

**Proposed University Library for Lead City University, Ibadan, Oyo State (Daylight
Strategies for Visual Comfort in University Library)**

Daniel Oluwadamilare FAYOMI

LCU/PG/002816

**Being a MSc Thesis Submitted to the Department of Architecture, Faculty of
Environmental Design and Management, Lead City University, Ibadan, Oyo State,
Nigeria**

**In Partial Fulfilment of the Requirements for the Award of Master Degree (MSc) in
Architecture**

2023

Certification

This is to certify that Daniel Oluwadamilare FAYOMI with matriculation number LCU/PG/002816 carried out this research work titled “Daylight Strategies for Visual Comfort in University Library” in the department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan, Oyo State, for the award of Master Degree (MSc) in Architecture. The thesis is an outcome of an independent and original work. I have duly acknowledged all the sources from which the ideas and the extracts have been taken. The project is free from any plagiarism and has not been previously submitted to any other institution.

(Signature)

30-07-2023

Arc. Olugbesan Adenike

(Supervisor)

(Signature)

30-07-2023

Arc. (Dr.) Funmilayo Adedire

(HOD)

Dedication

To Almighty God, my lecturers and my family and friends, the course of Daylighting.

Do Not Copy, Lead City University, Nigeria

Acknowledgement

I am profoundly thankful to Lead City University (LCU) for providing an exceptional opportunity and conducive atmosphere for my research. The university's library served as a valuable resource for data collection. My heartfelt appreciation goes to the academic and administrative teams of the Post Graduate (P.G.) School, particularly Provost Prof. Folakemi Oredein, for their significant contributions to my M.Sc. achievement.

I extend sincere gratitude to Dr. Funmi Adedire, my Head of Department (HOD), for unwavering belief in my capabilities and continuous support. Their mentorship and insights were pivotal in shaping this research. I am equally grateful to my supervisor, Arc. Olugbesan Adenike, whose expertise, patience, and dedication were indispensable. Their constructive criticism, feedback, and encouragement propelled me beyond my limitations.

I appreciate the instructors whose passion for teaching ignited my interest in this field of study. Their commitment to excellence transformed my learning journey. My beloved parents, Mr. & Mrs. Fayomi, and siblings Oluwatoyin, Oluwapelumi, and Ebunoluwa, deserve immense gratitude for their unwavering support and love. Your faith in me, encouragement, and constant presence fortified my strength throughout.

I acknowledge everyone who contributed, no matter how small, to shaping this thesis and enhancing my academic growth. Your support made this achievement possible, and I'm deeply thankful for your presence in my life. Lastly, I humbly recognize divine guidance and blessings. I am grateful for the bestowed opportunities and abilities. I firmly believe that my accomplishments reflect divine grace and continuous guidance.

Abstract

The use of daylighting or natural light has traditionally been a desirable building feature and a hallmark of good design. In educational institutions, daylighting has frequently been acknowledged as a practical source of energy savings and visual comfort. Building occupants want excellent illumination for their workspace. Students and other professionals can be more comfortable and productive with natural illumination. The efficient use of natural daylighting in library buildings has the potential to increase the advantages of visual comfort, save energy use, and create a high-quality indoor environment for building occupants. This research explores the use of daylight strategies to enhance visual comfort in university libraries. With the increasing emphasis on sustainable design and energy-efficient buildings, natural light is being used as an important resource for illumination. However, the effective use of daylighting requires a balance between visual comfort, energy savings, and the preservation of library collections. This study examines the design considerations for daylighting strategies in university libraries, including window size and placement, shading devices, and interior finishes. The impact of daylighting on visual comfort is evaluated using qualitative method through desktop reviews and case study. The findings suggest that careful consideration of daylighting strategies can provide visual comfort for library users while preserving valuable collections. The use of daylighting strategies also enhances energy-efficient in buildings. This research provides a valuable resource for Architects seeking to incorporate daylighting strategies for visual comfort in university libraries.

Keywords: Building Orientation, Daylight, Daylight Strategies, University Library, Visual Comfort, Shading Devices.

Words Count: 235

Table of Contents

Contents	Page
Certification	i
Dedication	ii
Acknowledgement	iii
Abstract	iv
Table of Contents	v
List of Table	viii
List of Figures	ix
Chapter One: Introduction	
1.1 Background to the Study	1
1.2 Statement of the Problem	3
1.3 Aim and Objectives of the Study	4
1.4 Research Questions	4
1.5 Significance of the Study	5
1.6 Scope of the Study	5
1.7 Operational Definition of Terms	5
Chapter Two : Literature Review	
2.1 Conceptual Review	7
2.1.1 Daylighting	7

2.1.2	Daylighting Strategies	10
2.1.3	Visual Comfort	13
2.1.4	Design Strategies for Visual Comfort	18
2.1.5	Library	19
2.1.6	University Library	27
2.2	Design Consideration	28
2.3	Empirical Review	30
2.3.1	Daylight Strategies for Visual Comfort in University Libraries	30
2.3.2	Use of Daylighting Strategies in Achieving Visual Comfort in Building	32
Chapter Three: Methodology		
3.1	Introduction	39
3.2	Case Study Analysis	39
3.2.1	Case Study One; The Hebei University of Science and Technology Library	39
3.2.2	Case Study Two; University of Birmingham's Library	53
3.2.3	Case Study Three; Hezekiah Oluwasanmi Library, Obafemi Awolowo University, Ile-Ife, Osun State.	66
3.2.4	Case Study Four; Kenneth Dike Library University of Ibadan	72
3.2.5	Case Study Five; Abubakar Tafawa Balewa University Library	77
3.2.6	Case Study Six; Timothy Olagbemi Library, Bowen University, Iwo, Osun State	88

3.3	Case Studies Deduction	91
Chapter Four: Site Analysis and Design Synthesis		
4.1	Study Area	92
4.1.1	Site Location	92
4.1.2	Site Selection Criteria	93
4.2	Project Analysis and Design Synthesis	93
4.2.1	Brief Analysis	94
4.2.2	Brief Development	95
4.2.3	Design Criteria	95
4.2.4	Conceptual Development	96
4.2.5	Functional Relationship	97
4.2.6	Space Allocation/ Schedule of Accommodation	98
4.2.7	Construction Methods and Materials	100
4.2.8	Building Services	104
Chapter Five: Conclusion		
5.1	Project Appraisal	111
5.2	Conclusion	112
5.3	Recommendations	112
	References	113
	Appendix	125

List of Table

Table	Title	Page
4.1	Schedule of Accommodation	97

Do Not Copy, Lead City University, Nigeria

List of Figures

Figures	Title	Page
2.1	Orientation of Building	11
2.2	Building Footprints	11
2.3	Skylight	13
2.4	Halifax Central Library (Halifax, Nova Scotia)	22
2.5	National Library of Wales, Aberystwyth	24
2.6	Children Library	25
3.1	Exterior view of the Hebei University of Science and Technology Library	43
3.2	Interior views of the Hebei University of Science and Technology Library	43
3.3	Facade views of the Hebei University of Science and Technology Library	46
3.4	Site plan of the Hebei University of Science and Technology Library	47

