EXPLORING THE USE OF HIGH-TECH ARCHITECTURE PRINCIPLES IN THE DESIGN OF CONVENTION AND EXHIBITION CENTRE, ABUJA

BY

Msc/Env-Des/14639/2010-2011

IFRAIMU, CHABEN YOHANNA

A THESIS SUBMITTED TO THE POSTGRADUATE SCHOOL AHMADU BELLO UNIVERSITY, ZARIA IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE AWARD OF MASTER OF SCIENCE DEGREE IN ARCHITECURE

DEPARTMENT OF ARCHITECTURE,

AHMADU BELLO UNIVERSITY,

ZARIA, NIGERIA

SEPTEMBER, 2015

DECARATION

I declare that the work in this thesis entitled "EXPLORING THE USE OF HIGH-TECH ARCHITECTURE PRINCIPLES IN THE DESIGN OF CONVENTION AND EXHIBITION CENTRE" has been performed by me in the Department of Architecture under the supervision of Arc. A. Eneh and Dr. M.L. Sagada.

All sources of materials used and the information derived from the literature have duly been acknowledged explicitly in the text and a list of references provided. No part of this dissertation was previously presented for another degree or diploma at any university

Ifraimu, Chaben Yohanna		September, 2015
Name of student	Signature	Date

CERTIFICATION

This thesis entitled "EXPLORING THE USE OF HIGH-TECH ARCHITECTURE PRINCIPLES IN THE DESIGN OF CONVENTION AND EXHIBITION CENTRE" by IFRAIMU, CHABEN YOHANNA has been examined and approved as having satisfied the regulations governing the award of the degree of Master of Science of Ahmadu Bello University, Zaria, and is approved for its contribution to knowledge and literary presentation.

_____ _____

Arc A.E.O ENEH Date

Chairman, Supervisory Committee

_____ _____

Dr. M. SAGADA Date

Member, Supervisory Committee

_____ _____

Dr. M.D. AHMED Date

Head of Department

_____ _____

Prof. K. BALA Date

Dean, School of Post Graduate Studies

ACKNOWLEDGEMENT

Praise is to God Almighty for giving me the strength and admonition in the successful completion of this programme, what is man without God dust!

Tremendous credit due my supervisors Arc.A.Eneh and Dr. M.L. Sagada, thanks to my lecturers Dr. M.D Ahmed, Arc. Salisu, , Dr. J.J. Maina, Dr. Steve, Dr. Ango and other academic and non-academic for their academic support and contributions.

Sincere gratitude is extended to my family, especially my parents Mr. and Mrs. Samuel Ifraimu for their moral and financial support and prayers whose role and importance on the essence of education has steered an impact on my academic life and people around me as well. Numerous thanks to my brothers Emmanuel, Museh and Daniel and my sister Edinya including relatives.

Most special thanks to my friends: Jim Lama, Yahaya Macido, Aminu Abubakar, Sarah Tsoken, Evelyn, Mrs Magaret, Mohammed Mohammed, Ado Kazaure, Moshood Olawumi, George Akume, Ediga Ebony, Dan Joseph,Joel Usman, Caleb Wasinda, Hassan, Tidwa Galumje, amongst others.

DEDICATION

This research is dedicated to the greatest architect who made all things perfect, Almighty God, and to my Wonderful parents Mr. and Mrs. Samuel Ifraimu, my Brothers and Sisters, cousins and participating friends alongside colleagues who strengthen, supported and encouraged me unconditionally, Thank You!

ABSTRACT

*The word "**high-tech"** with one accord to architecture looks upon as a restoration emissary of modernist functionality; the high-tech generalization is based on simple minded plans that strictly incorporate the use of technologically enhanced building materials and its characteristic materials are steel and glass, and that it puts a high priority on flexibility of space. The overall objective of this research is to analyze the principles of high-tech architecture, its characteristics and proponents through a survey of buildings of the said topic, thus highlighting the problems of convention centres, its potentials relevance to the convention centres in Nigeria as technology and economy, influence and offer possibilities for modifications. The methodology employed the use of data from literature review, Case studies of remarkable convention and exhibition centres have been documented and the principles channelizing the design to favourable outcome from the dependent variables; Architectural expression, Building Materials, Construction Technology and scope of facilities to bring an internationally enviable event space. Consequently it hinged on allowing all available natural light into the foyer and pre-function spaces, reducing the need for artificial light and ventilation displacement of air delivery and air exhaust in the plenary hall and foyer areas providing effective air flow which are design challenges figured out . It is clear that there is always an identity of the locality be it the Hong Kong Convention Centre whose roof features a bird-like rooftop and there can be no more illustrious example than Pompidou Centre to boast technical features often along with load-bearing structures. By adopting the aforementioned findings, conventional types of modern construction technology available in our contemporary construction industries today with focus on new materials, techniques of construction and how they can be harnessed will be a platform for a clearer understanding of this concept and initiates a reliable background for extensive research, studies and development within Nigeria domain.*

TABLE OF CONTENTS

Title Page…….. I

Declaration……... III

Certification ……. III

Dedication…… IV

Acknowledgement…….. IV

Abstract…… V

Table of Contents……. VI

List of Plates ……. VII

List of Figures …… VIII

List of Tables …… IX

CHAPTER ONE:

1.0 Introduction …….. 1

1.1 Background of Study……. …….. 1

1.2 Characteristics and Function of convention centres ……. 2

1.3 Statement of Problem …….. 2

1.4 Aim and Objectives ……. 4

1.5 Research Questions ……. 4

1.6 Scope and Delimitation …… 5

1.7 Justification…….. 6

CHAPTER TWO: LITERATURE REVIEW

2.0 Historical Review of High-Tech Architecture……... 6

2.1 Definition of High-Tech Architecture…… 6

2.2 Evolution Concept of High-Tech Architecture…….. 7

2.3 Convention centre destinations ……. 9

2.4 Recent Trends in Convention centre design …… 9

2.5 Contemporary Architecture in Nigeria ……. 10

2.6 Characteristics of high-tech Architecture …… 11

2.7 Principles of High-Tech Architecture……..... 11

2.3.1 Use of Pre-Fabricated Materials…… 11

2.3.2 Glorification of Technology by the Use of Clear Glass Facades ……. 12

2.3.3 Transparency, Layering and Movement …… 14

2.3.4 Prominent Display of The Building's Technical and Functional Components…… 15

2.3.5 Use of Light Tensile Members …….. 17

2.4 Proponents of High-Tech Architecture…… 18

2.4.1 Lord Norman Foster……. 18

2.4.2 Richard Roger……..... 21

2.4.3 Sir Michael Hopkins…… 22

2.4.4 Nicolas Grimshaw……... 24

2.4.5 Santiago Calatrava …….. 26

2.5 High-Tech Architecture in Practice……. 27

2.6 Significance of High-Tech Architecture……. 28

2.7 Materials for High-Tech…….. 29

2.7.1 Glass…… 29

2.7.2 Steel……. 30

2.8 Use of High-tech elements…….. 31

CHAPTER THREE: RESEARCH METHODOLOGY

3.0 Method of Study ……..... 33

3.1 Instrument of Data Collection…… 34

3.1.1 Literature and Documentation …….. 35

3.1.2 Visual Survey …… 35

3.2 Data Analysis and Presentation ……. 35

3.2.1 Photographs …….. 35

3.2.2 Tables …… 35

3.2.3 Figures …….. 35

3.2.4 Descriptive Analysis ……. 36

3.3 Sources of Data Collection …… 36

3.3.1 Interviews ……. 36

3.3.2 Direct Observation …… 36

3.3.3 Documents …… 36

3.3.4 Archival records …… 37

3.3.5 Physical Artefacts ……. 37

3.3.6 Participant Observation …… 37

3.4 Procedures for Data Collection ……. 37

3.4.1 Case Studies …….. 37

3.5 Case Study Selection Criteria ……. 38

3.5.1 Assessment of the Application of High-Tech Principles…… 38

CHAPTER FOUR: PROBLEM FORMULATION

4.1 Introduction……..…… 70

4.2 Design challenges in convention design ……. 70

4.3 Challenges posed by use of High-tech architecture…… 71

4.4 Definition of Design Problem……. 72

4.5Extractionfromtheprinciplesofhigh-techArchitecture…….. 73

4.6 Contemporary design Approach……..... 73

4.6.1 Prefabrication Materials……... 74

4.6.2 Energy Efficiency……. 75

4.6.3 Site and Orientation…..…… 76

CHAPTER FIVE: SITE STUDY

5.1 Site location……. 77

5.1.1 Demographics …….. 78

5.1.2 Land Use ……. 79

5.1.3 Site selection criteria……. 82

5.1.4 Site justification……... 84

5.1.5 Site determinant and suitability……... 84

5.1.6 Site drainage……..... 84

5.2 Climatic data of Abuja…… 85

5.4 Site analysis……. 89

5.4.1 Site characteristics and analysis……... 89

5.4.2 Topography…….. 89

5.4.3 Soil Type ……. 89

5.4.4 Vegetation …… 89

5.4.5 Sunshine …….. 90

5.4.6 Physiographic …….. 90

5.4.7 Geology……. 90

5.4.8 Site Potentials …….. 91

5.5 Brief Development …….. 95

5.6 Theme and Purpose of Design …….. 96

5.7 User Space Requirements …….. 97

5.7.1 Major categories of Exhibitors…… 97

5.8 Administrative section…… 98

5.9 Schedule of Accommodation …… 99

5.10 Exhibition Halls…… 102

5.10.1 Basic consideration for design of Exhibition space ……. 103

5.11 Ancillary Facilities …….. 104

CHAPTER SIX: DESIGN REPORT

6.1 Introduction…… 105

6.2 Architectural character…….. 106

6.3 Design philosophy……. 106

6.4 Design concept……. 106

6.4.1 Design conceptualization…… 107

6.4.2 Visual comfort…… 108

6.4.3 Form Concept …… 109

6.4.4 Functional concept ……... 110

6.4.5Structural concept…….. 110

6.4.5Material concept…… 110

6.4.7 Aesthetic concept……. 111

6.4.8SitePlanningConcept……..….. 111

6.4.9 Site zoning……... 112

6.5.1 Orientation/spatial arrangement…….. 112

6.5.2 Circulation …….. 112

6.5.3 Ventilation …….. 113

6.5.4 Visual Comfort…… 113

6.5.5Thermal Comfort ……. 113

6.5.6 Day-lighting …… 114

6.5.7 Room acoustics …….. 114

6.5.8 Energy Conservation systems ……..….. 114

6.5.9 Parking …… 115

6.5.10 Fire Precaution ……. 115

6.6.1 Site zoning …….. 115

6.6.2 Accessibility …… 115

6.6.3 Pedestrian circulation…… 116

6.6.4 Landscaping…….. 116

6.6.5 Crowd control …….. 116

6.6.6 Functional Space Organization ……. 116

6.6.7 Architectural Description ……. 117

6.8BuildingMaterials& Technology of Construction…… 117

6.8.1 Glass …… 117

6.8.2 Steel…….. 117

6.8.3 ETFE membrane…… 118

6.8.4 PVC panels…… 118

6.8.6 Building Elements …… 119

6.8.7 Building Services ……. 120

CHAPTER SEVEN: CONCLUSION

Summary of findings and Contributions to Knowledge, Science and Architecture…… 121

Conclusion…….. 122

Recommendation…… 123

List of references…… 128

Appendix…… 129

LIST OF TABLES

Table 3.1:Dependent Variable Study- International Conference Centre, Abuja ……. 43

Table 3.2:Showing Analysis Of Dependent Variables-Shehu Musa Yar Adua Centre… 48

Table 3.3: Showing Analysis Of Dependent Variables-Brisbane Convention Centre…… 56

Table 3.4:Showing Analysis Of Dependent Variables-Hong Kong Convention Centre,… 60

Table 3.5: Showing Analysis Of Dependent Variables- Pompidou Centre, Paris, France 66

Table 3.6: Summary Of Findings; Local Case Studies …… 68

Table 3.7: Summary Of Findings; Foreign Case Studies ……. 69

Table 5.3: Site Selection Criteria …… 83

Table 7.1:Schedule Of Accommodation Exhibition Hall …… 104

LIST OF FIGURES

Figure 2.1: Classification of Nigerian Architecture.....11

Figure 2.2: Tension members in structures ,.....20

Figure 5.1: Map of Aabuja.....78

Figure 5.2: Map showing phase 1 – 4, abuja 80

Figure 5.3:Central area land use map. 78

Figure 5.4.Land use map showing selected site 'M' 78

Figure 5.5:Aerial map showing proposed site 1, along Kulwaba District 79

Figure 5.6 Site selection criteria:. 85

Figure 5.7: Temperature.....86

Figure 5.8: Precipitation.....87

Figure 5.9: Mean Humidity.....87

Figure 5.10: Mean Sea level pressure 88

Figure 5.11: Wind Speed 88

Figure 5.12:Site Analysis: site climate. 90

Figure 5.13: Site Analysis : views/traffic. 92

Figure 5.14: Site Analysis: site surrounding features 93

Figure 5.15: Site Analysis: Site zoning.....94

Figure 5.16: Abuja land use map and selected sites A and B. 95

Figure 5.18: Space schedule-convention hall. 109

Figure 6.1: Concept development 110

Figure 6.2.: Plan Concept.....111

Figure 6.5 :Site Plan.....112

LIST OF PLATES

Plate I: The use of glass prefabricated and steel on the esclator…… 12

Plate II: SOM sears tower, showing glass curtain walls and skeleton steel pipe …… 12

Plate III: Lloyds Building, London….. …… 14

Plate IV: Torre Caja Madrid..…… 14

Plate V: 30 St.Mary Axe, London…… 15

Plate VI: Interior view of Reichstag dome, Berlin…… 16

Plate VII: Norman Foster's Hong kong and Shanghai Bank HQ…… 16

Plate VIII: Displaying the building's technical and functional elements…… 18

Plate X: Tension members in structures…… 19

Plate XI: Displaying the building's tension members in steel structure…… 20

Plate XII: Curved water-filled roof trusses at the HACTL super terminal,

Hong kong International Airport …… 21

Plate XIII: Curved enclosure at Cambridge university Law Faculty…… 22

PlateXIV: Olympic Velo Park, London 2012..…… 24

Plate XVI: Operations Centre at Waterloo, London..…… 25

PlateXVI I:Close view of the structure of the lightweight concrete…… 71

Plate XIX: Transparency, Layering and Movement …… 72

Plate XIX: The use of polycarbonate roofing for entrance canopy …… 77

Plate XX: Use of locally prefabricted materials in modular construction system..…… 78

Plate XXI: The lattice girder roof system in the departmental store exposes the

Services ……..….. 81

LIST OF APPENDICES

Figure 2: Aproach Elevation…… 127

Figure 3: Rear Elevation …… 127

Figure 4: Leftside Elevation …… 128

Figure 5: Rightside Elevation…… 128

Figure 6: 3d View Of The Approach…… 129

Figure 7: 3d View Of The Side …… 130

CHAPTER ONE

1.0 Introduction

1.1 Background of Study:

The High-tech architecture, sometimes unified into what some address as late modernism or structural expressionism, is an architectural style that emerged in the late 1970s, integrating elements of high-tech industry and technology into building design in all types of corporate buildings, housing, museums and so forth. High-tech according to Jencks (2009), attempts to highlights its imagery and its principle concerns considering "the part between inside and out, the celebration of process, a concern for transparency, layering and movement as well as a light height filigree of tensile members in a scientific culture". McArthur, (2006) claims that in view of a modernist perspective some of the contemporary inventions are traceable to the origins of modernity. However, it could be outlined in strictly personal and historical terms as the label we apply to virtually any building designed in the last twenty years, in essence it can be regarded as a fusion of technology and functionalism. In order to lend both a personal and a historical imprint to this definition, Davies, (1998) identifies the work of four of its leading architects although of course there are others; these are Richard Rogers, Norman Foster, Nichoas Grimshaw, or Micheal Hopkins. For now we can simply say that its characteristic materials are steel and glass, which it purports to adhere to a strict code of honesty of expression, that it usually embodies ideas about industrial production, as sources both of technology and of imagery, and that it puts a high priority on flexibility of use. The typology of high-tech architecture has varied somewhat, but all high-tech architecture had in common the glorification of the technical elements, with a demonstration of ostentatious technical and

functional components of buildings. Therefore it makes it easier for their repair and maintenance of buildings.

The proposed convention and exhibition centre, Abuja will be a mega structure that suggests the display of good architectural expressions and great visual impact using technical and functional components and an orderly arrangement and use of pre-fabricated elements such as glass walls, steel frames, modular walling systems (commonly referred to as high-tech concrete) and plastics through the integration of high-tech principles.

Generally the whole idea being that of deductive reasoning between the structure, materials, concepts, function and its surrounding landscape to achieve as remarkable facility to set new benchmarks for the international meeting industry. Some of convention centres' features include:

i. To host medium to large-scale international, national and local conferences as well as national and local consumer trade shows including industry related exhibition.

ii. It offers column-free spaces which can be used for meetings, exhibitions, or sporting events.

iii. Typically offers flexible and sufficient large spaces used for a variety of exhibition, trade shows, and meeting events.

iv. Contribute to the economy from tourism perspective, which are likely to impact the financial returns of the tourism spend.

1.2 Characteristics and Functions of Convention and Exhibition Centres

A convention centre, in essence is the benchmark which offers a comprehensive range of facilities and services of central forms of a separate, self-sufficient metropolitan node, characterized by a business and entertainment district. A convention centre which explores sense of place covers the knowledge of identity and heritage of the place with merging historical architecture with cutting-edge technology peculiar to a particular locality. In American English, a convention centre is an exhibition hall, or conference centre, that is designed to hold a convention. In British English very large venues suitable for major trade shows are known as Exhibition centres while the term 'Convention Centre is sometimes used for intermediate venues between exhibition centre and conference, which are much smaller and contain lecture halls and meeting rooms. Sense of place is regarded as being a highly multi-dimensional experience conveyed through environmental, social and cultural attributes of places, and people's psychological responses to these attributes (Low and Altman, (1992); Rapport, (1985); Relph, (1976). Architectural reflection is passing along through forms on various building types like museums, conference centres and convention centres.

1.3 Statement of Problem

Convention and exhibition centres in spite of its purpose to host conference meetings, trade shows, public shows and other large functions showed interrelationship of activities on functional spaces, flexibility of movements; which effects lack of ventilation displacement and insufficient natural light into the foyer and pre-function spaces for the use of contemporary architecture that exhibits character and identity of place while integrating multi-functional spaces. Some existing convention and exhibition centres in Nigeria which are experiencing competition related to size and flexibility in their designs as well as

inadequate parking space are major challenges faced with such integrated facility. Above all, this thesis is stressed-out with focusing on exploring how high-tech principles can bring possible modifications and solutions to Nigerian Architectural Designs and solve common problems associated with most convention and exhibition centres.

1.4 Aim and Objectives

Aim

The research seeks to apply the principles of high-tech architecture to provide architectural and planning solutions towards improving the performance and operational efficiency bringing an internationally enviable event space.

Objectives

The objectives includes

i. To identify the key principles of high-tech architecture.

ii. To highlight the basic problems of convention and exhibition centres as well as the problems of High tech architecture in Nigeria.

iii. To study and examine contemporary convention and exhibition centres that reflects High- Tech Architecture elements in their designs.

iv. To apply high-tech architecture to efficient use in the design of convention and exhibition centres.

1.5 Research Questions:

The research aims at answering the following questions:

1. To what extent can high-tech architecture be applied into the designs of contemporary convention and exhibition centres in Nigeria?
2. How can high-tech architecture be successfully more effective in Nigerian Architectural Designs and construction techniques?

1.6 Scope and delimitation:

This research will primarily stress on the design of a convention centre that will meet the spatial functional requirements of its users and at the same time successfully apply the principles or concepts of high-tech architecture.

The scope of this research work will be conferred in two parts:

(i) The first part of the research will be a study of convention centres in Nigeria in relation to available facilities such as: hotels, population density, roads, airports, and so on.

(ii) The second part is surveying some buildings (convention centres and also, buildings with convention facilities) where high tech elements are employed assessing its prospects and problems.

1.7 Justification:

Justification of support for both capital and revenue funding includes the following reasons:

i. *Socio-economic*: To create an additional avenue of investment that can be owned by government entities and in some instances by private developers or through public/private partnership.

ii. As the international meeting market is large and in being able to promote integrated whole-building facility that offers market through tourism perspectve.

CHAPTER TWO

2.0 HISTORICAL REVIEW OF HIGH-TECH ARCHITECTURE

2.1 High-tech architecture is aesthetically disputable whether it constitutes a form of late Modernism or genuine Post Modernism. This serves as a bridge between modernism and post-modernism, however there remain gray areas as to where one category ends and the other begins. In the 1980s, high-tech architecture became more difficult to distinguish from post-modern architecture. Many of its themes and ideas were absorbed into the language of the post-modern architectural schools. In order to lend both a personal and a historical imprint to this definition, Jencks, (2009) gave an alternative view identifying as purely representational and embodies ideas about production, it uses industries other than the building industry as sources both for technology and imagery, and it puts a high priority on flexibility of use."

In addition, in architecture, it correspond a combination of 'high style' and 'technology' that refers to the integration of prefabricated parts into the building process in order to attain functionality efficiency and accelerated construction (Davies, 1998). It is a concept or approach to architecture, rather than a style. It favours lightweight materials and flexibility. High tech architecture is also defined as the integration of the state of the art of engineering systems and materials in a building process to attain a high level of functional efficiency (Jenks, 2009). This high-tech style can be seen as both a continuation and a modification of Modernism. However, it could be outlined in strictly personal and historical terms as the label we apply to virtually any building designed in the last twenty years, in essence it can be regarded as a fusion of technology and functionalism. From the assorted definitions of high tech architecture, it could be deduced that high tech architecture is an approach rather than a

style emerging from modern architecture, which utilizes the available technologies from industries worldwide in the most relevant manner in order to attain functional efficiency in the building process. (Potiskum, 2010)

As Jukes-Hughes (1989), contributed in his paper "High Tech" architecture as an appearance is implicitly representative of significant advances in knowledge about building materials, components, assembly procedures and skills, structural and services efficiency. Slessor, (1997) suggests Sustainable architecture and high technology meant contemporary modern and industrialized technology has been a factor in architectural design. In the early years of experimentation, high technology was used to express the possibilities of mass production; however, in recent years architects have moved toward using of high technology to respond to the environment in which the building is placed.

Architecture must therefore participate in and make use of that technology - the technology of industry, transport, communication, flight, and space travel. Why, they ask, should buildings be any different from the other artifacts' of industrial culture? Why do we still continue to make buildings out of cumbersome, messy, imprecise materials such as bricks, mortar, concrete, and timber when we could be making them out of light, precision components of metal and glass, fabricated in factories and cast-In situ? High Tech according to Collins (1988) puts a forward-looking, optimistic architecture that believes in progress through industrial technology and invention rather than tradition**.**

2.2 EVOLUTION CONCEPT OF HIGH TECH ARCHITECTURE

Majority of such buildings in this architectural style were constructed mainly in Europe and North America. As a result of the World War II aftermath, historic buildings were considered a difficult matter in repairing them. This however, gave Architects the chance to decide

between replicating the historic elements and replacing it with new modern materials aesthetics. (http://www.encartaencyclopedia.com). As Jenks (1998) opined, this new world was undeniable, and was reflected heavily in the buildings that were being developed at the time.

The scientific and technological revolutions made a tremendous impact on societal developments in the late 1970s. These advances set people's minds thinking that much more can be achieved with advancing technology and high-tech constructions became more visible everyday to the average person (Potiskum, 2010). The style got its name from the book "High Tech: The Industrial Style and Source Book for The Home", written by design journalists Joan Kron and Suzanne Slesin and published in November 1978 by Potter, New York. The book, illustrated with hundreds of photos, showed how designers, architects, and home owners were appropriating classic industrial objects- library shelving, chemical glass, metal deck plate, restaurant supply, factory and airport runway light fixtures, movers' quilts, industrial carpeting etc.

High-tech architecture generally has created a new aesthetic in contrast with standard modern architecture. One aspect to the aims of high-tech architecture was that of a renewed belief in the power of technology to improve the world. This is especially evident in Kenzo Tange's plans for technically sophisticated buildings in Japan's post-war boom in the 1960s, but few of these plans actually became buildings. High-tech architecture aimed to achieve a new industrial aesthetic, spurred on by the renewed faith in the progression of technology. There is no need to look further than Rogers's Pompidou Centre for an example of this. This highlights one of the aims of high-tech architecture, to boast the technical elements of the building by externalizing them. Thus, the technical aspects create the building's aesthetic.

But however prominent industrial look appeared the functional element of modern architecture was very much retained. The pieces still served a purpose in the building's function. This dynamic property means that a building should be a "catalyst", the "technical services are provided but do not become set." (Jenks, 1998)

2.3 CONVENTION CENTRE DESTINATIONS

Convention centres given its location with regard to accessibility, size and environmentally conscious facilities are favourable to attract business-related events. In the US, there are multiple convention centres in popular tourist areas, including San Francisco, New York, and Florida. The spatial and functional design of tourism facilities has the potential to define space, human behaviour and perception (Jimoh, 2005). The convention centre may also be connected to a university, particularly if the convention is scholarly in nature. Universities are generally close to lodgings, or may provide on-campus lodging for overnight conventions and often use their large buildings for conventions because they make a little profit by doing so.

2.4 RECENT TRENDS IN CONVENTION CENTRE DESIGN

Contemporary convention centres seek to generally provide meetings and conferences for a wide varying number of people from all walks of life and destinations. Castelles (2004) provided a basis for the understanding of reflections of cultural identity on tourism facilities. Other than these primary functions, convention centres now incorporate sustainable design methods, the character of locality and harmonization of business and industry-related events. These recent trends include:

i.) Integrating a sense of identity and character with the landscape, going beyond colour to the roof, structure and building fabric to mimic the socio-cultural environment which evokes its beauty and features.

ii.) As rightly observed by Doyle (2010), convention centres are all the rage now with attributes of energy efficiency, waste management, responsible water use, greener transportation alternatives, and the use of environmentally friendly products.

iii.) Providing both conference and increase simultaneous services and events with a dedicated amount of meeting spaces pursuing comprehensive customer service initiatives marketing to new local and regional audiences.

iv.) Convention centres include a comprehensive collection of art in a variety of media, allowing the users to encounter them as they work through the structure. The art collection in the gallery can be visited by students, civic groups and conference attendee; thereby setting the tone of wonders and pleasure for the attendees.

2.5 CONTEMPORARY ARCHITECTURE IN NIGERIA

Contemporary modern Nigeria architecture was dominated by adapted international style, which usually explores simple geometrical forms but often with exposed parapet walls, characterized by the use of concrete external walls supplemented by concrete, steel or aluminum sun shading devices (Ogunsote, 1993). More than one third of modern buildings in Nigerian urban centers, especially in Abuja and Lagos belong to the International Style and many of them belong to the Pure Modern Trend. The buildings are designed along with modern ideas with the use of clean forms like cubes, cuboids or compositions of simple geometrical solids which explore the ideas of simplicity and functionality (Ogunsote, 1993).

