plate XI shows a gas cloud against the ceiling. This was caused by a sofa on fire, the incipient fire. Besides this, gases are being released from various items of furniture as a result of the heat radiated from the cloud to all objects in the room. The room is slowly filled with fire gases. This is a typical characteristic of the growth stage.

Plate XI: Growth state of a fire. (Source: Proulx, 2006)

2.12.2 Fully developed stage:

During the fully developed stage, the combustion process can be divided into fire with flames and smouldering. Fire with flames, or 'homogeneous oxidation', occurs when the

fuel and the oxidation agent are in the same state, e.g. two gases. Smouldering, or heterogeneous oxidation, takes place at the surface when the fuel and the oxidation agent are not in the same state, e.g. if the fuel is a solid and the oxidant is a gas.

Smouldering may occur at the surface or inside porous materials, as long as there is access to oxygen to enable oxidation to continue. The heat can even stay inside the material and can support pyrolysis until auto-ignition possibly takes place. The layer of solid carbon on scorched remnants is a porous, usually smouldering substance. A smouldering fire often produces lots of pyrolysis products not all of which oxidise at the same time. In the event of a fire in a closed room, the pyrolysis products are emitted by the burning object and collect in the upper part of the room without having burnt up. The room then gradually fills with smoke and fire gases that mainly consist of carbon monoxide (toxic if inhaled). As a result, smouldering fires can lead to fatalities. The fire curve contains a part between the growth stage and the fully developed stage in which the temperature rises quickly (Fillippidis, Galea, Gwynne viewed 2006, June 13).

The name of fully developed stage speaks for itself. If flashover occurs, the temperature goes up very fast. The room is suddenly completely on fire due to gases and vapours igniting. This leads to a short-term maximum flame front size. In that same period, there is also maximum heat radiation and release of gas from materials. If no flashover occurs, the temperature may rise more slowly. But even then, the temperature in the fully developed stage will rise to approx. 900 °C within 15 minutes. All combustible materials will burn up.

2.12.3 Smouldering stage

The combustion process slows down when almost all of the oxygen in the room has burnt up, and the temperature in the room will drop. The fully developed stage then turns into the smouldering stage. The remaining combustible material in the nearly closed room may be red-hot in this stage of the fire, but the flames will have already been extinguished due to a lack of oxygen. This causes the temperature to decrease. However, the temperature is still sufficiently high and there are still enough combustible gases to nevertheless cause backdraft if only the slightest amount of oxygen is supplied. The materials also continue to release gases due to the high temperature in the room combustable gases will ignite fast. (Fillippidis, Galea, Gwynne viewed 2006, June 13).

From the above studies the various stages of fire development was determined. The studies gave an in depth knowledge of the various stages of fire development in a building.

2.13 Classes of Fire

The classification of fire are:

1. Class A: This settled as normal or common flammables from burning of solids like cloth, wood, paper and plastics. It is importantly the ordinary fire accident experienced in diverse industries. Example is trash fire. It is normally extinguish with water or Mono-ammonium phosphate.
2. Class B: This outlined from the burning of combustible Liquid or like Kerosine, petroleum and paints. Combustible gases like propane or butane. It is normally extinguish by smothering to get the oxygen removed.

3. Class C: This types uses the components of electric or Electrical gadget. It is commonly extinguish by disconnecting the power off and the use of insulative chemical.
4. Class D: Fire involving from burning of metals like titanium, magnesium, sodium, potassium and lithium. The use of my dry powder as extinguishing agent.
5. Class K: This type is present in cooking appliances like fats, animal oil or vegetables. It is been extinguished or put out by wet chemical.

2.14 Heat Transfer

Heat can travel throughout a burning building by one or more of three methods, commonly referred to as conduction, convection and radiation. Since the existence of heat within a substance is caused by molecular action, the greater the molecular activity, the more the intense the heat. A number of natural laws of physics are involved in the 12 transmission of heat. One is called the Law of Heat Flow. It specifies that heat tends to flow from a substance to a cold substance. The colder of two bodies in contact will absorb heat until both objects are the same temperature.

2.14.1 Conduction

Heat may be conducted from one body to another by direct contact of the two bodies or by an intervening heat-conducting medium. The amount of heat that will be transferred and its rate of travel depends upon the conductivity of the material through which the, heat is passing. Not all materials have the same heat conductivity. Aluminum, copper and iron are good conductors. Fibrous materials, such as felt, cloth and paper are poor conductors. Liquids and gases are poor conductors of heat because of the movement of their molecules. Air is a relatively poor conductor. Certain solid materials when

shredded into fibers and packed into batts, make good insulation because the material itself is a poor conductor and there are air pockets within the batting. Figure 2.14 shows double building walls that contain an air space provide additional insulation (Runstard, 2005).

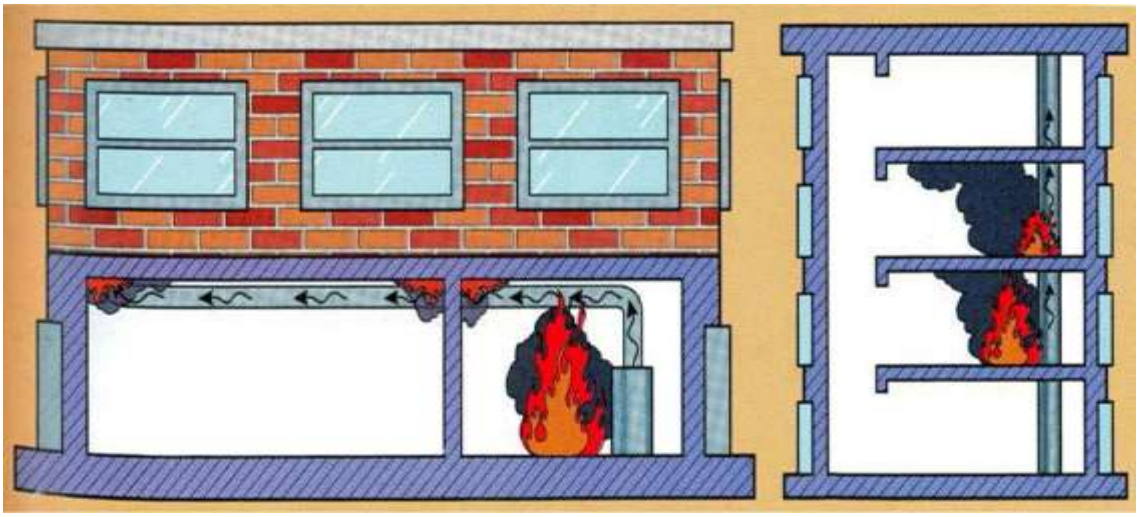


Figure 2.14: Conduction of Heat
(Source: International Fire Service Training Association, 1998)

2.14.2 Radiation

The warmth of the sun is felt soon after it rises. When the sun sets, the earth begins to cool with similar rapidity. We carry an umbrella to shade our bodies from the heat of the sun. A spray of water between a firefighter and a fire will lessen the heat reaching the firefighter. Although air is a poor conductor, it is obvious that heat can travel where matter does not exist. This method of heat transmission is known as radiation of heat waves. Heat and light waves are similar in nature, but they differ in length per cycle. Heat waves are longer than light waves and they are sometimes called infrared rays. Radiated heat will travel through space until it reaches an opaque object. As the object is exposed to heat radiation, it will in return radiate heat from its surface (Figure 2.15).

Radiated heat is one of the major sources of fire spread, and its importance demands immediate attention at points where radiation exposure is severe (Runstard, 2005).

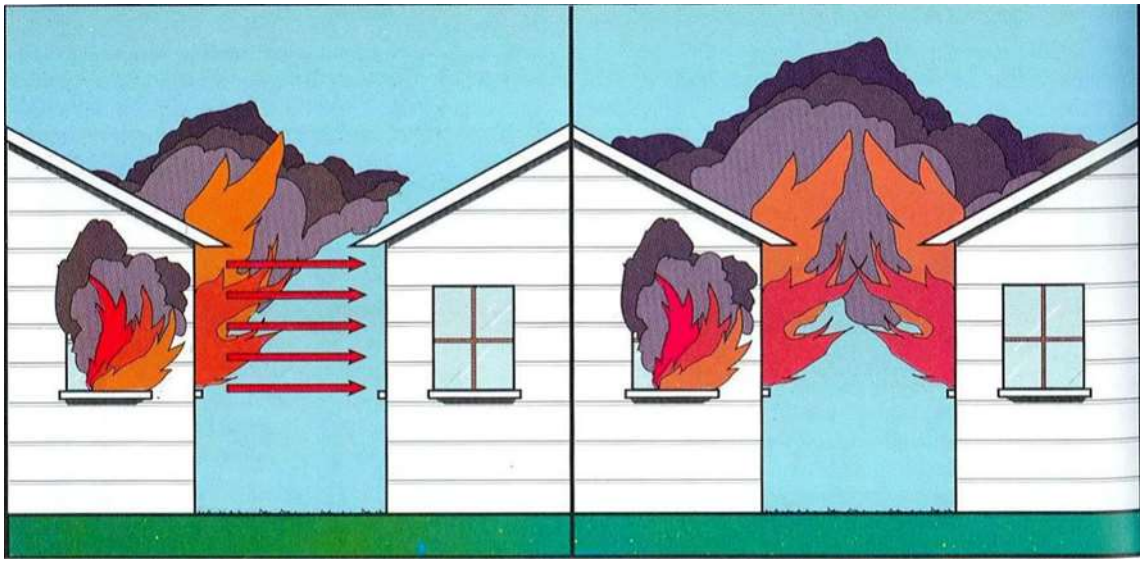


Figure 2.15: Radiation of Heat (Source: International Fire Service Training Association, 1998)

2.14.3 Convection

Convection is the transfer of heat by the movement of air or liquid. When water is heated in a glass container, the movement within the vessel can be observed through the glass. If some sawdust is added to the water, the movement is more apparent. As the water is heated, it expands and grows lighter, hence, the upward movement. In the same manner, air becomes heated near a steam radiator by conduction. It expands, becomes lighter and moves upward. As the heated air moves upward, cooler air takes its place at the lower levels. When liquids and gases are heated, they begin to move within themselves. This movement is different from the molecular motion discussed in conduction of heat and is knows as heat transfer by convection.

Heated air in a building will expand and rise. For this reason, fire spread by convection is mostly in an upward direction, although air currents can carry heat in any direction.

Convected currents are generally the cause of heat movement from floor to floor, from room to room and from area to area. Figure 2.16 shows the spread of fire through corridors, up stairwells and elevator shafts, between walls and through attics is mostly caused by the convection of heat currents and has more influence upon the positions for fire attack and ventilation than either radiation or conduction. Another form of heat transfer by convection is direct flame contact. When a substance is heated to the point where flammable vapors are given off, these vapors may be ignited, creating a flame. As other flammable materials come in contact with the burning vapors, or flame, they may be heated to a temperature where they too, will ignite and burn. The architectural solution to fire spread by convection is building compartmentalization (Runstard, 2005).

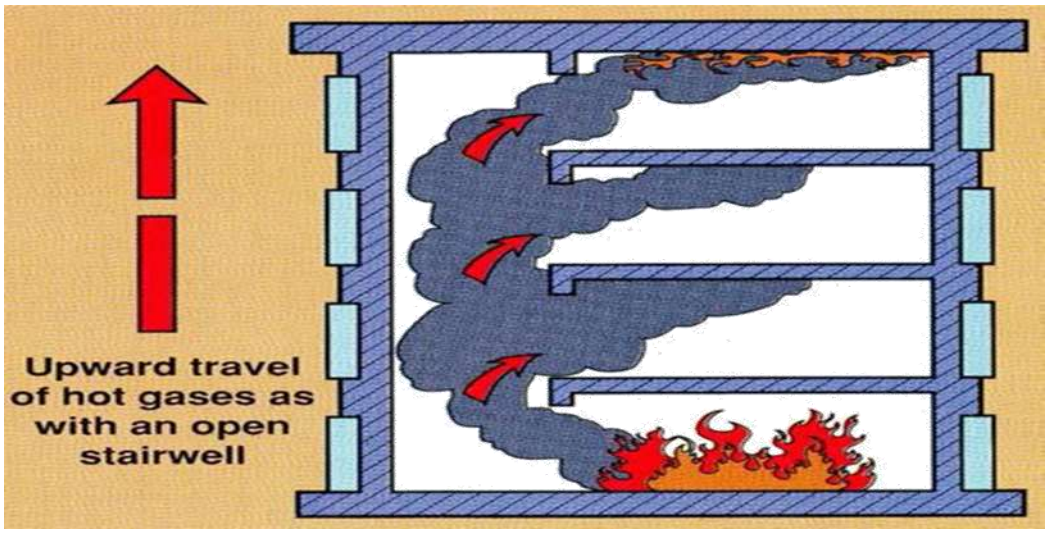


Figure 2.16: Convection of Heat
(Source: International Fire Service Training Association, 1998)

2.14.4 Updraught

Updraught is a special form of convection. The above description shows that up draught occurs in all rooms where there is a fire. Up draught refers to hot air or smoke rising through several storeys, e.g. in a stairwell or atrium. In addition to up draught, the temperature difference also causes pressure differences in a closed room. Overpressure

occurs in the upper part of the room where the air pressure is higher than the atmospheric air pressure, whereas under pressure occurs in the lower part of the room where the air pressure, whereas pressure is lower than the atmospheric air pressure. There is an area with neutral pressure between the areas of overpressure and under pressure, where the air pressure is more or less equal to the atmospheric air pressure. Repressive ventilation makes use of these pressure differences. Since the fire gases can be discharged to the outside air the fastest at the point where the pressure of the layer of fire gases is the highest, the outlet opening with repressive ventilation is usually placed at the highest possible point in the room with the fire.

2.15 Fire Safety Measures in Shopping Malls

Fire prevention is knowing what you can do to prevent a fire in the first place as well as what actions to take in case one happens anyway.

2.15.1 Fire precaution and prevention

The key elements of fire precaution policies are;

i. Building a facility in accordance with the version of the local building code
ii. Maintaining a facility and conducting yourself in accordance with the provisions of the fire code. This is based on the occupants and operators of the building being aware of the applicable regulations and advice.