3.5	Ground Floor Plan of the Hebei University of Science and Technology Library	48
3.6	First Floor Plan of the Hebei University of Science and Technology Library	49
3.7	Second Floor Plan of the Hebei University of Science and Technology Library	49
3.8	Third Floor Plan of the Hebei University of Science and Technology Library	50
3.9	Fourth Floor Plan of the Hebei University of Science and Technology Library	50
3.10	Fifth Floor Plan of the Hebei University of Science and Technology Library	51
3.11	Sixth Floor Plan of the Hebei University of Science and Technology Library	50
3.12	Seventh Floor Plan of the Hebei University of Science and Technology Library	50
3.13	Elevations of the Hebei University of Science and Technology Library	51
3.14	Approach view of University of Birmingham's Library	54
3.15	Aesthetic of University of Birmingham's Library	55

3.16	Main	Entrance	of	University	of	Birmingham's	Library
56							
3.17	Interior		of	University	of	Birmingham's	Library
57							
3.18	Interior		of	University	of	Birmingham's	Library
57							
3.19	Reading	Area	of	University	of	Birmingham's	Library
60							
3.20	Exterior	View	of	University	of	Birmingham's	Library
61							
3.21	Facade	Concept	Sketch	of	University	of	Birmingham's
61							Library
3.22	Basement	Floor	Plan	of	University	of	Birmingham's
61							Library
3.23	Ground	Floor	Plan	of	University	of	Birmingham's
61							Library
3.24	First	Floor	Plan	of	University	of	Birmingham's
62							Library
3.25	Section	1	of	University	of	Birmingham's	Library
62							
3.26	Section	2	of	University	of	Birmingham's	Library
63							

3.27	3D Views of University of Birmingham's Library	63
3.28	Entrance Gate of Obafemi Awolowo University	66
3.29	Google map of Obafemi Awolowo University	66
3.30	Entrance of Obafemi Awolowo University	67
3.31	Floor, Elevations and Section plans of Obafemi Awolowo University	72
3.32	Approach view of Obafemi Awolowo University	72
3.33	Floor plans of Kenneth Dike Library University	73
3.34	Entrance of Kenneth Dike Library University	73
3.35	Reading area of Kenneth Dike Library University	74
3.36	E-Library of Kenneth Dike Library University	75
3.37	Entrance Gate of Abubakar Tafawa Balewa University Library	76

3.38	Entrance of Abubakar Tafawa Balewa University Library	78
3.39	Large Windows to throw Light in Abubakar Tafawa Balewa University Library	82
3.40	Rows of Arranged Bookshelves in Abubakar Tafawa Balewa University Library	82
3.41	Reading area of Abubakar Tafawa Balewa University Library	841
3.42	Entrance Gate of Timothy Olagbemi Library	8683
3.43	Google map of Timothy Olagbemi Library	874
3.44	Site plan of Timothy Olagbemi Library	874
3.45	Ground floor plan of Timothy Olagbemi Library	884
3.46	First floor plan of Timothy Olagbemi Library	885
3.47	Second floor of Timothy Olagbemi Library	885
3.48	Approach view of Timothy Olagbemi Library	8985

3.49	Left and Rear view of Timothy Olagbemi	Library
896		
3.50	Aerial view of Timothy Olagbemi	Library
86		
3.51	Interior view of Timothy Olagbemi	Library
907		
3.52	Stair case area of Timothy Olagbemi	Library
917		
3.53	Book shelves of Timothy Olagbemi	Library
918		
3.54	Reading area of Timothy Olagbemi	Library
918		
3.55	Furniture used in Timothy Olagbemi	Library
928		
4.1	Google map of Ibadan City	
951		
4.3	Building	Footprints
95		
4.4	Bubble diagram of design	
1006		

Chapter One

Introduction

1.1 Background to the Study

University libraries are the most well-known style of architecture for the highest degree of education and the higher education and learning system. They are among the most important places to find information, services, a learning atmosphere, and opportunities for social connection (Bakr & Nagy, 2020). University libraries are important because they provide students with access to materials they need for their research, such as data sources and other services (Klain Gabbay & Shoham, 2019). More than in any other form of library, visual comfort and efficiency are prioritized in university libraries. The capacity of students to access libraries whenever they choose is influenced by their appearance and overall design. As a result, well-designed university libraries function as spaces for reading, studying, and access to digital resources in addition to being places for social gatherings (Buchanan et al., 2019).

More specifically, daylighting has a big impact on establishing visual comfort for library users. The light that results from sunlight that is visible from sunrise to sunset is referred to as daylighting, often known generally as natural lighting or sunshine. To lessen dependency on electric lighting and conserve energy, it is the controlled entrance of natural light, direct sunshine, and diffuse skylight into a building. The purpose of daylighting is to bring natural light into areas (Kurniasih et al., 2020). Contrary to artificial lighting, daylight offers a balanced distribution of wavelengths that is good for daily tasks and visual tasks (Saraswati et al., 2021). Also, daylighting contributes to the creation of a visually engaging and productive environment for library users while cutting down on energy expenses by as much as one-third by giving them a direct connection to the dynamic and constantly changing patterns of external illumination (Aderonmu et al., 2019).

Furthermore, the overall goal of daylighting is to produce efficient, high-quality light while minimizing direct glare, reflecting layers, and surplus light ratio. Natural light can be captured via the window in a variety of ways, including through direct sunlight, a clear or cloudy sky, and reflections of the surrounding landscape and buildings. These sources all create light, but each one does it in a unique way, varying not just in quantity and heat conveyed, but also in colour, dispersion, and energy efficiency. In order for a space to be naturally lit, it is advised that there be enormous windows or glass walls that cover at least 1/6 of the floor area (Kurniasih et al., 2020). In addition, a student's educational experience and perception of the entire university may be impacted by a library's secluded reading areas, crowded reading halls, and social gathering areas (Bakr & Nagy, 2020).

Numerous efforts have been made to highlight the psychological and physiological consequences of daylighting on human beings (Osibona et al., 2021). Research indicates that daylight exposure plays a significant role in triggering the release of melatonin, a crucial hormone responsible for regulating human brain activity and the circadian rhythm, also known as the human biological clock. Variations in melatonin levels affect human behaviour, with higher concentrations leading to drowsiness and lower concentrations inducing alertness (Natalia G Vasquez et al, 2022). Studies have provided evidence of a significant relationship between human emotions and the design of spaces, particularly regarding the impact of daylight on users' comfort and behaviour. Numerous research studies have shown that incorporating windows that offer views of natural landscapes can enhance both comfort and behaviour. Furthermore, empirical research consistently highlights the favourable influence of daylight on users' comfort (Aram & Alibaba, 2018b).

In other words, there is a connection between daylight and psychological effects. Flynn et al., (2013) assertion based on participant behaviour observations that variations in illumination can impact behavioural patterns, the authors pointed out that ambient lighting is one aspect

that affects user behaviour. This demonstrates how light may be seen as a tool for simplifying selection, changing the informative content of the visual field as well as the user's impression of their surroundings and sense of wellbeing (Knoop et al., 2020; Allan et al., 2019). The evaluation of the impact of daylighting on visual comfort utilizes qualitative methods, specifically through desktop reviews and case study analysis. In this light, this study is aimed at examining building-based daylighting strategies which can be used for creating a visually comfortable environment for library users. It is believed that a comprehensive understanding of library's layout, architectural design, window placement, glazing types, shading devices, and any other relevant factors will inform the design of the proposed Lead City University Library.