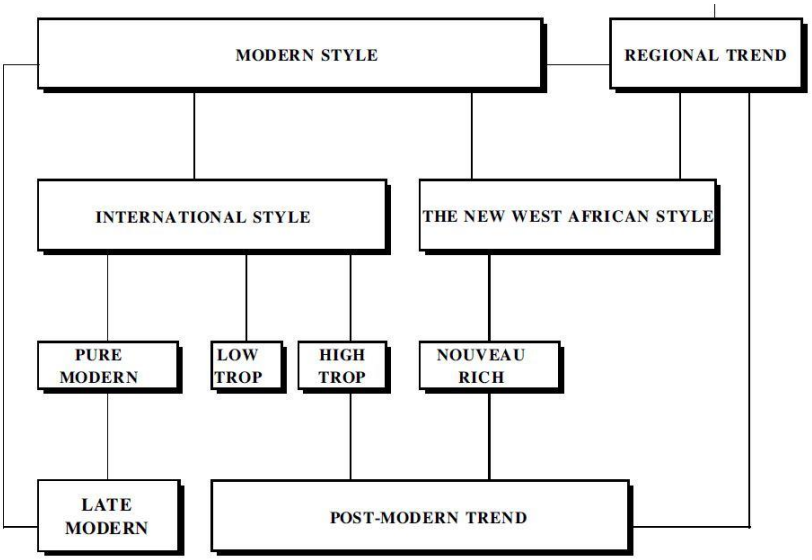


Figure 1.1: Classification of Nigerian Architecture
Source: Ogunsote, 1993

2.6 CHARACTERISTICS OF HIGH-TECH ARCHITECTURE

Characteristics of high-tech architecture have varied somewhat, yet all have accentuated technical elements. They included the prominent display of the building's technical and functional components, and an orderly arrangement and use of pre-fabricated elements. Davies, (2007) suggests that it characteristic materials are steel frames and glass walls which were readily available. To boast technical features, they were externalized, often along with load-bearing structures. There can be no more illustrious example than Pompidou Centre. The ventilation ducts are all prominently shown on the outside. This was a radical design, as previous ventilation ducts would have been a component hidden on the inside of the building. The means of access to the building is also on the outside, with the large tube allowing visitors to enter the building. The orderly and logical fashion in which buildings in the high-tech architectural style are designed to keep to their functional essence is demonstrated in Norman Foster's Hong Kong and Shanghai Bank HQ. Besides the technology being the overriding feature of the building, its design is very much functionally orientated. The large

interior open space and the easy access to all floors enhance the function of being a bank. Also, the elements of the buildings are very neatly composed to achieve optimal orderliness in order to logically solve the problem of the needs of a bank. This can be seen in the levels' structure and in the escalator.



Plate 2.1: The use of glass prefabricated glass
Source: www. Greatbuilding.com



Plate2.2 Use of steel on the escalator.
Source: www.greatbuilding.com



Plate 2.3: SOM sears tower, showing glass curtain walls and skeleton pipe structure of steel.
Source: www.skyscraper.com

2.7 PRINCIPLES OF HIGH-TECH ARCHITECTURE

Charles Jenks, whose article, “The Battle of High Tech; Great Buildings with Great faults,” in the Architectural Design magazine of the same year, also attempts to define High Tech. Jenks highlights its key imagery and its principle concerns. These are

The principles are characterized by the following:

a. The Play between Inside and Out (as opposed to the use of exposed services) to dramatize the technical function of the building elements.
b. The Celebration of process (as to ease the speed of production and to increase the durability, performance and quality of the building components).
c. A Concern forTransparency, layering and movement
d. Prominent display of the building’s technical and functional components;
e. Use of light tensile members

2.7.1 The Play Between Inside and Out

Exposed structure and exposed services are the two most visible distinguishing features of High Tech architecture, even though not all High Tech architects expose the structure and services of their buildings as a matter of course. Davies, (2007) asserts that the basic elements of the exterior, including the massive long-span trusses, remain the same, whatever the function. The Lloyd’s Building, sometimes called The Inside-Out Building, and is another Richard Rogers project that harnesses high-tech architecture to create an iconic structure. Opened in 1986, the Lloyd’s Building was highly rebellious in its attitude towards commercial architecture – much like the Pompidou Centre; all of the services of the three towers are external, including twelve glass lifts that were the first of their kind in the

UK...Richard Rogers loves to drape pipes and ducts all over the facades of his buildings, even if it means that everyone has to be separately insulated, protected from the elements and made accessible for maintenance. There is a functional justification, of course, but Rogers also frankly admits that the picturesque effect, the play of light and shade, is equally important.



Plate 2.4: Lloyds Building, London.
Source: www.greatbuilding.com

2.7.2 The Celebration of Process (as to ease the speed of production and to increase the durability, performance and quality of the building components).

Given High Tech architecture's tendency to dramatize the technical function of building elements, it is not surprising that steel tension members should be given such prominence. High Tech architects experiment with elaborate decorative tensile structures. If a building is to make use of the same technology, and achieve sophistication, then there must be a similar level of investment in its design and development (Davies, 2007). Of all the innovative features of that seminal building, Foster and Rogers' Reliance Controls Factory in Swindon of

1967, it is the external steel cross-bracing (much of it structurally redundant) that has had the most influence on High Tech architecture down the years. At first it was simply a matter of putting the lattice trusses above the roof rather than below (see, for example, the Patera buildings by Michael Hopkins – though these are actually portal frames, not trusses) but this was soon elaborated into a series of variations on the mast and suspension rod theme. All four of the major British High Tech architects have explored the dramatic potential of suspension structures: look at Rogers' Inmos factory, Foster's Renault warehouse, Grimshaw's Oxford lee Rink, and Hopkins' Schlumberger laboratories. Collins (1998) sums up there are not many good, practical reasons for putting a steel structure on the outside of a building, but plenty of reasons for not doing it. The Hong Kong Bank, gray maintenance cranes are powerful visual- metaphors, especially when they all point in the same direction like anti-aircraft guns on a battleship.



Plate 2.5: Torre Caja Madrid,
Source: www.greatbuildingsonline.com

Given High Tech architecture's tendency to dramatize the technical function of building elements, it is not surprising that steel tension members should be given such prominence.

Technological advancement has greatly influenced high-tech buildings. High-Tech style uses technology in an almost Futurist way, the style embraces an industrial look, in which the decor and the building itself are obviously very influenced by technology.



Plate 2.6: 30 St Mary Axe, London
Source: www.greatbuildingsonline.com



Plate 2.7: Sainsbury art gallery
Source: www.spacesyntax.com

2.7.3 A Concern for Transparency, Layering and Movement

The glass curtain wall which alternately transparent, reflective, or refractive depending on light conditions and viewing positions. Hays, (1984) underline an architectural choice that would impact the considered facade spaces from a phenomenological vantage point. These three aesthetic qualities are adopted virtually without exception. The extensive use of translucent and transparent glass, a layering of ducts, stairs and structure and of the internal space are being serviced by all these layers of technical contraptions. The purpose of the complicated exterior is precisely to keep the internal space as simple as possible. A perfect example is the current Reichstag dome is an iconic glass dome constructed on top of the rebuilt Reichstag building in Berlin. It was designed by architect Norman Foster and built to

symbolize the reunification of Germany. The distinctive appearance of the dome has made it a prominent landmark in Berlin.



Plate 2.8 Woods Street
Source: www.Greatbuilding.com



Plate 2.9: interior view of Reichstag dome, Berlin.
Source: www.greatbuildings.com

The various building components are clearly visible through the glass façade from the outside as well as the activities within. Glass-enclosed stairs and lifts usually located on the perimeter animate the glass facades with the movement of people.

2.7.4 Prominent Display of the Building's Technical and Functional Components

The accentuation of moving escalators and elevators characterize the high-tech building, the services and structures of a building are almost exposed on the exterior as a form of ornament or sculpture. Collins, (1998) indicated that architecture must therefore participate in and make use of that technology- the technology of industry, transport, communication, flight, and space travel. This expression of the 'servant' and the 'served' was formulated by Louis Khan in the sixties and has been justified by Architects like Richard Rogers for allowing fast changing technology to be modified without disrupting the interior. The most iconic prime example is the Norman Foster's Hong Kong and Shanghai Bank HQ.

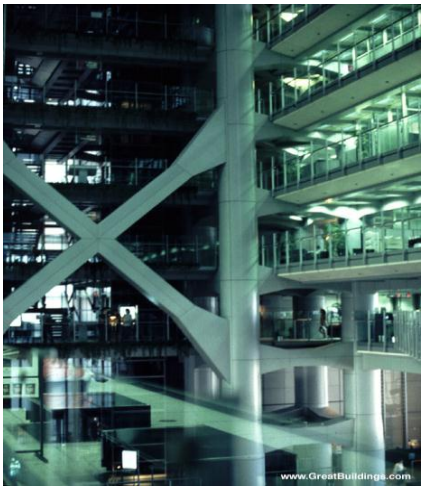


Plate 2.10: Norman Foster's Hong Kong
Source: www.greatbuildings.com

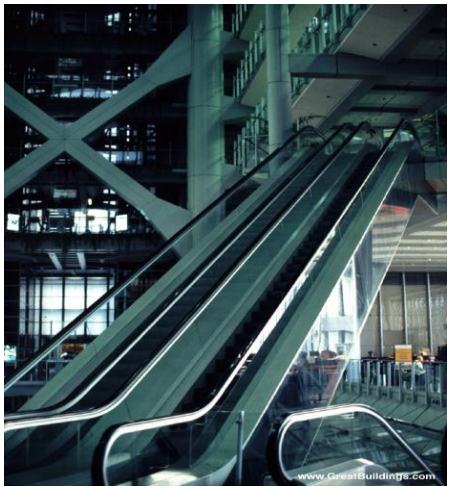


Plate 2.11 and Shanghai Bank HQ
Source: www.greatbuildings.com

The ‘servant’ has taken over the house from the ‘served’, which is technology has dominated Living- something that is of course appropriate at Inmost (factory) wishes to express its technological supremacy. A technology building built for technical performance. (Colin Davies, 1988).Simply explained there are not many good, practical reasons for putting a steel structure on the outside of a building, but plenty of reasons for not doing it.



Plate 2.12**:** Displaying the building’s technical and functional elements.
Source: www.greatbuilding.com

2.7.5 Use of Light Tensile Members

Davies, (2009) noted exposed structure services are the two most visible distinguishing features of High Tech architecture, even though not all High Tech architects expose the structure and services of their buildings as a matter of course. Tension members are linear members in which axial forces act so as to elongate (stretch) the member. Tension members carry loads most efficiently, since the entire cross section is subjected to uniform stress. Unlike compression members, they do not fail by buckling. Ties of trusses [Figure 2.1(a)], roof truss [Figure 2.1(b)], suspenders of cable stayed and suspension bridges [Figure 2.1(c)], suspenders of buildings systems hung from a central core [Figure 2.1(c)] (such buildings are used in earthquake prone zones as a way of minimizing inertia forces on the structure), [Figure 2.1(d)], sag rods of roof purlins and [Figure 2.1(e)], braced frames are other examples of tension members. Tension members are also encountered as bracings used for the lateral load resistance.

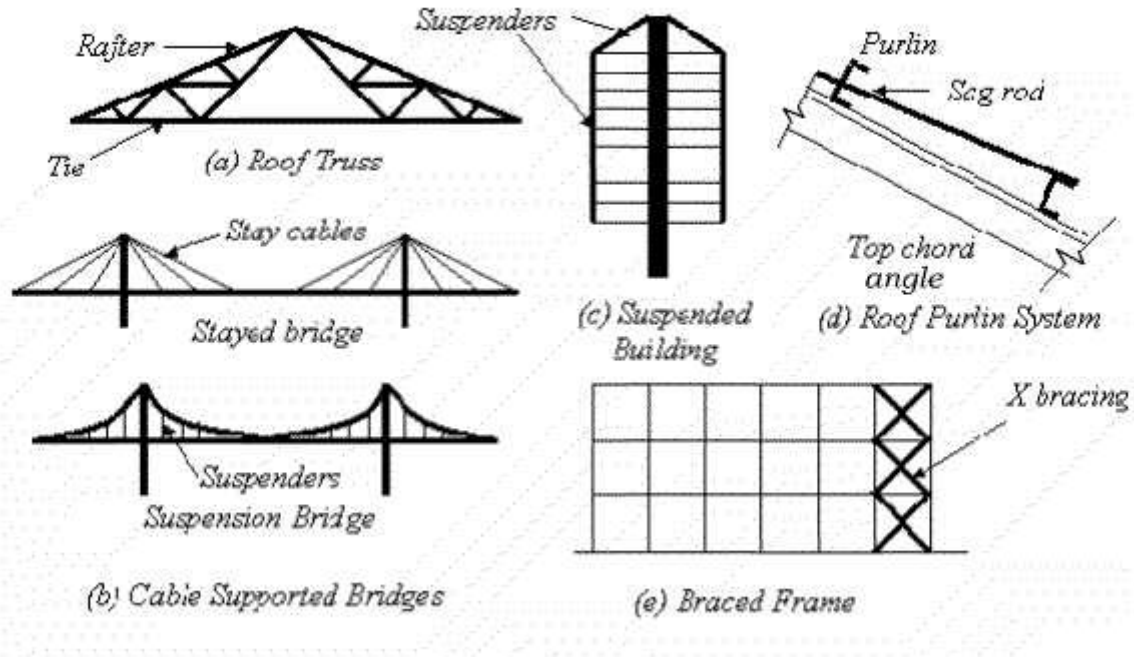


Figure 2.1: Tension members in structures
Source: www.greatbuildingsonline.com

Why do we continue to make buildings out of cumbersome, messy, imprecise materials such as bricks, mortar, concrete, and timber when we could be making them out of light, precision components of metal and glass, fabricated in factories and quickly bolted together on site?

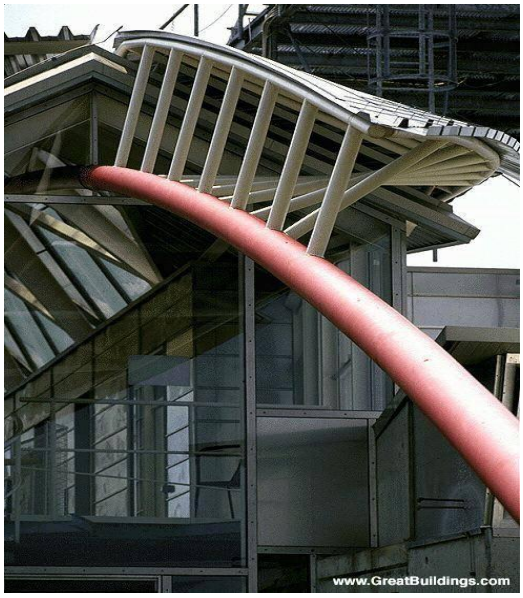


Plate 2.12**:** Displaying tension members Source: www.greatbuilding.com

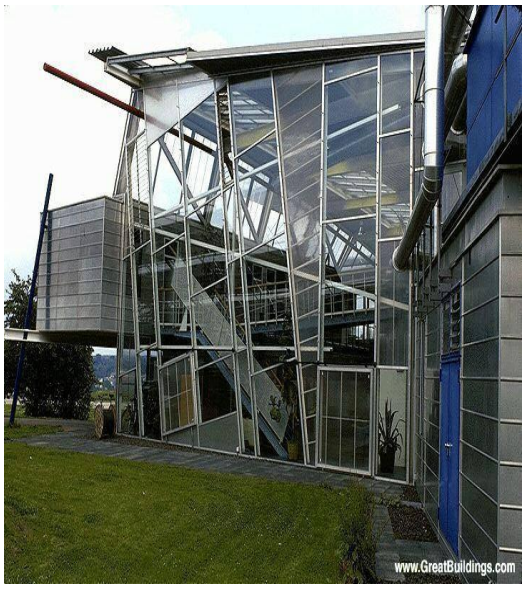


Plate2.13**:** Displaying light members in steel structure Source: www.greatbuilding.com

2.8 Proponents of High-Tech Architecture

2.8.1 Lord Norman Foster

British born architect and member of the famous Team-4 group with Richard Rogers and later forming his own private practice called Foster and Partners. Norman Foster is noted for his high-tech structures with his first major commission being the Willis Faber and Dumas Building in Ipswich 1974. He is deeply concerned with architectural details and the craftsmanship that goes into them. Emphasis is often laid on the industrialized 'modular' units in his work. Prefabricated offsite manufactured elements are frequently employed and specialist components are often specially designed for individual projects. Today Foster Partners work with its engineering collaborators to integrate complex computer systems with

the most basic physical laws, such as convention. The approach creates intelligent, efficient structures likes the Swiss Re London headquarters at 30 St. Mary Axe.



Plate 2.14**:** Curved water-filled roof trusses at the HACTL Super terminal One Cargo Handling Facility, Hong Kong International Airport
Source: www.greatbuilding.com



Plate 2.15: Curved members at Hong Kong International Airport
(Architect: Foster and Partners)

Source: www.greatbuilding.com

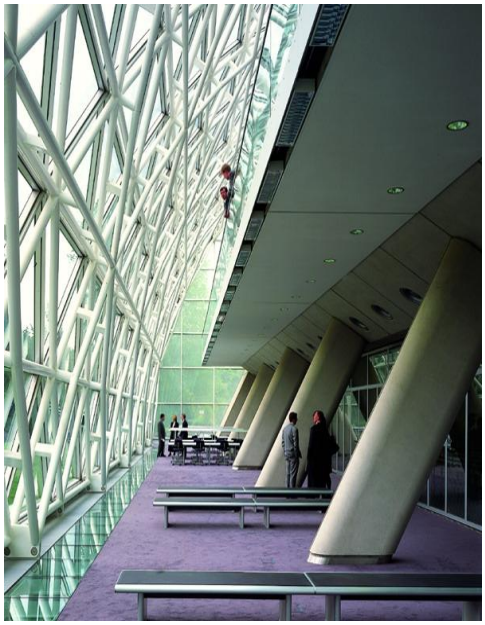


Plate 2.16**:** Curved enclosure at Cambridge University Law Faculty
Source: www.greatbuilding.com



Plate 2.17 External glorification of glass curtain wall
Source: www.greatbuilding.com

2.8.2 **Richard George Rogers**, CH, FRIBA.

British architect noted for his modernist and functionalist designs. He was born in Florence and attended the Architectural Association School of Architecture in London. In contrast to Foster, who went on to develop a refined engineering based high tech architecture, which is almost classical, his design are more exuberant. In many ways, he is one of the heirs to the functionalist's tradition. His concern with total flexibility and overt technical imagery has been termed high tech. Major works of Richard Rogers include the Pompidou Centre, the Lloyds Building, the Millennium dome, etc.



Plate 2.18**:** Lloyds Building, by Richard Rogers: Built 1979 to 1984
Source: www.greatbuilding.com



Plate 2.19 Tension-coupling system cables at the Millennium Dome, London
Source: www.greatbuilding.com

2.8.3 Sir Michael Hopkins

English architect, he studied at the Architectural Association and after working for Frederick Gibberd and partnership with Norman Foster, he set up his own practice with his wife, Patricia, together they received the Royal Institute of British Architects Royal Gold Medal. Their home in Hampstead was designed with steel frames, much glass and two walls of corrugated metal, classified as high tech building. He designed the Bottling Plant, Greene Brewery, Lords' Cricket Ground London (1987), with its load bearing brick arches, mild steel sitting area and tent like fabric roof.



Plate 2.20 Dynamic Earth Centre, Edinburgh
Source: www.greatbuilding.com



Plate 2.21: Olympic Velo Park, London 2012
Source: www.greatbuilding.com

2.8.4 Nicholas Grimshaw

Sir Nicholas Grimshaw, is a prominent English architect, particularly noted for several modernist buildings, including London's Waterloo International railway station and the Eden Project in Cornwall. He specializes in the design of high tech metallic buildings, finely crafted; his designs are characterized by simplicity and symmetry with an unusual transparent glass curtain wall. Grimshaw is behind the National institute for research into aquatic habitats design. Upon completion, this will become the world's largest aquarium. Among this is the waterloo International Railway Terminal.





Plate 19**:** Operations Centre at Waterloo, London,
Source: www.greatbuilding.com

Nicholas Grimshaw waterloo International Terminal London, Great Britain, 1990-93 snaking its way through a rather unpleasant section of London not far from the South bank complex, which includes the Hayward Gallery, the form of the new waterloo terminal was in part dictated by technical factors such as the turning radius of Euro-star trains.

2.9 HIGH-TECH ARCHITECTURE IN PRACTICE

The whole idea of a building typology based on function or use seems irrelevant when the aim is to make buildings flexible enough to adapt to almost any use. In practice, however, High Tech is commonly associated with a rather narrow range of building types. (Zhaoming, et al.2012), summarized as contemporary high-Tech buildings pursue ecological design; through the use of new technologies, new materials and advanced scientific means to solve ecological problems. By improving energy efficiency, reducing consumption of non-renewable resources, making full use of clean energy, architects create an ideal living environment. Norman Foster's Modern Art Glass factory at Thamesmead or Nicholas Grimshaw's Herman Miller warehouse at Chippenham are only slightly more elegant versions of the metal shed that is common on industrial and research parks all over Britain.

High-Tech architecture is today a very popular style, and is used widely across an international market. Simple and sleek, it has become the de rigueur style for large corporation headquarters, and has irreversibly shaped the international skyline. The most iconic example in London is the Lloyd’s Building, home to the insurance company Lloyd’s of London and situated in the heart of the City. The Lloyd’s Building, sometimes called The Inside-Out Building, and is another Richard Rogers project that harnesses high-tech architecture to create an iconic structure. (Yao, et al. 2012) suggested the 21st century will be the era of multiple technologies; scale and high efficiency are the future development trend.

This allows the services to be easily replaced as they wear out, leaving the essential structure of the building untouched and the interior floor space much larger than if the services were located internally. There is still the heavy emphasis on the structural, however, with glazing and steelwork making up repeating geometric patterns in the external faces of both buildings. (Yao, et al. 2012) Opined that the majority of developing countries are rapidly moving to modernize, in this situation rely solely on traditional technology or low-cost technology has been unable to fully meet the increasingly diverse people building demand, so the architects have to face and resolve how to achieve high-technological problems. This means that the glazing is held in place with steelwork producing straight geometric lines within curved external faces and creating the skeleton effect that is at the heart of structural expressionism. The triangulated glazing also serves to make the buildings stiffer, meaning that less reinforcement is required to keep the skyscrapers stable. Hays considered architecture as an instrument of culture and as an autonomous form (Hays 1984). As with all structural expressionist buildings, function becomes the form – the practical engineering elements used become the aesthetics of the building.



Plate 22: National centre for performing arts, China
Source: www.origindesignstudio.com

Finally, High-Tech Architecture, despite its rebellious, edgy and industrial roots, can produce structures that are extremely graceful and feel somehow organic and natural. The National

Centre for the Performing Arts in China is a 212 metre wide ellipsoid dome of titanium and glass, surrounded by a man-made lake, and could have been a dense, heavy construction that dwarfed everything around it. Instead, it manages to feel somehow light and delicate, with the glass intersection and geometric beams adding just enough diversity in the external face to create interest without becoming overpowering.

2.10 SIGNIFICANCE OF HIGH-TECH ARCHITECTURE

There are plenty of examples of individual houses that are thoroughgoing exercises in the High Tech style. Till (2009) builds on presenting high design of an architecture that embraces the everyday needs of people, contingency, and the inevitability of change over time. When High Tech architects tackle housing, they commonly resort to traditional building methods and materials. If High Tech is biased toward certain building types, it is also biased toward certain types of client. It is perhaps not surprising, given High Tech architects' enthusiasm for industrial technology, that their clients should commonly be industrial and business corporations.

High-tech style came about when architects and designers were looking for a way to liven up modern architecture. The Premature failure of the original cladding panels of Norman Foster’s Centre for the Visual Arts in Norwich (1978) is thought to have been due to factors related to material incompatibility between the phenolic core and the aluminium panel (Stacey, 2001, p.109). The high-tech style not only showed a rebellious attitude on the part designers who were willing to try something completely different, but also displayed impressive faith in what was to come. Technological advances were on everyone's mind, and this high-tech style leaned away from traditional architecture and more toward science fiction and the world of tomorrow.

Whether it's viewed as elegant or an eyesore, the high-tech look has become an important architectural and decor style in the 21st century. One of the latest in a long line of architectural styles, high-tech has been met with all of the gusto and disgust that greeted its predecessors.

2.11 MATERIALS FOR HIGH-TECH

The major types of materials for high-tech architecture are glass and steel. These materials are further subdivided into sub groups of groups of varying types and properties.

2.11.1 Glass

This refers to a hard, brittle, transparent solid. In the scientific sense, glass is an inorganic product of fusion which has been cooled to a rigid condition without crystallizing. Many glasses contain silica as their main component. In the scientific sense the term glass is often extended to all amorphous solids including plastics, resins, or other silica free amorphous solids. The glazed membranes of Le Corbusier's Swiss Pavilion and Salvation Army building offer another example of a then new technology, the glazed curtain wall, whose early implementation was frequently problematic: the facades of both buildings required replacement less than 20 years after construction (Ford, 1997). The optical and physical properties of glass make it suitable for applications such as flat glass, container glass, optics and optoelectronics materials, laboratory equipment, thermal insulator (glass wool), reinforcement fibre (glass-reinforced plastic, glass fibre reinforced concrete).

Glass is commonly used in buildings as transparent windows, internal glazed partitions, and as architectural features. It is also possible to use glass as a structural material, for example, in beams and columns, as well as in the form of "fins" for wind reinforcement, which are visible in many glass frontages like large shop windows. Safe load capacity is, however,

limited; although glass has a high theoretical yield stress, it is very susceptible to brittle (sudden) failure, and has a tendency to shatter upon localized impact. One well-known example of a structure made entirely from glass is the northern entrance to Buchanan Street subway station in Glasgow.