Examples of these includes;

i. Not exceeding the maximum occupancy within any part of the building.
ii. Maintaining proper fire exits and proper exit signage (e.g., exit signs pointing to them that can function in a power failure)

iii. Compliance with electrical codes to prevent overheating and ignition from electrical faults or problems such as poor wire insulation or overloading wiring, conductors, or other fixtures with more electric current than they are rated for.

iv. Placing and maintaining the correct type of fire extinguishers in easily accessible places.

v. Properly storing and using, hazardous materials that may be needed inside the building for storage or operational requirements (such as solvents in spray booths).

vi. Prohibiting flammable materials in certain areas of the facility.

vii. Periodically inspecting buildings for violations, issuing Orders to Comply and, potentially, prosecuting or closing buildings that are not in compliance, until the deficiencies are corrected or condemning it in extreme cases.

viii. Maintaining fire alarm systems for detection and warning of fire.

ix. Obtaining and maintaining a complete inventory of fire stops. Ensuring that spray fireproofing remains undamaged.

x. Maintaining a high level of training and awareness of occupants and users of the building to avoid obvious mistakes, such as the propping open of fire doors.

xi. Conduct fire drills at regular intervals throughout the year (Justice and Reynolds, 2003).

2.16 Fire Control

Fire control varies from one building to the other and it can be broken down into;

a. Passive fire prevention

b. Active fire prevention

A. Passive Fire Prevention

This has to do with the design of the building itself and the type of materials used to resist fire. It is done at the pre-contract and post-contract stages of a project. Fire safety measures are fixed in a premises to act an important aspect in life protection and injury prevention in fire outbreak (Justice and Reynolds, 2003).

These basic fire prevention requirements are:

i. Site planning
ii. Design and detailing
iii. Path of travel to exit
iv. Evacuation plan
v. Compartmentalization
vi. Incombustible surface finishes and materials
vii. Emergency lifts
viii. Fire control centers and rooms
ix. Smoke and heat vents
x. Occupancy separation

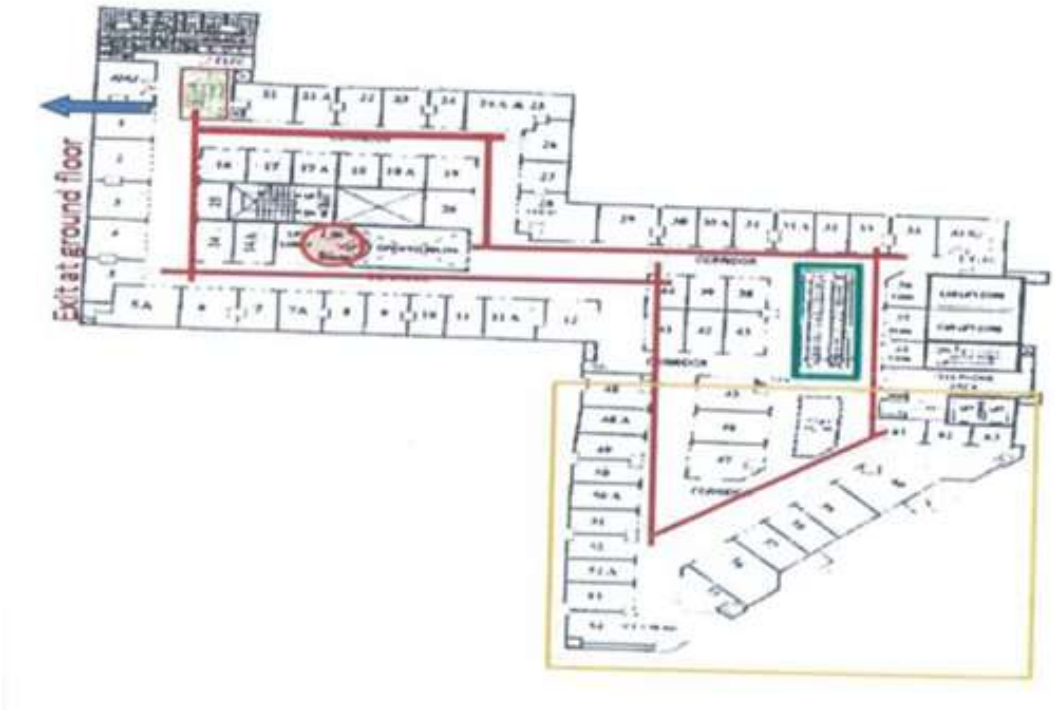


Figure 2.17: Evacuation plan in a shopping mall (Source: Capenter, 2006)

2.17 Site Planning

Access and exit from and into the site should be provided especially for motorised equipment and fire brigade should be able to bring the vehicle into the site and move around the building. Adequate spacing between building and site.

2.18 Design and Detailing

2.18.1 Means of escape

This is the primary and the head and the most influential on the design of building. The factors to be considered in the planning of an escape routes includes:

i. The suggested evacuation time for five grading committees is 2.5 minutes.

ii. Enough ability with appropriate exits number should be positioned with enough lighting exists and comfortable access path.

iii. All the exits point should be secured from smoke and fire during outbreak of fire.

iv. Route for escapes are useful to be unimpeded, straight and obviously signed.

v. The corridors and exists should have same width rather than the total number to be discharged.

vi. The entire doors in the escape route should be open in the escape path, the last exit door should be protected by paric bolts.

vii. The speed of movement is affected by openness of escape path which may be 12.5m and 18m per minute in walkways and unrestrained spaces. This allow the distance of travel of 30 and 45 meters accordingly.

viii. Any materials responsible for fire outbreak should not be found in any part of a secured escape route.

ix. In high and low rise structure, substitute escape is necessary and should be positioned in the contrary guidance of the major path incase of main exist blockage by fire or smoke.

x. Five brigade services are not realizable because of overcrowding and the state of traffic.

However, it is apparent that smoke vents screens and means of fire escape could be achieved through architectural and engineering design.

2.18.2 Compartmentation

Compartment is the strategy of creating fire-resistive enclosures around each occupied space in a building. The goal of establishing Compartmentation during building design is to prevent the spread of smoke, flames, and heat from a fire zone into adjacent areas of the building. The dual purposes of inhibiting the fire spread are to afford occupants adequate time to leave the fire zone and to limit the property destruction caused by the fire to the immediate, localized fire zone. The creation of separate compartments

throughout a building involves developing wall, floor, and ceiling or roof assemblies that exhibit adequate time-rated fire-spread resistances. Fire spread seldom occurs strictly as a result of heat transfer through building assemblies (i.e., the heat produced by a fire in one space rarely passes through a horizontal or vertical assembly and induces combustible materials in the next space to ignite).

Much more often fire spread happens because of the existence of discontinuities - intentional or not- in walls, floors, or ceilings (or roofs). Typical examples of situations that enable fire spread include having fire doors left open (by occupants), unenclosed stairways or vertical shafts, unprotected penetrations (where ducts, pipes, electrical conduit or raceways, and horizontal and vertical conveyances such as dumbwaiters and pneumatic tubes pass through fire-resistive assemblies), and non-fire stopped concealed spaces. For many fire events that have occurred in well-compartmented buildings, once the fuel in the enclosed fire zone - furnishings, internal surface finishes, work materials, and the like-has been expended by burning, the fire will self-extinguish. And the fire damage will be limited to the single localized fire zone. Thus, a first design task in laying out buildings - while thinking about the potentialities of fire events - is to incorporate fire- resistive and fire-enclosing walls, floors, and ceilings (or roofs) throughout the building. At what spacing walls should be placed to create appropriate sizes for potential fire zones has not been established through industry standards but allowable floor areas are stated.

B. Active Fire Prevention

Active fire prevention is used to suppress fire when it has started. The active prevention requirements include;

i. Automated water sprinkler system

ii. Fire hydrant system

iii. Smoke and heat detectors

iv. Smoke exhaust systems

v. Stand-by power system

2.19 Fire Suppression Equipment in Public Buildings

According to Backer et al., (2004) fire suppressing equipment is used to extinguish fire in all sorts of buildings. There exists several medium of fighting fire in buildings and they include the following;

Sprinkler Systems: are systems designed to either control or suppress the spread of fire in buildings. Depending on the type of building, different types of installation are employed which ranges from wet pipe system, dry pipe systems, deluge systems and pre-action systems.

Hose reels: these are placed at stair case landing red in colour. Fire hose reel system consists of pumps, pipes, water supply and a hose located strategically in a building. Its aim is to ensure a proper coverage of water to combat the spread of fire.

Fire Extinguisher: This is an active fire protection device used for putting out small fires before the fire fighters arrive.

Fire Hydrant: This is an emergency supply for firefighters. It includes an upright pipe with a spout or nozzle with its source of drawing war being the street mains.

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 Research Method

The data gotten from empirical investigation was explained using the read – up from descriptive statistical tools. The research questions raised are been answered mainly by the descriptive statistical tools which are graphs, charts and tables. According to (Richard W.), Descriptive survey has to do with the group facilities or organizations, persons description which are the study aspect. It portrays participator in an exact manner. This offers better idea of the state of things under assessment by the identification of the characteristics of the observed variables or through the assessment of the comparison between two or more occurrences.

There are three ways through which descriptive research can be carried out which is user discussion as regard specific topic, case study which explains group study or area study and by observation. The first two (observation and case study) were the approach used in this project.

3.2 The Study Area (Abuja)

Abuja is the Nigeria Headquarter sited at the middle of the nation. It is designed and constructed to take over the position of Lagos in the 80s. It is enclosed in the eastern part by Nassarawa State. Northern area by Kaduna State, western part by Niger State and Southern area by Kogi. These Locations were selected due to their constant exposure to the modern trend of architectural form aided by the resultant effect of urbanization and industrialization engulfing the globe.

3.3 Data Types and Sources

Data has been obtained from diverse origins by researchers. Definitely, the two kinds of data has serve as systemizing of the research work. They are primary and secondary data separately.

3.3.1 Primary data

It is obtained and from hand on direct source from researcher using method like surveys. It is acquired by a research project in mind that have received publication. This kind of data are more safe, guaranteed and dependable. For this reason its soundness is higher.

3.3.2 Secondary data

They are data obtained by someone who someone other than the user. They lack reliability, authenticity and objectivity as primary data. They are originated from journals, books, encyclopedia and magazines.

3.4 Method of Data Collection

To effectively engage in research work, necessary information was gathered by the use of various techniques of data collection. The data sources were collected for this research work. Case studies and scheduled observation constitute the data sources. The secondary data sources are data gotten from the Journals, internet, seminar, papers, conferences, publications, academic paper and magazines. Review of literature was ready from the gathered information from the origin.

Research works primary data means data obtained through empirical finding to suit important connection. Diversity or overall evaluation of variables. They could be achieved from observation, evaluation and assessment.

3.4.1 Case studies and scheduled observations

A Case study is the study of a component done to comprehend the competent with part of factors under reflection. This method is often used by designers and researcher to obtain viable answer to a problem of design by the read up of some previous design by the read up of same previous design done. It is important in having data in an issue by going through the character of an element. The whole case studies some were on. Nigerian Shopping mall. This is to enable the gathering of local data in order to arrive at the ways through local facilities would answer the research questions posed by this study. This study reviewed Ten shopping mall across the length and breadth of Abuja with adequate photographs, pictures, description and analysis provided. A scheduled observation which is attached in the Apex was used to measure the variables under study.

3.5 Procedure of Data Collection

The collection of data's procedure involves visit to ten shopping mall building. Visual analyses of the architectural features in the facilities were taken and approximate layout plans derived. The analyses were done considering the implementation of fire safety codes and standards.

3.6 Variables of the Study

The variables in a work of research are the elements under investigation. They are quantities which can be altered or experimented. The research focuses on assessing a safe shopping mall building for customers and shop staff. Therefore, some of the variables under investigation include; Design and Management of Entrances and entry routes, Components of a Means of Egress, Performance Metrics for Egress and Performance Goals for Egress Systems.

3.7 Method of Data Analysis and Presentation

The method of data analysis refers to the several techniques of providing potential answers to relevant questions arising in the research work. This is done through the analysis of data gotten from the various sources. The data gotten was analysed descriptively with Statistical tools employed for the analysis. Elements of statistics such as pie charts, bar charts, tables, plates, and figures were used. A form of appraisal is also provided for analysis of observed data gotten in the process of case studies, tables, figures, charts and other data analysis techniques are used to provide space analysis of the proposed design. Plates were used to describe the physical environment in the selected study areas in relations to this project. Sketches of the site, site inventory, site analysis, concept, and map of the site location are some of the features which are employed also as data analysis techniques.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

This chapter accesses the data acquired in the process of the research. Outcome from the assessment of data are also provided and weighted. This chapter talks about data shows and outcome in multiple sub headings starting with the assessment of data gathered through field work (physical observation) engaged in by the researcher on six shopping mall in Abuja. Observation schedule completing the field work was submitted. This interpreted fire safety aspects of the shopping mall buildings that are not adequate for the purpose of safety or not even provided at all.

4.1 Case Study Selection Criteria

The facilities selected because they will provide substantial information as regards the study area of this project. The purposive sampling technique was used in identifying these case studies due to the fact that it was significant to direct towards a particular class of population of study. Selection of case study counted on the judgment of the researcher. In view of a suggested shopping mall is sited in Lokoja. The collection data is from shopping mall in Abuja. The studied shopping malls building (case studies) includes:

1. Area 1 shopping Mall
2. Jabbi lake mall
3. Park and Shop Plaza
4. Silver bird Galleria
5. Shoprite Lugbe/Lugbe mall
6. Hebron Plaza Gudu District
7. Ceddi Plaza Central Area

8. MKK Plaza
9. Shagari Plaza
10. Bannex Plaza, zone.

4.2 Findings and Discussion of Results

The results obtained via scheduled observations were recorded in two categories for both objectives. The first category examines the availability of critical fire and circulation safety features that are indispensible in a shopping mall design while the second category measures the extent to which certain fire safety design features are incorporated in the studied shopping malls.

The categories was recorded using the representations below.

a. available
b. not available

To represent the degree of availability of the assessed design features.

4.2.1 Objective 2: Fire Safety design feature in shopping mall building in Abuja.

The result in table 4.1 and 4.2 show availability and non-availability of the assessed passive fire safety design features. Table 4.1 shows that all of the studied shopping malls have provisions made for emergency staircases as well as emergency exits which are required to safely evacuate the facilities occupants in a disaster. It shows also that 60% of the facilities have clear spaces behind their exit points. This is to allow the spread of passengers as they make their ways out of the buildings avoiding the formation of bottle necks and crowd. The facilities however lack possible assembly points of their users in an emergency event as this is available in only 40% of the malls.

The table shows also the extent to which these shopping malls have the assessed passive safety features available in them. It is shown that all the features upon which the

assessment of the various passive fire safety features is based are present at the Jabi lake mall, Hebron plaza, Lugbe mall and Silverbird galleria. This makes movement within the facility safe especially during an event of fire emergency. Other malls have these facilities present at 75% and 50%.