1.2 Statement of the Problem

Nowadays, the concept of daylighting has mostly been abandoned in architectural plans. Daylight is essential for a building's interior, particularly for occupants inside a structure. For a building like a library, an effective plan for day lighting idea is essential to facilitating user activities and comfort (Othman & Mazli, 2012).

According to recent studies, the human life cycle is significantly preserved and improved by daylight, which also provides special health advantages for a variety of physical and mental illnesses. Even though daylighting can provide enough illumination, it can also have a number of unfavourable emotional and behavioural effects on user's comfort. Daylighting is impacted by the internal processes of the body as well as the self-conscious system, and a protracted lack of daylight can cause serious problems including anxiety, mental illness, insomnia, weariness, odd behaviour, and a desire for inactivity. The quantity of daylight in a library may make it pleasant or unpleasant, which affects people's emotions (Aram & Alibaba, 2018b).

During the initial case studies research, observation was made and corroborated by users and available literature, which suggests inadequate daylighting in several university libraries in Nigeria.

This thesis will contribute to knowledge by highlighting solutions to the problem of lack of daylighting for visual comfort in university libraries.

1.3 Aim and Objectives of the Study

1.3.1 Aim

The aim of this thesis is to understand and examine daylighting strategies that will enhance visual comfort of the users in the proposed design for Lead City University library, Ibadan, Oyo state and as a means of improving university library design in Nigeria.

1.3.2 Objectives of the Study

- i. To identify daylighting strategies that can be used to achieve visual comfort in library design.
- ii. To examine daylight strategies that will enhance visual comfort in selected library case studies.
- iii. To adopt the identified daylight strategies for visual comfort in the design of a university library.

1.4 Research Questions

- i. What daylighting strategies can be identified to achieve visual comfort in library design?
- ii. What daylight strategies can be examined to enhance visual comfort within selected library case studies?
- iii. How can the identified daylight strategies for visual comfort be adopted in the design of a university library?

1.5 Significance of the Study

This study will add to the exiting literature on the use of daylighting strategies for improved visual comfort in libraries, so as to enhance experience to improve student learning environment and also help to provide a valuable resource for Architects seeking to incorporate daylighting strategies in university libraries.

1.6 Scope of the Study

This research aims at studying issues concerning selected existing university in south western Nigeria. This will help to determine areas where improvements are needed. Information was gathered through the study of these existing case studies to determine the daylighting approach that was used to achieve visual comfort. The pieces of information obtained were important in coming up with a proposed university library in Lead City University, Ibadan, Oyo state.

This thesis focuses on applying architectural daylight design strategies to improve the visual comfort of users in the proposed university library in Lead City University, Ibadan.

1.7 Operational Definition of Terms

1. **Daylight;** is the total amount of daylight radiation that comes from both direct and indirect sources, including diffuse sky radiation, and that is typically reflected off of the Earth and other terrestrial things like buildings and landforms. Sunlight that is reflected or dispersed by celestial bodies is typically not seen as daylight. Moonlight is not included in daylight despite being reflected sunlight.
2. **Visual Comfort;** is often characterized using a set of standards that take into account the amount of light in a space, the harmony of contrasts, the colour "temperature," and whether or not glare is present.

3. **University Library;** is a library that is a part of a college or university and has the dual function of supporting academic programs and student and faculty research.
4. **Glare;** refers to an extreme brightness or contrast that impairs vision or creates visual discomfort. When there is a large disparity in brightness between various locations or objects within the visual field, it happens. Direct sunshine, reflections from bright surfaces, and improperly built lighting systems are just a few of the causes of glare.
5. **Sunlight;** refers to the solar radiation that the Sun produces. It is a natural source of light that illuminates, warms, and energises the planet. Visible light, infrared radiation, and ultraviolet (UV) radiation all combine to form sunlight.
6. **Luminance;** refers to the quantity of light or brightness that a surface or item emits, transmits, or reflects. It calculates the amount of light that the human eye can perceive. Lighting design, photography, display technology, and many other areas where the visual sense of brightness is significant all use luminance as a key metric.
7. **Illuminance;** is the quantity of light that reaches a surface per square inch. It gauges the degree of brightness or lighting on a surface as seen by the human eye. In lighting design, architecture, and other industries where a determination of the lighting environment is required, illumination is a crucial factor.
8. **Psychological;** relate to the effects and forces that have an effect on a person's thoughts, emotions, behaviours, and general mental health. Numerous elements, such as outside events, interpersonal interactions, personal experiences, and internal processes, might have these consequences.
9. **Physiological;** refers to the actions and operations carried out by living things, particularly those that are necessary for the body and its systems to operate normally. It entails the investigation of the roles that numerous biological functions including

respiration, circulation, digestion, and hormone regulation play in the general operation and upkeep of an organism's health.

Chapter Two

Literature Review

2.1 Conceptual Review

2.1.1 Daylighting

Daylighting is a vital component of architectural design that is necessary for producing welcoming/comfortable and effective spaces in learning environments. In recent years, it has been shown to improve visual comfort, advance energy efficiency, and improve human well-being, daylighting has recently drawn more attention in the design of university libraries (Iommi, 2018). Daylighting is crucial when designing a building in order to save energy and improve visual comfort for users (D. H. W. Li, 2010; Su et al., 2020).

Daylighting may enhance user comfort and satisfaction, which boosts performance while saving money that would otherwise be spent on ballasts, fixtures, and controllers for artificial lighting (electricity). Because daylighting is a control architecture technique, it has an impact on user behaviour and perception. One element that might improve a space's quality and length of occupancy is daylight (Kilic & Hasirci, 2011). Diffuse light, direct transmitted light, and redirected transmitted light are the three types of daylight that are transmitted through windows. Daylight fluctuates because the sun moves, changing the direction and amount of daylight that enters into a space through a window or roof vary (Othman & Mazli, 2012).

Kong et al., (2022), who conducted study at the University of Illinois in Urbana-Champaign stated that even being in an air-conditioned and thermally comfortable environment, people are still drawn to sunshine because it provides pleasant and warming sensations. It demonstrates that even in an air-conditioned environment like the library, individuals still

prefer to sit near or inside the sun patch, albeit some elected to position their desks back toward the window so they would not have a direct view of the outside.

The quantity of daylight in a library may make it pleasant or unpleasant, which influences psychological behaviour. There is very little research on the use of daylight in library spaces, particularly in university libraries (Shafavi et al., 2020). The process of achieving systematic, optimum daylighting is difficult for both designers and building owners. Building and site orientation, building entrances, window size and direction, control systems, and consistent maintenance are only a few of the many different aspects that contribute to the difficulty (Aram & Alibaba, 2018b). The distribution of constant sunshine, bringing daylight into deeper sections of a structure, and reducing direct glare are three issues that the majority of daylighting technologies aim to solve by obtaining excellent daylight quality. There are two different kinds of daylighting systems, depending on how they work (1) solar canopies, which reduce glare from daylight, (2) transmission and distribution systems, which ensure that light is distributed evenly and gets deeper into buildings. Based on the fundamental processes of reflection and refraction, contemporary daylighting systems (Aram & Alibaba, 2018b).