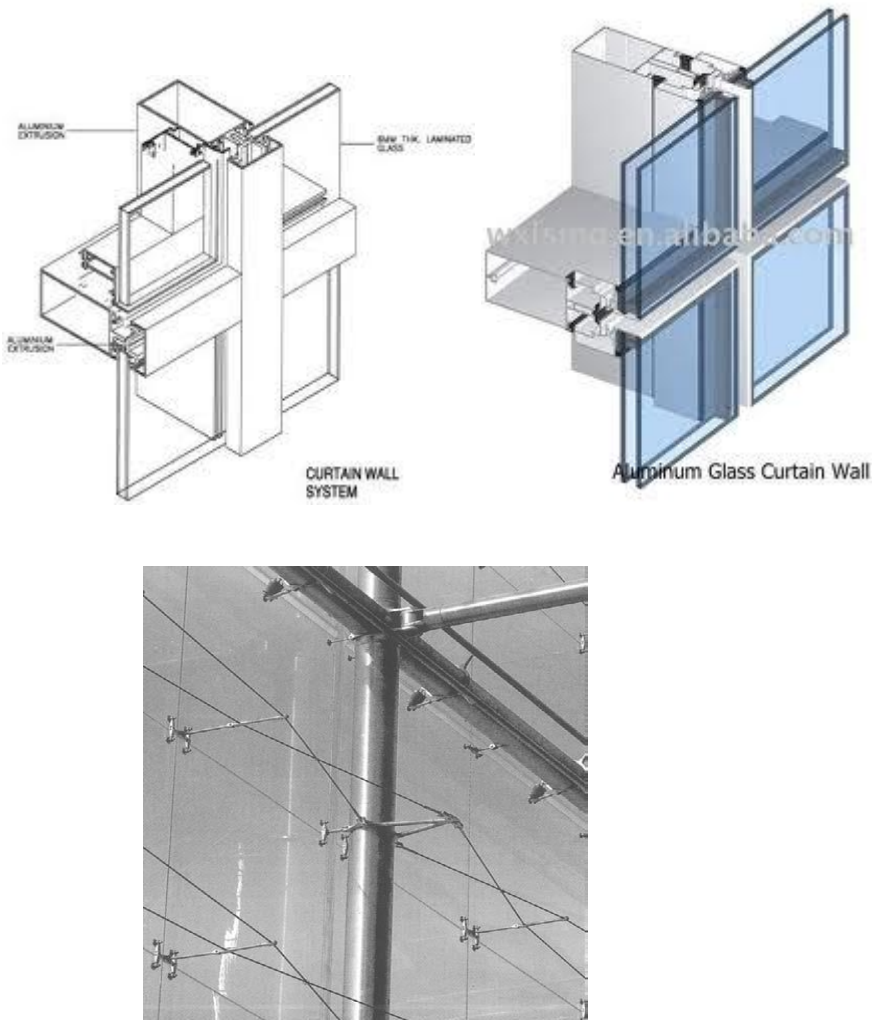


Plate 24: City of Science, La Villette, Paris, 1986.
Source: www.origindesignstudio.com

Glass in building can be of a safety type, including wired, heat strengthened (tempered) and laminated glass. Glass fibre insulation is common in roofs and walls. Foamed glass, made from waste glass, can be used as lightweight, closed-cell insulation. As insulation, glass (e.g. fibreglass) is also used. In the form of long, fluffy-looking sheets, it is commonly found in

homes. Fibreglass insulation is used particularly in attics, and is given an R-rating, denoting the insulating ability. (Source: www.wikipediaencyclopedia*).*

2.12.2 Steel

Its introduction resulted in the construction of tall structures (skyscrapers and towers) and long-span structures in the form of bridges and spaces covered by domes, shells and space Trusses (Seitz, 1995) but it has been used in all sorts of standard buildings as well as industrial halls, sheets forming the skins on one or both sides.

Modern steels are made with varying combinations of alloy metals to fulfil many purposes. Carbon steel, composed simply of iron and carbon, accounts for 90% of steel production. Some more modern steels include tool steels, which are alloyed with large amounts of tungsten and cobalt or other elements to maximize solution hardening.

Many other high-strength alloys exist, such as dual-phase steel, which is heat treated to contain both a ferrite and marten sic microstructure for extra strength.

2.12.3 Ercolith, a lightweight concrete is a material based of Concrete and Styrofoam (EPS)**.** Its properties in terms of density, resistance, energy efficiency, fire resistance, sound insulation, earthquake resistance and low water absorption are outstanding. The modular construction system is an innovative frame construction system that is based on various elements built with the lightweight concrete. This modular construction system has many advantages in terms of construction speed, flexibility, ease of use etc.

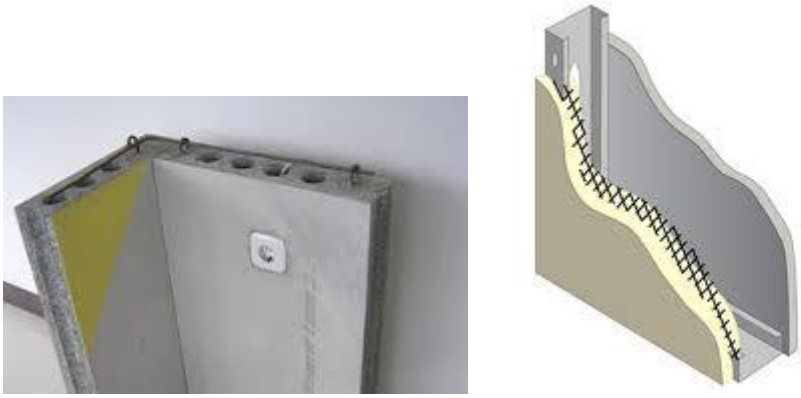


Plate 2.21: Close view of the structure of the lightweight concrete
Sources: www.ercolith.com

Ercolith as an innovative high-tech modular construction system for domestic, commercial and industrial constructions has special demands on heat and cold insulation, noise protection and simplified set-up technique with individual architectural design options. The data and plate below give detailed physical and chemical properties of Lightweight concrete.

- It has the capability to be fabricated into and shape depending on the construction need
- The sizes‟ range is (220-300 x 100 x 20-40) cm
- weights approximately 180 kg (typical wall of 265cm); it can be carried onsite with a trolley and moved by two men
- It is composed of approximately 81% of void volume (Styrofoam and air)
- It can easily be cut to fit the specific needs with a handsaw or an electric saw

a) Ercolith structural wall elements: The Centrepiece of the ercolith modular construction system is the structural wall element, which forms the major structural part of any building. Each element has four vertical cylinders: three full cylinders in the middle and two half cylinders on the sides. The half cylinders are filled onsite with concrete and, depending on the structural needs, with additional reinforcing steel. The other 3 cylinders are either filled with Styrofoam cylinder shaped blocs, or with concrete, depending on the structural needs.

The structural needs will mainly depend on the height of the building and the envisaged earthquake resistance



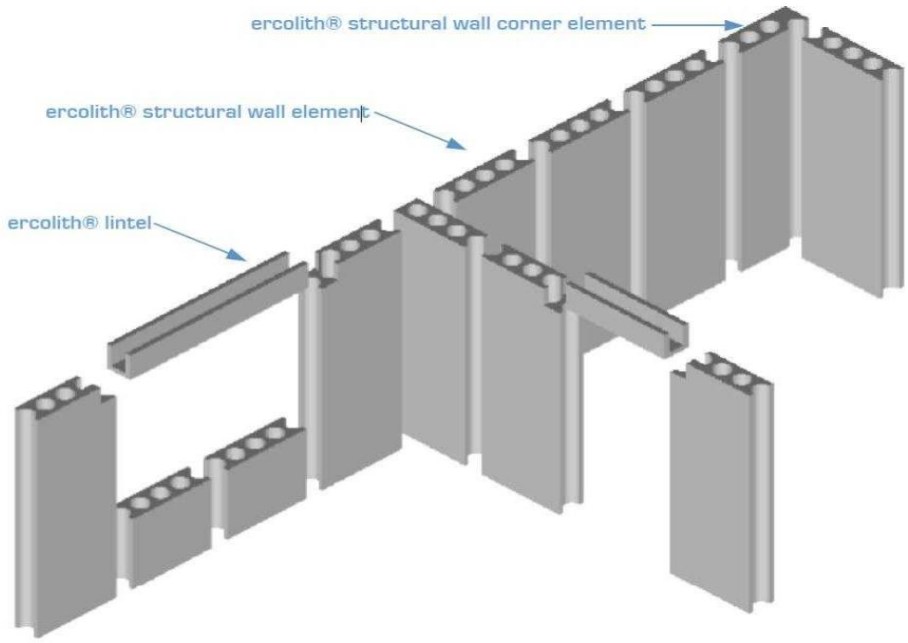


Plate 2.22: Structural wall elements
Sources: www.ercolith.com

CHAPTER THREE

3.0 RESEARCH METHODOLOGY

3.1 METHOD OF STUDY

The method of study for this thesis is based on qualitative research method and analysis of case studies as well as a study of published and unpublished literature. These methods include: observation, visual survey and checklist, interviews, questionnaire, models and simulation and scientific measuring among others. For the purpose of this research, visual survey, structured interview, analytical and comparative study under sets of dependent and independent variables.

The research method is basically qualitative. The following methods were used

(i) Physical observation:

Visit of the building and careful observation of its features, guided tour around the building and its facilities

(ii) Visual Survey:

Visual Survey of the entire convention centre proximity on several aspects of the auditorium: its history, construction, administration, events hosted, maintenance issues, and so on.

(iii) Review of existing literature:

Government policy documents, convention and exhibition publications, Architectural magazines, architectural reviews, architectural data books, journal articles, unpublished thesis projects.

(iv) Analytical and comparative study:

Comparisons of convention and exhibition centre design under the following independent variables:

a) Architectural style and building concept

b) Primary means of circulation

c) Major facilities

d) Auditorium characteristics

e) Meeting rooms characteristics

Dependent variables shall discuss the research area. Here the variables used are extracted from the principles of High-Tech architecture.

a) Building materials

   i) Use of light tensile members

   ii) Use of glass

b) Building technology

   i) Inside out

   ii) Celebration of process

c) External building form

   i) Architectural expression

d) Spatial space organization

   i) Flexibility of spaces

3.1 Instrument of Data Collection

During the design phase of the case study research, different approaches were used in selecting the case studies so as to examine the in depth and which instruments and data

gathering approaches to be used. Tools to collect data included literature; visual surveys, interviews, documentation review, observation, and the collection of physical artefacts. The collection of data was done through various ways which include:

3.1.1 Literature and Documentation

Literatures on the selected case studies were consulted so as to get relevant information, history and data concerning the projects in question. . Data in the form of online media, digital documents, and journals, etc. on convention and exhibition centres were carried out.

3.1.2 Visual Survey

This strategy involves observing the subject. Visits at International Conference Centre and Yar Adua Centre, Abuja, were made and careful observation of each building features, guided tour around the convention centres and its facilities as well as identifying elements of High-Tech design features that could be found in such building projects, this was done by the use of photographs

3.2 Data Analysis and Presentation

The databases were prepared to assist with categorizing, sorting, storing, and retrieving data for analysis. Data collected on each case study was analysed and represented in different forms which include:

3.2.1 Photographs, Tables and Figures

Photographs of the structures of the case studies were documented. See the case study section for illustrations. Data collected on this research were documented and presented on the use of High-Tech principles case study assessment tables. Refer to tables under summary of case

studies. Data collected on the case studies were also documented in form of drawings. Refer to figures under case studies.

3.3 Sources of Data Collection

There are a number of different sources and methods that can be used to gather information for a research topic. The major sources that have been used are as follows:

3.3.1 Structured Interviews

This is one of the most important methods for gathering information in case studies. Interviews were carried out at two convention centres by the administrative staffs on several aspects of the building such as its history, construction, administration, peak periods and other relevant information that was required.

3.3.2 Direct Observation

This strategy involves observing the subject. Visits at International Conference Centre and Yar Adua Centre, Abuja, were made and careful observation of each building features, guided tour around the convention centres and its facilities.

3.3.3 Documents

Data such as Letters, newspaper articles, administrative records, etc on convention and exhibition centres and High-Tech buildings were carried out.

3.3.4 Physical Artefacts

Tools, objects, instruments and other artefacts often observed during a direct observation of the subject.

3.3.5 Participant Observation

For the proposed research topic, the researcher was involved in actually serving as a participant in events and observing the actions and outcomes.

3.4 Procedures for Data Collection

The case study method, with multiple data collection methods used and analysis techniques, has provided opportunities to triangulate data in order to strengthen the research findings and conclusions. The procedure for data collection involved visits to two local case studies and taking a visual analysis of their architectural features. These buildings were then evaluated on the created field forms. However, the foreign case studies were gotten through the internet and their features evaluated on the field forms as well.

3.4.1 Case Studies

The case studies selections for this thesis were sampled purposively on two bases:

1. As a design with features denoting it for meetings, conventions, and the display of merchandise by a wide variety of professional groups and trade organizations.
2. As buildings having use of High-Tech elements/principles

3.4.2 Case Study Selection Criteria

The case studies were purposely selected on the bases of being a convention and exhibition centre on one hand as buildings possessing High-Tech design principles.

The case studies have been analyzed based on two aspects:

1. Descriptive analysis as a convention and exhibition centre.

2. Analysis as buildings with High-Tech design principles.

3.5 Case Study Variables

A variable is something that is likely to changes or subject to variation. It changes according to different factors. Some variables change easily, while other variables are almost constant. In this research, the variables are defined according to what is being measured. The independent variable is the variable in which one would like to measure (the cause), while dependant variables is the effect (or assumed effect), dependent on the independent variable.

The dependent variable studies for this research are as follows:

1. Use of high-tech principles
2. Flexibility in terms of space and form
3. Building technology
4. Building materials
5. Scope of facilities

3.6 Method of Analysis

The method of analysis for the case studies is by analytical and comparative study: Comparisons of convention centres and other institutional buildings under dependent and independent variables. These variables each describe functions that are differentiable from others, they are examined and conclusions are drawn out after analysis of all the case studies. Each dependent variable was evaluated on a case by case basis to establish the extent of its meaning.

3.7 CASE STUDY ONE: INTERNATIONAL CONFERENCE CENTRE, ABUJA.

- **Architect:** Albert Speer.
- **Location:** Abuja-Federal Capital Territory, Nigeria.
- **Building Type:** Conference Centre
- **Construction Material:** Concrete, Glass, aluminium and steel.
- **Style:** Modern
- **Building form:** Rectilinear/Curve linear
- **Climate:** Tropical

3.7.1 Background

The Abuja International Conference Centre was constructed in 1991 to host the extra-ordinary session of the Organization of African Unity Heads of Government meeting in Nigeria. A magnificent edifice overlooking the Radio House, 'mould' and lying in its own lovely garden filled with historic shady pine trees and well paved driveway. The new wing was designed by Albert Speer & Partners and built by Julius Berger Nigeria Ltd. It is a fully air-conditioned centre with interlinked but separate halls; the African Hall and Gallery, Foyer, the Mezzanine floor and Banquet Hall include some of the facilities.



Plate 3.1: Approach View of Abuja International Conference Centre, Nigeria
(Source: Field survey, 2013)

3.7.2 Building Element: The conference centre is architecturally designed to complement its surrounding environment. The Abuja International Conference Centre has a design which is modern in style having a simpler linear plan concept with a central lobby serving as main access to the halls. The building is a frame structure covered by a lattice steel roof carried on large cylindrical columns while the walling material is aluminium cladding.



Plate 3.2: View of Entrance foyer/lobby
(Source: Field work, 2013)

3.7.3 Building Structure. A frame structure covered by a lattice steel roof

(i) African Hall has a capacity for 3000 people theatre sitting or 1200 people for banquet sitting.



Plate 3.3: Interior View of African Hall
(Source: http://Abuja-icc.com/photo_gallery.html)

(ii) Niger Hall, 100 people theatre sitting and 50 people banquet sitting



Plate 3.4: Interior View of Niger Hall.
(Source: Field work, 2013)

(iii) Benue Hall, 100 people theatre sitting and 50 people banquet sitting



Plate 3.5: Interior View of Benue Hall.
(Source: Field work, 2013)

(iv) A lattice steel roof carried on large cylindrical columns

Abuja Hall, capacity for 700 and 600 people for theatre and banquet sitting respectively



Plate 3.6: Interior View of Benue Hall.
(Source: http://Abuja-icc.com/photo_gallery.html)

TABLE 3.1: DEPENDENT VARIABLE STUDY: INTERNATIONAL CONFERENCE CENTRE, ABUJA

Source: Researcher

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech principles/Architectural Expression	-The distinctive conference centre building has a parabolic shaped roof. Contemporary architecture which refers to specific structures which essentially dynamic with a prominent display of ornamentation.
Transparency, Layering and Movement	- The use of glass curtain wall at the façade to cover an enormous spaces enhances the presence of natural day lighting into building and a large lobby to contain the circulation flow
Building Technology	-The roofing system is made of steel construction and aluminium roofing sheet, the interior floors covered with decorated marble floors tiles. -Parabolic shaped roof of aluminium sheets and glazed glass supported by concrete columns
Building Materials	-Aluminium sheets and glazed glass with 4no. Anodized double swing doors -The walls are covered with padded paper, carpet and concrete panels. -Floors are finished in granite and ceramic tiles.
Flexibility in terms of space and forms	- The building in its entirety takes an organic character that brought synergy among the various activity spaces hence, a functional and organized use of space.
Scope of Facilities	- A foyer with 2 Nos. offices, - an outdoor Arcade, an executive session room, VIP Lounge, Africa Hall (2000 seat main conference hall, occasionally converted to Banquet Hall) with attached kitchen facilities, Gallery (above African Hall 900 seat capacity), Snack bar, 2 Nos. committee rooms(40-60 seat capacity), -Aso-Hall (100-250 persons capacity) convertible to press centre -and audio-visual communication room

3.8 CASE STUDY TWO: SHEHU MUSA YAR ADUA CENTRE, (ABUJA)

- **Location:** One Memorial Drive, Central Business District. Opposite Sheraton Hotel and Towers, Federal Capital Territory (F.C.T), Abuja, Nigeria.
- **Building Type:** Convention Centre
- **Construction Material:** Concrete, Glass, aluminium and steel
- **Style:** Modern
- **Building form:** Rectilinear/Curve linear
- **Climate:** Tropical

3.8.1 Brief History

The Shehu Musa Yar' Adua Centre was built by JB Nigeria in 2000. The centre was established by the friends, family and associates of Shehu Musa Yar' Adua.



Plate 3.7: Approach view of Shehu Musa Yar'Adua Centre
(Source: Field work, 2013)

3.8.2 Architectural Character

The centre is planned with all facilities being accessed through the central atrium. The architecture is modern in style, having an open square plan covered by a large glass dome which provides the atrium with natural lighting.



Plate 3.8: Aerial view of Shehu Musa Yar'Adua Centre
(Source: http://www,google.com/ Shehu Musa Yar'Adua Centre /photo_gallery.html)

3.8.3 Description

The Centre offers optimum conference facilities, including an auditorium, meeting rooms and state of the art of technology to assist in ensuring the success of every occasion. The Centre is available seven days a week as well as evenings.

3.8.4 Facilities and their capacities

(i) Auditorium for 450 and 250 people depending on sitting arrangement.



Plate 3.9: Auditorium, Shehu Musa Yar'Adua Centre
(Source: Field work, 2013)

(ii) Exhibition Hall





Plate 3.10: Exhibition Hall, Shehu Musa Yar'Adua Centre
(Source: Field work, 2013)

(iii) Central Atrium





Plate 3.11: Atrium, Shehu Musa Yar' Adua Centre
(Source: http://www,google.com/ Shehu Musa Yar'Adua Centre /photo_gallery.html)

(i) Garden Pavilion.



Plate 3.12: Green open space, Shehu Musa Yar' Adua Centre
(Source:http://www,google.com/ Shehu Musa Yar'Adua Centre /photo_gallery.html)

3.8.5 Activities

(i) Meetings/ Conferences.

(ii) Concerts.

(iii) Trade Shows.

(ii) Social/ Civic gatherings

3.8.6 Merits

(i) Location: The Centre is located within the city centre of Abuja and very close to supporting facilities such as hotels, major roads and the airport.

(ii) Plan: The plan for the Centre is a regular square plan covered by a large glass dome providing natural light into the interior space.

(iii)A well landscaped environment ideal for outdoor activities.

3.8.7 Demerits

(i) The major disadvantage with the centre is the floor finish. Smooth marble tiles was used which makes it difficult to work on.

(ii) The second disadvantage is inadequate parking for cars during events.

Table 3.2: Showing Analysis of Dependent Variables: Shehu Musa Yar' Adua, Nigeria
Source: Researcher

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech principles/Architectural Expression	- The building takes a rectilinear form. -Open and uninterrupted spaces and continuous use of double volumes within the interior of the building. - Partition walls which demountable are a combination of steel and glass to enhance visuals around the interior spaces.
Transparency, Layering and Movement	- The presence of a central atrium housing the circulation flow, and it is covered with polycarbonate roofing sheets to allow natural lighting into the building
Building Technology	- The building is mostly constructed using concrete. The roofing system is made of steel construction and the interior floors are covered with marble floors tiles.
Building Materials	-Use of reinforced concrete, curtain glass, steel and aluminium. - The public areas especially within the interior spaces are decorated polished terrazzo floors.
Flexibility in terms of space and forms	- The building's advantage of larger area covered with tiles materials hence, gives room for efficient circulation - The building in its entirety takes a rectangular form with a dome cap but has most of its interior space open to enhance convertibility and flexibility.
Harmony of Site and Buildings	- The shape of the building is in relation to that of its site. - Circulation space is usually a problem in most public facilities and the major challenge is parking space as this is not adequate.

\

3.9 CASE STUDY THREE: BRISBANE CONVENTION & EXHIBITION CENTRE

- **Location:** South Bank, Queensland, Australia.
- **Building Type:** Convention Centre
- **Construction Material:** Concrete, Glass, aluminium and steel.
- **Style:** Modern
- **Building form:** Rectilinear/Curve linear
- **Climate:** Temperate

3.12.1 Brief History

The Centre is centrally located in the city's unique riverside precinct at South Bank, home to Brisbane's thriving arts and cultural community. The Centre is built upon the former site of World Expo Park, the rollercoaster theme park built for the successful hosting of Brisbane's World Expo '88.

3.12.2 Architectural Character

The building is 450 meters in length, 120 m wide and 24 m high. The complex roof design is based on five hyperbolic parabolise. The building is stabilized by concrete shear walls and clad in steel. A car park is located on the ground floor.

3.9.1 Facilities revealing the use of glass curtain wall and steel truss roof system



Plate 3.20: Use of prefabricated glass curtain walls to enhance lighting at the entrance



Plate 3.21 Use of prefabricated glass curtain walls to enhance lighting at the counter

(Source: http//www.Brisbane convention centre.com)



Plate 3.22: Structural steel frame used at the entrance foyer to provide cover



Plate 3.23: Boulevard auditorium averaging 1500 seats

(Source: http//www.Brisbane convention centre.com)

3.12.4 Facilities and their capacities displaying lattice steel truss roof system

Exhibition halls and Great hall audio visual



Plate 3.24: Use of Structural steel trusses Used as roof membrane to cover large space



Plate 3.25: Use of Structural steel trusses used as roof membrane

(Source:http//www.Brisbane convention centre.com)



Plate 3.26: showing the complex arrangement of escalators connected at different floors.
Source: www.architonic.com

Table 3.4: Showing Analysis of Dependent Variables: Brisbane convention & exhibition Centre.

Source: Researcher

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech pronciples/Architectural Expression	-Open and uninterrupted spaces and continuous use of double volumes within the interior of the building. -Scenic lifts and escalators connect to different floors at different intervals
Transparency, Layering and Movement	-The building exterior is cladded with light and media façade, which had to be effective both during day and night.
Building Technology	The partition walls within the interior spaces are a combination of steel/aluminium and glass to aid visuals perception
Building Materials	- Three layers of membrane materials (ETFE) is the major building envelope -Extensive use of concrete, steel and glass as well as prefabricated materials such as tampered glass -The major materials used as building envelope are the TECU brass and panelled wood materials over steel frame systems.
Flexibility in terms of space and forms	-The building in its entirety takes a free form and has most of its interior space open or free of obstructions like columns to enhance convertibility and flexibility.
Harmony Of Site and Buildings	-The shape of the building is a combination of a convex form and regular form. -The site is an open area and allows free form building but because of its small size, most of the building is suspended on steel pylons

3.13 CASE STUDY FIVE: HONG KONG CONVENTION & EXHIBITION CENTRE

- **Location:** Wan Chain North, Hong Kong Island.
- **Building Type:** Convention Centre
- **Construction Material:** Concrete, Glass, aluminium and steel.
- **Style:** Modern
- **Building form:** Rectilinear/Curve linear
- **Climate:** Temperate.
- **Floor count:** 6

3.13.1 Brief History

The Hong Kong Convention and Exhibition Centre (HKCEC) is one of the two major convention and exhibition venues in Hong Kong, along with Asia World-Expo. It is built along the Victoria Harbour; it is linked by covered walkways to nearby hotels and commercial buildings.



Plate 3.24: Aerial view of the Hong Kong exhibition centre

(Source:http://www.google.com/hongkong exhibition centre)

3.13.2 Architectural Character

The original building was built on reclaimed land off Gloucester Road in 1988. The glass curtain was the world's largest at the time, overlooking the Victoria Harbour on three sides.

The second phase of the centre, located on an artificial island, was constructed from 1994 to 1997, and features a bird-like rooftop (also referred to as a turtle by some critics).

3.13.3 Facilities displaying high headroom of lattice steel truss roof system

- 6 exhibition halls: 53,292 m²
- 2 convention halls: 5,699 m²; total seating for 6,100




Plate 3.25: A large auditorium trade show events and auditorium averaging 600
(Source:http://www.google.com/hongkong exhibition centre)

- 2 theatres: 800 m²; total seating for 1,000
- 52 meeting rooms: Pre-function areas;



Plate 3.26: Meeting rooms and Pre-function areas
(Source:http://www.google.com/hongkong exhibition centre)

3.13.4 Space Circulation & Flexibility

Numerous functions are held at the HKCEC each year, including exhibitions, conventions/meetings, banquets and other special events. The centre hosts more than 45

international trade fairs for buyers from more than 100 countries each year, including the world's largest leather fair and watch and clock fair. The regular international fairs for giftware, toys, fashion, jewellery, electronics and optical products are Asia's largest. The facility also includes provisions for video-conferencing, teleconferencing, satellite links, and simultaneous interpretation in up to eight languages, audio-visual equipment, foyer registration space, and event signage



Plate 3.27: Transparency, layering and movement are achieved through the use of glass curtain wall on the exterior panel
(Source:http://www.google.com/hongkong exhibition centre)

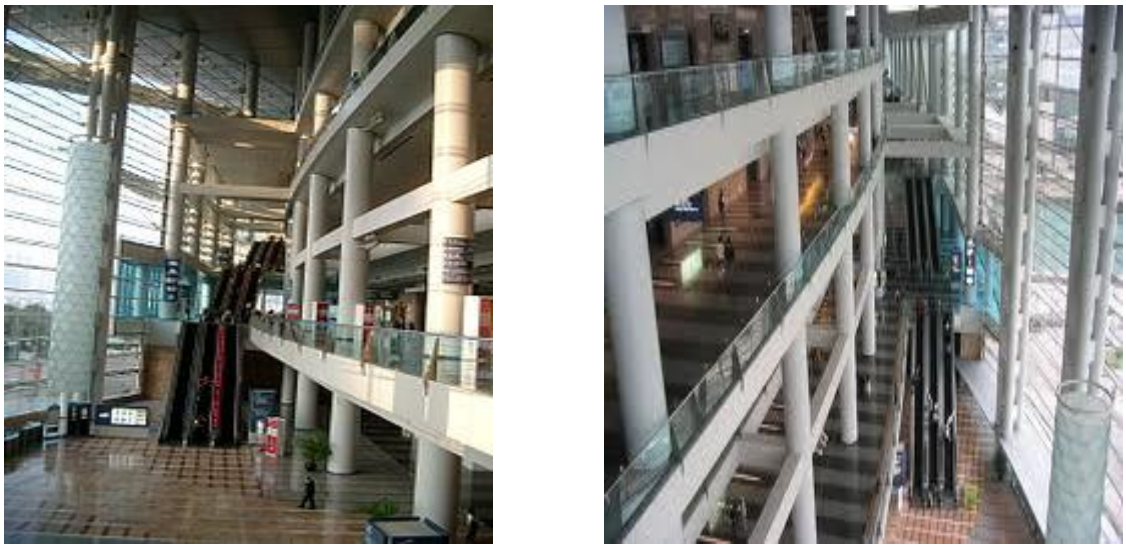


Plate 3.28: Use of technological advancement which is seen in the complex use and arrangement of escalators connecting to different floor at different intervals
(Source:http://www.google.com/hongkong exhibition centre)




Plate 3.29: Variety of trade show events with exposition of steel and metal
(Source:http://www.google.com/hongkong exhibition centre)

Table 3.5: Showing Analysis of Dependent Variables: Hong Kong convention & exhibition centre

(Source: researcher)

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech pronciples/Architectural Expression	-Expressionist and extensive use of glass curtain walls for natural day lighting to make impact on visibility. Shifting away from the conventional rigid forms the building stands as a large rock with plain faceted angular surface. -Some of the ducts systems are not completely exposed but are noticeable around the rear of the building.
Transparency, Layering and Movement	-Light penetrates the building's business centre and VIP area through glazed vertical strips, which illuminate the pavilion from within by night.
Building Technology	-Complex structure and features a bird-like rooftop (also referred to as a turtle by some critics) -Use of glass curtain wall overlooking the Victoria Harbour on three sides.
Building Materials	-Use of prefabricated materials such as stainless steel and tampered glass. - The partition walls within the interior spaces are a combination of aluminium frames. -Public areas within the interior spaces are cladded with decorative tiles.
Flexibility in terms of space and forms	- The building in its entirety takes an organic character that brought synergy among the various activity spaces hence, a functional and organized use of space.
Harmony of site and buildings	-The buildings was designed to flow with the site form and at the same time rising high into the skyline if the city.