Table 4.1: Passive Fire Safety Features

Name of Shopping Mall	Emergency Stair Case	Emergency Exits	Clear distance behind exits	Possible fire assembly point	TOTAL PER MALL
Area 1 shopping Mall, Area 1	✓	✓	•	•	50%
Bannex Plaza, Zone 2	✓	✓	•	•	50%
Ceddi Plaza, Central Area	✓	✓	✓	•	75%
Hebron Plaza, Gudu District	✓	✓	✓	✓	100%
Jabbi lake mall, Jabi	✓	✓	✓	✓	100%
MKK Plaza, Gudu district	✓	✓	✓	•	75%
Park and Shop Plaza	✓	✓	•	•	50%
Shagari Plaza,	✓	✓	•	•	50%
Shoprite Lugbe /Lugbe mall	✓	✓	✓	✓	100%
Silverbird Galleria,	✓	✓	✓	✓	100%
TOTAL PER FEATURE	**10**	**10**	**6**	**4**	
PERCENTAGE	**100%**	**100%**	**60%**	**40%**	

(Source: Author's Field Work, 2019) **Key; ✓ = Available**
• = Not Available

4.2.2 Objective 3: Fire Safety Design Features and the adherence to it design principle and codes in Nigeria Shopping buildings

The result in table 4.2 that the none of the studied shopping malls has its escape point designed to hold fire for as long as necessary for their safe and timely evacuation in an event of fire. The table shows also that 70% of the facilities have their exit points accessible through a clear, non- rented space while 80% of the malls have provisions made for emergency vehicular access which aids fire fighters and other firefighting machineries gain access to the various sides of the buildings. However, only 20% of the malls have emergency locations provided indoor or within the premise of the buildings.

On the part of individual facility analysis, none has all of the features of assessment available. Jabi lake mall and Lugbe mall have these features available at 75% while Hebron plaza, MKK plaza and Silverbird galleria have these features at 50%. 50% of the studied facilities however lack appropriate incorporation of these features in them as they are available only at 20%.

Table 4.2: Passive fire safety features in shopping malls

Name of Shopping Mall	Fire resistant escape point	Clear exist access	Emergency vehicular access	Indoor emergency location	**TOTAL PER MALL**
Area 1 shopping Mall, Area 1	•	•	✓	•	25%
Bannex Plaza, Zone 2	•	•	✓	•	25%
Ceddi Plaza, Central Area	•	✓	•	•	25%
Hebron Plaza, Gudu District	•	✓	✓	•	50%
Jabbi lake mall, Jabi	•	✓	✓	✓	75%
MKK Plaza, Gudu district	•	✓	✓	•	50%
Park and Shop Plaza	•	✓	•	•	25%
Shagari Plaza,	•	•	✓	•	25%
Shoprite Lugbe /Lugbe mall	•	✓	✓	✓	75%
Silverbird Galleria,	•	✓	✓	•	50%
TOTAL PER FEATURE	**0**	**7**	**8**	**2**	
PERCENTAGE	**0%**	**70%**	**80%**	**20%**	

(Source: Author's Field Work, 2019)

Key; ✓ **= Available**
• **= Not Available**

Table 4.3 shows the availability and non-availability of the various features of the fixed system of passive fire safety designs in shopping malls. It shows that 90% of the studied facilities have water hose reels present at the various points of the buildings. They were however not tested of the functional states. Sprinkles are only available at 40% while on-site fire hydrant and heat detectors are available at 60%and 50% respectively.

By way of analysis of individual facility, Jabi lake mall, MKK plaza, Lugbe mall as well as Silverbird galleria have all of these features of fixed system of fire safety available in them. All others only have these features at average or below average.

Table 4.3: Fixed system of Active fire safety features in shopping malls.

Name of Shopping Mall	Water hose	Sprinklers On-Site	Heat/smoke reels	Hydrant detectors	TOTAL PER MALL
Area 1 shopping Mall, Area 1	✓	•	•	•	25%
Bannex Plaza, Zone 2	✓	•	✓	•	50%
Ceddi Plaza, Central Area	✓	✓	•	✓	75%
Hebron Plaza, Gudu District	✓	•	✓	•	50%
Jabbi lake mall, Jabi	✓	✓	✓	✓	100%
MKK Plaza, Gudu district	✓	•	•	✓	50%
Park and Shop Plaza	✓	•	•	•	25%
Shagari Plaza,	•	•	✓	•	25%
Shoprite Lugbe /Lugbe mall	✓	✓	✓	✓	100%
Silverbird Galleria,	✓	✓	✓	✓	100%
TOTAL PER FEATURE	**9**	**4**	**6**	**5**	**6**
PERCENTAGE	**90%**	**40%**	**60%**	**50%**	**60%**

(Source: Author's Field Work, 2019) **Key; ✓ = Available**
• = Not Available

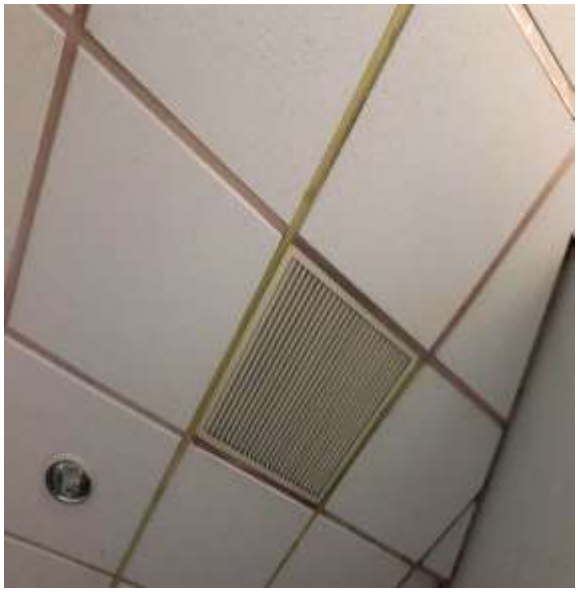



Plate XII: Showing the fireproof ceiling, Fire Hose and extinguisher


Plate XIII: Showing the fire sprinkler, smoke detector and Hose reel
(Source: Field Survey)

Plate XVI: Showing the fire control sprinklers and the Emergency Exit Door HVAC. (Source: Field Survey)

Table 4.4: Mobile system of active fire safety features in shopping malls.

Table 4.4 shows the availability and non-availability of the various features of the mobile system of passive fire safety designs in shopping malls. It shows that crowd management personnel are available in all of the shopping malls to give people directives especially at the facilities entry points. 70% of the malls make use of the signage system to aid the human personnel in the management of crowd flow. Indoor public address system which is also an effective means of crowd management was present only in 40% of the buildings while fire fighters were readily available around the premise of the facilities at only 20%. By way of analysis of individual facility, Jabi lake mall and Lugbe mall have all of these features of mobile system of fire safety available in them. All others only have these features available at 75%, 50% and even 25% average or below average.

Table 4.4: Mobile system of active fire safety features in shopping malls.

Name of Shopping Mall	Indoor Public Address System	Signage System	Crowd Management personnel	**Fire fighters**	**T OTAL PER MALL**
Area 1 shopping Mall, Area 1	•	•	✓	•	25%
Bannex Plaza, Zone 2	•	✓	✓	•	50%
Ceddi Plaza, Central Area	✓	✓	✓	•	75%
Hebron Plaza, Gudu District	•	✓	✓	•	50%
Jabbi lake mall, Jabi	✓	✓	✓	✓	100%
MKK Plaza, Gudu district	•	✓	✓	•	50%
Park and Shop Plaza	•	•	✓	•	25%
Shagari Plaza,	•	•	✓	•	25%
Shoprite Lugbe /Lugbe mall	✓	✓	✓	✓	100%
Silverbird Galleria,	✓	✓	✓	•	75%
TOTAL PER FEATURE	**4**	**7**	**10**	**2**	
PERCENTAGE	**40%**	**70%**	**100%**	**20%**	

(Source: Author's Field Work, 2019) **Key;** ✓ **= Available** • **= Not Available**

4.3 Objective 4: To design a shopping mall building where the safety of its users is enhanced through the incorporation of fire safety design features

This aspect of the analysis is meant to interpret or put through in details, the aspect of this work in consonance with importance of safety with details on fire to promote safety in shopping mall. The result shows and explains the outcome in the research process and it application in the suggested design.

4.3.1 The site

This site is referred to as proposed site and a place where the proposed will be situated. The success of any building in terms of its fast design, construction, and operations

depends on the site location, site selection criteria, site inventory, planning laws and regulations.

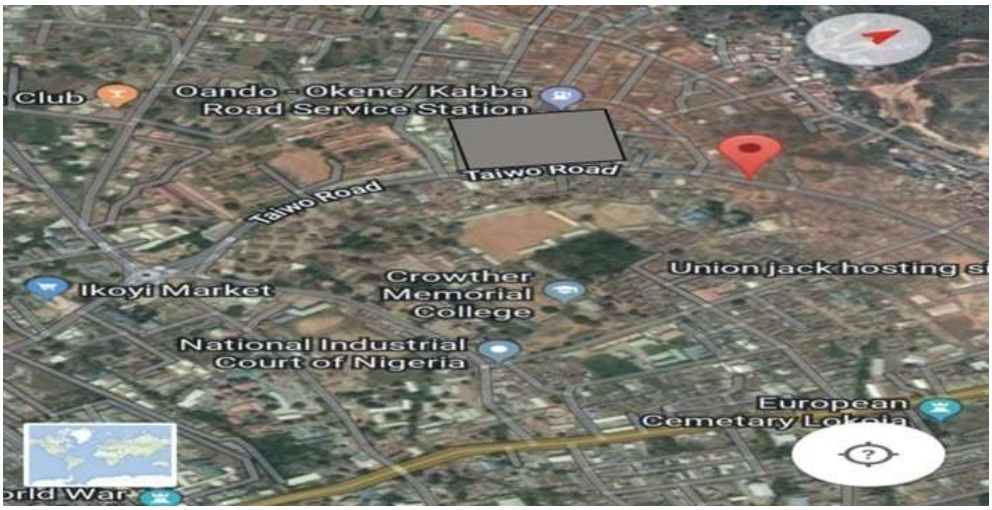


Figure 2.18: Showing the site Location

4.3.2 Site location

The area is sited along Taiwo road (immediately after and opposite Kogi specialist hospital) in the centre (heart) of Lokoja town (the Sttae capital), Kogi state, Nigeria. It is the major road that connects Lokoja to other parts of the country. Where the place is located and it features has attracted developers and architects.

4.3.3 Site selection criteria

Factors suggested in the choice of selection site:

a. Topography, that is, a area that can be built with less expenses.

b. Adequate size and suitable (regular) shape.

c. The presence of social amenities and services such as telephone, electricity and water supply on the site and installable at acceptable cost.

d. Availability of site for d evelopment at the heart (centre) of the town.

e. Accessibility, that is, easily accessible location, preferably a site along one of the major streets of the town.

4.3.4 Site inventory

The site area is 43,713.2 m^2. The natural features on the site are scanty shrub, sparsely spaced trees and some small stones. The site has a very gentle slope and the soil is the sandy type containing few rocks. See plate 1.33 below.

4.3.5 Site analysis and evaluation

i. **Rainfall** – in the month of May and November the place recorded heavy rainfall. The water required in construction. The rainfall is needed to assist it.

ii. **Temperature** – at the termination of raining season the temperature is at the its lowest point. The dry season which is harmattan season is when the highest temperature occurs. The everyday temperature is 27^0c – 30^0c.

iii. **Topography** – the land is slightly sloppy which does not pose serious challenge to foundation and suoer structure. The sloppiness is adequate for draining system and waste pipe.

iv. **Vegetation** – certain area or part of the site is occupied by weeds, grasses and trees and it will be cleared off in a space that are not needed

v. **Prevailing wind**: the two are the north east and the Southwest trade wind. At the harmattan season, the north east trade wind blows high temperature at noon and considerably cold at night in the case of southwest trade wind. It gives room throughout the year.

vi. **Accessibility:** the place has two accesses when approaching the site. The north part and the southern part. For customers or buyers and service vehicles.

4.4 Design Report

4.4.1 Schedule of accommodation

After a series of case studies and review of related books articles of shopping mall design; in depth analysis of the brief, the brief was developed thereby forming a detail schedule requirement of individual spaces critical to the design of a shopping mall and as well the bulk spaces schedule (Table 4.5).

Table 4.5: Schedule of Accommodation of Anchor Store

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Anchor Store	545	2	1090
2.	Storages	47	1	47
3.	Toilets	8	1	8
4.	Offices	9	1	9
	Total			1154

Source: Author's Field Work (2019)

Table 4.6: Schedule of Accommodation of Food court

No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Dining Area	558	1	558
2.	Kitchen	39	1	39
3.	Store	14	1	14
4.	Toilets	4	1	4
5.	General Store	10	1	10
6.	Changing Room	9	2	18
7.	Services	12	1	12
	Total			**655**

Source: Author's Field Work (2019)

Table 4.7: Schedule of Accommodation of Retail Services

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Retail Shop Type A	51	15	765
2.	Retail Shop Type B	70	8	560
3.	Retail Shop Type C	95	10	950
4.	M.S.U	285	8	2280
5.	Exhibition 1	20	1	20
6	Exhibition 2	10	2	20
	Total			**4035**

Source: Author's Field Work (2019)

Table 4.8: Schedule of Accommodation of Fitness Centre

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Entrance Foyer	76	1	76
2.	Changing Room	36	1	36
3.	Refreshment Bar	9	1	9
4.	Coaches Office	15	1	15
5.	Fitness Room	406	1	406
6	Toilet	4	4	16
	Total			**558**

Source: Author's Field Work (2019)

Table 4.9: Schedule of Accommodation of Games

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Arcade	71	3	213
2.	Children‟s Game Arena	406	1	406
3.	Snack Bar	12	1	12
4.	Pin Storage & Tool Area	8	1	8
5.	Toilets	8	1	8
6.	Service Aisle	15	1	15
7.	Office	6	1	6
	Total			**668**

Source: Author's Field Work (2019)

Table 4.10: Schedule of Accommodation of Customer Care Facilities

S/No	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Welcome Hall	25	1	25
2.	Concierge/ Info.	6	3	18
3.	Toilets	45	6	270
4.	Luggage	26	3	48
5.	Security	12	1	12
6.	Crèches	37	1	37
7.	Lounges	9	2	18
8.	Atrium	735	1	735
	Total			**1163**

Source: Author's Field Work (2019)

Table 4.11: Schedule of Accommodation of Centre Management

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Reception	4	1	4
2.	General Office	103	1	103
3.	Conference Room	45	1	45
4.	Staff Toilets	9	1	9
5.	Control Rooms	6	4	24
6.	General Store	12	1	12
7.	First Aid Room	6	2	12
8.	Secure Room	6	1	6
	Total			**215**

Source: Author's Field Work (2019)

Table 4.12: Schedule of Accommodation of Access and Delivery

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	General Lobby	662	4	2648
2.	Service Corridor	36	3	108
3.	Service Lift	30	1	30
4.	Fireman‟s Lift	36	1	36
5.	Emergency stairs	30	2	30
6.	Refuge	44	8	352
7.	Fire Balcony	40	6	240
	Total			3444

Source: Author's Field Work (2019)

Table 4.13: Total Gross Area

S/No.	Spaces	Area (m2)	Unit	Net Area (m2)
1.	Retail Shops	4035	1	4035
2.	Anchor Store	542	2	1090
3.	Food Courts	655	1	655
4.	Restaurant	182.2	3	546
5.	Games	668	1	668
6.	Fitness Centre	558	1	558
7.	Customer Facilities	1163	1	1163
8.	Centre Management	215	1	215
9.	Access & Deliveries	3444	1	3444
	Total Gross Area (TGA)			15374
	Gross Leasable Area (GLA)			12306
Parking Spaces				12306*4/100=492 Parking Spaces

Source: Author's Field Work (2019)

The Total Gross Area (TGA) and the Gross Leasable Area (GLA) of the bulk spaces of the shopping mall was used to calculate the number of parking spaces requirements. According to the lCSC (2004) spaces for parking are calculated with respect to the GLA, it is estimated that 5 parking spaces per 100msq GLA.