Humans require daylight to maintain their physical and psychological health. Enhancing sunshine increases user comfort, health, productivity, and functioning. Opportunities to change user behaviour are presented by taking environmental elements into account, measuring them, and controlling them. Given that light has a significant impact on behaviour, and that modifying characteristics like brightness, sunshine, and window views may have a range of effects on behaviour in a given area, light is particularly crucial in defining a place (Kompier et al., 2020).

Ineffective daylighting in libraries is a major issue in educational settings, and its detrimental effects on behaviour can result in a drop in academic achievement. In order to enhance the quality of daylighting in library study rooms, it is vital to investigate how daylight affects patron behaviour in library spaces because there is a dearth of research in this area (Aram & Alibaba, 2018b).

Overall, daylighting has numerous benefits and is widely recognized as an essential aspect of sustainable building design. Here are some key advantages and considerations associated with daylighting:

- 1) **Energy Efficiency:** By harnessing natural light, daylighting reduces reliance on artificial lighting during the daytime, resulting in significant energy savings. This contributes to lower electricity consumption and a reduced carbon footprint, making it an environmentally friendly choice.
- 2) **Cost Savings:** As daylighting decreases the need for artificial lighting, it can lead to substantial cost savings in terms of electricity bills and maintenance expenses. Although daylighting systems may involve initial investments, the long-term savings often outweigh the upfront costs.
- 3) **Health and Well-being:** Exposure to natural light has been linked to various health benefits, including improved mood, increased productivity, and better sleep patterns. Daylighting enhances occupants' comfort, reduces eye strain, and creates a more pleasant and stimulating indoor environment.
- 4) **Visual Comfort:** Natural light is dynamic, providing variations in intensity, colour, and direction throughout the day. It helps create visually appealing spaces, enhances the perception of textures, and enables better visual clarity compared to artificial lighting alone.

- 5) **Connection with Nature:** Daylighting brings a sense of connection to the outdoors and the changing natural environment. It allows occupants to have glimpses of the sky, outdoor views, and the passage of time, which can improve overall well-being and create a more inviting atmosphere.

2.1.2 Daylighting Strategies

Daylighting strategies and architectural design strategies are intertwined; thus, they must be taken into account from the very beginning of a building's design. Therefore, preparing for daylight entails incorporating the viewpoints and needs of numerous specialties and experts. One of the key elements that might affect how people use the library facilities is daylighting (Bakr et al., 2020).

Daylighting strategies are dependent on the availability of natural light, which is governed by the structure's orientation and the surroundings, such as the existence of barriers, immediately to the north and south of the planned building. Climatic has an impact on lighting techniques as well, thus it's critical to understand seasonal fluctuations, current climate conditions, especially ambient temperatures, and sunlight likelihood. The first step in planning for daylight is to understand the environment and the daylighting potential at each proposed building's façade (IEA, 2010).

Designers typically seek to enhance daylight penetration in a structure during the winter months when daylight levels are low due to the differing summer and winter conditions seen at high latitudes. At these latitudes, it makes sense to direct sunlight from the sky's brightest areas toward structures. In contrast, in tropical regions with high amounts of year-round sunshine, the design focus is typically on reducing overheating by limiting the amount of daylight entering a structure. This can be done either directly utilizing light reflected from the

ground or indirectly by blocking significant portions of the sky, especially those close to the zenith, and allowing daylight only from lower portions of the sky (Awad & Abd-rabo, 2019).

2.1.2.1 Ways to Achieve Daylighting Strategies

1. **Building Orientation:** To maximize access to natural light, proper construction orientation is essential. Controlling the quantity of heating, cooling, and daylight entering the building depends heavily on the orientation of the structure (Bakr & Nagy, 2020). Enhancing daylight penetration and lowering the requirement for artificial lighting can both be accomplished by orienting the structure to take advantage of the sun's movement during the day. For instance, the structure will participate in a passive amount of heating or cooling on a seasonal basis if its long side is oriented towards the east-west side (Bakr et al., 2020).

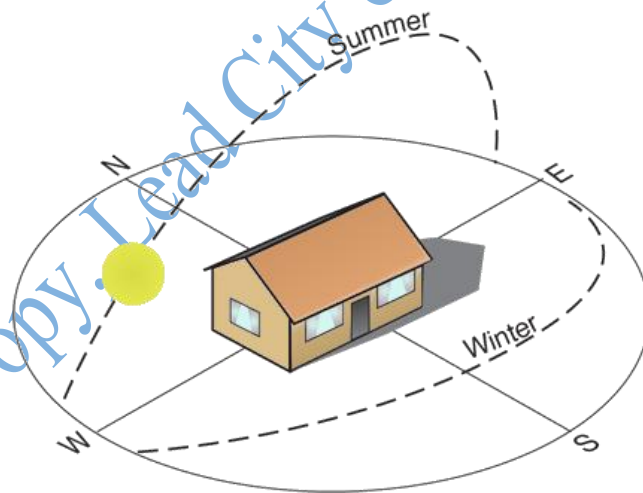


Figure 2.1: Orientation of Building

Source: (Bakr & Nagy, 2020)

2. **Building Form:** Building footprints vary, and each form has a unique technique of letting daylight into a space. It might be square, L-shaped, U-shaped, linear and thin, or long and narrow. Long and narrow footprints are preferable to square ones for maximizing the amount of daylight entering the structure. To save on land while

maintaining daylight access, buildings can be organized as a series of wings (Bakr & Nagy, 2020).

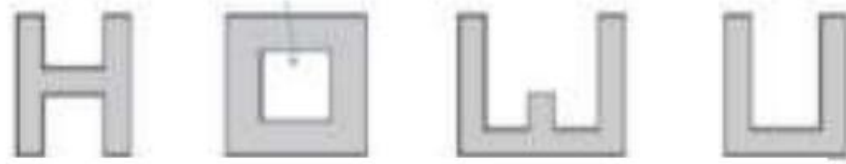


Figure 2.2: Building Footprints

Source: (Bakr & Nagy, 2020).

3. **Window Design and Placement:** Effective daylighting requires well considered window location and design. Windows should be strategically positioned to maximize natural light and limit glare in order to increase visual comfort and save energy usage. By regulating the quantity of heat, solar energy, natural light, and light intensity within the structure, openings are the best approach to create an optimal daylighting environment. The amount of useable daylight will depend on the opening placement and how much light will enter the space. The link between the occupants outside view and eye level should be taken into account while choosing the position of windows. By regulating the quantity of heat, solar energy, natural light, and light intensity within the structure, openings are the best approach to create an optimal daylighting environment. The amount of useable daylight will depend on the opening placement and how much light will enter the space. The link between the occupants' outside view and eye level should be taken into account while choosing the position of windows (A.M. Muhammad and I.G. Aliyu, 2021).
4. **Shading Systems:** The amount of direct sunlight that enters the building can be managed while still allowing diffused light to enter by installing the proper shading systems, such as movable blinds, shades, or exterior overhangs. With the aid of these systems, occupants can modify the shading to suit their needs and preferences (Xue et al., 2021).