3.12 CASE STUDY SIX: POMPIDOU CENTRE, PARIS, FRANCE.

- Location: Beaubourg area, near Les Halles, Paris, France
- Building name: Pompidou centre
- Building type: Modern art museum
- Building materials: Reinforced concrete, Steel, Glazed surfaces
- Building form: Rectilinear
- Building style: High-Tech Architecture
- Construction Date: 1977
- Architect: Richard Rogers, Renzo Pianoand Su Rogers, Gianfranco Franchini



Plate 3.30: Approach view of Pompidou centre, Paris
Source: www.greatbuildings.com

3.12.1 Description

The building character is renowned for its structure. Its distinctive architecture depicts all of the air ducts, water pipes, electrical lines, etc. on the outside of the building; which gives an interesting example of visual perception. The building could be mapped with its pipes as well as electrical lines that are usually hidden within the walls. The Pompidou Centre shows all of these lines and pipes painted in different colours so that one can distinguish them; the air

ducts are painted blue, water ducts are green, electricity lines are yellow and staircase and elevators are red.

3.12.2 Spatial Organization

From the approach of the building; it has two main entrances, one entrance leads to the wide exhibition area in the first floor, and the other is through the escalator that is inside a duct like structure made of glass. The library occupies the first three floors of the building, while the museum's permanent collection is located on floors 4 and 5. The first and top floors are used for large expositions. The museum has one of the most important collections of modern art. Its more than 59,000 works cover a broad spectrum of 20th century arts. The 4th floor contains works from 1905 to 1965 and covers art movements such as fauvism, abstract art, surrealism and cubist art. Some of the featured artists include Matisse, Kadinsky, Miró and Picasso. The 5th floor covers the period after 1965, including the pop-art movement and figurative art.

3.13.5 **Pompidou centre Facilities**

(i) Museum: The museum has a depository of the most important collections of modern art. Its more than 59,000 works cover a broad spectrum of 20th century arts. The museum's permanent collection is located on floors 4 and 5. The first and top floors are used for large expositions.

(ii) Library: The Public Information Library boasts a collection of 450,000 books, 2,600 magazines and a large number of new media items.

(iii) Place Beaubourg: The square in front of the Centre Pompidou, the 'Place Georges Pompidou' or 'Place Beaubourg', is very popular. The large crowds are animated by mimes, street portraitists and entertainers.

(iv) Bookshop.

(v) Theater

(vi) A panoramic terrace.

(vii) Exhibition area.

(viii) Exposition area.

3.12.4 Use of High-Tech elements

(a.) Prominent display of the building's technical and functional elements by exposing the construction elements, including load bearing elements.



Plate 3.31**:** Displaying the building's technical and functional elements.

Source: www.greatbuilding.com

(b.) Exposure of building services like the service ducts by externalizing them.



Plate 3.32: Showing exposition of service ducts.

Source: www.greatbuilding.com

(c.) The use of bright coloration to show emphasis on the exposed services of the structure.



Plate 3.33: showing lines and pipes painted in different colours to emphasize the exposed services.
Source: www.pompidoucenter.com

(d.) The use of prefabricated materials like glass, metal and steel in the interior and exterior.



Plate 3.34: The use of glass prefabricated glass and steel on the escalator.
Source: www.greatbuilding.com

(e.) Use of technological advancement by the use of mechanical means of transportation like escalators. The escalators are placed in the glass tubes.



Plate 3.35**:** Showing escalator, placed inside a tube made of prefabricated glass and steel.

Source: www.greatbuilding.com

TABLE 3.6 DEPENDENT VARIABLE STUDY; POMPIDOU CENTER, PARIS, FRANCE. Source: Researcher

Use of high tech principles/Architectural Expression	Transparency, layering and movement	Building Technology/form	Building materials	Spatial organization
-Extensive use of translucent and transparent glass, layering of ducts, stairs and structure, and the accentuation of moving escalators and elevators characterize the high-tech building.	-Light penetrates the building's business centre and VIP area through glazed vertical strips, which illuminate the pavilion from within by night. Internally, a dynamic lighting design will reveal the exposed lattice shell of the structure	-Pompidou center takes a rectilinear form. Its distinctive architecture depicts all of the air ducts, water pipes, electrical lines, etc. on the outside of the building. It is an interesting example visual mapping.	-Reinforced concrete 50,000m3, Metal, steel, Facades, glass surfaces and opaque surfaces	-Simple floor layout with flexible spaces

3.13 FINDINGS AND DISCUSSION

This research has attempted to identify and examine the key principles of high-tech architecture and concepts, more so the application of high-tech architecture to maximum efficiency in the design of convention and exhibition centres. The use of elements and forms which are capable of affecting our senses, incorporated into contemporary design thereby, creating a distinctive look to various iconic buildings.

Form-concept design has been an issue agitating the minds of architects and architecture students. The problem of form-concept is not a problem of rearranging lines not a question of new mouldings new architraves for doors and windows, but to raise the new built structure on a sane plan gleaning every part, benefit of science and technology setting nobly every demand of our habit and spirits, projecting all that is heavy, grotesque and unsympathetic to us (traditions, styles, aesthetic, proportions), establishing new forms, new lines, new reason

for existence. Solely out of the condition for modern living and its projection as, aesthetic value in our sensibility. Ban ham, (1996)

Table 3.10 Summary of findings; Local Case Studies

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech pronciples/Architectural Expression	-Functionalist; circular shaped plan. -Atriums as source of internal natural lighting, transparent glass for artificial lighting and visual perception & open volumes in the internal spaces. -Inside-out design theory; mimic the undulation of the geometry shapes, tree-like columns are a metaphor for the local Qatari tree
Transparency, Layering and Movement	-The building exterior is cladded with light and glazed façade, which had to be effective both during day and night.
Building Technology	- Concrete grid structural system -Interstitial floors and peristitial walls, 24m column-free floor plate, exterior façade offers solar shading for inhabitants, but also hides from view servicing equipment
Building Materials	- Concrete, aluminium, glass, sandscrete block - Locally manufactured & readily available materials in terms of steel, aluminium cladding greatly used in the buildings studied - The interior spaces cladded with granite tile finish, metal and wooden furniture and suspended lighting systems and ceilings.
Flexibility in terms of space and forms	- Open planning concept. - The building in its entirety takes an organic character that brought synergy among the various activity spaces hence, a functional and organized use of space. -Flexible open-plan workspace that could develop, expand interchange as the needs of the user did, flexibility for maintenance and refitting along the outside perimeter.
Harmony Of Site and Buildings	-The shape of the building is a combination of a convex form and regular form. -Even though the building is in harmony with the site, the available circulation space for traffic is inadequate.

(Source: Researcher)

Table 3.10 Summary of findings; Foreign Case Studies

DEPENDENT VARIABLES	DESCRIPTION
Use of high tech pronciples/Architectural Expression	- Extensive use of glass curtain walls for natural day lighting to make impact on visibility. -Scenic lifts and escalators connect to different floors at different intervals
Transparency, Layering and Movement	- Light penetrates the building's business centre and VIP area through glazed vertical strips, which illuminate the pavilion from within by night. Internally, a dynamic lighting design will reveal the exposed lattice truss
Building Technology	- There is mezzanine floors 18.5m wide incorporated in the 12.5m from ground to roof level, with effective natural lighting used and renewable energy, the lake is a vital part of the cooling infrastructure for the building. - Complex structures is a triangulated lattice of flat stainless steel panels, joined by adjustable nodes, the peak rises to 20m in height and it is entered via a glazed lip at the pavilion's base
Building Materials	-Glass wall, concrete columns and foundation, steel skeleton, outer skin of glass and aluminium cladding. -Basically steel and reinforced concrete in combination with prefabricated elements such as pipes and cable systems. -Extensive use of concrete, steel and glass as well as prefabricated materials such as tampered glass
Flexibility in terms of space and forms	- Offering sufficient large space to enhance visual perception. Pivoting reflecting canopy over the platform, used to oscillate objects round. - Double-height linear paths form circulation routes and articulate fingers of flexible sufficient space; they give everyone working inside an awareness of the outside.
Harmony Of Site and Buildings	-The buildings were designed in harmony to flow with the site

(Source: Researcher)

3.14 GENERAL INFERENCES

1. In the design of the convention and exhibition centre, the architects made conscious effort to create a massing which is not expressively dictated by the shape of the plan. In other words, the auditorium geometry does not describe what you see on the outside. The External form concept of the building is created from an iconic perspective, and it's meant to impress as a whole. Function and form are one.
2. There is always a unique symbolic expression associated with convention and exhibition buildings.
3. Titanium and glass are the major contemporary finish materials.
4. Reinforced concrete and steel are still used as structural materials.
5. Convention and exhibition centre projects funding is usually by the government. It has been observed that these edifices are targeted to be monuments right from the design brief, hence the system is not expected to sustain itself economically. In most cases, these edifices are financed by government taxes.
6. The used acoustically transparent walls, for optimising room acoustics.

CHAPTER FOUR

4.1 ANALYSIS OF CASE STUDIES AND DESIGN FORMULATION

In designing a convention and exhibition centre to portray an integrated edifice of which is functional in the aspects of efficient and rapid circulations, adequate lighting, ventilation, acoustics, structural representation and issues of services like thermal comfort than other buildings because of the level of use in terms of the number of users, the frequency of use and the activities that take place there. The Premature failure of the original cladding panels of Norman Foster's Centre for the Visual Arts in Norwich (1978) is thought to have been due to factors related to material incompatibility between the phenolic core and the aluminium panel (Stacey, 2001, p.109).

Convention centres are meant to be iconic and expressive with the characteristics of the locality and place in which it is located as they bring together visitors from different backgrounds and walks of life. This chapter will focus on exploring the information gathered, applying this information into a likely solution that will eventually increase the confidence of architects, engineers and even the interested clients in the use of high-tech principles for the design and construction of buildings within the urban areas.

4.2 DESIGN CHALLENGES IN CONVENTION AND EXHIBITION CENTRES

The design parameters in Convention and exhibition Centre are the factors and considerations that will be dealt with when considering the use of the principles of high-tech in the design of such buildings. Buildings that incorporated the use of high-tech principles were able to solve the problems associated with construction of convention and exhibition centres in terms of materials, spaces and time as well as other issues of services, HVAC, and adequate lighting, Jencks, (2009). The first issue to consider is the availability of such material resource, the risk being that the resources may become aged, leaving future generations without that particular

resource and, therefore, at a disadvantage. A sustainable building design approach that embraces the principles of high-tech architecture has to consider these major resources in terms of their depletion and the environmental and social impacts associated with their use. The major focus of the high-tech principles especially in the design of large structures like the convention and exhibition centres is its characters and prospects be exemplified towards functional interior spaces. Designing buildings so that components can be removed and replaced or even dismantle and reassemble is not only beneficial in terms of high-tech principles but reasonable maintenance is facilitated and made less costly.

Construction of buildings to minimize energy needs means adopting measures that primarily affect the building envelope and the spatial design. These are passive measures that include; orientating the building in relation to the sun, the wind and the site characteristics, insulating the building and providing heat storage or heat repellent mechanisms according to climatic needs, integrating systems to passively cool and ventilate the building, and providing appropriate natural light to minimize the need for electrical lighting. Orienting the building away from the sun and shading the whole building with double- layered roofs, planting or creating openings can also be effective.

4.3 THE CHALLENGE POSED BY USE OF HIGH-TECH ARCHITECTURE

High-tech architecture generally has a positive influence on design principles, construction methods and impact on energy use throughout the life cycle of the building which using these principles of High-tech save significant energy, cost and time during construction stages. The major focus on the building structure, on one hand is of essence in high-tech architecture as different innovative construction techniques and prefabricated materials are used in its achievement (Davies, 2007). High-tech design also incorporates ecologically sensitive materials creating healthy buildings and processes that do not negatively affect the environment before, during, or after manufacture and construction. High-tech uses efficient

mechanical systems and high-performance technologies and functions primarily to achieve thermal comfort. One of the ways in which high-tech principles have contributed in this regards is the use of Transparency, Layering and Movement on the façade of their buildings such as that noticed in a perfect example is the current Reichstag dome, an iconic glass dome constructed on top of the rebuilt Reichstag building in Berlin and the Hong kong Convention and Exhibition centre.



Plate 4.1: Transparency, Layering and Movement



Plate 4.2 Glass curtain wall delivering lighting display

Sources: www.greatbuildings.com

4.4 DEFINITION OF DESIGN CHALLENGE

The design theme to be underlined in this chapter is strictly the core of the research. The user is drawn to this quality of an architectural landmark which symbolizes cultural and environmental richness. The design problem is that of identify; what makes the building Nigerian? What symbols will effectively communicate the uniqueness of the edifice to the user? How can high-tech principles be incorporated in the design of convention and exhibition centres? The design process is a very important tool in handling issues relating to buildings, as this will predict the type of spaces and facilities to be created, the type of materials to use for its construction and the maintenance strategies required after construction and lastly the implementation or construction stage. Till (2009) builds on presenting high

design of an architecture that embraces the everyday needs of people, contingency, and the inevitability of change over time. Consequently, advanced construction techniques and material usage for the construction of such buildings become challenging to a total problem for indigenous building contractor. However, with the emerging emphasis on using sustainable buildings there is a growing confidence on the use of high-tech local materials that have a low impact on the life cycle of the building.

4.5 EXTRACTION FROM THE PRINCIPLES OF HIGH-TECH ARCHITECTURE

From case study findings, most of the designs were inspired by the place character, contemporary architecture by the use of materials and mode of construction and also the relationship of the building to it physical and historical environment to create a sense of place in turn to achieve an appropriate form for a convention centre in Abuja. (Yao, et. al. 2012) suggested the 21st century will be the era of multiple technologies; scale and high efficiency are the future development trend. With the application of advanced technology, effective high-tech buildings are more than just an arbitrary collection of environmentally friendly techniques. They are rather a careful systematic approach of interaction between the exterior and interior space of a building because they dissolve mass and do not define efficient space. For a designer, having looked at the application of high-tech architecture and the resulting benefits, especially in terms of its application, techniques, thermal insulation/comfort and maintenance, has the responsibility to extract relevant information which will be applied to design. The following should be noted when designing structure using the principles of high-tech architecture.

a) Location or region

b) Design for flexibility and convertibility

c) Design for reuse and Recycling

d) Design for Longevity that reduce the life impacts of materials

4.6 Contemporary Design Approach

The convention centre being a building typology that accommodates a large number of people should be able to cater for ease of movement, flexibility of use, and sustainable means of maintaining the structure other than its primary use of mainly conferencing and exhibition as well as entertainment facilities with the use of modern building materials planning space planning techniques and contemporary construction technology.

4.6.1 Prefabricated Materials

The use of prefabricated materials in the design and construction of buildings incorporating principles of high-tech architecture, essentially have to be environmentally friendly materials and also readily available. Salingoros, (2007) suggests there is no need to exclude high-tech materials, just as there is no need to exclude local materials. The application of demountable panel walls manufactured from locally based materials like Styrofoam and a mix of cement in the right proportion for construction has found common use in recent times.



Plate 4.2: Use of locally prefabricated materials Mbora Estate



Plate 4.2: Modular construction system,

Source: Researcher's field work

The advanced model of this modular system of construction materials popularly influenced in developed countries has made tremendous progress in its efficiency to respond and adapt quickly to climatic changes. It is an innovative and cutting-edge construction system that aims to provide technologies enabling affordable buildings, light, simple and safe construction methods, high energy efficiency to reduce energy consumptions, with the capacity to scale up for mass production volumes. It provides building needs such as:

i) Cheap and affordable within reasonable cost

ii) Adequate maintenance competence

iii) High-energy efficiency to save consumption of fuels

iv) Reliable basic infrastructure

Even though this technology has not fully been defined in Nigeria; the prospect the technology hope to offer and with the contemporary trend of its type used in some mass housing projects in the country shows that this high-tech system is possible in our economy. Similarly, high-tech exterior cladding and roof covering materials capable of providing good thermal properties in buildings, low maintenance capability, economical and locally sourced have emerged from local zinc and copper materials. These materials create massive opportunity for creativity and unique possibilities for most high-tech construction which includes the TECU Copper for roof and Façade Cladding Product Range.

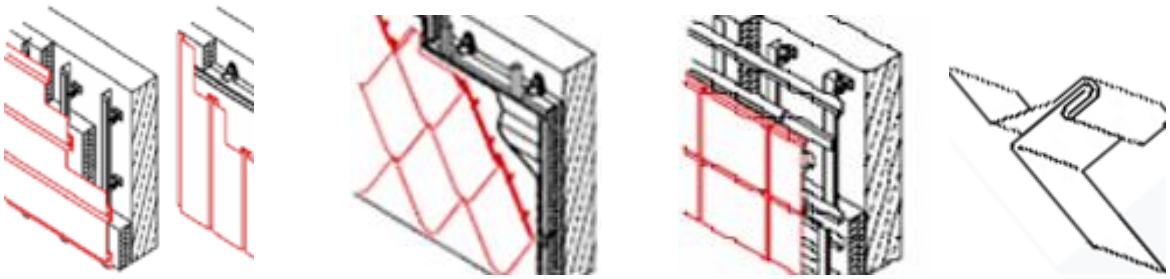


Plate 4.3: Typical TECU cladding materials
Sources: www.kme.com

4.6.2 Energy Efficiency

Energy saving in the building sector, nowadays is predominantly done through energy-intensive measures such as the use of insulation materials, high-tech materials and available technologies for improvement energy efficient performance of buildings. (Zhaoming, et al.2012), summarized as contemporary high-Tech buildings pursue ecological design; through the use of new technologies, new materials and advanced scientific means to solve ecological problems. For hotter regions insulation is required to keep excessive heat out of the building because heat is reduced by half and as such, materials used to achieve this is essential. However, in hot climates the use of thermal mass as a regulator or storage radiator can be explored to cool the building. It is imperative that where supplementary energy is required, it should be renewable. Solar energy systems are now capable of meeting a high percentage of domestic needs for water heating and running appliances

Another alternative for solar energy source are photovoltaic systems which convert radiant solar energy into electricity that can be stored for later use. Photovoltaic (PV) glazed facades can be installed as part of the building fabric, which partially offsets installation costs or on a separate structure. Glazed elements can also be used as wall cladding, as roof finish or as shading devices. Single-ply roof membranes with integrated PVs are now available, as are flexible rolls of PVs which can be attached to a metal roof system. However, as technologies progress and their use shoot up, prices will drop in due time and therefore making this low maintenance, zero-CO energy source more affordable.

4.6.3 Site and Orientation

The geographical location, ecology, climatic conditions and orientation are all important factors in high-tech buildings. The position and orientation based on macro-climatic conditions to maximize energy efficiency; framing the building structure with landscaped plants that can grow up to provide a living screen helps keep the building cool. Siting a building to benefit from solar loss or gain can dramatically reduce the amount of energy needed to heat or cool it. The first step will be to determine the sun's strength, angle and path across the site. In hot climates, the sun is the enemy; openings on the sunny side prevent the interior from overheating.

CHAPTER FIVE

5.0 SITE STUDY

5.1 SITE LOCATION:

The site is located in the Federal Capital Territory (FCT) of Nigeria located in the geographical centre of the Nation. It lies between latitude 8°25” and 9°20’ north of the equator and 6°45” and 7°30” east of the Greenwich meridian. Abuja is surrounded by abundant hills, highlands, Savannah grassland, and tropical rainforests. It occupies a total area of Abuja is 8000 square kilometres. The territory is north of the confluence of the Niger and Benue Rivers It is slightly west of the centre of the country. Its area covers 2,824 square miles (7,315 square km). (Koleoso 1998) .Abuja's geography, and very character, is defined by the two renowned rock formations around it—the Zuma Rock and the Aso Rock. The Zuma Rock is called the "Gateway to Abuja," as the Federal Capital Territory begins at its base.

The city is categorized into six phases, each having its design proposals for city planning, functions and projected population. As it encompasses different building types, and forms to serve for their different functions. The need for an appealing and well planned Federal Capital Territory has necessitated the need for building and developing forms of building that appropriately speak for and serve their function. The form used in the city comprises of different architectural styles and philosophies, most of which are generated as a result of a preceding concept and ideologies.

Two sites have been selected for the proposed convention and exhibition centre which is located in the central area; Phase 1 of the Federal Capital territory of Nigeria. Site one is

located in the commercial axis of the central area of phase 1. The other site is in Wuse, phase II, adjacent to Wonderland and the national stadium.

The design has invested heavily in the site's immediate infrastructure. The site has an alternative driveway along Nicolle Highway and Raffles Boulevard. Access to site, the right facilities, technical support and knowledgeable staff are basic ingredients for successful exhibitions, conventions and conferences. But what a venue offers in outside activities and socialising is that 'extra' that puts it on the A-list of meeting places. It offers sound facilities, as well as entertainment and lots of activities.



Figure 5.1: Map of Abuja
Source: www.fct.gov.ng

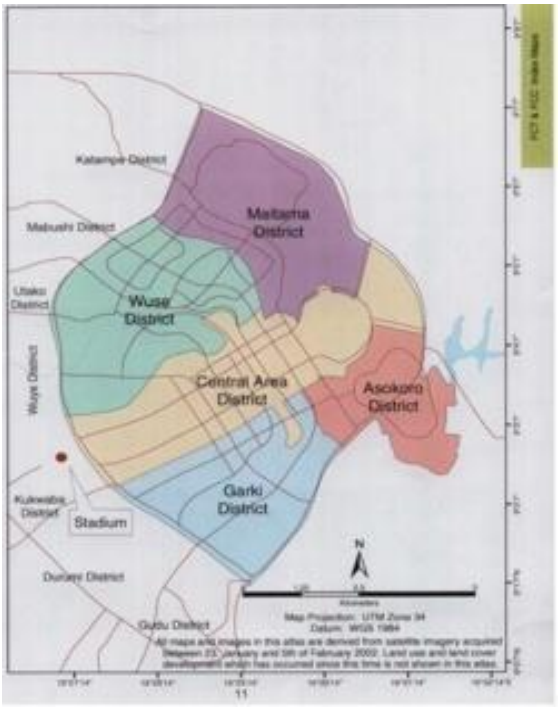


Figure 5.2: Abuja master plan
Source: www.fct.gov.ng

5.1.1 Demographics

The Federal Capital Territory had a population of 778,567 in 2006. Both the city and the Federal Capital Territory have undergone a huge population growth—with some areas around Abuja growing at a rate of up to 30 percent each year.

5.1.2 Land Use

The location of the FCT was carefully selected as it can actually be defined as a place. It relates both with the natural and manmade surroundings. The central axis transverses four low, rounded hills interspaced with minor stream valleys. These cross at right angles to the axis where it crosses the high point of each hill.

The national assembly building and its supporting legislative offices, official ministerial residences, the National Monument and the National Botanical gardens are located on a promontory at the axis with Aso Hill overlooking the body of the central area.

A central square is created on a knoll where the axis and central parkway intersect. This Nation square is surrounded with buildings housing the Supreme Court and the municipal administration centre. The inclusion of the museum along the cultural axis also allows for clearer and better definition of cultural institution as a whole. The idea that all the very important buildings are in proximity to each other shows that the need for contact and reinforcing the concept of unity.

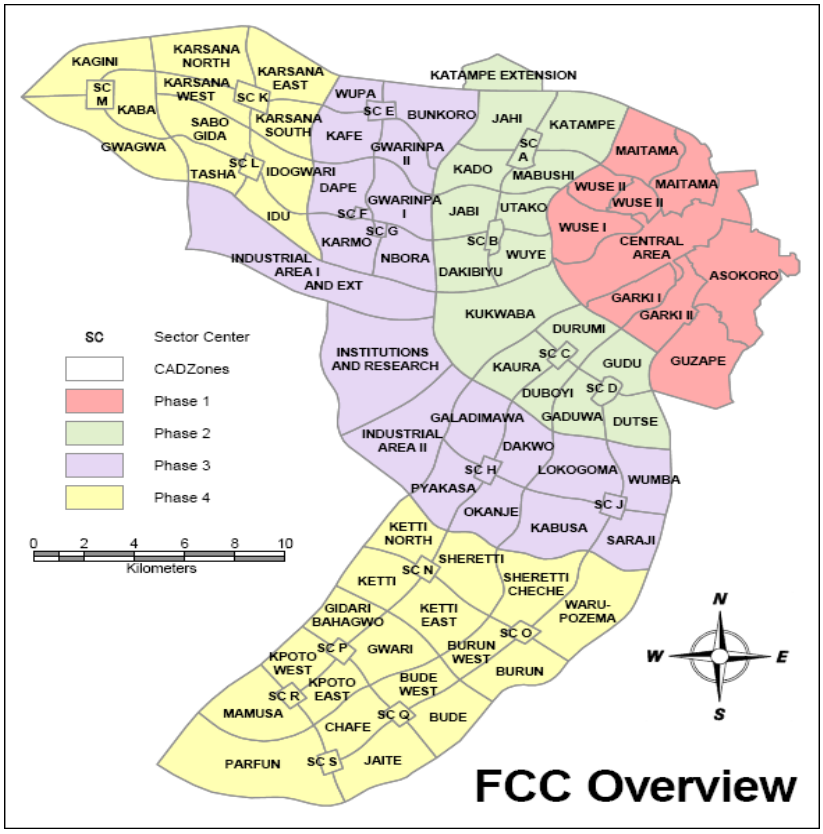


Fig.5.3: Map showing Phase 1 – 4, Abuja
Source: AGIS, Abuja 2010.