4.4.2 Design considerations, planning principles and concept

The location is separated into an un-restricted and work zone. The unrestricted area is basically the outdoor aspect of the items such as the parking lots for stranger and passenger position their vehicles. This site does not have much security check as it is far from the building and the area where activities are carried out. The work are basically the indoor spaces which are kept safe by allowing only screened people into them. By design, the public spaces are distant from the activities zones. This is to allow the spread

of crowd between them rather than having them close and entwined which consequently result in crowd build-up and bottle-necks formation.

Figure 4.1: 3D impression of confluence shopping mall depicting the design concept, pattern of circulation and planning
(Source: Researcher's Drawings, 2019)

4.4.3 Construction

The suggested location put into consideration, the materials, element and principles that aid the safety of users and customers of the shopping mall as discussed in both objectives. As shown in the said appendix, the road connecting to the. site has the capacity to accommodate the traffic likely to be caused by its users. Service roads are provided to the sides of the building in form of parking to aid fire fighters and the Unloading/uploading of services fixtures and heavy machineries. The site terrain is slightly sloppy in the direction of the north and only need little filling.

Its demands leveling to make it a flat terrain that allows the activities of the equipment. The loamy nature of the soil serves as pillar for growth of plant and payment construction.

The Analysis of Concept

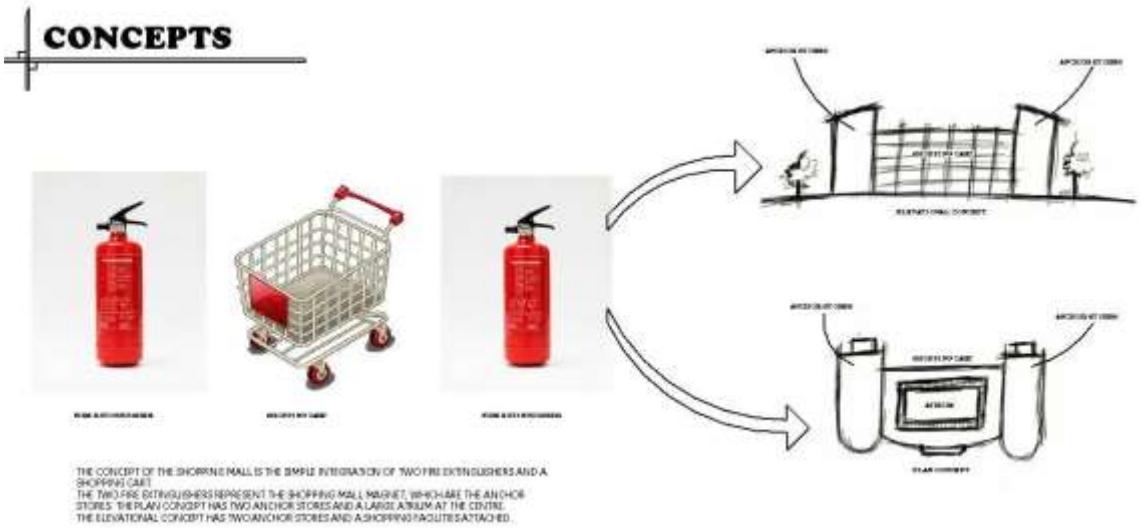


Figure 4.2: Showing the analysis of the concept

The form of the plan was used to ensure free flow of crowd within and around the building. The various activities are then spread within the building and adequately spaced for a safe usage of the shopping mall with respect to the capacity it is designed. The use of concrete reinforcement wire mesh is used for the ground floor and the suspended floors is high tensile steel. For the floor the use glaze marble tiles for the finishes to guarantee durability and welcoming show.

Divisions are done as follows:

1. On the ground floor is the Anchor store, food court, bank, furniture and other related shops. This was done in order to make the movement of goods and people in and out of such stores easier.

2. The first floor consists of electronics, sports equipment and other related items. This was done in order to make the movement of goods in and out of such stores easier.
3. The second floor consists of beauty salon, retail shops, book store, boutique and other related facilities.
4. The third floor consists of food court, beauty salon, barbers shop children's play area, arcade games, departmental stores. This is done in order to locate the food area midway the shopping mall to allow for equal distance to all customers and occupants.
5. The fourth floor are the commercial activities like bank, travel agency and leasable office spaces. The volume of shoppers is much less on the last two floors which makes it easy to control traffic in case of emergency.

Precast hollow clay pot is recommended for the construction of floors. This reduces cost because of the reduction in the concrete volume by 50%, the reinforcement weight by 25% and the size of the foundation by 10%. The floor kind is not only less expensive but reduces the load of the building and sand insulation.

The building wall are built with reinforced concrete and glass. This make the building durable and at the same time aesthetics requirement of a shopping mall.

The Glazed sade of the shopping mall are built with double skin reflective glass to keep out heat and reflect the radiation from the sun.

The role of the walls the building is the protection of the element weather which are rain, dew, wind, heat and dust. Also the provision of aesthetics due to the finishes to be used. For proper functioning of the wall, it is pertinent that they possess required stability, strength, thermal insulation, resistance to dampness and five resistance. For all the building that needs the use of wall, 450mm x 225mm x 225 mm are to be applied.

The component of the roofing systems are two which includes the structural which is the steel lattice beams running between the columns and hoisted to un-even heights thereby creating the slope and shape of the roof. The other aspect of the roof is the barrel vault over the platforms. This is built with concrete reinforcement and drained at the column for adequate drains of water from the roof. The barrel roof is slightly along the columns using mortar to control the movement of water.

4.4.4 Materials and finishes

Concrete is needed mainly in the building of a considered shopping mall. The construction material are made up of fme aggregates (sand, cement and coarse aggregate in combination with water which get hardening in a period of time into a rock-like mass.

Reinforced Concrete: This is an essential part of any building materials in which steel is embedded in such a manner that two materials serves together in resisting forces. This is actualized to utilize the compressive strength of concrete and tensile strength.

Steel: is needed for the building of the structural roof members as well as the reinforcement for columns is an alloy of iron and carbon and sometimes other elements. Because of its high tensile strength and low cost, it is a major component used in buildings.

Aluminum Sheets: Mainly needed as an exterior section of roof covering. This aluminum is a remarkably versatile material in part due to the large variety of surface finishes. It can be given for panty to the large variety of surface furnishes. It can be given for party to anodizing texturing and polishing.

Blocks: is the material constituting part of the building envelope. It will be used as the wall material at the left, right and rear elevators respectively. The mixture of water, five aggregate and cement is what forms block moulding. Two types of blocks, the 9 inches

and 6 inch respectively for external work and partitioning. Building walls which gives space for diverse functions.

Glass: Will be used extensively at the building facade and rear glass in a material for building which has been cooled to a solid state. Glass is mainly needed in an open place to allow light and for air to pass the space. There are different kinds of glass but the recommended one here because of the considered design is the sheet glass used in covering the openings. At the rear and approach (Entrance) the reinforced concrete column where the sheet glass is enveloped is used. At the left and right elevation. The envelopment of the sheet glass in the window cache is the type of window to be used.

Ceramic and Marble: Will be used mainly inside the shopping mall- building. There production is as the result of the burning of clay mixture to achieve a desirable shapes. This are used in Conveniences and office spaces finishing and other suspended floors while marble will be used at the entrance, man shopping mall and other V.I.P spaces. The durability nature is the result of it wide range of use in these places and easy to handle.

Figure 4.3: 3D impression of the Shopping mall depicting the material and finishing (Source: Researcher's drawings, 2019)

4.4.5 Landscape and external works

Interlocking stones, plant, mainly the use of shrubs to direct the movement of human being and cars. The use of landscape element such as soft and hard to give beauty to the immediate surroundings.

The site parking spaces is essential because it is a public building. This has created more parking lots within the buyers. With it away from the building the other space for the parking lots beside the shopping mall are for the executive and staff member respectively. Facilities introduced at the environment to promote the facilities functions are walkways, two security houses at the site.

Security light and proper landscaping is introduced to make the facility meat up to standard at the night hours for security reasons.

4.4.6 Building Services

Electricity serves as the engine room for adequate operative of the shopping mall. Because shopping mall as this with massive interior space and electronic gadgets will only be under-utilized if its electricity supply is paralytic. Different kinds of appliance which includes five alarms, lighting points with the cables needed for the facility wiring to meet up with the standard code of efficiency; reliability, safety and durability. The conduct system are used in the electrical cables in the complex with socket outlets positioned at different areas to give power to every part of the building.

The cooling of the building is by the use of central air conditioning system through the wall ceiling. It supplies into different spaces.

The numbers of people determines the ventilation needed in a place.

Lokoja water board supplies the portable water at the place which is used by firefighting, maintenance and sanitation of the surrounding the water is pumped into the

overhead tanks by the one stored in the reservoir. In the area of plumbing, metal pipes and duct were used in different places to maintain or stop sound transfer.

The drainage system are constructed in line with road and walkway pattern. The nature of the law allows for discharge and flow into a nearby drainage. Arrangement of sewage soak away tank and pit is needed. The construction of drains is with materials that is durable.

The design orderliness includes designing an every spaces separating it with quite and noisy areas. The structural design with using architectural concept to resolve five issue.

4.4.7 Security and maintenance policy

This a key aspect in the considered facility. The active measure of security entails building safety of the buyers and what it contains. This involves the different aspects which are the setbacks, artificial lighting, and sufficient standoff, site layout. This need incorporation in the design in order to improve its safety.

The essential factor for adequate security in the facility is to demarcate the main building from the parking and the outdoor area. Due to the fact that occurrences of attack are the burning of vehicle.

Maintenance is also important in the suggested facility to guide the structure from the deprecated which poses risk to users life of the facility. This is done by putting in order the component of the building in a deteriorating state and complete change when they are outdated. Services maintenance includes lighting, heating into protecting fire system are the part of building that demands organized schedules maintenance. Adequate maintenance will assist in keeping the value aesthetically. Putting into consideration that building is a general facility.

Attempt have been done to show that materials for building dictate in those that needs little maintenance by the dictation of quality, good and durability.

4.5 Summary of Findings

The outcome shows that the studied shopping mall have insufficient of the required safety measures in place and among these present safety features, some of them are adequate for the purposed they were provided while others were not. The facilities were assessed on both active and passive fire features for circulation safety and fire safety respectively. Regarding fire safety, the analysis shows that 75% of the passive features assessed were present at the shopping mall below average. It also shows in table 4.5 that half of the passive fire safety features were present above 50%.

By way of Analysis of individual facilities, it is shown in tables 4.2, 4.3, 4.4 and 4.5 that Jabbi, Lugbe shopping mall and silver galleries in Abuja has majority of the studied features such as multiple number of entrance doors, optional platform staircase, emergency staircase, multiple exit points, wide ingress to egress distance, incorporated in them. The remaining shopping mall have these features at or below average on most of the areas the analysis is based.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

From the above analysis which shows the fire safety level of shopping malls, it is concluded that shopping mall consider the need of moving out its occupants in emergency events by making emergency exits available in all of the facilities. However, the shopping mall lack emergency staircases at their emergency exits with its provision at only 16.6%, but there is due consideration for a clear space behind the emergency exits which allows for customers free dissipation.

It is also concluded that the Nigerian shopping malls adopt the active means of crowd management by means of crowd management personnel who control customers' movement and physical activities thereby making less use of public address system. Crowd management personnel as an active means of crowd control have obviously side-lined the use and need for the passage of information via the public system. The absence of some basic safety features of a shopping mall in Abuja render them low on the scale as it becomes difficult for customers to easily find their ways out at the platforms after or before getting on/off the shopping mall, locate the emergency exit from the floor above as well as get informed on the shopping mall' public state of facilities and the services in general.

The shopping mall do not fully consider customers' safety in an event of fire as only very few fire safety features are provided in them. Features like an indoor emergency space, emergency vehicular access and emergency stair case which are necessary for the safety of users of the facilities in an event of fire are lacking greatly in the facilities. The

need to provide fire extinguishers in the facilities was however met as this was available in all the studied shopping mall.

5.2 Recommendations

Building Professionals committed to public facilities should establish findings in the research. There is need for an emergency staircase to be provided near the emergency exits of the shopping malls to make the functions of the exits effective. It is also needful that there is an optional staircase at each platform to allow the spread of customers along the platforms. Improvement on the available features will also make safer the activities of users as they move between the various functions. It is also obvious that there is room for improvement on the available features of the shopping malls which would improve fire safety. Features such as the distance between the shopping malls ingress and egress needs improvement as the majority of 10 – 20 metres seem too tight for the activities that are contained in a shopping mall and could lead to crowd build-up and circulation crisis.

There is need to make provisions for an emergency vehicular access to the shopping malls for fire fighters and emergency evacuation. Fire sensors which are necessary to trigger fire alarms also need instalments in the facilities. Safety of pedestrians in shopping malls building should be a serious concern as the shopping malls are been restored and new ones constructed.

REFERENCES

Alexander, D. (2002). *Principles of Emergency Planning and Management*. England: Terra Publishing.

Averill, J., Mileti, D., Peacock, R., Kuligowski, E., Groner, N., Proulx, G., Reneke, P. & Nelson, H. (2005). Occupant Behavior, Egress, and Emergency Communications. *American Fire Safety Movement*. 6:1-7

Ayodele, S. (2000). *The strategies for National Development in Nigeria in the Next Millenium in Jiboku*. *Perspectives on National Development*. Ilaro: Marvel Books.

Backer, D. M., Jensen, S. E. & McPHERSON, G. R. (2004). Impacts of fire-suppression activities on natural communities. *Conservation Biology, 18*(4), 937-946.

Barry, M. (2014). *The New Architecture of the Retail Mall*. London: *Architecture Design and Technology Press*. 155.

Billington, M. J., Ferguson, A. & Copping, A. G. (2002). *Means of Escape from Fire*; Oxford. Blackwell Science.