5. **Skylight:** Both clear and overcast skies can be used to construct diffuse skylight strategies. The way these methods handle direct sunlight, however, is their most important feature. Except for facades facing the North or South Pole (in the northern or southern hemisphere, respectively), solar shadowing is always a problem for daylighting. A technique to prevent glare can also be employed for solar shade if it is only marginally important due to direction and impediments. Glare protection and solar shading are two distinct purposes that call for unique design considerations. Glare protection is a visual function that reduces excessive brightness in the visual field, whereas solar shading is a thermal function that primarily shields from direct sunlight. Systems for glare protection take into account skylights and reflected sunlight in addition to direct sunlight. Systems that provide sun shade to minimize overheating may not be sufficient to prevent glare (Gkaniats et al., 2019).



Figure 2.3: skylight
Source: (Google search)

2.1.3 Visual Comfort

Frequently, the sensation of visual performance is significantly influenced by lighting settings. Both situations of excessive brightness and dimness cause eye strain and discomfort in people. Artificial lighting can exactly provide the necessary illumination; however, measurements of

sunlight and skylight vary due to environmental variations. However, because sunshine circumstances vary, it is difficult to guarantee acceptable levels of illumination when using daylight as the source of light, which is the case for all visual comfort measures (Mohamedali, 2017). The typical value for any library activity ranges between 300 and 750 lx, or about 500 lx, as reading and writing are visual jobs (Leccese et al., 2020).

A subjective assessment of how satisfied one is with the environment is called visual comfort (Kong et al., 2022). An essential component of interior spaces is visual comfort, which has an impact on occupant pleasure, productivity, and well-being. It includes the level of illumination, the lack of glare, and the overall impression (Korsavi et al., 2016). The definition of visual comfort is "a subjective condition of visual well-being caused by the visual surroundings." According to this definition, the physical characteristics of the visual environment must be considered in order to assess its quality (Fakhari et al., 2021). In educational settings, Well-designed lighting systems improve visual comfort and assist learning outcomes by taking daylighting and colour rendering into account. Additionally, window ratio directly affects how comfortable thermal conditions are for building occupants; this impact can be either favourable or negative. Windows with diverse shading mechanisms can have a variety of effects on the quality of learning environments (Aram & Alibaba, 2018a).

Today, People are chasing contentment more and more, particularly satisfaction with the environment. Many libraries employ fully transparent floor-to-ceiling windows that allow visitors to watch from both inside and outside as examples of contemporary urban structures. While maintaining the building's architectural attributes, this construction gives the inside environment's visual comfort comparatively less consideration. People are more prone to experience excessive glare (Xue et al., 2021). Visual comfort is the recommended lighting level that does not exceed the stated threshold and brightness level, and no glare space occurs.

Not only to illuminate a room, but the level of lighting also affects the condition of the room created (Kurniasih et al., 2020).

An efficient and crucial level of knowledge throughout the design process is one of the additional factors that influence visual comfort likelihood. These embrace the absence of glare, veiled reflections, and colour rendering, which typically occurs when artificial lighting is used. Additionally, the function of both natural and artificial sources of light, which reflect its traces on the enjoyment of users, primarily expresses the architectural goal. Essentially, the building's windows play a crucial function in regulating the amount of daylight and offering an exterior view, both of which have a beneficial psychological impact on the occupants. The appealing view can help to offset some of the negative consequences of the windows' lack of daylighting. The following strategic goals should be attained by maximizing the use of daylight:

1. Workplaces should have access to daylight, which is supplied by most of the day throughout building design.
2. For the inhabitants to be able to execute certain visual activities, there must be adequate illumination.
3. To achieve deep comfort daylighting, large vertical glass surfaces require well considered design. However, glare and excessive brightness should be avoided by using a control method.
4. Preventing glare by examining the location and reflectance of internal and exterior surfaces.
5. When artificial lighting is used in areas that will be used for an extended period of time, low glare and appropriate colour rendering are requirements. As a result, the luminaire and lighting fixture should be selected appropriately.

6. Automated daylight control strategies have to be created with less disruption and annoyance to the occupants.
7. Designing the lighting, both natural and artificial, should take into account human preferences as well as the work that will be carried out in the room (Baker & Steemers, 2003).

Two key conclusions were drawn from previous research on indoor illumination based on the most recent findings. First, according to our study, using natural light to its fullest extent may help save the environment by using natural energy to its fullest extent, which can save 64 percent more energy than similar technologies used in other schools (Koç & Maçka Kalfa, 2021). Changes in library lighting settings may impact visuals' reading, mood, comfort, and behaviour there, according to the data that is now available. The lighting also has an impact on satisfaction and length of stay. Better lighting encourages readers to behave more positively and favour areas that are lighter. Second, the majority of recent research has only addressed broad concepts like form, function, space, the efficient design of libraries, and the structure of future digital libraries (Xue et al., 2021).

As a result of the interplay between objective and subjective factors, comfort is a nuanced impression. As a consequence, the appraisal of human senses produces the sensation of overall comfort. The visual comfort of the surroundings is influenced by the occupants' various activities as well as their eyesight, perception, and space form. An interesting atmosphere without physiological issues, diversions, or improper circumstances is produced by proper light dispersion (Steffy, 2002). Overall, the key to creating visual comfort is to maximize the visual qualities of interior spaces. When visual messages from the visual world are understood clearly, visual comfort increases. The architecture of the structure should contribute to comfort. By delivering the necessary lighting intensity, avoiding glare, and ensuring uniform light dispersion, visual comfort conditions are accomplished. Artificial light

sources are required if sunshine is insufficient to meet these goals (Nasrollahi & Shokry, 2020). The contrast of surfaces and the flexibility of the lighting in a room significantly influence visual comfort. Glare is a significant source of visual discomfort in lighting design. Our eyes itch or sting from the brightness brought on by the limitless contradiction in a particular field. The local medium-intensity light level must be rated by the general public in order to achieve visual comfort (Nasrollahi & Shokry, 2020).

Visual comfort is associated with the human senses of vision, that eye. The eye is a sensitive sense organ in humans. Within the vast range of electromagnetic spectrum frequencies known as the visible spectrum, but in the limited lanes, our eyes are sensitive to a relatively small band of frequencies. The human eye is capable of detecting little differences in colour and light intensity. The human eye is made up of several sections, some of which have unique abilities related to acceptance, response, and light perception. Visual comfort related to acceptable levels of glare and normal lighting conditions. factors impacting visual activity, such as lighting effects in classroom teaching and learning activities. The following are the minimum light levels and colour renderings advised for indoor function institutions:

1. Classroom: 250 lux
2. **Library: 300 lux**
3. Laboratory: 500 lux
4. Room Picture: 750 lux
5. Diner: 200 lux

Lighting has both quantity (light intensity) and quality components (colour glare). Direct glare (highlighted light) and indirect glare both exist (reflected light). When a space is overly bright, the users will contract for an extended period of time, making the eyes fatigued (Anugrah & Munawaroh, 2017).