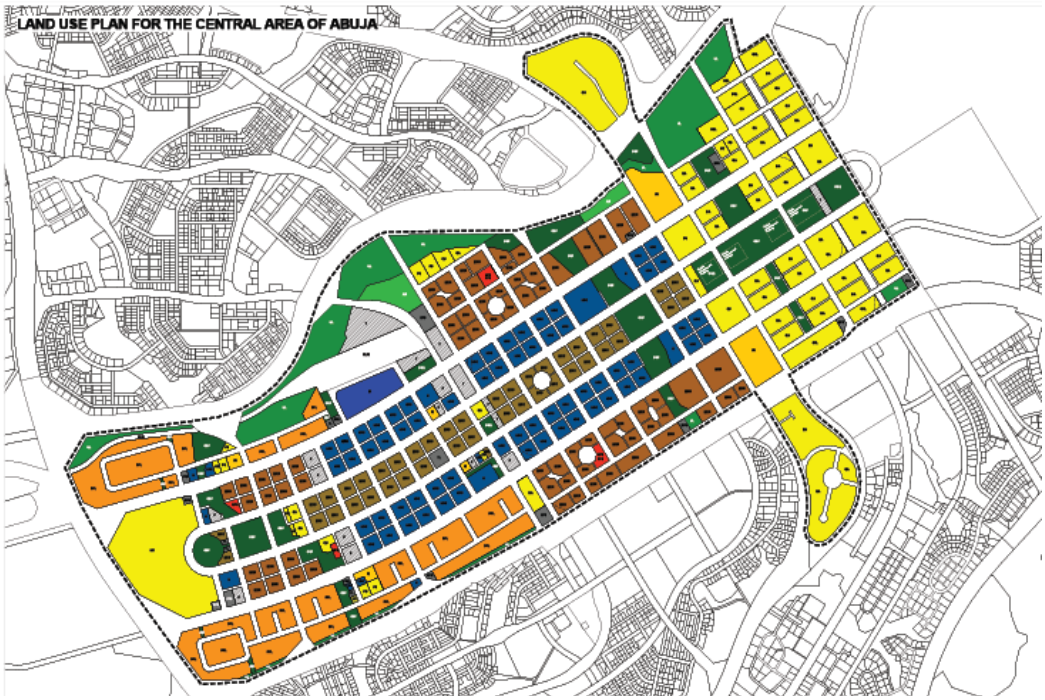


Fig. 5.4: Central area land use map
Source: AGIS, Abuja 2010.

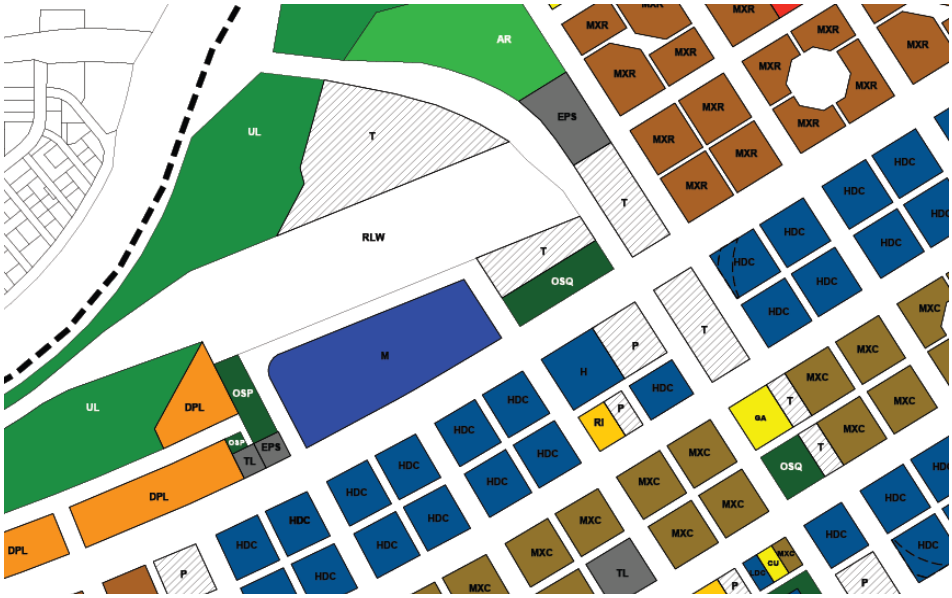


Fig. 5.5: Land use map showing selected site "M"
Source: AGIS, Abuja 2010



Fig. 5.6: Aerial map showing proposed site 1, along Kukwaba District
Source: Google-Earth

5.1.3 SITE SELECTION CRITERIA

The site selection was based on the following. These include:

a.) Location: The choice of location should be in relation to the following;

(i) Zoning: The site should be within an area reserved for institutional facilities and public utilities. It should be free from industrial zones to avoid pollution by harmful smokes, fumes and boots.

(ii) Ease of access: There should be ease of access to and from site to allow for smooth traffic flow.

(iii) There should be adequate space for future expansion.

(iv) Sufficient and adequate space for parking.

(v) Compatible with current and probable future zoning regulations.

(vi) Close to parks, museums, and other community services.

(vii) Favourable orientation to wind and natural light.

b.) Size of site, Possibility for expansion, suitability and availability;

c.) Commercial potential of surrounding area;

d.) Land-use compliance;

e.) Visual and aesthetic potential.

f.) Proximity to national landmarks

g.) Utility service: Availability of water, electricity, sewer Feasibility of bringing utilities to site at reasonable cost Restrictions on right of way.

Table 5.3: Site selection criteria
Source: researcher. 2013.

CRITERIA	**SITE 1** – (KUKWABA DISTRICT))	**SITE 2** (ALONG SAMUEL ADESOJO ADEMULEGUN AVE. CENTRAL A.)	**REMARKS**
Appropriate size, including adequate space for buidings and convenient, plentiful parking.	4	2	Site 2 is relatively small compared to site 1
Location/Accessibility: as a prominent landmark that encourages community use	5	3	Site 1 is a bit outside Abuja city centre but marks the bridge between the city and suburban areas
Utility service: utilities-availability and cost of electrical services, sanitary service	3	4	Site 1 is far better
Size of site, Possibility for expansion, suitability and availability	4	4	Site 1 is more spacious
Land use compliance	5	5	Site 1 is more compliant
Visual and aesthetic potential	5	3	
Proximity to major landmark buildings	5	3	Site 1 is in the central area, and most landmark buildings are located there
Total	28	22	

Weighing scale:

- Excellent -------- 5;
- Very good -------- 4;
- Good -------- 3;
- Fair ---------- 2;

- Poor ---------- 1;
- Very poor ----------0.

5.1.4 Site Justification

i.) The site is large enough to accommodate all anticipated facilities for centre.

ii) It can satisfy parking requirements as well as room for expansion.

iii.) It is strategically located to attract patronage and accessibility from all parts of Abuja metropolis.

iv.) Well connected to infrastructures like electricity, water supply and traffic access.

v.) The site generally offers a very good view.

5.1.5 Site Determinant and Suitability

There are several factors that contribute to the site selection and these make it suitable for the design. Its position within the layout where related facilities are located makes it easy to merge functions together. Facilities such as hotels, petrol stations, fire stations, commercial bus routes are favourable to the site.

5.1.6 Site Drainage

Surface drainage of the site is excellent due to the nature of the site and its slope. The soils underlying the site are deep and well drained. Therefore, drainage as a design consideration has already been taken care of by the topography of site. The following main points were deduced from the above points.

(i) **Natural context**

- Size with sufficient parking for minimum of 1000 cars

- Surface drainage
- Suitability and potential for expansion
- Proposing new town view.

(ii) **Local context**

- Proper access to site accommodating taxi, Shuttle buses and personal vehicles.
- Economic potentials of the area surrounding the convention centre.
- Good hotel accommodation, entertainment, Trade, and restaurants.
- Electricity, pipe-borne water.
- The site is located not more than 20km from Nnamdi Azikiwe International airport.

5.2 Climatic Data of Abuja

Abuja under koppen climate classification features a tropical wet and dry climate. The FCT experiences three weather conditions annually. This includes a warm, humid rainy season and a blistering dry season. In between the two, there is a brief interlude of harmattan occasioned by the northeast trade wind, with the main feature of dust haze, intensified coldness and dryness.

The rainy season begins from April and ends in October, when daytime temperatures reach 28ºC (82.4 ºF) to 30ºC (86.0 ºF) and night time lows hover around 22ºC (71.6ºF) to 23ºC (73.4ºF). In the dry season, daytime temperatures can soar as high as 40ºC (104.0ºF) and night time temperatures can dip to 12ºC (53.6ºF). Even the chilliest nights can be followed by

daytime temperatures well above 30ºC (86.0 ºF). The high altitudes and undulating terrain of the FCT act as a moderating influence on the weather of the territory. Rainfall in the FCT reflects the territory's location on the windward side of the Jos Plateau and the zone of rising air masses with the city receiving frequent rainfall during the rainy season from March to November every year.

The climate of the FCT is typical of the guinea savannah. The table below gives the mean monthly climatic conditions of Abuja.

i. Temperature: The highest temperatures are recorded during the dry season. Diurnal temperature change of as much as 18° has been recorded. Lower temperatures abound during the rainy season, especially the month of august due to dense cloud cover.Humidity: High humidity levels are attained during the rainy season. Humidity values generally drop during the dry season, from November –March.

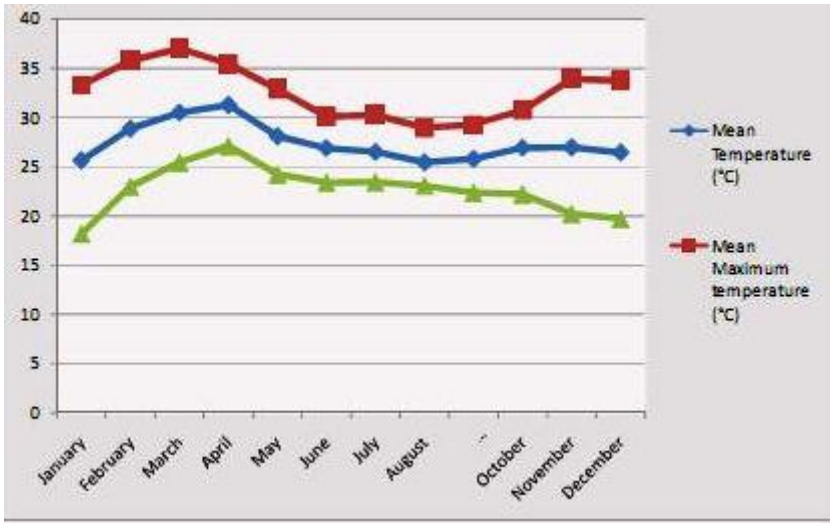


Fig. 5.1: Temperature
Source:www.gaisma.com

ii. Rainfall: Rainfall begins in April and rapidly tapers off after October. The rainy season lasts for an average of 185 days. The duration and intensity of rainfall would influence the roof slope and roof covering materials to be used in the proposed facility. Due to the little or moderate effect of rainfall in this region a gentle slope would be considered and a roof covering to suit these conditions. The orientation of the building would be considered to conform to the rainfall patterns as well.

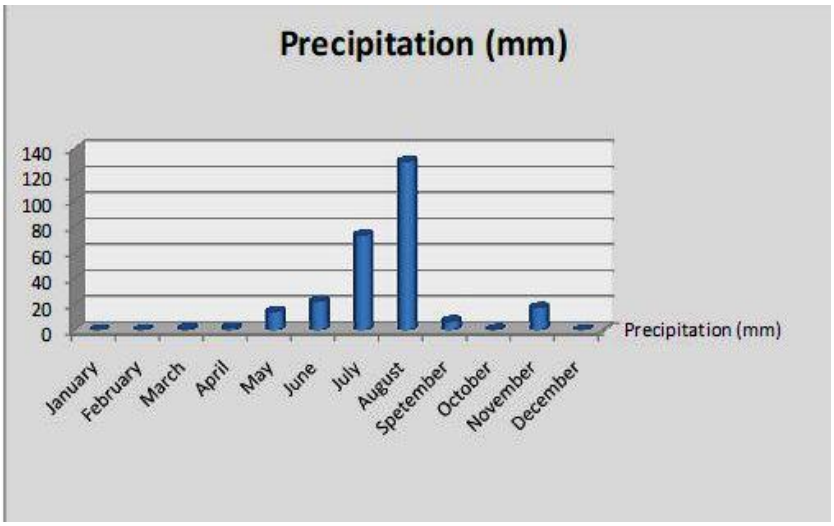


Fig. 5.1: Precipitation
Source:www.gaisma.com

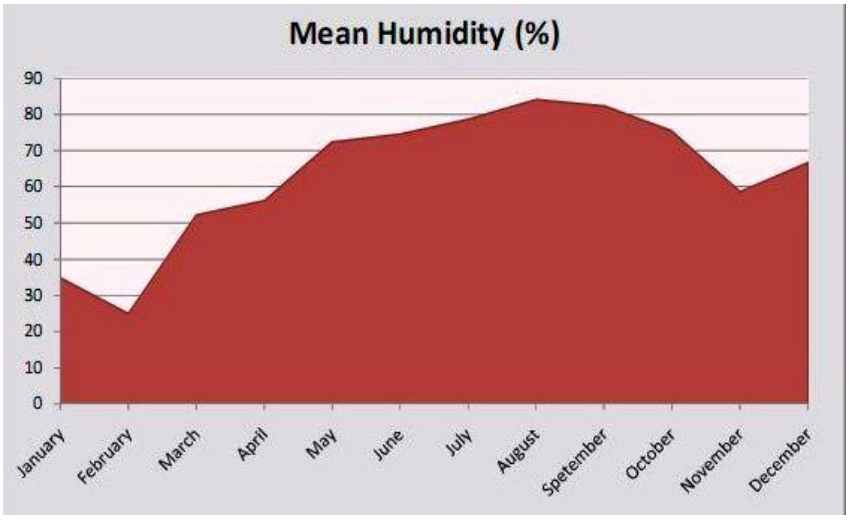


Fig. 5.1: Mean Humidity
Source:www.gaisma.com

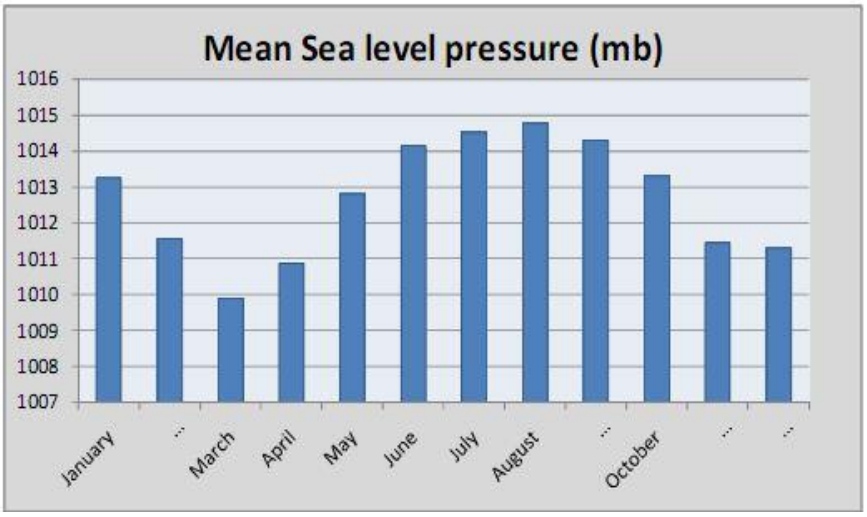


Fig. 5.1: Mean Sea level pressure
Source:www.gaisma.com

iii. Wind: The Tropical Maritime air mass and the Tropical Continental Air mass are the two major air masses dominate the Federal Capital Territory: The tropical maritime air mass is formed over the Atlantic ocean of the south of the country and is therefore warm and moist. It blows from south-west to north-east the tropical continental is developed over the Sahara desert and thus is warm and dry and blows from north-east to south-west.

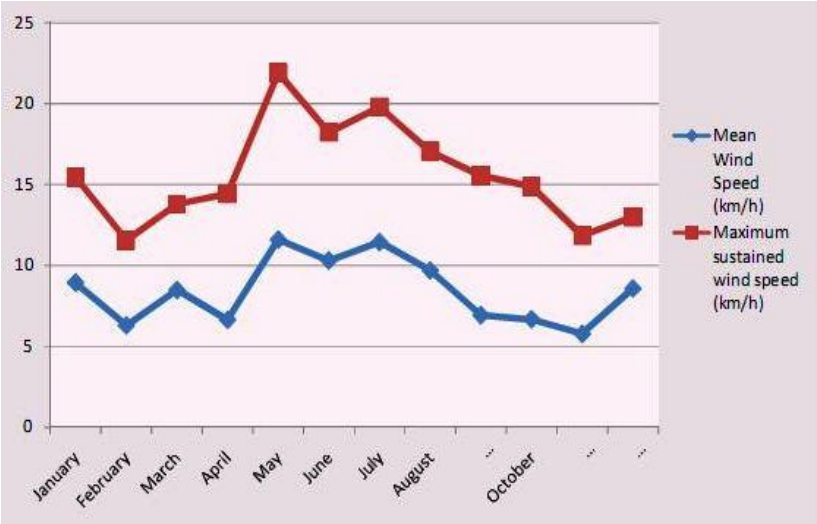


Fig. 5.1: Wind Speed
Source:www.gaisma.com

5.4 SITE ANALYSIS

The selected site was fully analyzed against the backdrop of the aforementioned criteria to assess the suitability of the site for the proposed project that would further influence the design in a positive manner. The analysis of the site included the following:

5.4.1 Site characteristics and Analysis:

The site has been analysed and some of the constraints have been identified so that proper planning and design could be achieved. The site analysis was based on the: topography, soil type, sunshine, rainfall, together with their associated elements.

5.4.2 Topography:

The site gently slopes from east to west and this will determine the location of the drainage gutters, the change in levels in the design where necessary and the general nature of the soil.

5.4.3 Soil Type:

The soils underlying the capital city are derived from granite gneiss and magmatite underlie the Gwagwa plains. Their suitability for development land uses varies with depth, occurrence or iron pan, texture, run-off potential and drainage. The laterite nature of the soil has provided a convenient bearing capacity for the location of structures on the proposed site and the utilization of the strip foundation type for the construction can be used for some part of the construction.

5.4.4 Vegetation:

The FCT falls within the Guinea forest-savannah mosaic zone of the West African sub-region. Patches of rain forest, however, occur in the Gwagwa plains, especially in the rugged terrain to the south south-eastern parts of the territory, where a landscape of gullies and rough

terrain is found. These areas of the Federal Capital Territory (FCT) form one of the few surviving occurrences of the mature forest vegetation in Nigeria. The vegetation of the capital city generally is characterized by park savannah. Riverine depressions are typically skirted by fringes of thickets and high trees. There are occasional patches of forest or heavily wooded areas. Park savannah is typically a stratified community with a discontinuous canopy, shrub and grass layer.

5.4.5 Sunshine:

This would greatly affect the fenestration of the buildings and sun shading devices. Orientation along east west axis will be employed with vertical shading devices at the east and west of buildings; the utilization of horizontal shading devices at the north and southern parts of the buildings. Solar dependent machineries would be located at sensitive and strategic points for the optimized utilization of sunlight for its operation; these may include pumping machines.

5.4.6 Physiographic:

The area is characterized by gently undulating terrain interlaced by riverine depressions. A visual scale is created by the inselbergs protruding from the plains. The central and southern access consists of uplands and plains with numerous inselbergs and rock outcrops of various sizes.

5.4.7 Geology:

The rocks underlying the FCT site itself are classified in the three categories below as documented by Koloeso, (1998)

i. Metamorphic rock: biotite – muscovite, schist, limited to four narrow outcrop bands along ridge tops at the eastern edge of the site. Migmatite underlying most of the city,

porphyritic Gneiss underlying the Usman river valley in the northwest of the city and granite gneiss

ii. Igneous Rock: including Biotite Granite, large intrusive masses commonly elliptical in shape forming dissected zones of the Zuma-Bwari-Aso hills and outcrops of the Gwagwa plains

iii. Sedimentary Rock: alluvium located in streambeds throughout the territory, consisting largely of sand with rare gravel beds and local deposits of clay.

5.4.8. Site Potentials: The site is a little beat on a high ground which would help in enhancing the viewing quality of the proposed facility.

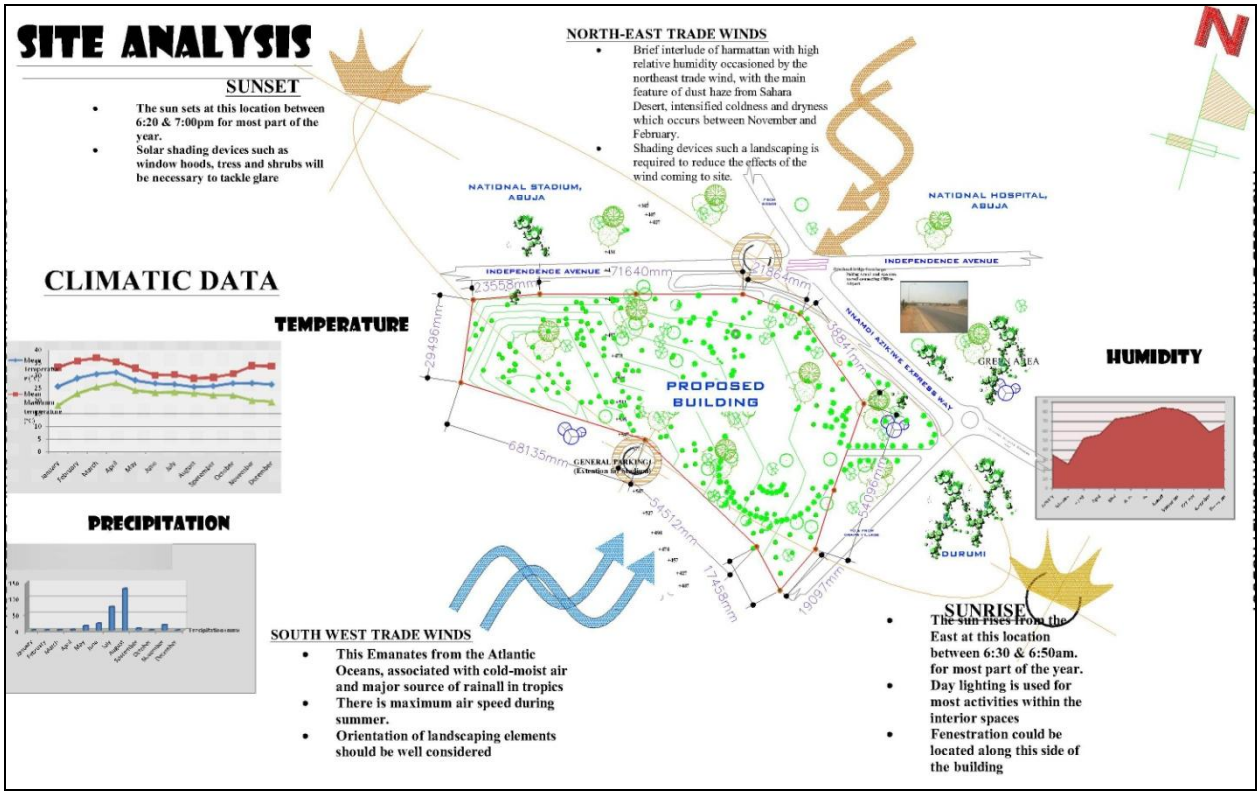


Figure 5.4: Site Analysis: Site climate
Source: Authors field work

There are three seasons, including a warm, humid rainy season, from April to October, and a blistering dry season, when daytime temperatures can soar as high as 40 degrees Celsius

(104 degrees Fahrenheit). Between these seasons is a brief interlude of harmattan occasioned by the north-east trade wind, with characteristic dust haze, intensified coldness and dryness.

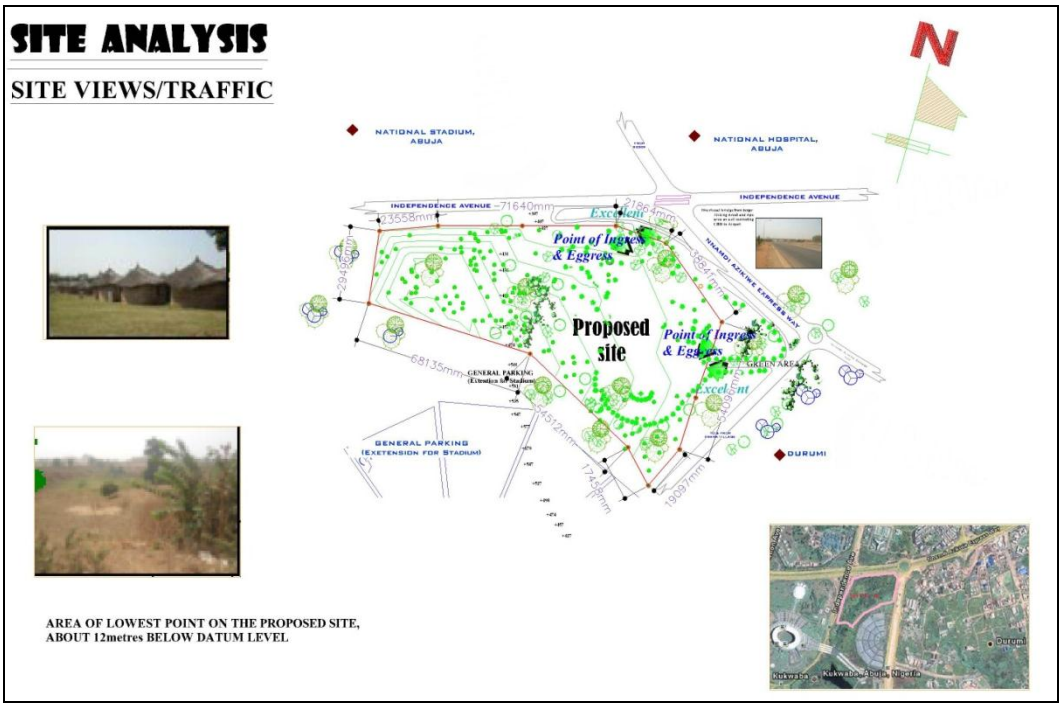


Figure 5.5: Site Analysis: Views / Traffic
Source: Authors field work

Building orientation as shown in fig. 5.5 was determined by placing emphasis on the traffic and also views both from and to the site giving passerby an elaborate view of the building form and also giving occupant of the building beautiful vistas to behold.