British Council of Shopping Centres (2000). *A Briefing Guide for Shopping Centre Development*. BCSC, p. 31.

Brown, T. & Downey, D. T. (2006). The Changing Role of Architect in Disaster Response. *Environmental Health.* Retrieved July 2005 from http://www.aia.org/nwsltraiaj.cfm?pagename=aiaj

Bukowski, R. W. & Kuligowski, E. D. (2004).The Basis for Egress Provisions. U.S. *Building Codes*, New York: Edinburgh.

Carpenter H. (Jnr.) (1978). Shopping Centre Management Principles and Practice International Councils of Shopping Centres, New York. New York, United States of America.

Cohen, E. (2003). *America's Marketplace: The History of Shopping Centres.* New York Greenwich Publishing Group.

Conditioned Shopping Centres at Dhaka City. *Asian Journal of Applied Science and Engineering*, 3(2), 6-8.

David, B. (2006). *British Council of Shopping Centres*. Retrieved March, 2011 from http://www.bcsccorg.uk

Filippidis, L., Galea, E. R., Gwynne, S. & Lawrence, P. J. (2006). Representing the Influence of Sign age on Evacuation Behaviour Within an Evacuation Model. *Fire Protection Engineering*, 16, 37- 73.

Frank, E. (2008). Map of Abuja. *Abuja Geographical Institute*. Retrieved July 5,2011 from http://www.fcda.gov.ng

Fruin, J. J. (1984). Crowd Dynamics and Auditorium Management. *International Association Auditorium Managers*. Retrieved May 2017 from http://www.crowddynamic.s.comlMainiFruin%20-%20causes.htm

Fruin, J. J. (1993). *The Causes and Prevention of Crowd Disasters*. London International Conference on Engineering for Crowd Safety. Greenwich Publishing Group. Retrieved March 2016 from http://www.crowddynamics.comlMainiFruin%20-%20causes.htm.

Guildhall Online Library (2006). *British Council of Shopping Centres*. Retrieved March, 2011 from http://www.bcsc.org.uk.

Hale, A., Kirwan, B. L. & Kjellen, U. (2007). Safe by design: where are we now?. *Safety Science*. 1(2), 305- 327.

Hani, H. A. (2009). *An assessment of vulnerability and risk in mass gatherings; How can vulnerability and risk be reduced in large-scale gatherings?* School of Built Environment, Oxford: Oxford Brookes University.

Hardwick, M. & Jeffrey, L. (2004): Mall Makers: Victor Gruen, Architect of an American Dream. University of Pennsylvania Press, Philadelphia.

Harrison, M. (1975). People and Shopping: A social Background. Totowa, New Jersey

Helen, T. (2008). *Great public markets*. http://www.architectureweek.coml2008/0709/culture_1- l.html. Retrieved June 16, 2013.

International Council of Shopping Centers. (2014) Retrieved October 10, 2014 from www .icsc.org/research/references/ c-shopping -center-definations

James, R. D. (2005). *Shopping Center Classifications: Challenges and Opportunities*. Retrieved September 14, 2014 from www.reuw.washington.edu.

John, R. H. (2014). Fires starting with flammable gas or flammable liquid or combustible liquid. Retrieved February 23, 2014 from www.nfpa.org.

Justice, F. C. & Reynolds, M. P. (2003). Construction & Engineering Law.

Maitland, B. (2002). The New Architecture of Retail mall. *Architectural Design and Technology press*. Pp 234.

Martin, M. & Andrew, O. (2005). *Introduction to Fire Safety Management. Architectural Press,* Cambridge, England. 56.

Martine, H. (2004). *British Council of Shopping Centres*. Retrieved March, 2011 from http://www.bcsc.org.uk

McKeeve, J. R., Griffin, N. M. & Spink, F.A. (1978). Shopping Centre Development Handbook (Community Builders Series).

Oluigbo, S. N. (2010). Context and Application of Case Studies in Architectural Research.

Oluigbo, S. N. (2011). *Case studies in Architectural context*. Paper presentation in the Department of Architecture, Ahmadu Bello University, Zaria.

Opara, N. L. (1988). A Modern Shopping Complex Victoria Island, Lagos Unpublished M.Sc (Architecture) Thesis ABU, Zaria Nigeria.

Peter, C. (2006). Shopping Environments Evolution, planning and Design. Architectural Press, Oxford, London, England. 423.

Pevsner, N. (2004). A History of Building Types. Thamesband Hudson. *International Council of Shopping Centres* (New York). A Brief History of Shopping Centres

Prior, J. (1999). Sustainable Retail Premises, An Environmental Guide to Design, Refurbishment and Management of Retail Premises. *BRE Publications*, 13-16.

Proulx, G. & Eid, I. (2006). Occupant Behavior and Evacuation during the Chicago Cook County Administration Building Fire. *Fire Protection Engineering*, 16. 17-22.

Richard, W. & Bukowski, P. E. (2007). *Building and Fire Research Laboratory Maryland*: Mindset.

Robert, D. (2002). Shopping Centres Futures. *Future Foundation*, Pp. 9.

Saniya, T. Sabbir, A & Taqir, M.R. (2014). An Investigation on Fire Safety of Air-conditioned Shopping Centers at Dhaka City. *Asian Journal of Applied Science and Engineering*, 3, (2), 20.

Schoenherr, S. E. (2006). Evolution of the Shopping Center. Retrieved from http://www.bcsc.com October 12, 2008.

Scott, N., (1989). *Shopping Centre Design*, Van Nastran Reinhold (International)

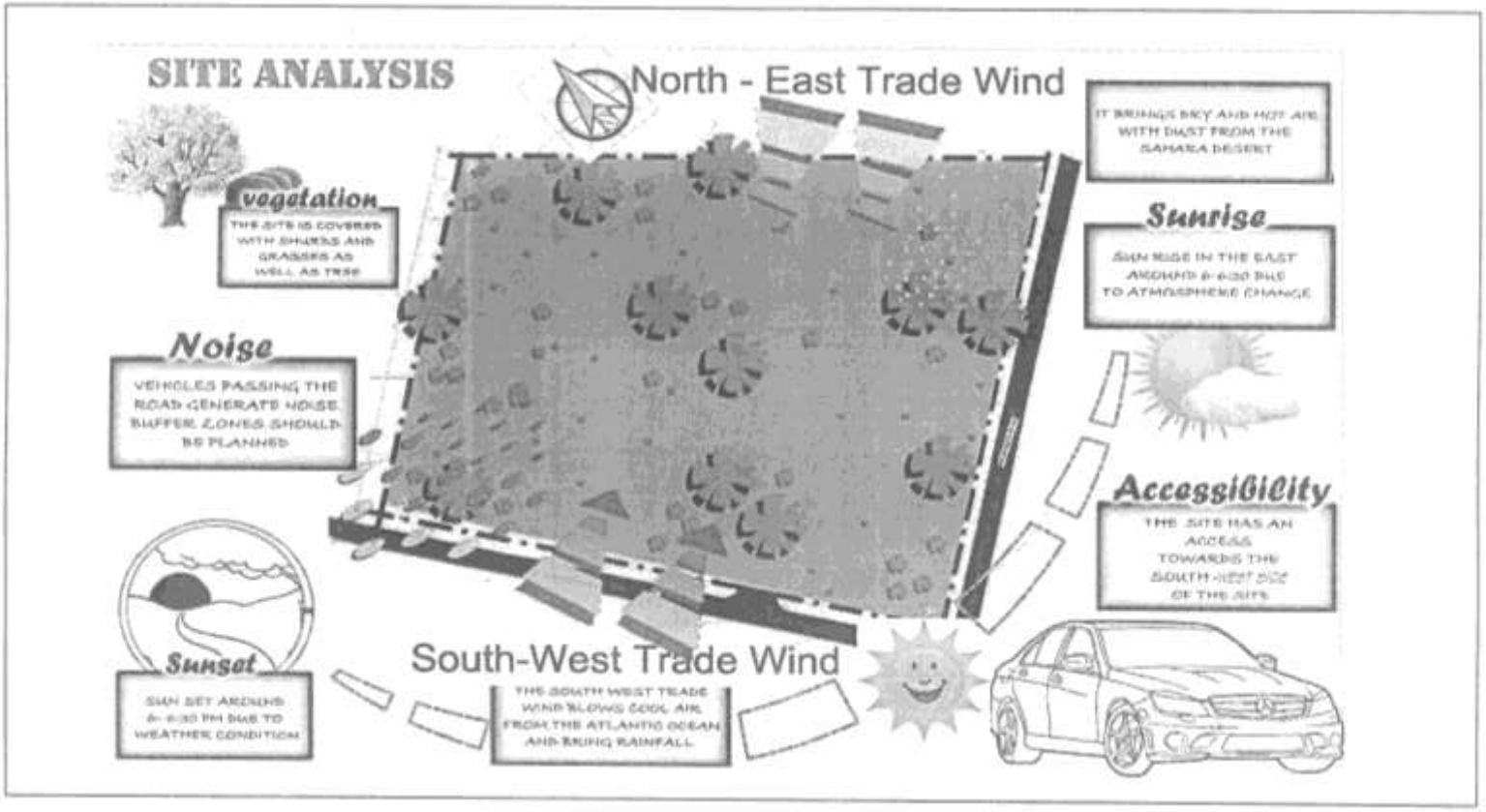
Sroulx, G. & Koroluk, W. (1997). Fires Fast and Accurate Information, CABA. *Home and Building Automation*, 15. 17-19.

Suleiman, J. (2000). *A modem shopping complex: A study of the impact of recreation on the design of shopping complex*. Unpublished MSc. Thesis, Department of Architecture, A. B. U. Zaria, Nigeria.

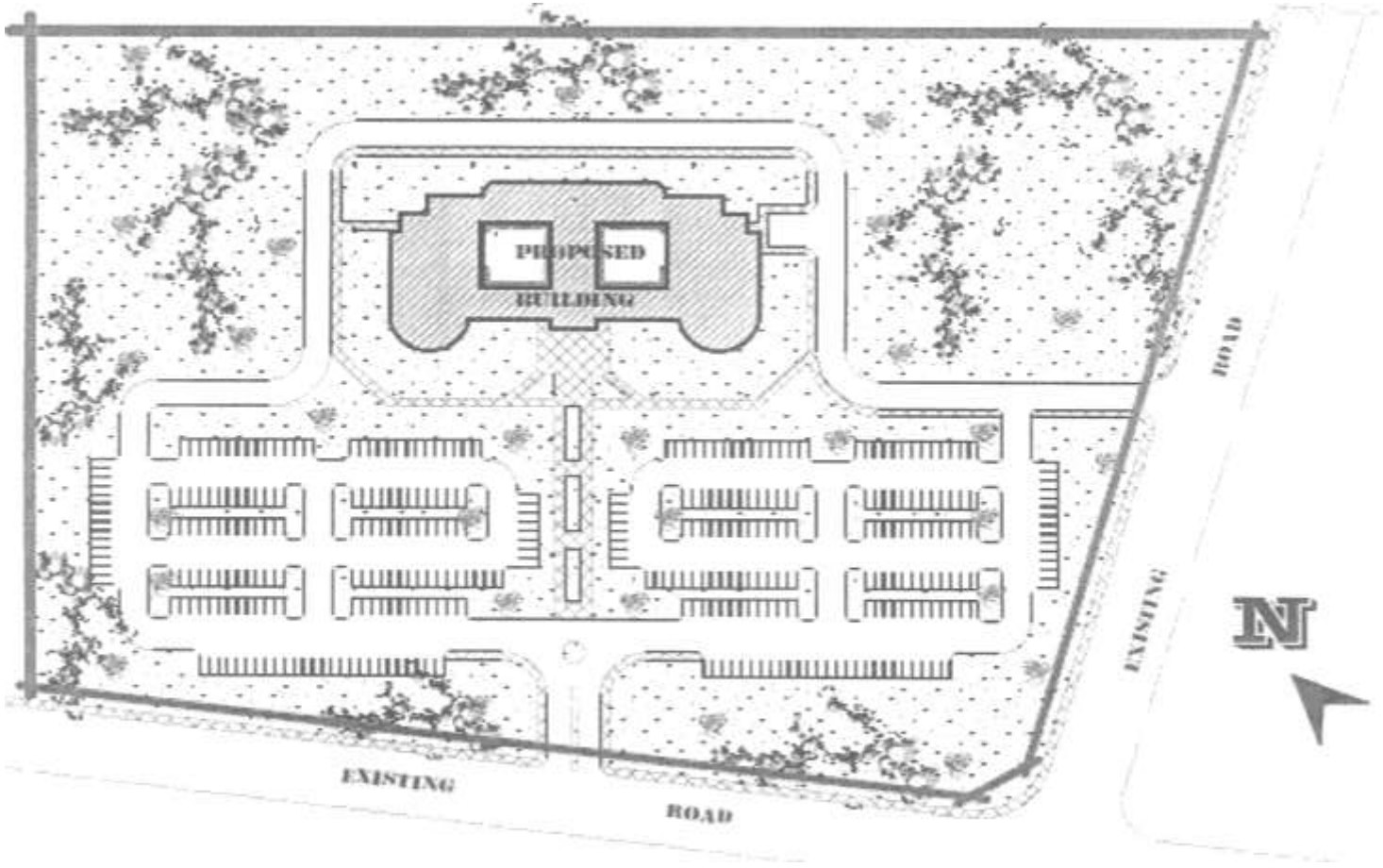
Tutt, P. & Adler, D. (1990). *New metric Handbook: Planning and Design Data*. Oxford: Reed Educational and Professional.

Westminster Archive, (2006). British Council of Shopping centres. Retrieved March 2011 from http://www.bcsc.com.