The amount of light or light at the strong level (lighting level), the distribution of light density (luminance), the reduction of glare, The components generating visual comfort include the directions from which shadows form and the dispersion of light (shadows and light directionality), a light colour and reflection colour (light colour and colour rendering), and the climatic conditions in the room (Xue et al., 2021).

2.1.4 Design Strategies for Visual Comfort

Visual comfort is often described in terms of the quantity of light in a room, the harmony of contrasts, the color temperature, and whether or not there is glare. Studies demonstrate that harnessing natural sunshine increases users' health and productivity while reducing the demand for electric illumination. However, the level of light in the place shouldn't be so great that it disturbs the users (Bakmohammadi & Noorzai, 2020).

Using design principles effectively is essential for attaining visual comfort. By strategically placing windows, deploying shading equipment, and using light-diffusing materials, one may maximize daylighting and lessen their dependency on artificial lighting (Pilechiha et al., 2020), (Lakhdari et al., 2021). Enhancing visual comfort can be achieved by effectively managing task and ambient lighting, implementing adaptable lighting controls, and giving due consideration to colour quality (Brémond & Brémond, 2020). The following are the strategies for visual comfort;

- 1) **Daylighting:** Integrating natural daylight into indoor environments has proven to enhance visual comfort and decrease dependence on artificial lighting. Successful daylighting approaches involve careful window design, implementation of shading systems, and the use of light redirecting devices to maximize the benefits of natural light while effectively managing glare (Konstantzos et al., 2020).

- 2) **Lighting Design:** Optimal visual comfort relies heavily on meticulous lighting design, encompassing the careful selection of light sources, fixtures, and controls. By incorporating a blend of ambient, task, and accent lighting, spaces can achieve flexibility and adaptability to accommodate diverse activities and cater to individual user preferences (Lakhdari et al., 2021).
- 3) **Ergonomics:** Visual comfort is influenced by ergonomic factors, which include the correct placement and positioning of lighting fixtures, work surfaces, and furniture. By ensuring proper lighting angles, avoiding shadows, and minimizing reflections on screens and glossy surfaces, a conducive environment for visual comfort can be created. Careful attention to these essential considerations enhances the overall visual experience (Favero et al., 2023).
- 4) **User Preferences:** Acknowledging user preferences and subjective perceptions of visual comfort is crucial. Research has demonstrated that individuals have varying preferences for lighting levels, colour temperatures, and lighting control. By designing lighting systems that facilitate personalization and user control, overall visual comfort can be enhanced. Empowering occupants to adjust lighting settings according to their preferences contributes to a more satisfying and comfortable visual environment (Lakhdari et al., 2021).

2.1.5 Library

According to (Lee Fallin, 2020), The English term "library" is derived from the Latin word "libraria," which meaning "a place for books." Another important term is "liber," which means "a book".

Libraries have held a timeless importance as essential institutions, serving as vital repositories of knowledge, centers for learning, and vibrant hubs for community engagement. They are revered as invaluable sources of information, where individuals can access a vast

array of resources and expand their intellectual horizons. Beyond books, libraries now embrace modern technology, offering digital resources and innovative programs to cater to diverse interests and needs. They continue to foster a sense of belonging, facilitate lifelong learning, and promote social interaction, making them indispensable pillars of education, culture, and community development (Corrall & Jolly, 2019). A library is a curated collection of physical and digital resources, readily available for individuals' seeking information, education, or recreational materials. It serves as a convenient and accessible repository, catering to the diverse needs of its users (Yousefi, 2022). A library is a designated space or building where a variety of books and informational materials are stored, providing individuals with opportunities for reading, studying, and referencing valuable resources (Yousefi, 2022). A library is a meticulously arranged collection of information resources, available for reference or borrowing, and catered to a specific community. It grants individuals physical or digital access to a wide range of materials, serving as a physical structure, a virtual platform, or a combination of both. Its purpose is to facilitate knowledge dissemination and offer convenient access to valuable resources (Richard & Foundations, 2020). Over the years, libraries have changed to accommodate new technology, societal demands, and educational perspectives.

Throughout history, libraries have been traditionally linked to books, manuscripts, and printed materials. Their primary objective has been to safeguard and ensure access to written works, serving as custodians of knowledge and fostering intellectual development. However, modern libraries have evolved to encompass a broader spectrum of resources, including digital content, multimedia materials, and interactive platforms. While their fundamental purpose remains the preservation and dissemination of information, libraries now embrace innovative technologies and diverse formats, adapting to the changing needs of their users in an ever-evolving information landscape (Ranganathan, 1951). The traditional boundaries of

libraries have been surpassed with the rapid progress of technology and the advent of the digital era. As a result, the concept of a library has expanded to encompass a broader range of resources and formats, adapting to the changing information landscape and meeting the evolving needs of its users

In the digital era, libraries have evolved to incorporate a diverse array of formats and resources. In addition to physical books, libraries now provide access to e-books, online journals, databases, multimedia materials, and interactive learning tools. This expansion reflects the changing landscape of information consumption, enabling libraries to offer a more comprehensive and dynamic collection that meets the diverse needs and preferences of their patrons in today's digital age (Owusu-Ansah et al., 2019). Libraries serve as gateways to extensive volumes of information, catering to a wide range of interests, academic endeavors, and recreational pursuits. They offer access to a wealth of resources that meet the diverse needs and curiosities of individuals, fostering a culture of lifelong learning and enrichment.

In addition, libraries have adopted the principles of digital literacy and information literacy. They play a vital role in guiding individuals through the vast expanse of online information, imparting essential skills for critical evaluation and fostering responsible and ethical use of information resources. Libraries actively contribute to equipping individuals with the knowledge and tools needed to navigate the digital landscape, empowering them to make informed decisions and engage with information in a discerning and responsible manner (Igbo et al., 2022). Libraries contribute to digital inclusion by offering computer access, internet connectivity, and technology training. They strive to bridge the digital divide, empowering individuals with essential digital skills and ensuring that everyone has the opportunity to participate in the digital world, regardless of their background or access to resources (Rahman, 2020 & Igbo et al., 2022).

The physical spaces of libraries have experienced a notable transformation in recent years. Modern library designs have embraced a user-centered approach, placing a premium on creating spaces that cater to the needs and preferences of library patrons. These contemporary designs prioritize comfortable reading areas, group study rooms, quiet zones, and collaborative spaces. By offering a variety of environments, libraries accommodate different learning styles and activities, promoting focused research, social interaction, and creative pursuits. This shift reflects the recognition that libraries are no longer solely dedicated to quiet reading, but have become dynamic and adaptable spaces that foster engagement, collaboration, and the exploration of knowledge in a multifaceted manner (Arndt et al., 2021).

2.1.5.1 Types of Libraries

1. **Public Libraries:** Public libraries serve as inclusive community centers, welcoming the general public and fostering information dissemination, education, and cultural engagement. They offer an extensive array of resources, such as books, multimedia materials, digital content, and public access computers, to cater to the diverse needs and interests of their patrons (Hughes & Boss, 2021). To cater to the diverse needs and interests of local communities, public libraries provide a multitude of services and programs. These encompass activities like children's story time, adult education classes, computer training sessions, and public lectures. By offering a wide range of programs, libraries strive to engage and serve their communities in meaningful and impactful ways.