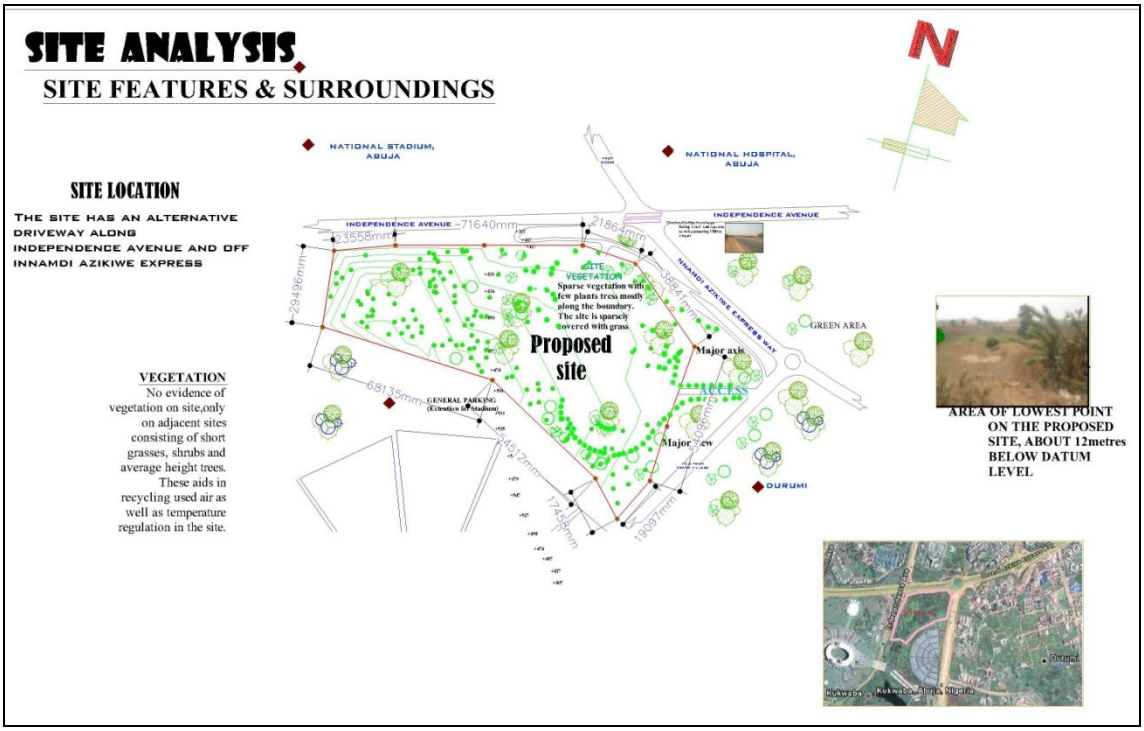


Figure 5.6: Site Analysis: Site Surrounding features
Source: Authors field work

The surrounding features as shown in fig 5.6 comprises of the following: the art and craft village, the central mosque, a low residential area along the northern park way and the silver bird building behind the site.

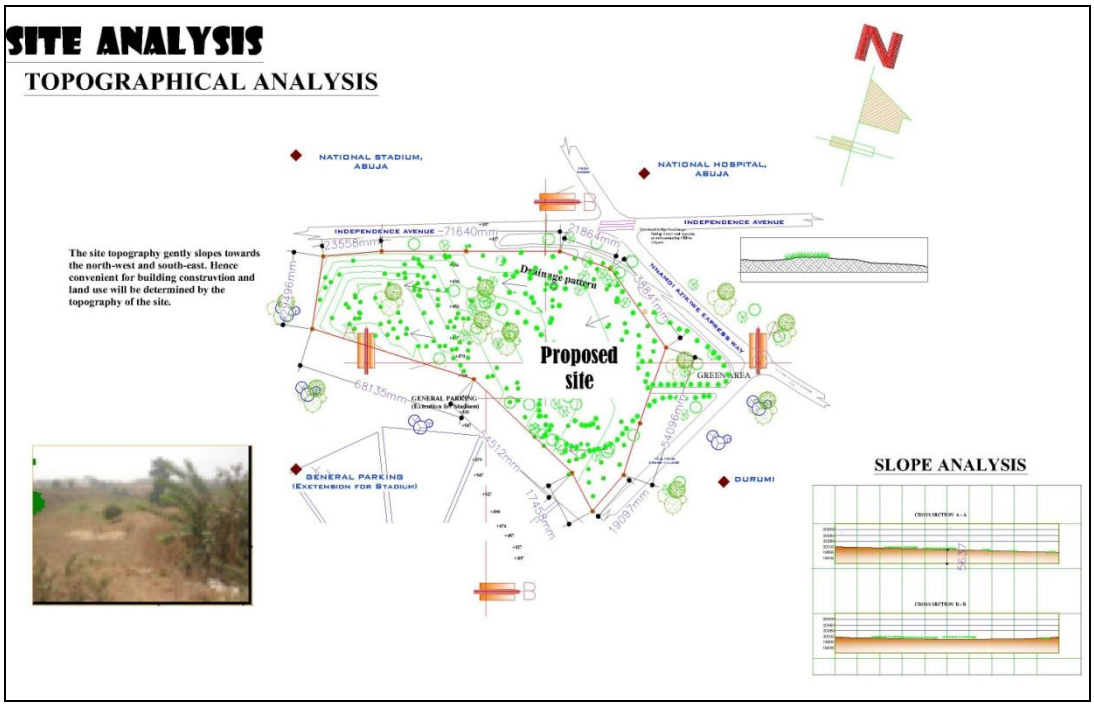


Figure 5.7: Site Analysis: Site terrain

Source: Authors field work

The total site size is **4.6 hectares** with total perimeter of the site as **928.043 metres** and sparse vegetation as well has a gentle slope with a good access road on the site

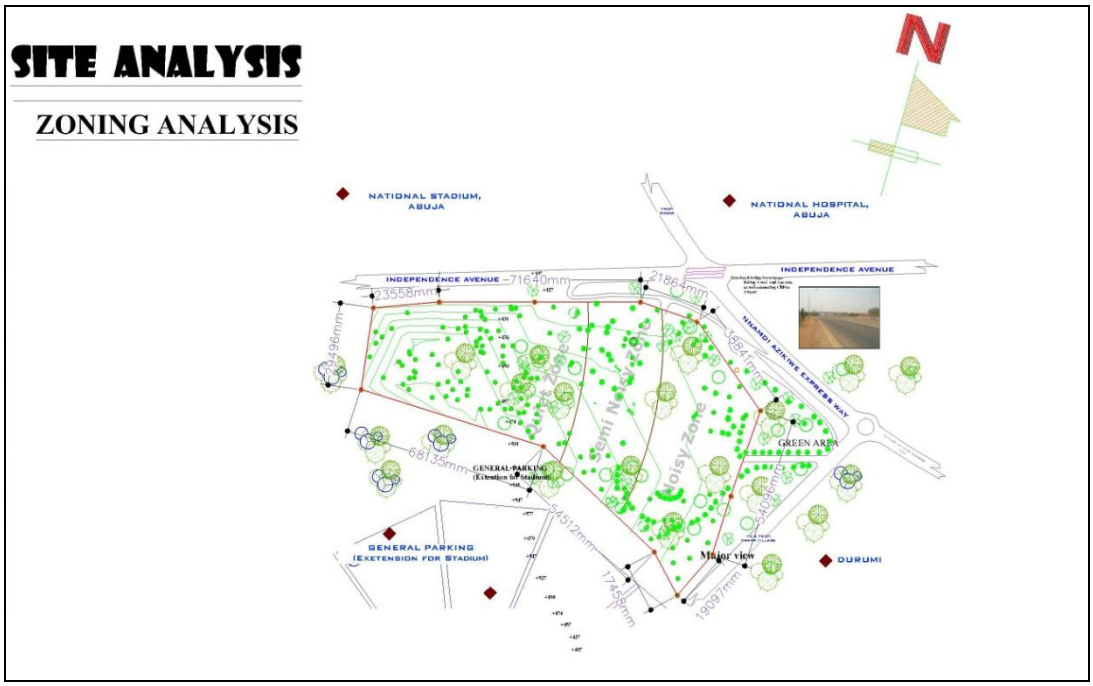


Figure 5.8: Site Analysis: Site zoning

Source: Authors field work

The site was zoned as shown in fig 5.8 to develop a well thought out plan for an orderly and functional layout which takes advantage of the natural topography of the site and also in line with the design brief. Therefore, in determining the harmonious relationship between various spaces will facilitate the optimal use of the site as well as providing efficiency and liveability in accordance with the client brief.

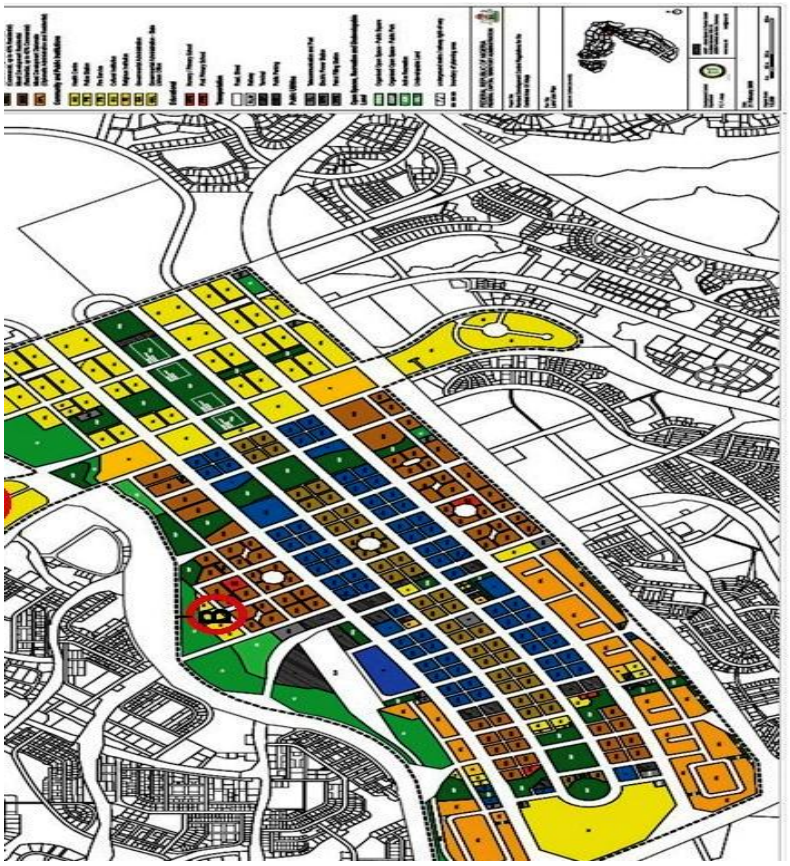


Figure 5.3: Abuja land use map and the selected sites A and B
Source: Federal Capital Development Authority F.C.D.A

5.5 Brief Development

Client: Ministry Of Culture and Tourism

The ministry of culture and tourism aimed at the rapid development of the Federal capital desires to build a convention and exhibition centre whose theme would be educating, enlightening, enriching and entertaining diverse audiences through a rich array of corporate meetings as well as trade shows and also to have an architectural landmark that will symbolize the cultural richness of the country. The project will be located on the cultural axis of the central area of the capital city.

The proposed multi-purpose convention and exhibition centre will have four major sections to accommodate for the activities of the centre. These include:

(i) The Administrative section

(ii) The Multi-purpose Convention Hall and related facilities.

(iii) The Exhibition Halls, Areas and facilities.

(iv) Multipurpose Auditorium/Seminar Halls

(v) Educational multimedia centre

(vi) Restaurants

(vii) The Auxiliary facilities

(viii) Landscaped gardens

5.6 Theme and Purpose of Design

This thesis focuses on the design of a modern multipurpose convention and exhibition centre using the principles and concepts of high-tech architecture. It is a proposal for a building facility which host public and private gatherings such as: business and corporate meetings, conferences, exhibitions, trade shows as well as social events for the surerounding municipals and metropolitan areas. The design is seen as a single unit of an integrated complex which is hoped to be a reflection of the new approach to the changing trends in Nigerian architectural concept.

The aim and objectives of the proposed design is to explore the principles of high tech architecture in the design of Convention and Exhibition Centre by analyzing the concept of high tech architecture, its characteristics and proponents, survey Nigerian buildings with high tech elements, identify the problems of high tech in Nigeria and to infuse high level of architecture into its design. The expected scope of the design was to include indoor and outdoor exhibition halls and areas closely linked to convention facilities, and administrative section.

Furthermore, after an in-depth analysis of case studies of similar and existing facilities in Nigeria and abroad as well as other necessary requirements identified from these studies and literature reviews were also amended into the brief. The major criteria would be flexibility of spaces and simplicity of design using the principles and concepts of high-tech architecture. The design is also aimed at being able to adapt to other uses apart from the proposed project it is considered in order to enhance cost effectiveness and maximum space utilization all year round.

5.7 User Space Requirements

This is based on an analysis of the type of exhibits, category of exhibitors and the visitors. In order to achieve this, a list of the expected exhibitors and exhibits has been drawn out.

5.7.1 Major Categories of Exhibitors

(i) International organization.

(ii) Foreign investors.

(iii) The Nigerian Federal Government.

(iv) The State Government.

(v) Private companies.

(vi) Professional bodies.

The exhibits have been divided into the following major groups or categories. These are:

(i) Heavy or large exhibits: This includes; construction and building, automobile and aviation, and agriculture.

(ii) Medium exhibits: This includes; chemicals, computer and communications, cultural, textiles, furniture, general goods, etc.

(iii) Light exhibits: Chemicals, electrical and electronics, education/literary publications, etc.

(iv) Small exhibits: This includes; healthcare/ medical, general goods, etc.

The exhibition spaces would be designed in such a way to be able to accommodate the above group of categories.

5.8 The Administrative Section

This section will accommodate the management and staff, information offices, the reception and other supporting facilities. The activities within this section would include: meetings, organization, records, accounts and corporate affairs, etc. According to Neufert Architects Data, office area requirements are calculated in two parts:

1. People space is calculated as (standard individual space x number of people) + allowances for ancillary needs + a factor (usually 15% for primary calculations.
2. Non-people space, e.g. machines rooms, and libraries, and the like for which the fittings and equipment sizes should be calculated by informed estimates based on existing good practice or comparable examples + an additional factor for primary circulation.

The representative circulation of the workstation is 8.0m² min. floor area. Free circulation space min. 1.5sqm per employee, but min. 1m wide.

The following floor to ceiling heights are recommended for floor areas of:

Table 5.1 Recommended floors to ceiling heights.
Source: (Neufert Architectect's Data)

Up to 50m²	2.5m
Over 50m²	3.0m
Over 100m²	3.0m
Over 250 and up to 2000m²	3.25m

5.8.1 Schedule of Accommodation: Administrative Section

The admin section is sub-divided into three main sections. These are:

(i) Management offices

(ii) Accounts section

(iii) Corporate Affairs offices/Outlets

(iv) Maintenance office

(v) Fire service unit

(vi) Security offices/ICT

Table 5.2 Space Schedule Administrative sectio
Source: (Neufert Architectect's Data)

S/No	Spaces	Sizes	Area (m²)
1	General Manager	12m x 10m	120sqm
2	Deputy Manager Operations	10m x 90m	90sqm

3	Deputy Manager Corporate Affairs	10m x 10m	100sqm
4	Chief Accountant	9m x 9.5m	85.5sqm
5	Clerk/Cashier	7.5m x 8.5m	63.75sqm
6	Records and Information Officer	9.5m x 10m	95sqm
7	Computer Room	8.5m x 9.7m	82.5sqm
8	Secretary	9.5m x 8.5m	80.8sqm
9	Waiting	5.5m x 6.5m	35.8sqm
10	Board Room	12.5m x 15m	187.5sqm
11	General Store	6m x 7m	42sqm
12	General office	5.5m x 7.5m	41.5sqm
13	Toilets (5)	1.85m x 2.4m	4.44sqm

5.9 The Convention Hall and Facilities

This section will accommodate multi-purpose hall/auditorium, conference rooms, banquet hall, audio-visual room, computer room, control office, library, and other supporting facilities. The major activities will be: conferences, seminars, workshops, entertainment, and symposia. The standard space area allowable per person according to Neufert Architects Data is 1.5-2.0 m² and 2.25-4.0 m² for a lecture room or theatre, rest areas for refreshment breaks during board meetings, management meetings, convention lunches, and so on. 1000 folding chairs need 20-36 m² storage space, seat size depends on type of chair and this determines the chair spacing.

Table 5.3 Spacing between chairs.
Source: (Neufert Architectect's Data)

Minimum spacing	840-500mm width
Maximum spacing	1400-750mm width

The space standard for exits and escape routes is 1m wide per 150 people min. width 0.8m the volume of the room is obtained on the basis of acoustics requirements (reverberation). E.g. approx. 4.5m³/ spectator for play houses and 6-8m³/ spectator of air volume for opera. Proportions of auditorium: These are obtained from the spectator's psychological perception and viewing angle, as well as the requirement for a good view from all seats.

- Good view without head movement but slight eye movement of about 30º.
- Good view with slight head movement and slight eye movement approx. 60º.
- Maximum perception angle without head movement is about 110º, i.e. everything which takes place between the corners of the eyes is perceived. There is uncertainty beyond this field because something may be missed from the field of vision.
- With full head and shoulders movement, a perception field of vision of 360º is possible.

The audio-visual room, projection/control room takes about the same space for modern automated systems, switch rooms, workshop and staff, store rooms. Each is given a space standard of 6-10m average size of 5.5m x 3.5m is allowable. Standard space allowable for projector room within the audio-visual unit is 19-25m² including staff room.

5.9.1 Schedule of Accommodation: Convention Hall

This is grouped into the multi-purpose halls, auditorium, library, audio-visual, seminar/lecture rooms, archives, toilets.

Table 5.4 Space Schedule: Multi-purpose Convention Hall.
Source: (Neufert Architectect's Data)

S/No	Spaces	Sizes	Area (m^2)
1.	Auditorium	24m x 30m	720sqm
2.	Multi-purpose halls	21m x 24m	504sqm
3.	Conference rooms (4)	15m x 12m	180sqm
4.	Seminar/Lecture rooms	16m x 24m	384sqm
5.	Audio-visual room	8m x 6m	48sqm
6.	Library	14m x 9m	126sqm
7.	Projection/control room	10m x 9m	90sqm
8.	Archives	3.5m x 2.5m	8.75sqm
9.	Switch room	6.50m x 5.5m	35.8sqm
10.	Store	4.0m x 3.5m	14qm
11.	Toilets	2.4m x 1.8m	4.32sqm

5.10 The Exhibition Halls

The exhibition halls cater for the categories of exhibitions listed above. The galleries, pre-function areas, shops and outdoor exhibition areas along with other supporting facilities as well as the activities within this unit includes permanent exhibitions, sales and purchase of exhibits, relaxation and windows shopping.

5.10.1 Basic Consideration for Design of Exhibition Spaces

(i) Maximum and efficient space for circulation, viewing and observation.

(ii) Avoidance of intermediate support within spaces.

(iii)Exhibition spaces that are partitioned should be done with demountable or folded panels to allow for enlargement or reduction of spaces as required.

(vii) Spaces provided for standard exhibitions must be such that a maximum of 1500 people capacity can participate at once (based on population survey of convention and exhibition delegations (1970-94). The major spaces within an exhibition area include;

(a) The reception/information area.

(b) The administrative section.

(c) Indoor exhibition halls, often large opened spaces with huge bedrooms.

(d) Outdoor or open air exhibition areas.

(e) Service spaces for escalators, lifts, ramps, utilities, and so on.

(f) Landscaped spaces to enhance aesthetic values.

(g) Auxiliary spaces meant for circulation and conveying.

(h) Security of exhibits must be ensured within any given space it occupies.

5.10.2 Space Schedule: Exhibition Halls

These include indoor exhibition halls for the four categories of exhibits.

Table 5.5 Space Schedule: Exhibition Halls.
Source: (Neufert Architectect's Data)

S/No	Spaces	Sizes	Area (m^2)
1	Heavy booth	20m x 20m	400sqm
2	Medium booth	15m x 15m	225sqm
3	Small booth	12m x 12m	144sqm
4	Gallery	15m x 20m	300sqm
5	Pre-function area	3m x 4m	12sqm
6	Storage	5m x 6m	30sqm
7	Security post	3m x 4m	12sqm

5.11 The Ancillary Facilities

These are facilities that serve the whole centre. Activities like storage, repairs, maintenance, first aid, security, delivery, parking, clearing, etc.

(i) Parking: This will be divided into three, i.e. for staff, exhibitors and visitors. According to Neufert Architect Data, visiting traffic will require parking spaces to accommodate 7-9% of the regular visitors. The parking space needed (including drive in) is about 20-25m^2 /car. Safety strips of 500mm wide are recommended between parking lanes and moving traffic. In permanent car parks, lanes and bay would be

clearly marked with safety strips for pedestrian, and provision for 20% bay is needed for larger cars.

5.11.1 Schedule of accommodation: Ancillary Facilities

Table 5.6 Space Schedule: Ancillary Facilities
Source: (Neufert Architectect's Data)
.

S/No	Spaces	Sizes	Area (m^2)
1	Maintenance unit	17m x 20m	340sqm
2	Power House	9m x 8m	72sqm
3	Central A.C Plant	8m x 6m	48sqm
4	Generator house	6m x 5m	30sqm
5	Parking area per one (450cars)	3.5m x 4.2m	14.7sqm
6	Delivery bay	9m x 10m	90sqm
7	Water tank (33000litres)	4m x 3m	12sqm
8	Restaurant	14m x 15m	210sqm
9	Garden	20m x 15m	300sqm
10	Public toilets	2.1m x 1.8m	3.78sqm

CHAPTER SIX

6.0 DESIGN REPORT

6.1 Introduction

The design task which is embedded in the sub-topic of this thesis was achievable to a large extent through detail analysis, synthesis of concept, ideas and schemes. The design report is presented based on the previous literature reviews, case studies, problem analysis, design criteria and parameters used and subsequently, the proposed solution. It is hoped that the combination of all these will culminate in the unique solution to the problem earlier stated with respect to high-tech architecture for the design of a convention and exhibition centre for Abuja.

6.2 Architectural Character

The architecture of the proposed design seeks to demonstrate the concepts of high-tech architecture in deliberately composed scheme incorporating the fundamental elements of functionality, aesthetics and structural stability. The architecture will also be characterized by a permanent structure with large column free spaces for convention and exhibition uses. Also, the spaces being enclosed would have appropriate access points that allow for maximum circulation flow, and services would be arranged around the spaces. The materials to be used would be those with good structural stability, maintenance free, weathering resistant, durable and also, high aesthetics appeal which will be creatively put together so that the best possible standards of safety, performance and quality are met.

6.3 Design Philosophy

The project design tries to achieve a comprehensive and well articulated structure, space/spatial organization, material expression, expression of construction techniques, and so on. This is in collaboration with a simple design that reflects the qualities of functionality, flexibility, aesthetics, performance and engineering expertise. However, the main focus of the project design is principles of high-tech architecture it seeks to successfully use/apply.

6.4 Design Concept

Concept formation is basically the process of obtaining an explicable vocabulary of architectural forms and spatial relationship that is a true reflection of the goal and objective of the client as sought to be represented by the building. (Evolution of design thought). White (1979) considered a concept as: the primary generator, the central theme, or the essence of a problem. The architect arrangement of forms realizes an order, which is a pure creation of his sprit (Le Corbusier, 1946*)***.** The fewer the units, the greater the central focus. This allows for central control and better coordination with greater flexibility, motion and efficiency at the same time.

The simplest forms that could be considered include simple geometric forms such as the circle, triangle and square. Considering this three forms; one can easily see that the circle has a lot more connotation in the design of convention and exhibition centre as it is a place where different people socialize and interact.

6.4.1 Concept Development

The concept of this design proposal has its basis from the case studies conducted. There are basically three aspects of the concept development which are the functional concept and the form concept.

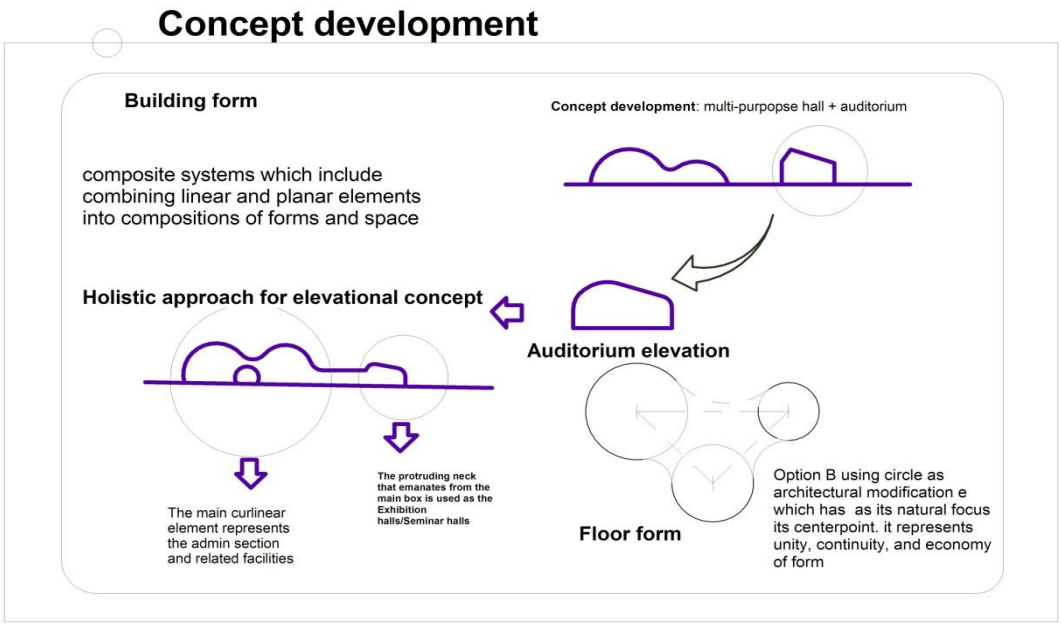


Figure 6.1: Concept Development 1

6.4.2 Plan Concept

A convention and exhibition centre is open to a large number of people; it is therefore a public space whereby movement of people is very important. The concept behind this design proposal is to use sinuous forms to maximize the use of space and depict the movement of people. The building is open to the public realm by introducing internal large lobbies, galleries and atria. Furthermore, a flexible and transparent design is aimed at so as to allow people move about freely with greater flexibility. The main idea is displayed by connecting geometric circles such that they flow into each other, in other to create a flow of relationship between the visitors, guests and services.

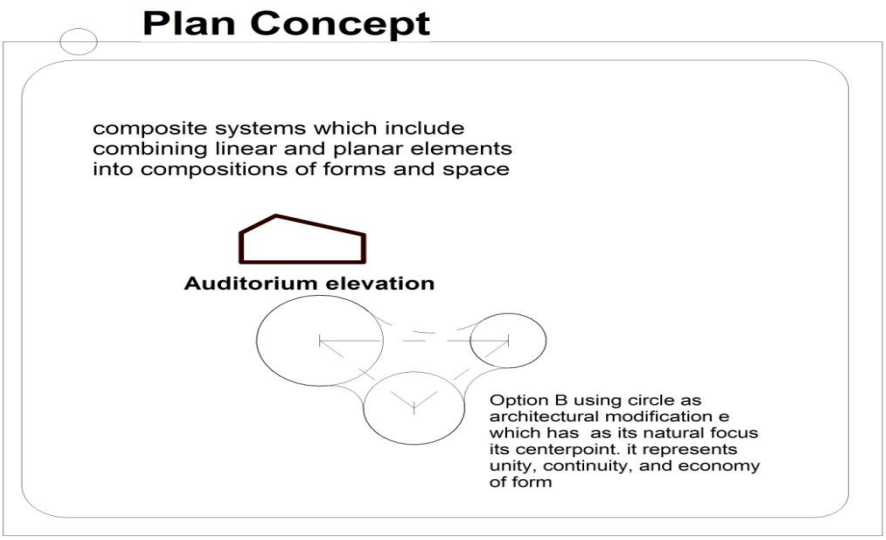


Figure 6.2: Plan Concept, the Massing of the Dimensions of Geometry

6.4.3 Form Concept

High-tech buildings employ a more technical concept. The forms used are hardly organic. Here geometry is been employed to its full advantage. In comparison to the major geometrical shapes. Circle was more appropriate for the design of this building, it was not used directly but it was customized into various curves and semi-circular shapes both in plan and elevation. Based on previous studies circles, semicircles and all forms of curvilinear shapes have worked more on High-tech buildings and also in favour of air and natural light because of its continuous free flow with no sharp edges. The design concept is bold unpretentious and geometric. The concept for the design proposed evolves from the form and structure of a bird. A gathering of birds could be used to depict convention due to their large numbers and the songs they sing.