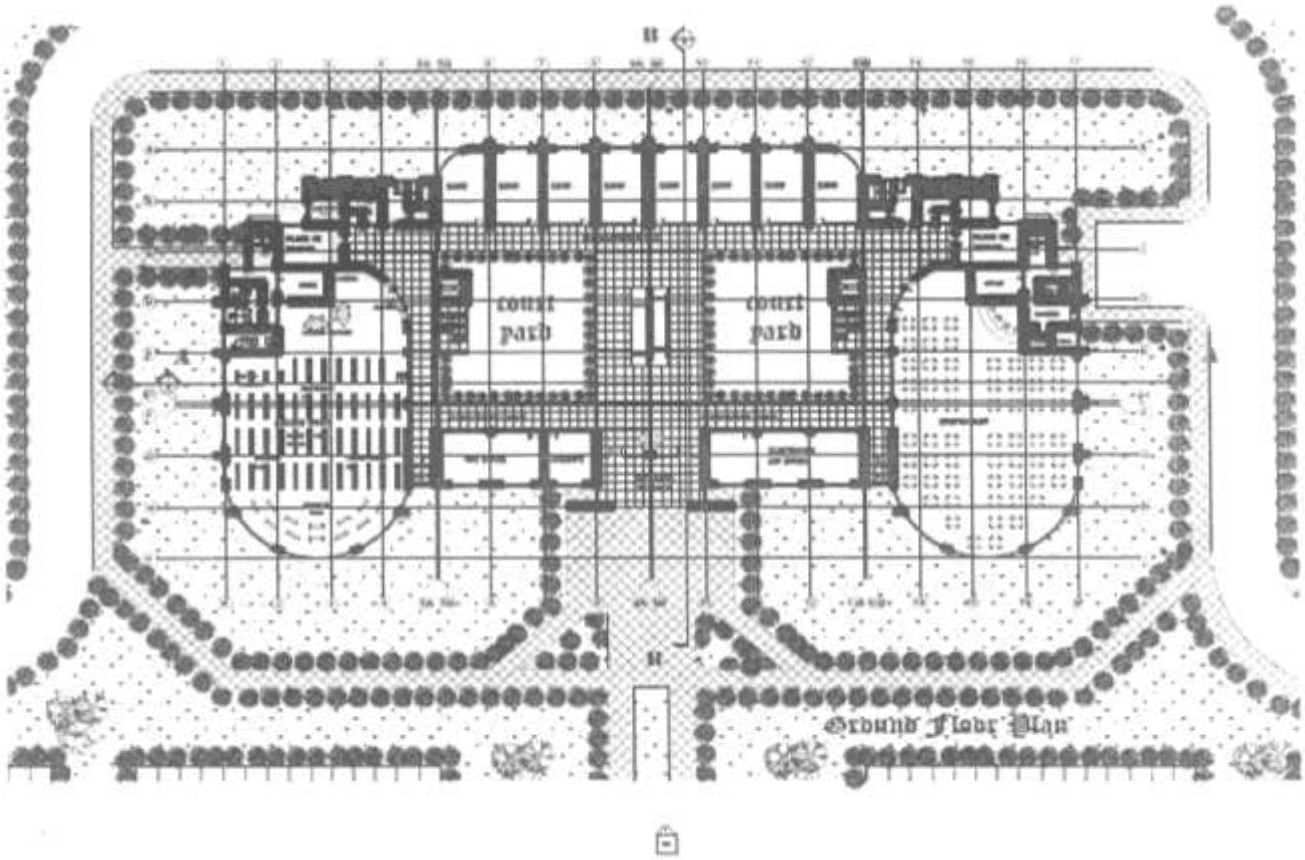
APPENDIX A


SITE ANALYSIS
North - East Trade Wind
IT BRINGS DRY AND HOT AIR WITH DUST FROM THE SAHARA DESERT
vegetation
THE SITE IS COVERED WITH SHRUBS AND GRASSES AS WELL AS TREE
Sunrise
SUN RISE IN THE EAST AROUND 6-6:30 DUE TO ATMOSPHERE CHANGE
Noise
VEHICLES PASSING THE ROAD GENERATE NOISE. BUFFER ZONES SHOULD BE PLANNED
Accessibility
THE SITE HAS AN ACCESS TOWARDS THE SOUTH-WEST SIDE OF THE SITE
Sunset
SUN SET AROUND 6-6:30 PM DUE TO WEATHER CONDITION
South-West Trade Wind
THE SOUTH WEST TRADE WIND BLOWS COOL AIR FROM THE ATLANTIC OCEAN AND BRING RAINFALL