Figure 2.4: Halifax Central Library (Halifax, Nova Scotia)

Source: (Google search)

2. **Special Libraries:** Specialized libraries concentrate on specific subject areas or cater to particular organizations or professions. They encompass medical libraries, law libraries, corporate libraries, and government libraries, among others. These libraries curate collections that are tailored to the unique requirements of their users, offering resources such as medical journals and databases in a medical library, or legal references in a law library (Saunders, 2019). Within their respective fields, specialized librarians frequently offer focused information services, research guidance, and specialized support in knowledge management. They are adept at providing targeted assistance, leveraging their expertise to meet the specific information needs of their users and effectively manage knowledge resources within their specialized domains.
3. **Digital Libraries:** Digital libraries are online platforms that offer access to an extensive selection of digital resources. These web-based repositories provide a wide range of materials, such as digitized books, journals, manuscripts, multimedia content, and archival collections, enabling users to conveniently explore and retrieve information from the comfort of their devices (Sharifabadi, 2006). The primary focus of digital libraries lies in curating, preserving, and disseminating digital content, often utilizing technologies to improve search capabilities and user

accessibility. By offering global access to information, these libraries transcend geographical limitations, enabling users to remotely explore their vast collections. Digital libraries play a crucial role in bridging the gap between users and valuable resources, facilitating convenient and widespread access to information regardless of physical location (Owusu-Ansah et al., 2019).

4. **National Libraries:** National libraries function as guardians of a country's published works and cultural legacy, safeguarding, preserving, and granting access to materials of national importance. These institutions collect a wide range of resources, including books, manuscripts, maps, and archival documents. National libraries often house legal deposit collections, which mandate that publishers submit copies of their publications. This process ensures the enduring preservation of a nation's intellectual output, enabling future generations to explore and benefit from the rich literary and cultural heritage of their country (Opara et al., 2018). Playing a crucial role in upholding national identity, these libraries actively contribute to research, education, and cultural advancement. By preserving valuable resources and fostering access to knowledge, they support scholarly pursuits, provide resources for educational endeavors, and promote cultural development within the nation. Through their comprehensive collections and services, these libraries serve as important pillars of intellectual and cultural enrichment, nurturing a sense of national heritage and facilitating the growth of society as a whole.



Figure 2.5: National Library of Wales, Aberystwyth

Source: (Google search)

5. **Children Library:** A children's library, alternatively referred to as a juvenile library or a library for young readers, is a distinct area within a library specifically designed to cater to the unique requirements and interests of children and young adults. It offers a range of materials, resources, and services that are suitable for various age groups, encouraging reading, learning, and the development of literacy skills among young library patrons. The children's library serves as a nurturing environment that fosters a love for literature and supports the educational and intellectual growth of young individuals (Onuorah, 2021). A children's library is a dedicated space within a library that offers a wide variety of age-appropriate resources to engage young readers, promote literacy development, and support their educational and recreational needs (Heng & Rueda, 2022).



Figure 2.6: Children Library

Source: (Google search)

6. **Reference Libraries:** Reference libraries do not allow borrowing of books and other materials; instead, they are available for on-site reading only. These libraries primarily serve research purposes, providing access to valuable resources, including historical and unique items.
7. **Research Libraries:** A research library serves as a repository for materials related to specific topics, supporting scholarly and scientific research. It houses both primary and secondary sources, maintaining permanent collections, and endeavours to ensure access to all essential materials for researchers.
8. **Academic Libraries:** Academic libraries are situated within educational institutions, such as universities, colleges, and research centers, to cater to the educational and research requirements of students, faculty, and researchers. These libraries house comprehensive collections of scholarly resources, including books, journals, databases, and specialized collections that pertain to diverse academic disciplines. They play a pivotal role in supporting teaching, facilitating learning, and advancing research endeavors within the academic community (Bladek, 2021). To facilitate academic pursuits, these libraries provide a range of services, including reference assistance, information literacy instruction, and interlibrary loan. Reference assistance aids users in finding relevant resources and conducting research

effectively. Information literacy instruction equips individuals with the skills to navigate and evaluate information critically. Interlibrary loan enables access to materials not available in the library's own collection, expanding the resources available for academic exploration. These services contribute to the academic success and scholarly growth of students, faculty, and researchers within the institution (Ismayilov et al., 2019).

2.1.6 University Library

Within academic institutions, the university library holds a fundamental position as a central hub for learning, teaching, research, and the dissemination of knowledge. It serves as a vital resource, supporting the educational and research endeavors of students, faculty, and researchers. Additionally, the library extends its valuable resources and services to the wider community. With its vast collection of materials and digital resources, the university library provides a dynamic space for intellectual growth, collaboration, and exploration. It facilitates access to scholarly information, offers expert guidance, fosters information literacy skills, and cultivates an environment conducive to academic excellence and lifelong learning (Bakr et al., 2020).

University libraries are dedicated academic institutions that function as repositories of scholarly resources and information spanning a wide range of academic disciplines (Burrows & Hill, 2019). By offering an extensive array of books, journals, databases, and research materials, university libraries ensure that students and faculty have the essential resources to foster their academic pursuits. These libraries serve a critical function in promoting academic excellence and enhancing research output within the institution (Corrall & Jolly, 2019).

Alongside their vast collection of resources, university libraries provide a diverse array of services and facilities to bolster learning and research endeavors. These services encompass

reference assistance, information literacy programs, research support, interlibrary loan services, and access to specialized databases. These offerings further enhance the library's role in supporting and empowering students, faculty, and researchers in their academic pursuits (Corrall & Jolly, 2019). Skilled librarians, well-versed in the navigation of information resources, play a pivotal role in assisting users in effectively accessing and utilizing the available materials. Their expertise ensures that students and faculty can fully leverage the offerings of the library, optimizing their research and learning experiences (S. Li et al., 2019).

Moreover, university libraries serve as vibrant intellectual and cultural hubs within the campus community. They curate events, exhibitions, and lectures that foster intellectual discourse, encourage interdisciplinary collaboration, and highlight the accomplishments of the university community. These activities contribute to a dynamic and enriching academic environment, creating opportunities for knowledge sharing, inspiration, and the celebration of scholarly achievements (Khanna et al., 2018). These initiatives support students' intellectual and social growth while promoting a dynamic learning environment.

2.2 Design Consideration

- 1) **Aesthetics and Ambiance:** A library's design should create a welcoming and inspiring ambiance. Thoughtful interior design, colour schemes, comfortable seating, artwork, and natural elements can contribute to a pleasant atmosphere that encourages learning, creativity, and relaxation.
- 2) **Information Desk and Circulation Area:** A well-designed information desk and circulation area are essential for efficient library operations. Considerations should include an accessible and clearly marked service desk, self-checkout stations, book return slots, and a layout that enables smooth flow of users and staff.