6.4.4 Functional concept

The idea behind the functional concept is for the exterior view to look complicated, the elements of which are very clearly articulated and expressive of their functions. The purpose

of the complicated exterior is precisely to keep the internal space as simple as possible so as to enhance space flexibility and to articulate function.

6.4.5 Structural Concept

The structural concept allows for the application of the simple circular grid construction scheme which allows for larger spans to be covered. Also, for the side exhibition and multi-purpose halls, the structural concept permits the application of a unique technological construction scheme that takes care of the axial forces acting upon the structure by transmitting them along the tapering zenith directly to the ground.

6.4.6 Material Concept

Good quality material usage enhances and complements expression of form. Glass and steel have been chosen as the major materials for the design project as well as laying emphasis the qualities of lightness/weightlessness, strength, visual continuity, performance and durability.

6.4.7 Aesthetic Concept

This is based on the balance achieved in the overall conceptualization process including the massing and arrangement of forms. The idea portrayed can then be interpreted as a combination of pure geometric form structure and materials in a beautiful composition.

6.4.8 Site Planning Concept

The main concept of the site planning is to have an easy flow of vehicular and pedestrian movement from the gate to the parking lot and into the main building. This was achieved by placing pedestrian walkways along the sides of every road on the site road. Trees and shrubs

have been used along walkways and at different areas within the site to create a friendly atmosphere for people to move about comfortably.

The site will be properly zoned to achieve a warm, relaxing and comfortable tropical environment by the inter play of material, hard and soft landscape element while allowing an integration of the internal and external spaces with the provision of terraces and courtyard(s) where necessary. The site its self guides the arrangement of form from the entrance way into the site. Making use of the site contours to place a dual road spreading along the site contour allowing the site is the generator; also making use of the best positions and views in determining the orientation of the building considering views both to the building and from the building.