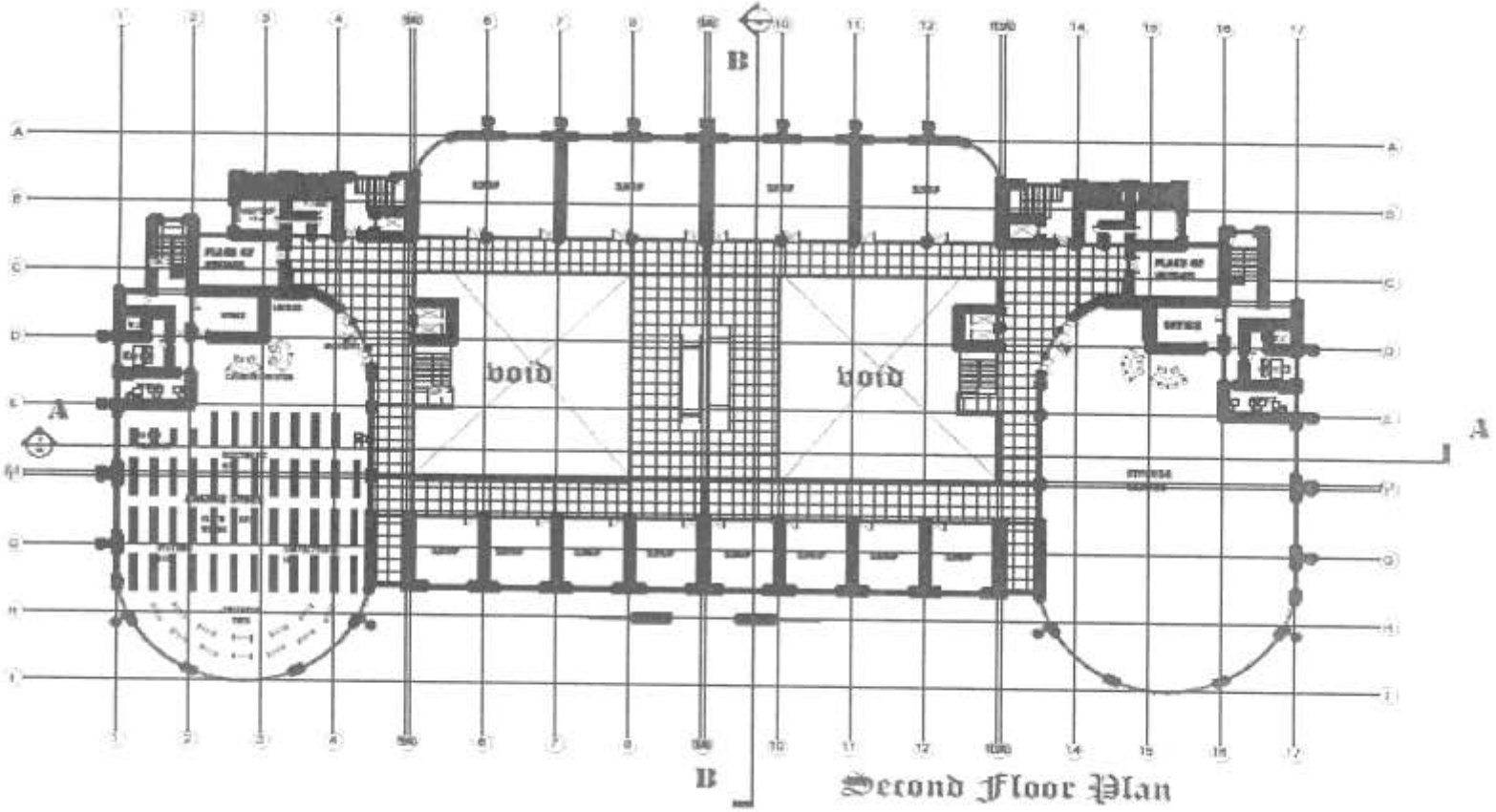
APPENDIX B



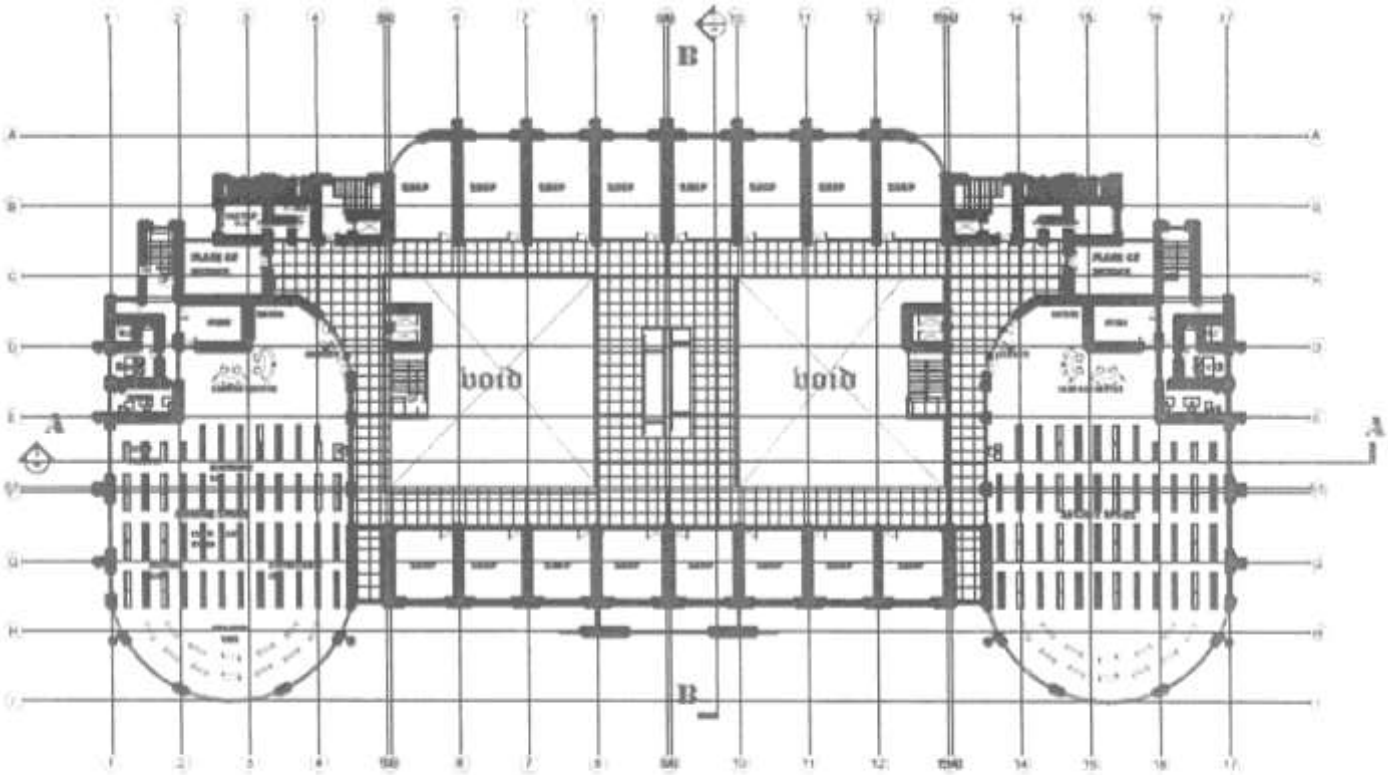
APPENDIX C



APPENDIX D

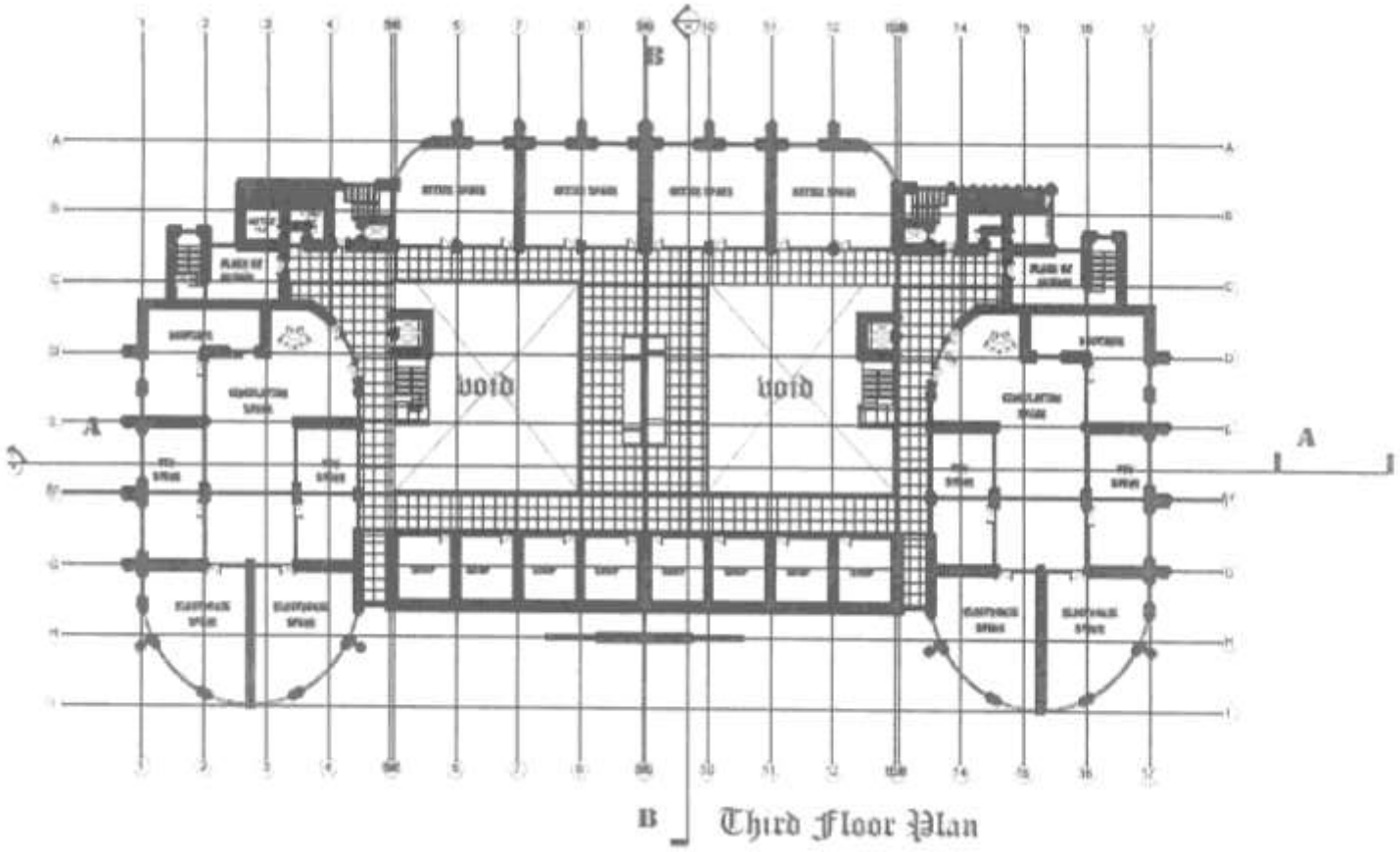


APPENDIX E



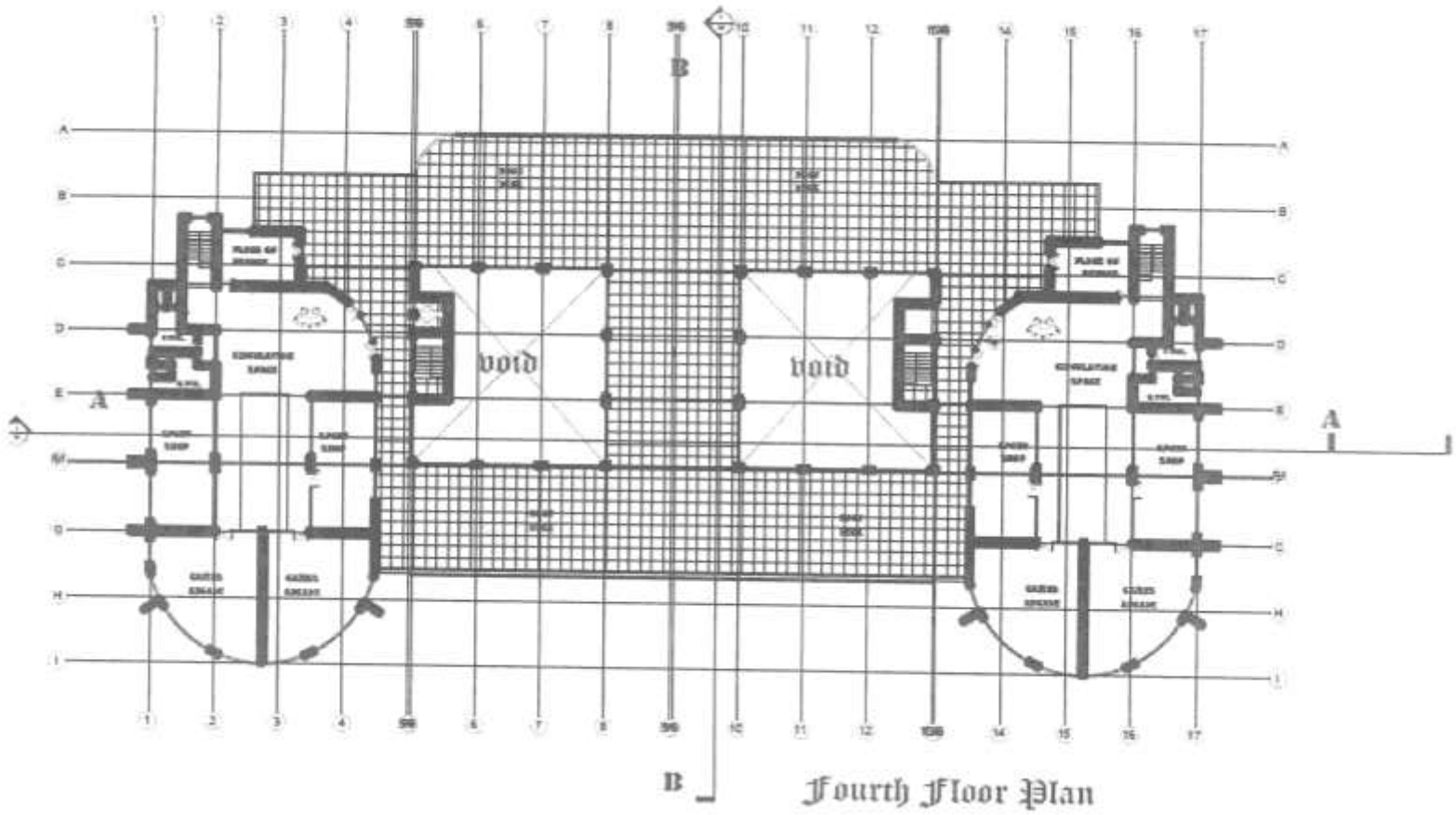
First Floor Plan

APPENDIX F



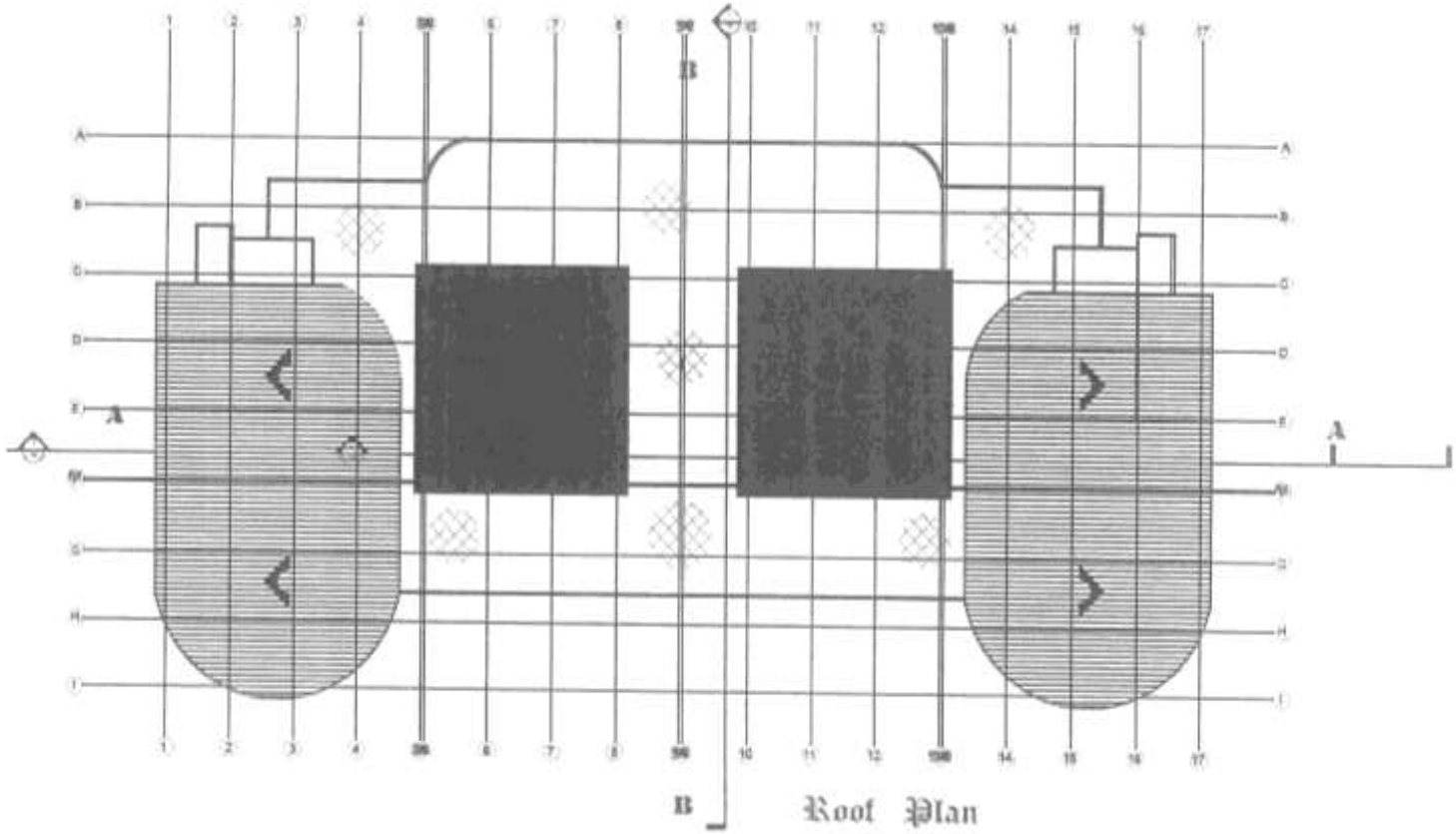
Third Floor Plan

APPENDIX G

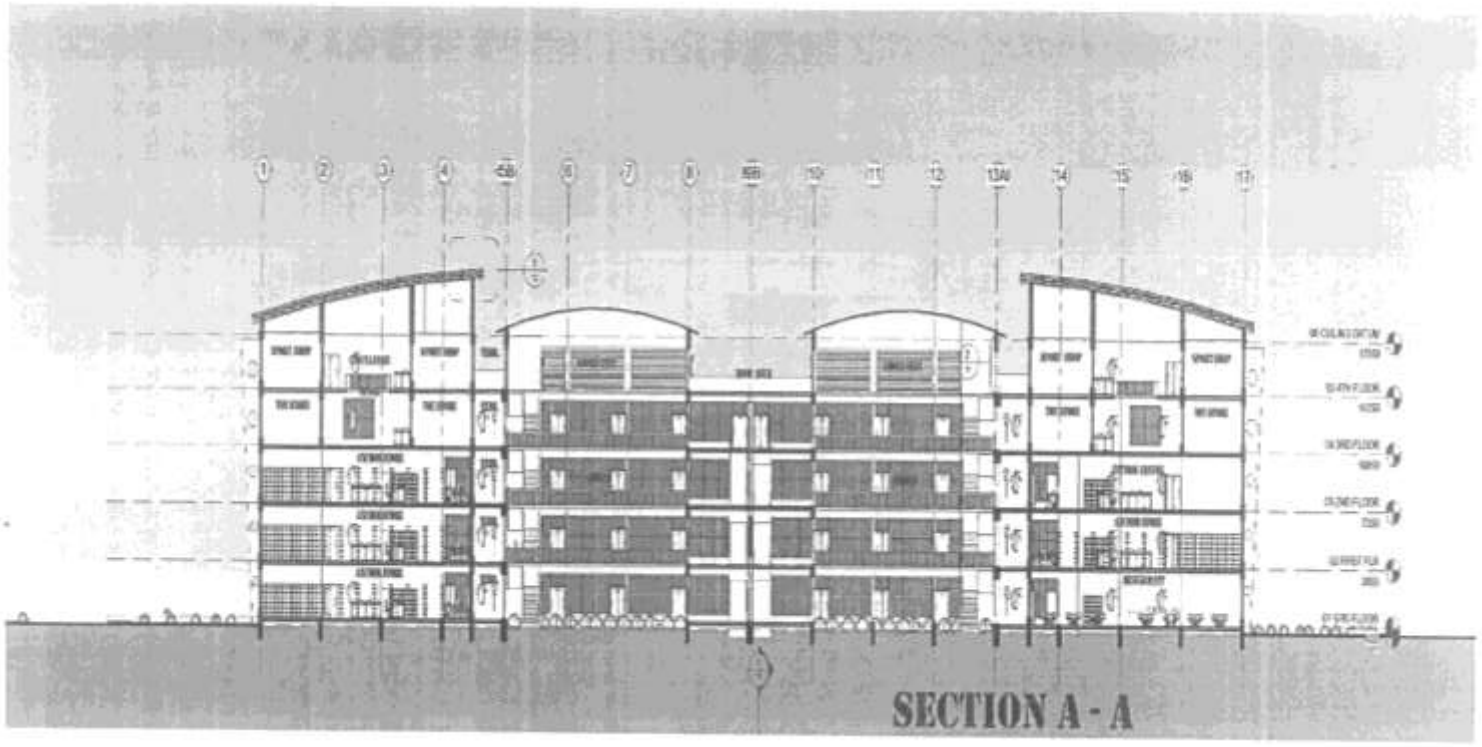


Fourth Floor Plan

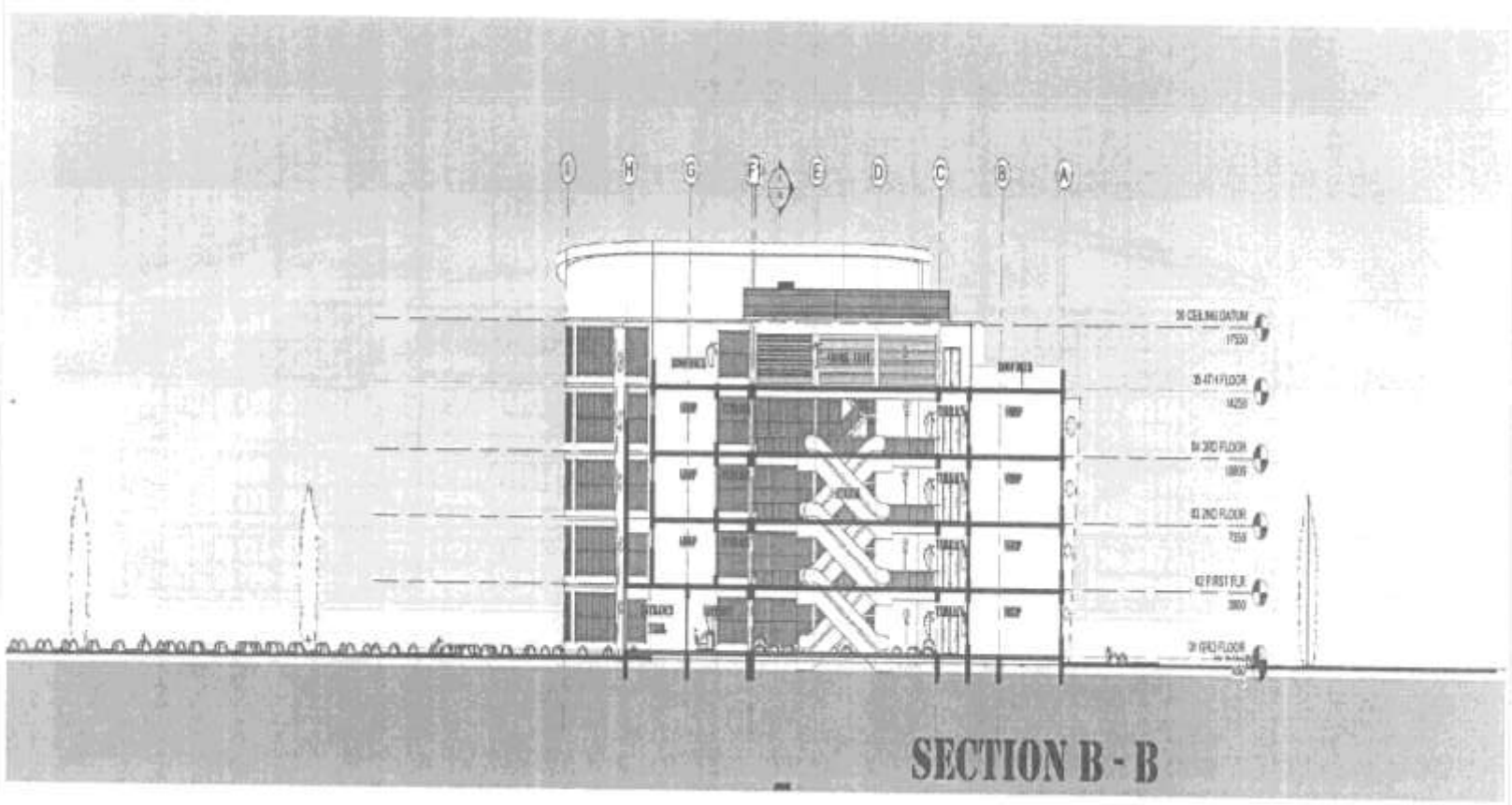
APPENDIX H



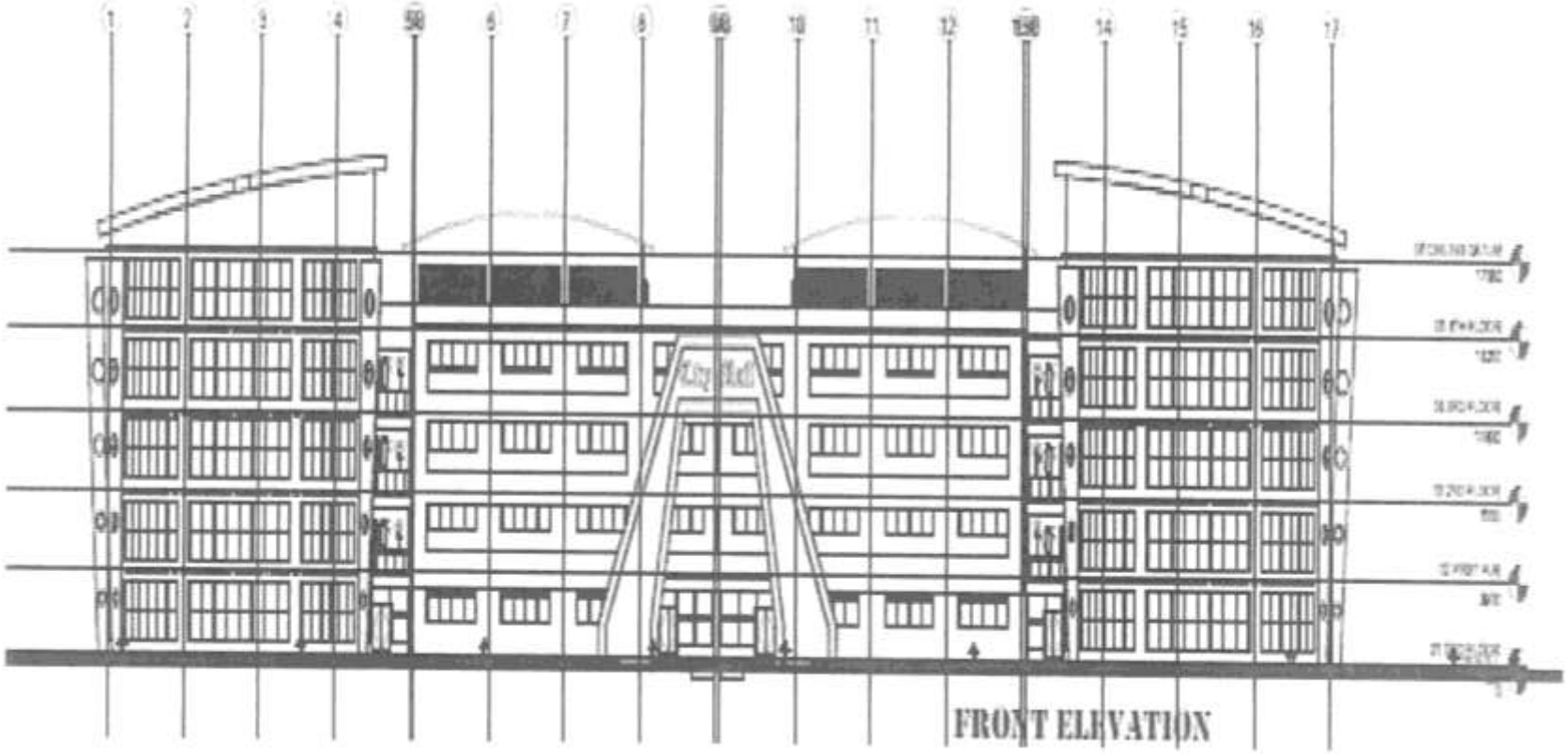
APPENDIX I



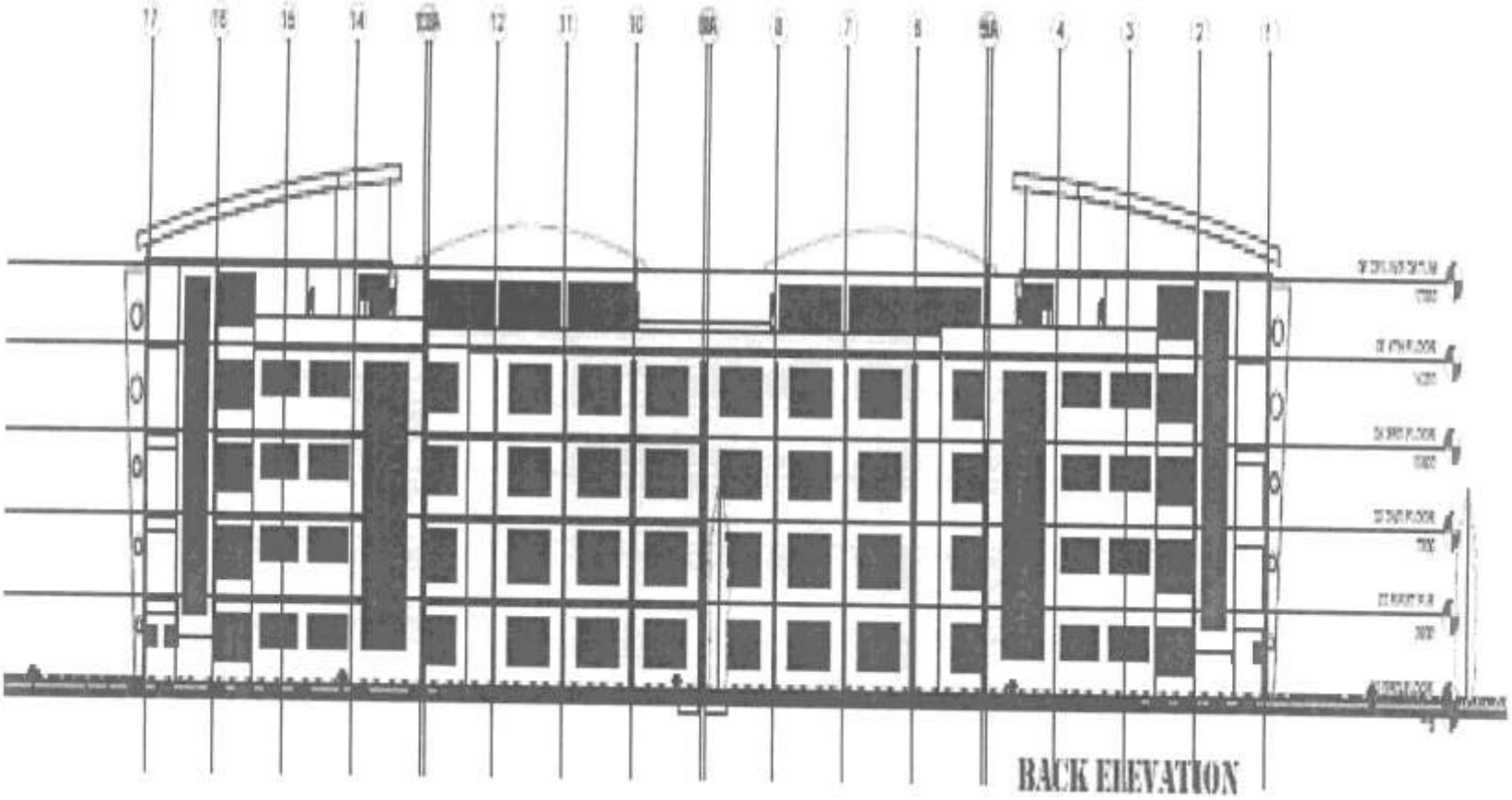
APPENDIX J



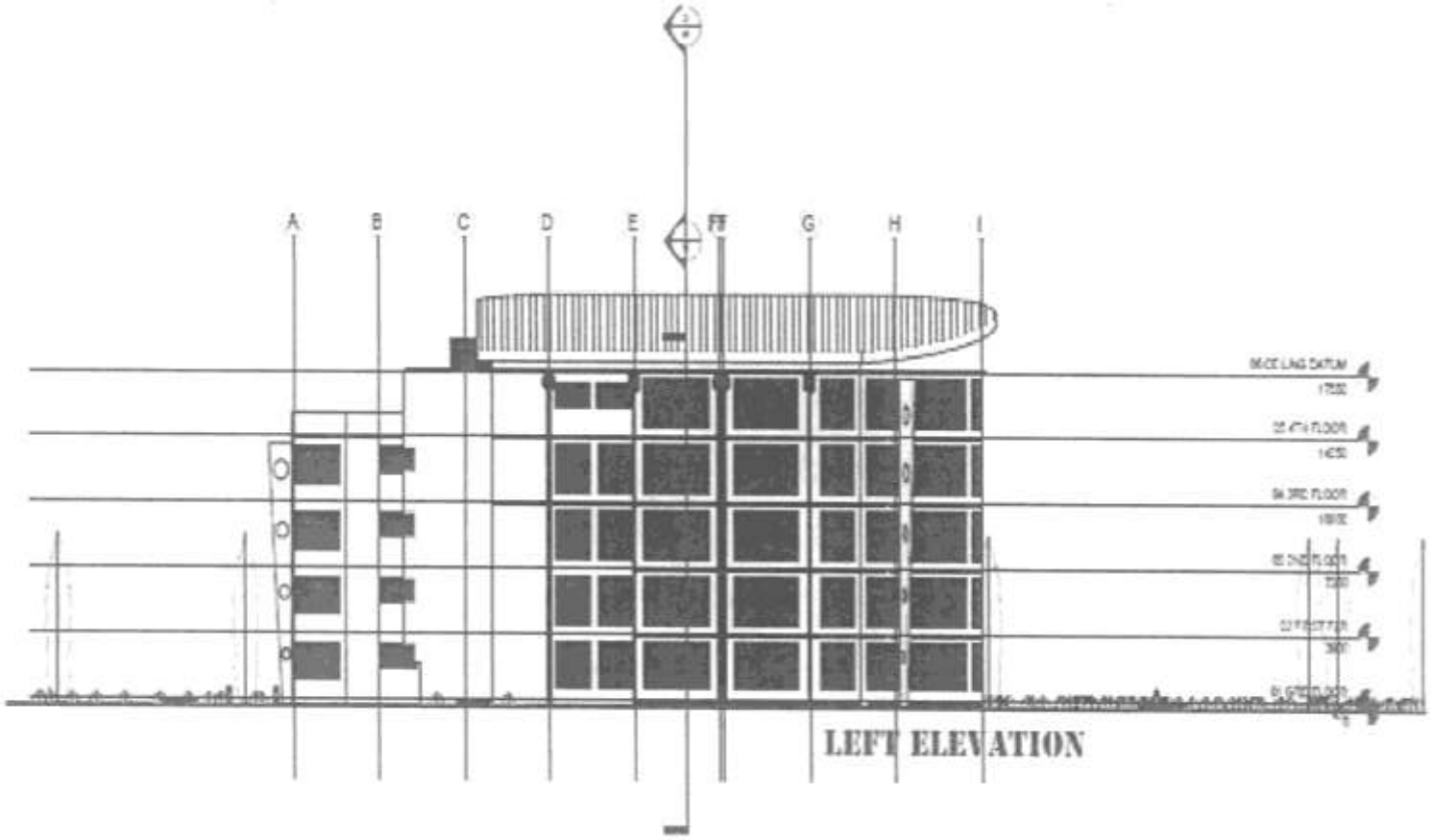
APPENDIX K



APPENDIX L



APPENDIX M



LEFT ELEVATION

FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER STATE
MASTERS DEGREE PROGRAM IN ARCHITECTURE
ASSESSMENT OF SAFETY DESIGN FEATURES IN SHOPPING MALL BUILDINGS IN NIGERIA.

NAME & LOCATION OF SHOPPING MALL: .....
YEAR OF DEVELOPMENT: .....
ESTIMATED TOTAL FLOOR AREA: .....
NUMBER OF FLOORS: .....
BASIC SERVICES AVAILABLE OUTSIDE THE SHOPPING MALL BUILDING (Eg, Bank/ATM, Eatery, etc

.....

BASIC SERVICES AVAILABLE WITHIN THE SHOPPING MALL BUILDING (Eg, Bank/ATM, Eatery, etc.

.....

PART A: SHOPPING MALL

1. Number of building(s) at the Shopping mall
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 & Above
2. Estimated Capacity of Shopping mall
   ☐ 1-200 ☐ 200-500 ☐ 500-1000 ☐ 1000& above
3. Types of Adjoining Facilities around the Shopping mall
   ☐ Residential ☐ Health ☐ Industrial ☐ Commercial ☐ ecreational
4. Mode of Accessibility at the Shopping mall
   ☐ Pedestrian ☐ Vehicular ☐ Mixed
5. Location of the station
   ☐ By road side ☐ Closed to the road ☐ Away from the road
6. Number of Entry points at the shopping mall.
   ☐ ☐ 2-4 ☐ 5-7 ☐ 8 & Above

PART B: SAFETY FEATURES IN SHOPPING MALL

7. Number of building Ingres/Entrance doors
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 & Above
8. Number of building Egress/Exit doors
   ☐ 1 ☐ 2 ☐ 3 ☐ 4 ☐ 5 & Above
9. Estimated distance between each of the Egress doors
   ☐ 0-2M ☐ 2-5M ☐ 5-10M ☐ Over 10M
10. Estimated travel distance between building's Ingress and egress
    ☐ 0-10M ☐ 10-20M ☐ 20-50M ☐ Over 50M
11. Estimated length and breadth of the Shopping mall building's Shopping mall hall free/circulation space .....
12. Number of Escape routes available at the Shopping mall
    1 ☐ 2 ☐ 3 ☐ 4 & Above ☐
13. Dimension of Each of the Escape routes with the egress door(s)
    0-0.9 ☐ 0.9-1.2m ☐ 1.2-1.8m ☐ 1.8M &Above ☐
14. Width of Escape Stair Case
    ☐ 1.2-1.5M ☐ 1.5-1.8M ☐ 1.8-2.1M ☐ Above 2.1M
15. Width of Escalator

☐ 1.2-1.5M ☐ 1.5-1.8M ☐ 1.8-2.1M ☐ Above 2.1M

16. Width of Corridors in the Shopping mall building

☐ 1.2-1.5M ☐ 1.5-1.8M ☐ 1.8-2.1M ☐ Above 2.1M

17. Clear distance behind the Emergency Exits

☐ 0-5M ☐ 5-10M ☐ 10-15M ☐ 15M and Above

18. Availability of emergency route for fire fighters

☐ Yes ☐ No

19. Availability of emergency structure for emergency evacuation.

☐ Yes ☐ No