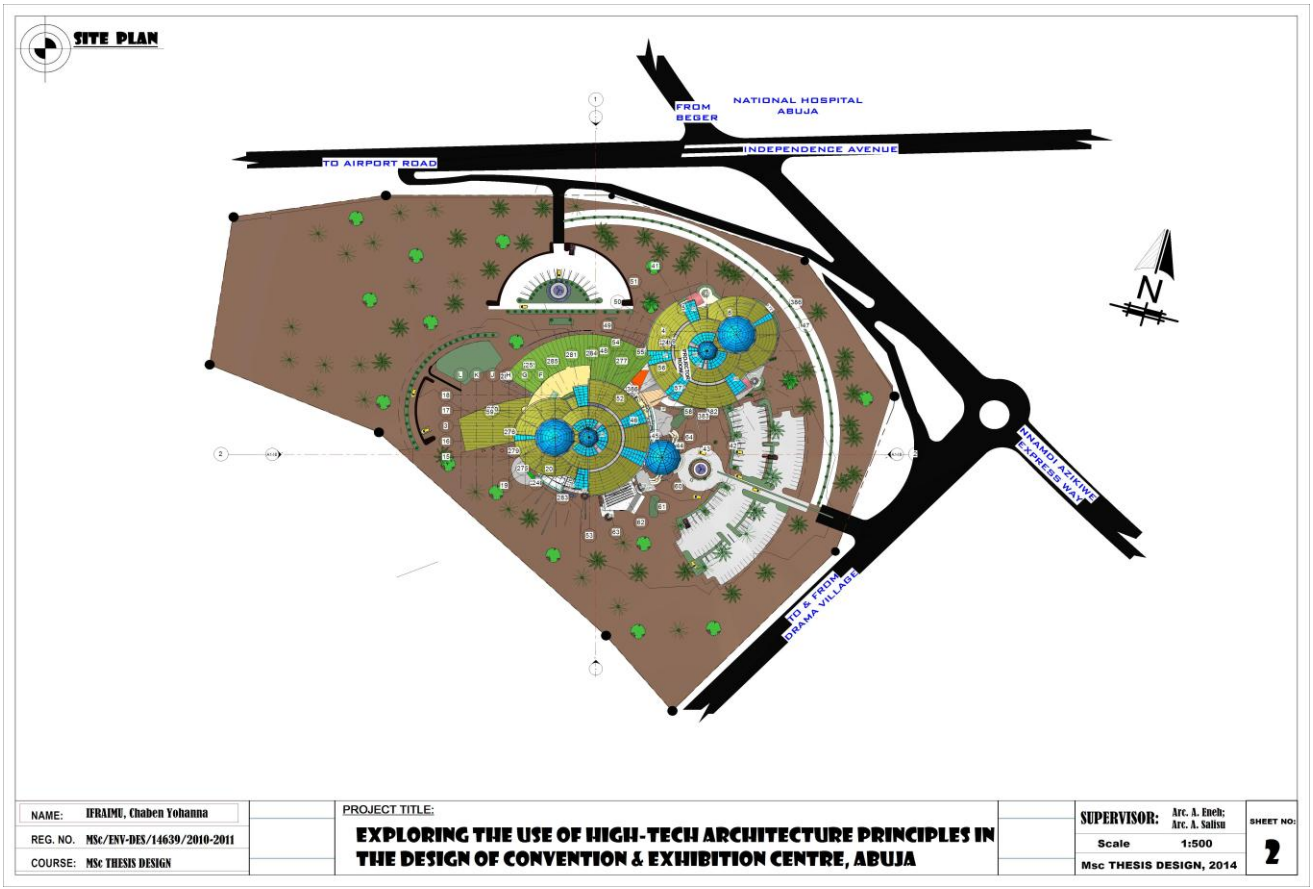


Figure 6.5: Site plan

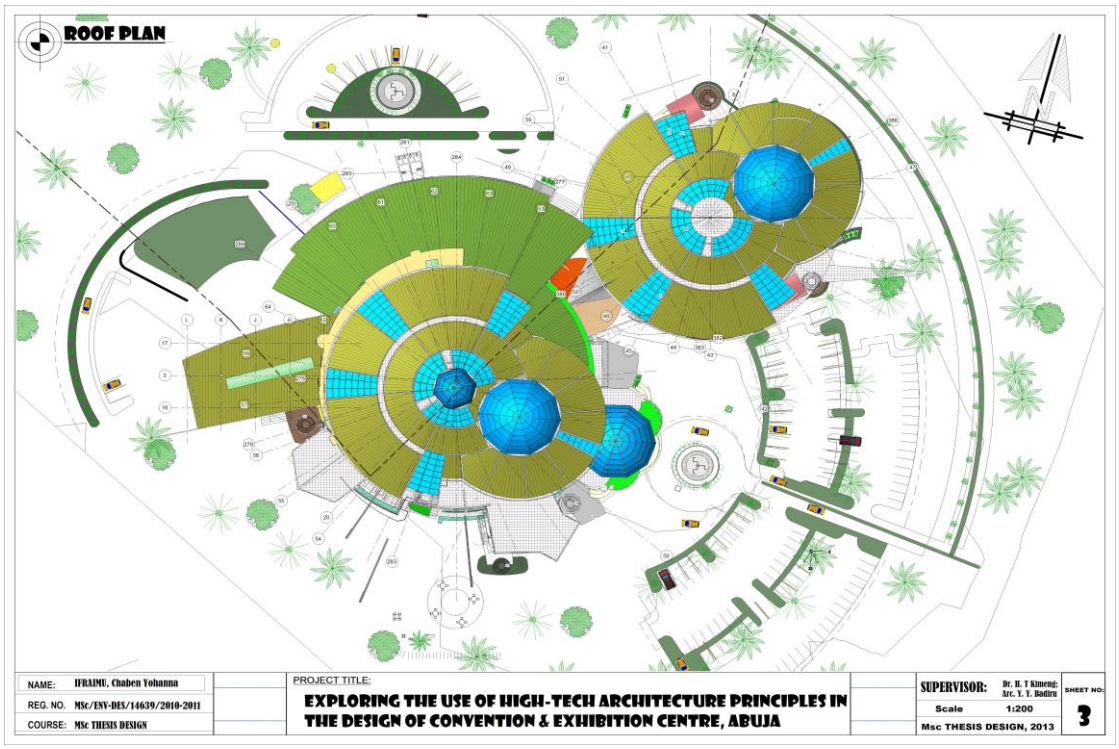


Figure 6.6: Roof plan



Figure 6.7: Ground floor plan

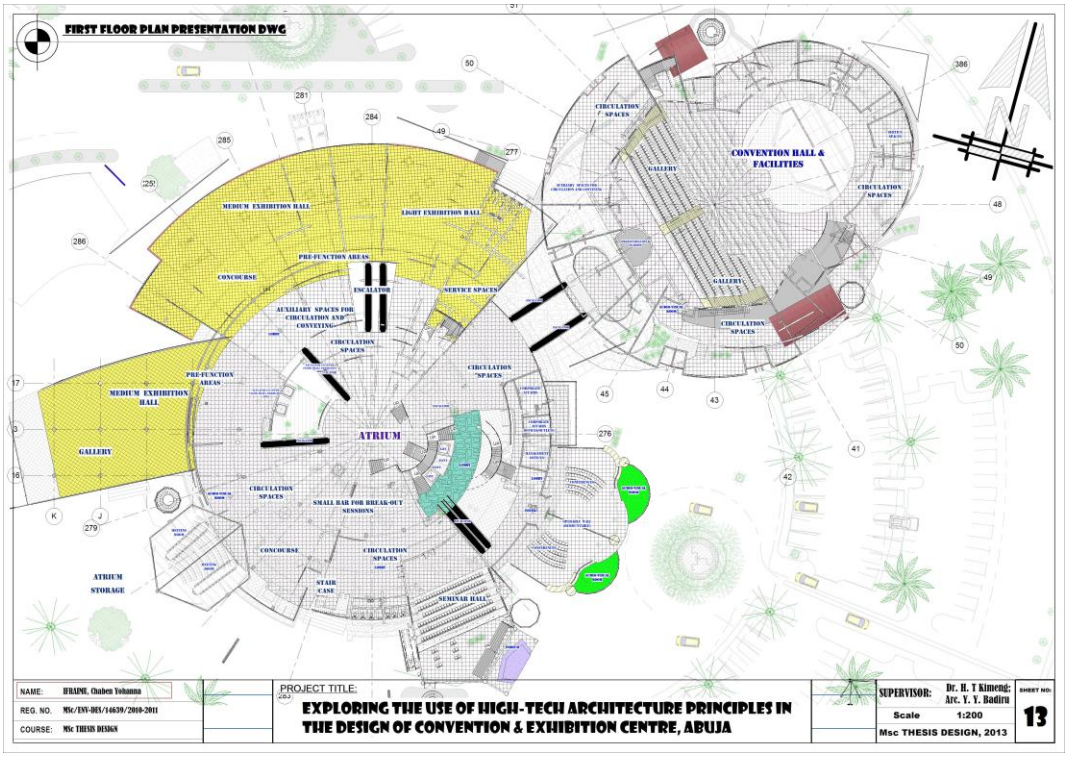


Figure 6.8: First floor plan

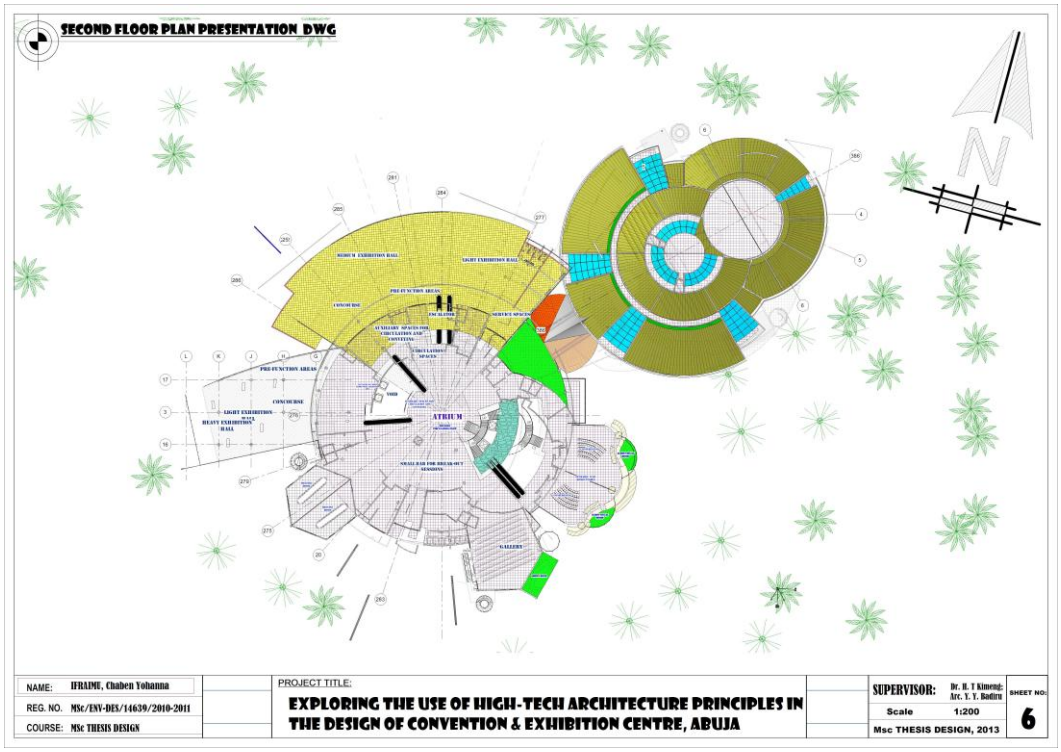


Figure 6.8: Second floor plan

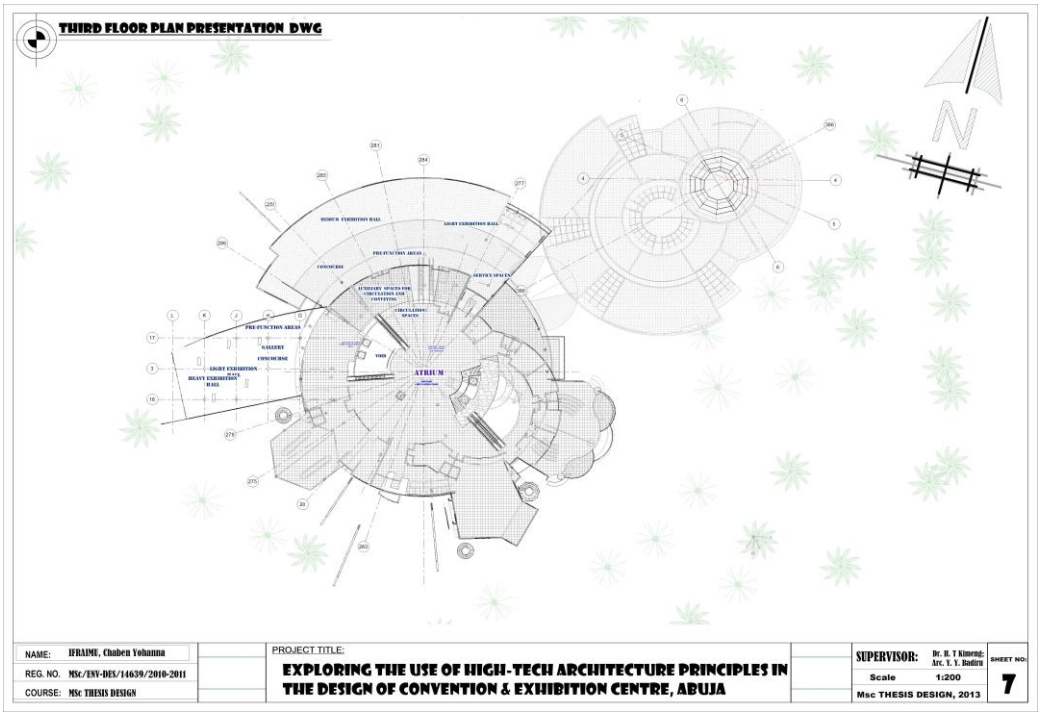


Figure 6.9: Third floor plan

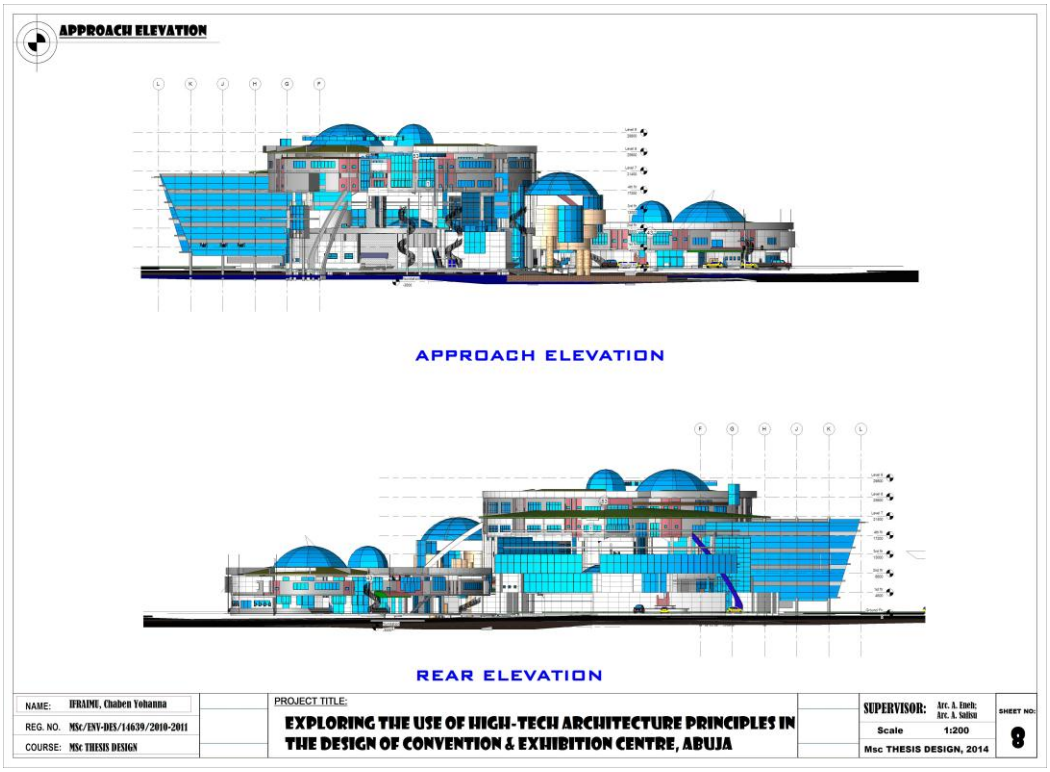


Figure 6.10: Approach/Rear Elevations

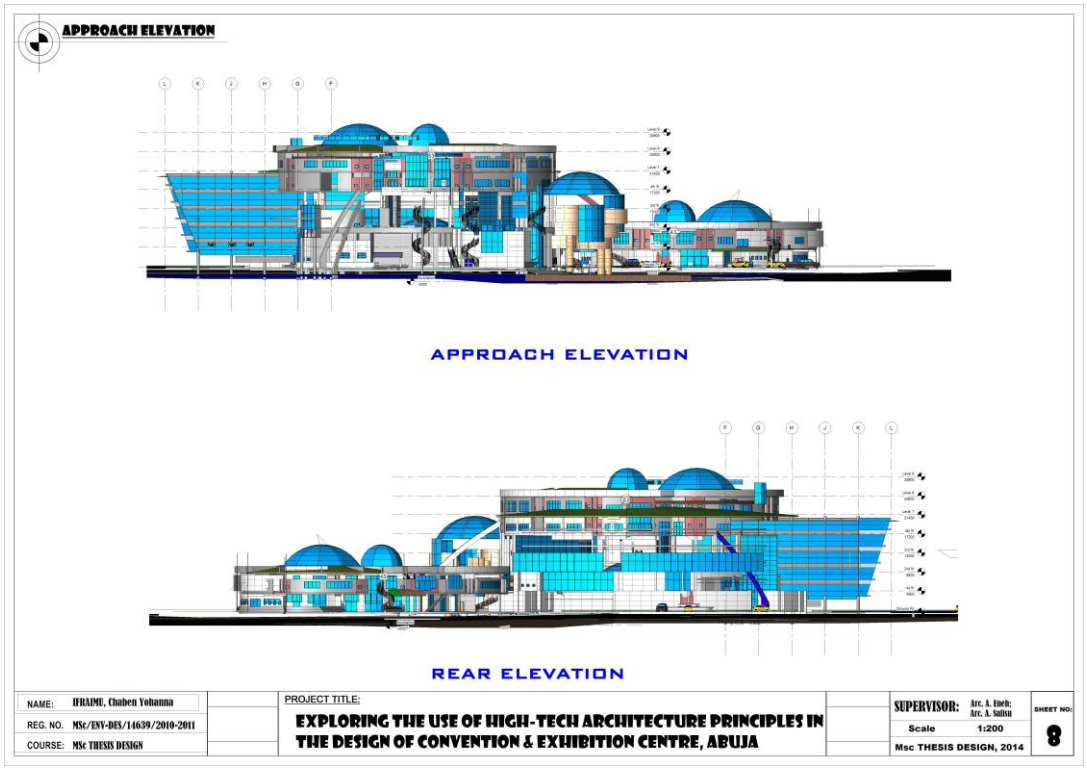


Figure 6.11: Right/Left Elevations

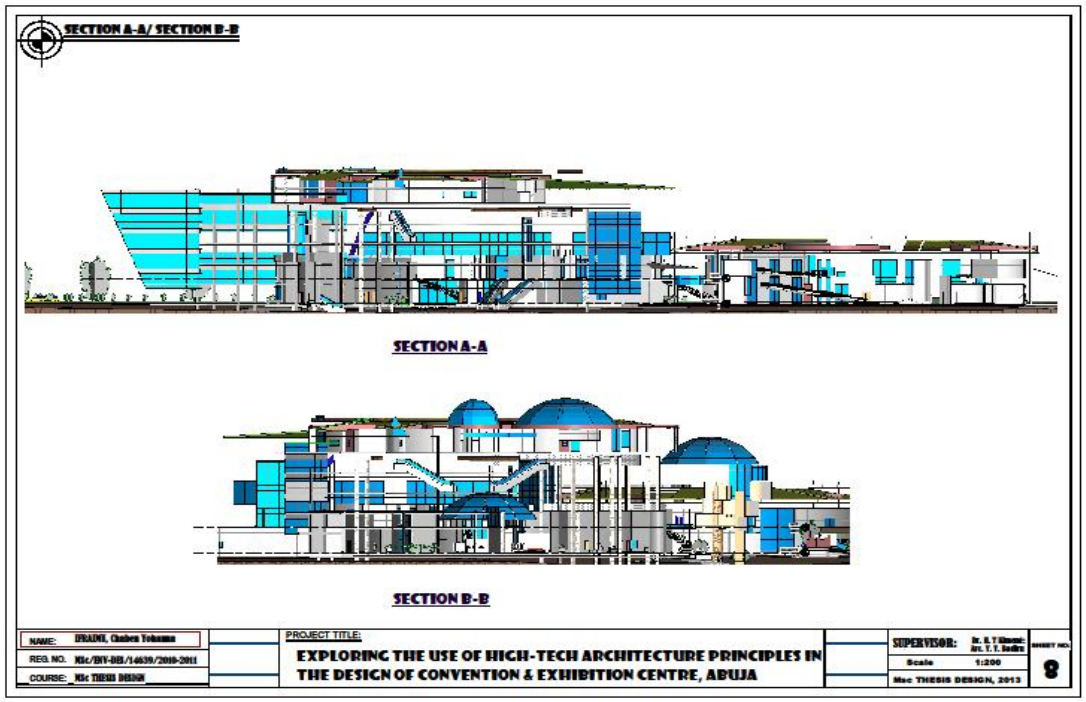


Figure 6.12: Section A-A

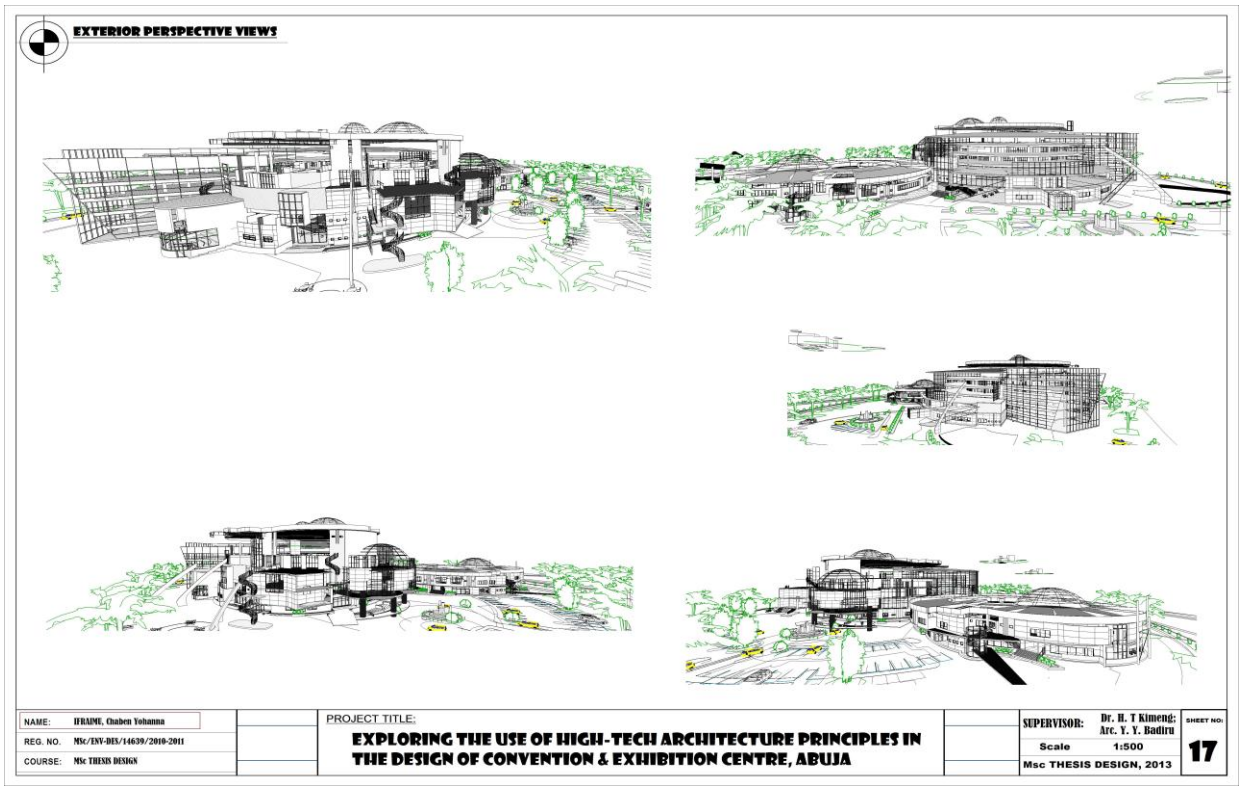


Figure 6.13: Perspective

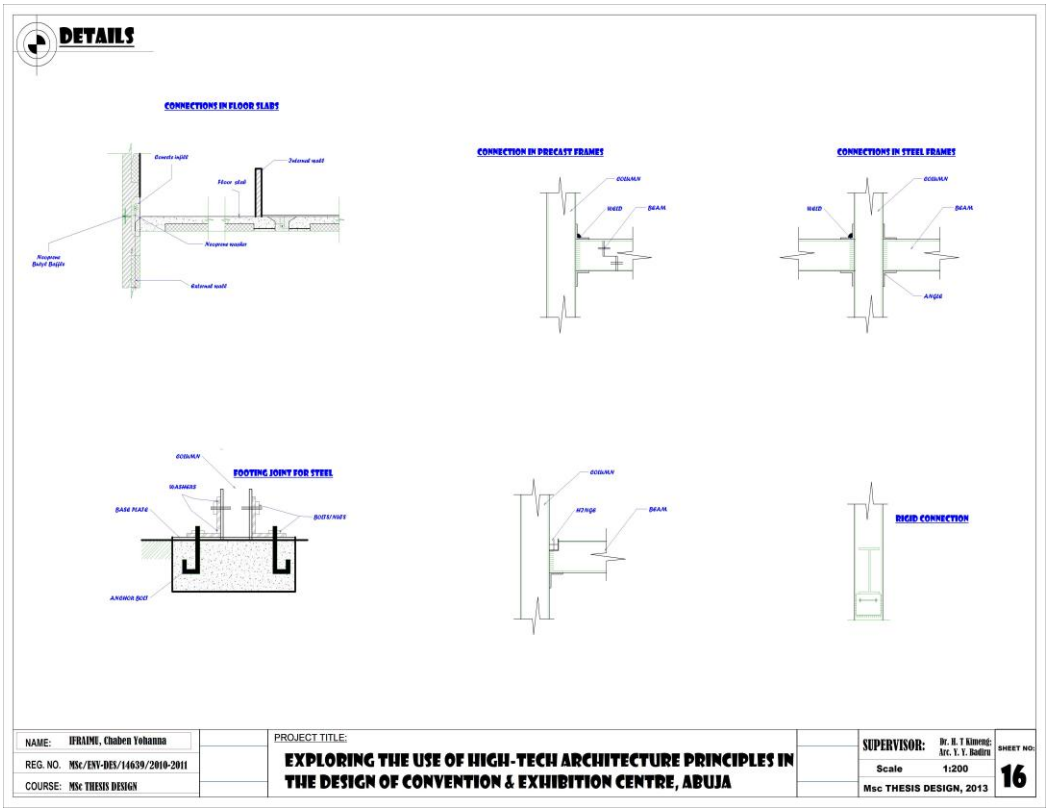


Figure 6.14: Detail

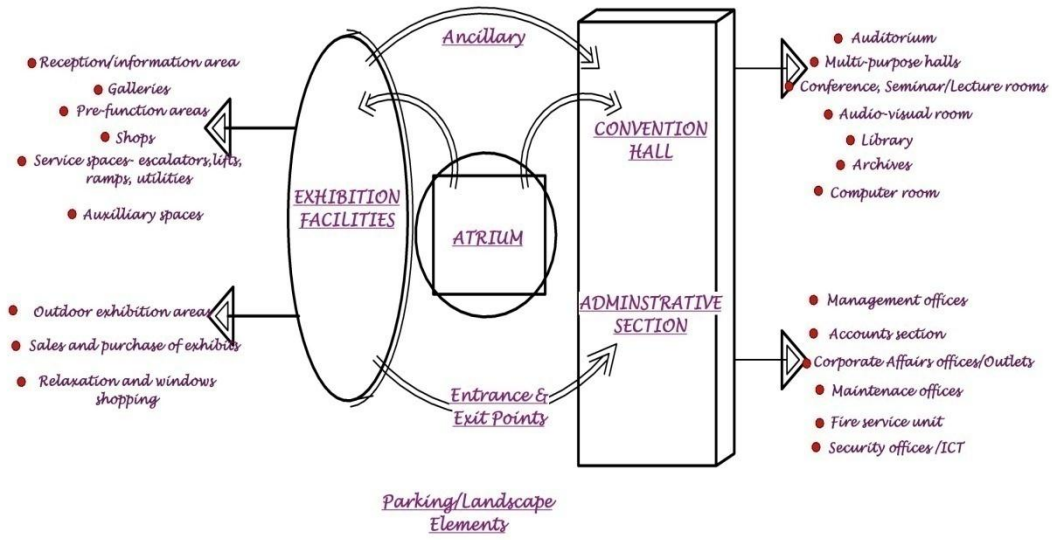
6.5 Design Consideration

6.5.1 Orientation/spatial arrangement

The main building is oriented with the longer side facing the east and west direction. Facilities are arranged in a row to encourage shadow effect on the smaller buildings. The building is not positioned at the core of the site so as to optimally utilize the site. The parking lots are located in front of the building to give visitors a complete sense of confidence to navigate within the site without using any guide.

6.5.2 Circulation

There are two main routes to the site, which are from the east and west direction respectively. This is done so as to decongest the major road at the north direction of the site; this would enhance free flow of traffic within and outside the site. Within the site, the pedestrian and vehicular routes are separated to reduce risk of accidents also there is no pedestrian route that crosses a vehicular road. This is also aimed at reducing risks of accidents and traffic congestion. All the site facilities are linked by the walkways; there is easy navigation from any part of the site to the other.



6.5.3 Ventilation

Displacement ventilation as to low-level air delivery and high-level air exhaust in the plenary hall and foyer areas provide effective air flow with high air quality at low energy consumption. The building materials used for this design all have excellent thermal resistant which will further be explained later. 60% of the glazing at the east and west direction of the building are not fixed they can be opened at any point in time, using remote sensors (a new technology employed); also HVAC(heating ventilation and air-conditioning) systems would be installed to supplement for natural ventilation in extreme weather situation.

6.5.4 Visual Comfort

This system however, whereby there is deficiency insufficiency in visual access from the internal environment to the external environment without compromising visibility.

6.5.5 Thermal Comfort

That is where the use of artificial ventilation parameters dominates the building envelope). The use of passive measures such as natural cross ventilation (passive ventilation and passive cooling is not neglected.

6.5.6 Day-lighting

High-tech structures are famous for their excessive use of steel and glass. This structure is no exception, the whole building is clad with transparent and translucent materials such as glass and ETFE (Ethylene-tetrafluoroethylene) which all has excellent thermal resistance and light transmission. The horizontal aluminium panels that goes round the exterior walls of the building is used as shading device. Whereby the use of artificial/mechanical lighting dominates the entirety of the building and natural light in the form of daylight is often un-incorporated.

6.5.7 Room Acoustics

Whereby artificial building and automation control systems dominate the building environment and in Nigerian context, could fail due inconsistent/insistent power failures. In other words, alternative control systems for acoustics where not taken into consideration.

6.5.8 Energy Conservation Systems

Light fittings selected and positioned to minimise resource and energy consumption. Where buildings solely rely on mechanical means for proper functioning, thus the concept of sustainability is highly compromised. It was however observed that passive measures coupled with auxiliary energy systems that are renewable and environment friendly can considerably bring down the costs as well as the energy needs of the buildings. I have been able to extract

those elements of high-tech architecture that could be used to address problems in convention and exhibition centres

6.5.9 Parking

The parking is designed to cater for more than 450 cars, which is efficient in ratio to the size of the building. The parking is designed into four rings with separate route to each ring to avert traffic. There is also a service route and parking for trucks and heavy vehicles, close to the warehouse for easy loading and off loading, also designed to avert heavy traffic within and outside the site. Each vehicular road is about 6m wide enough for two vehicles to move side by side.

6.5.10 Fire Precautions

The possibility of fire outbreak in any public building should be considered in its design. To start with, the use of fire fighting tools like smoke detectors, sprinkler system, and fire extinguisher shall be provided at the strategic locations. Also the roads within the proposed site shall be made wide enough to allow the fire fighting vehicles to access the building with ease, two entrances and exits routes will be provided in case of any emergencies, and also parking spaces will be accessed at considerable distance from the main building.

6.6 Design Layout

6.6.1 Site Zoning

This is based on user requirements of convention and exhibition which are the major requirements of the centre. Other supporting facilities such as the administration and auxiliary facilities are zoned taking into consideration the orientation of the site, slope and

other existing elements; to complements the overall layout. Also, visitors who have nothing to do with ongoing conferences have direct access to exhibitions.

6.6.2 Accessibility

The major access to the site is from the south-east end of the site. There is also the service road which is connected to the main access running along the south-west end boundary of the site. The main access is to serve the visitors and staff, while the service road as the name implies is to be used by the service trucks and heavy vehicles to and from site. Therefore, the parking arrangement has been drawn to complement this layout as shown on the site plan.

6.6.3 Pedestrian Circulation

Well defined walkways have been provided all over the site to separate vehicular and pedestrian circulation as this would enhance circulatory efficiency.

6.6.4 Landscaping

The landscaping of the building environment is very important as such, landscaping elements like; shrubs, water fountains, royal palm trees, umbrella trees, well defined walkways, sit-out areas, and well moved lawns have been provided as shown on the site plan to evoke feeling of celebration, security, and a generally relaxed atmosphere.

6.6.5 Crowd Control

To prevent and reduce the hazards related to crowd control, huge spaces for pre-function and socialization have been provided within and outside the building, especially in the convention and exhibition areas.

6.6.6 Functional Space Organization

The major functions of the centre are grouped into four .i.e., convention, exhibition, administration and auxiliary facilities, have been zoned with priority for the conventions, exhibitions, administration and auxiliary facilities' respectively.

6.6.7 Architectural Description

The forms as depicted in the elevations are bold and imposing and clearly showing the ideas, of high-tech architecture designs.

6.7 Outdoor Facilities

- Multi-purpose hall**:** This building contains functional floors as well as the event hall. The spaces are flexible because each space can be converted to both out-door relaxation and event hall when one of the facilities is in more demand.

- Rentable ware house: These are double volume to accommodate goods of enormous proportions; they are rented out for stores owners, to store goods which are not yet in circulation.

6.8 Building Materials and Technology of Construction

The main building materials used in most high tech buildings include high performance glass and steel; others include PVC (polyvinylchloride) panels, dampalon ETFE Ethylene-tetrafluoroethylene (fabric wall)

6.8.1 Glass: Architectural glass is glass that is used as a building material. It is most typically used as transparent glazing material in the proposed building envelope, including doors, and also in the internal and external walls. When used in buildings, glass is often of a safety type, which includes fibre, high performance and laminated glasses. Expansive glass facade allowing all available natural light into the foyer and pre-function spaces, reduce the need for artificial light.

6.8.2 Steel: Steel is one of the very few building materials that is strong in tension. Given High Tech architecture's tendency to dramatize the technical function of building elements; it is not surprising that steel tension members are given much prominence in the proposed design of convention & exhibition centre. The proposed design is mainly of steel construction. Steel in the proposed designs have been used as columns, beams, roofing and the entire exterior facade. Steel has many beneficial properties such as its durability, flexibility and strength offer significant advantages in the material efficiency of a product application

6.8.3 ETFE membrane: Ethylene-tetrafluoroethylene, better known by its acronym ETFE, offers designers a remarkable opportunity to develop solutions that integrate modern lightness, durability, design and ecological values. The main advantages of this exceptional material: lightweight, flame retardant, transparency, self-cleaning, long lasting service life with many other features. The entire structure is covered with a highly transparent ant

translucent ETFE memetrane, the transperent ETFE features a translucency of 95 percent. The centre of the roofing which covers the atrium is covered with transparent ETFE and the rest of the roofing is covered with translucent. Their structure and transparency create the illusion of being in the open. Some parts of the exterior wall of the propsed design are also covered with transperent ETFE (Ethylene-tetrafluoroethylene).

6.8.4 PVC plastic panels: PVC (polyvinylchloride) Plastics panels vary immensely in heat tolerance, hardness, and resiliency. Combined with this adaptability, the general uniformity of composition and lightness of plastics ensures their use in almost all industrial, institutional and commercial applications today. PVC (polyvinylchloride) panels of different colours are also used to create dynamism in the aesthetics and also to supplement for excessive use of glass. The PVC plastic panels have been used in the interior and exterior of this proposed design, for the interior it is used for the partitioning of the spaces, and it was used at the rear view exterior.

6.8.5 Reinforced concrete:

Concrete has been the predominant building material in this modern age due to its longevity, formability, and ease of transport. Recent advancements, such as Insulating concrete forms, combine the concrete forming and other construction steps have been applied in the proposed design. Reinforced concrete is used in this design in all the floors and in some parts of the foundation.

6.8.6 Building Elements

- **The Roof**:

  Specially designed light-weight concrete was placed on steel trusses because of their self supporting structures were used to serve as solution to the large spaces in the multi-purpose halls. This truss systems spans large spaces because its self supporting, eliminates use of intermittent columns as supports. Bridge trusses used as stiffeners between the major side trusses also helps to tie them together. This also prevents deflections due to wind effects and imposed loads. Deep concrete piles were used as main foundation for the main complex which transmits the loading to the solid rock base while concrete buttress foundations were used to anchor the base of the trusses and receive the imposed loads in the multi-purpose halls. Glass reinforced plastic coated with Teflon to increase its durability, was used together with the most modern solar panels as covering material for the multi-purpose halls.

- **Walls:**

The external walls for the convention building are a combination of glass cladding with concrete. The glass is specially designed to allow for maximum natural light, increase visual comfort and increase thermal comfort by reducing the amount of solar radiation into the building. The concrete cladding on the other hand, is designed with a hollow polystyrene core which serves as both heat and sound insulator for the building. Some of the internal walls are glass panels.

- **Floors:**

  They are a composite between steel and concrete. The concrete floor are to anchored welded plates on the steel girder truss (beam), these are overlaid with well polished marble of high-quality.

- **Finishes:**

  The floor finish for the convention centre building is marble, terrazzo floor tiles and rugged to aid acoustics while for the multi-purpose halls is terrazzo floor tiles.

6.8.7 Building Services:

The servant equipment, mechanical services, lifts, toilets, kitchens, fire stairs, and lobbies, sit loosely in the tower framework, easily accessible for maintenance, and replaceable in the case of obsolescence.

- **Water supply:**

  Borehole water supply is proposed for the facility.

- **Power supply:**

  Power shall be tapped from the PHCN national grid. There is provision for a power house, with generator sets –standbys, to cater for power failure.

- **HVAC system:**

  To complement natural ventilation, a central air conditioning system was installed.

CHAPTER SEVEN

7.0 SUMMARY, CONCLUSION AND RECOMMENDATIONS

7.1 SUMMARY OF FINDINGS:

The research Application of High-tech principles in convention and exhibition centre attempts to explore the current trends and developments in convention and exhibition environments through a critical analysis of the technological advancements in the world of architecture today. The proposed convention and exhibition design seeks to create a unique structure by incorporating technology into the building and expressing it in appropriate ways that caters for the needs of its users socially, aesthetically and economically. It further seeks to create a unique architectural landmark in Abuja city, by the use of the principles of high-tech architecture. To ensure the achievement of the stated aim the following objectives were highlighted:

i. To identify the key principles of high-tech architecture and concepts.

ii. To apply high-tech architecture to maximum efficiency in the design of convention and exhibition centres.

iii. To study and examine contemporary convention and exhibition centres that have in-cooperated High- Tech Architecture elements in their designs.

iv. To identify the basic problems of convention and exhibition centres as well as the problems of High tech architecture in Nigeria.

7.2 CONTRIBUTIONS TO ARCHITECTURE, KNOWLEDGE/SCIENCE

7.2.1 Displacement ventilation- low-level air delivery and high-level air exhaust in the plenary hall and foyer areas providing effective air flow with high air quality at low energy consumption

7.2.2 Expansive glass facade allowing all available natural light into the foyer and pre-function spaces, reducing the need for artificial light and providing good thermal qualities.

7.2.3 Light fittings selected and positioned to minimise resource and energy consumption. The lighting system is fundamental to the energy performance of any building.

7.2.4 Principle of high-tech initiates an awareness of the types of modern construction technology available in our contemporary construction industries today with focus on new materials, techniques of construction

7.3 CONCLUSION

The future of the use of high-tech architectural concept has its fulcrum on strategic planning in order to move architecture forward along societal changing demands and advancing technological innovations. Basically the design task seeks to use high-tech architectural concept in a logical and comprehensive approach of a modern multi-purpose convention and exhibition centre for Nigerian capital city, Abuja. In order to create awareness about high-tech architecture, and throw a challenge that will serve as a reference point for futuristic concepts and adventures. The approach to achieving this objective has been through an analytical study of the principles, concept, materials and technology which was done through case studies, literature reviews, journals, etc.; fashioned to suit our

Nigerian context and at the same time, make an architectural statement that will be seen as an exhibit in itself and a unique landmark for Abuja city and Nigeria as a whole. An example of what has been achieved technologically and what could be achieved in the nearest future with technology, architectural schemes and engineering expertise which when combined stands out as the pillars on which the concepts of high-tech are based on.

In addition, seeing modern architectural practices centrally situated in both business and the arts openly canvassed for the integration of conference meeting and exhibition trade show; the overall objectives of the research were to document buildings done with high-tech architecture and thereby extracting relevant ideas which was to be incorporated into the proposed centre. The design aimed at satisfying the stated objectives. On the whole it can be concluded that this thesis is a successful and also useful addition to scientific research in response to the growing challenge of advanced construction technology.

7.4 RECOMMENDATIONS:

For the successful execution and implementation of the proposed facility, the following recommendations have been outlined to promote.

i) Convention and exhibition edifices should integrate facilities for a much wider spectrum of users. These edifices should not only serve as venues for meetings, but should serve, educational, recreational purposes, conferencing and commercial purposes.

ii) The project when completed will not just boast the revenue of Abuja city but also the country as a whole mainly through: job creation, increase commercial activities, increase in number of tourist visiting the city etc.

iii) The project when completed will boasts technical advancement as well as environmentally conscious facilities that make it exceptionally equipped and visitors long into the future.

iv) This thesis recommends how schools of architecture practitioners in the country and the government can effectively contribute and ensure the success of architectural education in Nigeria, in future beyond the 21st century (Eneh, 2007).

v) Nigerian architects should employ the use of contemporary elements and forms which are capable of affecting our senses, incorporated into contemporary design thereby, creating a distinctive look particularly to us.

vi) The funding for the project should be raised through partnership by the government and other financial institutions.

vii) A board should be set-up to govern the affairs of the centre management which should be done by well trained and experienced facility managers.

viii) The government should facilitate the implementation process of the program by encouraging corporate companies and Ministry of Commerce and Industry with loans or funds if necessary.

REFERENCES:

Aksoy, A. And Baslo, M. (2013): Thoughts and Ideas on Ecological Sustainability and the Reflections on Architecture: *International Journal for Housing Science. Vol.37, No.3 pp.151-160*

Andrew, W. C. (2005). *Structure as Architecture*. United Kingdom: Architectural Press publications. Pp 51-188.

Bodlender, J., and Lickorish, J. L. (1991): Developing Tourism destination Policies and Perspectives. Harliw : Longman

Buchanan, P. 'A Nostalgic Utopia**',** Architects' Journal, 4 Sept. 1985, pp.60-69

Castells, M. (2004): The relationship between globalization and cultural identity in the early 21st Century, Forum 2004 Barcelona. Retrieved from http://www.barcelona2004.Orglenglbanco_del_Conocimiento/documento/ficha.cfm? IdDoc=1628)

Catherine Slessor, *Eco-Tech: Sustainable Architecture and High Technology (*London:Thames and Hudson, 1997).

Ching, F.D.K (1996): Architecture: Form, Space and Order. New York, NY: John Wiley & Sons.

Colin, D. (1992). *Elements/Characteristics of High-Tech Architecture, High-Tech Architecture*

Colin, D. (1998). *High-Tech Architecture.Archi-Tech, Vol. 11.*

Curtis, William J.R. (1996). *Modern Architecture since 1900*. 3rd ed. London: Phaidon Press.

Doyle, (2010): Contract Magazine, *Convention Centres that don't Make an Impact*.

Encarta English Dictionary (2006): *Evolution of the concept of High-Tech Architecture*. Retrieved Nov 2008 from http://www.wikipedia Encyclopaedia.com

Eneh, A.O. (2009): Developing the Potentials of the Nigerian Architect through Architectural Education Curriculum: *International Journal of Architecture and Environment. Vol. (1), No.(1) pp.13*

Ford, E. (1997): The theory and practice of impermanence. *Harvard Design Magazine, (3).*

Gyula, S. and Chris, P. (2003). *"New Architecture and Technology".* Architectural Press, Linacre House, Jordan Hill, Oxford, United Kingdom.

Hays, K.M. (1984) Critical Architecture: "Between Culture and form, Perspective", Vol. 21, pp, 14-29

Jencks, C. (1993). *New in Architectural Design Vol. 67, No.9/10 September issue; "Science New Architecture";* John Wiley and Sons London.

Jencks, C. (1987): '*Post-Modernism, the New Classicism in Art and Architecture',* Rizzoli.

Jencks, C. and Karl K. (1997) *Theories and Manifestoes of Contemporary Architecture*. New York: Wiley.

Jenks, C. (1988**)** "The Battle of High Tech: Great buildings with Great Faults," in Architectural Design. Vol. 58, No. 11/12.

Jencks, C. Ed., (2009) 'New Science' New Architecture, Architectural Design. ©2010 John Wiley Son Ltd.

Jimoh, O.A. (2005): Architecture and Tourism; an analytical Synopsis of traditional architecture. *Journal of the Nigerian Institute of Architects, 4(3), 32-35*

Joyce, George, Sumona and Tejal, (2006). *"Development and Characteristics of a Porous Micro-patterned Scaffold for Vascular Tissue Engineering Applications".* University of California San Francisco, USA.

John, D.(2003). *Why has high-tech architecture made?* Retrieved January 12, 2012 from http://www.DesignCommunity.com/discussion/31745.html

Jukes-Hughes, D. (1989): *High Tech Architecture: A Critique*

Lin, Y., Yang, W. and Liu, M."Energy Efficiency Measures for a High-Tech Building with a solar Roof**"** *Journal of Advanced Materials Research, (2014), Vol.1073-1076*

Livesay, G. (2011). Changing histories and theories of Postmodern architecture, *Building Research and Information, 39:1 pp. 93-96*

Low, S. M and Altman, I. (2011): Place *Attachment: A Conceptual Inquiry*. New York: Plenum Press.

McArthur, J. (2006) Modern Movement: On some issues in the Contemporary of Architecture and image types. *Architectural, 12:5, pp. 477-487.*

MacDonald, S. (1998). Post-it culture: Post-Modernism and art and design education. *International Journal of Art and Design Education, 17(3), pp.227-235*

Manley, G. (2009). Climate and House Design: *RIBA Journal Vol.156, p.317-323*

Neufert, E. (1980). *Architects Data. Third Eition, Blackwell Science, UK.*

Ogunsote, B. (1993). "*Classification of Nigerian Architecture". ARCHES Journal vol. 1pg.49*

Potiskum, U. (2010). "Convention and Exhibition Centre, Kaduna: *Use of High-tech Architecture in design of convention and exhibition centres".* Unpublished M.sc Project dissertation: Ahmadu Bello University, Zaria, Nigeria.

Rapoport (1985): Place Image and Place Making. Unpublished Keynote Paper to the People and Physical Environments Research Conference (PAPER) – Place and Place Making - Melbourne, Australia.

Relph, E. (1976). *Place and Placelessness*. London: Pion Ltd.

Salingaros, N.A. (2006): A Theory of Architecture, umbau-verlag, Solingen, Germany.

Salingaros, N.A. and Masden, K.G. (2007): Restructuring 21st –Century Architecture through human Intelligence. *International Journal of Architectural R*esearch, Vol. (1), 2007, pp. (36-52)

Samaila, S. A. (2006): Increasing the Academic Content of Architecture curriculum of Nigerian Universities: *Panacea for Meeting Contemporary Challenges,* Paper presented at the 2006 Biennial Conference of Association of Architecture Educators in Nigeria, at Minna in February, 2006.

Simon Guy and Graham Farmer, Reinterpreting Sustainable Architecture: The Place of Technology. *Journal of Architectural Education,* (2001): *p. 142*

Stacey, M. (2001): Component Design (New Technology Series). Architectural Press.

Taiye, A. (1999). *Millennium Exhibition and Convention Centre, Abuja.* Unpublished M.Sc. thesis department of Architecture, A.B.U. Zaria.

Till, J. (2009) Architectural Depends. Cambridge, MA, MIT Press

Umar, M.L. (1998). *The User and Application of Glass Curtain Wall as an Architectural Element in Public Buildings.* Unpublished B.Sc. Project dissertation; Ahmadu Bello University, Zaria, Nigeria.

Wikipedia Encyclopaedia (2008). *High-tech architecture,* Retrieved Nov 2008 from http://www.wikipedia.com.

Wilson, E. (1989). *High-tech Architecture is the Standard work on this Fascinating episode in the story of the 20th Century Architecture.* Thames and Hudson, United Kingdom.

Zhaoming Hou and Jiawei Yao:"Ecological Design Strategy of High-Tech Architecture", *Applied mechanics and materials:* vols. 174-177 (2010) pp 3186-3189

APPENDIX

SURVEY QUESTIONAIRE SAMPLE

Dear Respondent,

I am a postgraduate student from the Department of Architecture, Faculty of Environmental Design, Ahmadu Bello University Zaria, undertaking a research on "**Exploring the use of High-Tech Architecture Principles in the Design of Convention and Exhibition Centre,**

Note that all information given will be treated with utmost confidentiality.

Please tick the appropriate option of your choice and write your responses where necessary

SECTION A: BIO-DATA

1. Age

   a) 19-25 ☐ b)26-32 ☐ c)33-39 ☒ d)40 and above ☐

2. Gender

   a) Male ☒ b) Female ☐

3. Occupation .....conference organizer.....

4. How many years have you been working?
   a)1-5☐ b)6-10☒ c)11-15☐ d)15 and above ☐

SECTION B: CONFERENCE CENTRE DESIGN

1. Size of convention hall space meets minimum standard
   a) Strongly agree ☒ b) Disagree ☐ c)Agree ☐ d)Strongly Disagree ☐

2. The conference centre design incorporates community values

   a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

3. Overall design is aesthetically pleasing and iconic

   a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

4. The conference centre design incorporates interesting landscape with prominent natural elements

a) Strongly agree ☒ b) Disagree ☐ c) Agree ☐ d) Strongly Disagree ☐

5. Building materials provide attractive colour schemes and texture

a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

6. The building through its building form expresses itself in quality and meaning

a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

7. The design style communicates the outlook of a culture

a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

8. The building is composed of beautiful, interesting glass curtain walls

a) Strongly agree ☐ b) Disagree ☐ c) Agree ☒ d) Strongly Disagree ☐

9. The building is environmentally friendly

a) Strongly agree ☒ b) Disagree ☐ c) Agree ☐ d) Strongly Disagree ☐