- 3) **Acoustics:** Libraries require a quiet atmosphere conducive to reading and studying. Design considerations should include soundproofing measures, such as acoustic ceiling tiles, carpeting, and sound-absorbing panels, to minimize noise levels and distractions.
- 4) **Collaborative Spaces:** University libraries have evolved into collaborative learning environments. Design considerations should include areas for group study, discussion rooms, and project workspaces. These spaces should be equipped with flexible furniture arrangements, technology integration, and whiteboards or other tools to facilitate collaboration among students and faculty (Flores et al., 2021).
- 5) **Research Facilities:** University libraries often support advanced research and academic pursuits. Considerations should be made for specialized research facilities, such as quiet study areas, research carrels, and dedicated spaces for accessing rare or valuable collections (Sengupta et al., 2020).
- 6) **Information Commons:** An information common is a dedicated area where students can access technology resources and receive assistance with research, information literacy, and technology-related queries. Design considerations should include a help desk, computer terminals, printers, scanners, and other equipment required for digital research and learning (Rafi et al., 2019).
- 7) **Collections and Stacks:** Libraries are repositories of knowledge, and careful consideration should be given to the organization and accessibility of physical collections. The design should include well-arranged shelves, clear signage, and efficient stack management systems to enable easy navigation and retrieval of books and other resources.
- 8) **Technology Integration:** University libraries should embrace cutting-edge technologies to support research, digital scholarship, and information access. Design

considerations should include provisions for computer labs, multimedia rooms, data visualization spaces, and access to online resources. Power outlets, charging stations, and wireless connectivity should be readily available throughout the library.

- 9) **Distance Learning Support:** Many universities offer distance learning programs, and the library should provide resources and services to support remote students. Design considerations should include virtual access to databases, e-books, and online journals.
- 10) **Faculty and Researcher Support:** University libraries often serve as hubs for faculty and researchers. Design considerations should include dedicated spaces for faculty research, faculty offices, and research support services. These areas should be designed to facilitate interaction, idea exchange, and collaboration among faculty members.
- 11) **Sustainable Design:** Incorporating sustainable design principles is crucial in a university library to align with the institution's environmental goals. Considerations may include energy-efficient lighting, natural daylighting.
- 12) **Safety and Security:** Libraries need to ensure the safety and security of their patrons and collections. Design considerations should include appropriate lighting in parking areas, surveillance systems, emergency exits, fire safety measures, and secure areas for valuable or rare collections.

2.3 Empirical Review

2.3.1 Daylight Strategies for Visual Comfort in University Libraries

Several strategies have been proposed to optimize daylighting and enhance visual comfort in university libraries. Researchers have explored the use of shading devices such as external louvers, fins and brise soleil, which can control solar heat gain and reduce glare while maintaining visual comfort (Su et al., 2020). Additionally, researchers have suggested the use

of smart glass technology, which can adjust transparency based on daylight levels, to optimize visual comfort and energy efficiency and translucent polycarbonate can be used to distribute natural light more evenly throughout the space, minimizing contrast and reducing visual discomfort (Ebenehi, 2015), (Gkanias et al., 2019).

Another approach involves the integration of daylighting systems with lighting controls, allowing for seamless transition between natural and artificial lighting based on occupancy and daylight levels (S. Li et al., 2019). Furthermore, researchers have emphasized the importance of user feedback and engagement in the design of daylighting strategies, highlighting the need for user-centred design approaches that prioritize visual comfort and well-being (Nasrollahi & Shokry, 2020).

Implementing daylight strategies in university libraries can greatly enhance visual comfort for library users. Here are some strategies to consider:

- 1) **Daylighting Design:** Incorporate large windows, skylights, or lightwells to maximize the entry of natural light into the library space. This allows for a connection with the outdoors and brings in abundant daylight. Consider the orientation and placement of windows to optimize the distribution of natural light throughout the library.
- 2) **Glazing and Window Treatments:** Select glazing materials that offer high transparency and clarity to maximize the transmission of natural light. Use window treatments such as blinds, shades, or curtains to control the amount of light entering the library, especially during periods of intense sunlight or when glare becomes an issue.
- 3) **Light Shelves:** Install light shelves or horizontal reflectors above windows to bounce natural light deeper into the library space. Light shelves help to distribute daylight

more evenly, reduce glare, and increase the penetration of light into the interior areas of the library.

- 4) **Skylights and Light Tubes:** Consider incorporating skylights or light tubes in areas where windows may not be feasible or to supplement natural light in specific sections of the library. Skylights and light tubes can bring diffused natural light into interior spaces, reducing the need for artificial lighting.
- 5) **Solar Control:** Implement solar control strategies to manage the amount of heat and glare that accompanies direct sunlight. External shading devices, such as awnings, louvers, or brise-soleil, can help block excessive sunlight while still allowing natural light to enter the library.
- 6) **Interior Light Distribution:** Utilize interior design elements and materials that optimize the distribution of natural light within the library. Light-colored walls, ceilings, and flooring surfaces can reflect and diffuse light, improving overall brightness and reducing the need for artificial lighting during the day.
- 7) **Lighting Controls:** Install lighting controls, such as dimmers or automated systems, to adjust artificial lighting levels based on the availability of natural light. This ensures a balanced and energy-efficient lighting environment, with artificial lighting complementing the natural light as needed.
- 8) **Glare Control:** Incorporate glare control measures to minimize discomfort and visual impairment caused by excessive brightness. Use window treatments, adjustable blinds, or diffusing films on windows to diffuse direct sunlight and reduce glare on computer screens, reading materials, and work surfaces.
- 9) **User Control:** Provide users with the ability to personalize their lighting environment by offering adjustable task lighting or movable furniture that can be repositioned to optimize lighting conditions for individual needs.

10) **Lighting Quality:** Consider the quality of natural and artificial lighting sources to ensure a visually comfortable environment. Natural light should be diffuse and evenly distributed, while artificial lighting should provide adequate illumination levels and colour rendering to support various reading, studying, and research activities.

2.3.2 Use of Daylighting Strategies in Achieving Visual Comfort in Building

1. Building Orientation

Research has shown that building orientation plays a crucial role in achieving visual comfort through daylighting strategies. Properly orienting a building can optimize the utilization of natural light, reducing the reliance on artificial lighting and enhancing the visual experience for occupants.

An investigation on the impact of building orientation on daylighting performance in educational buildings. The research focused on assessing the visual comfort levels achieved through different orientations and found that buildings with optimal orientations demonstrated improved visual comfort due to better distribution of daylight and reduced glare (Anumah & Anumah, 2017).

Another study explored the influence of building orientation on visual comfort in office spaces. The research utilized computer simulations and on-site measurements to analyse the daylighting conditions and user satisfaction. The findings revealed that buildings with favourable orientations effectively controlled glare and provided balanced illumination, leading to enhanced visual comfort for occupants (Kaushik et al., 2021).

Furthermore, a study by (Kaminska, 2020) investigated the impact of building orientation on visual comfort. The researchers examined the daylighting performance of different orientations and their effects on reading conditions and user satisfaction.

The results indicated that properly oriented libraries achieved higher levels of visual comfort, resulting in improved reading experiences for library users.

Research conducted by (Ślipek et al., 2017) investigated the impact of building orientation on visual comfort in residential buildings. The study utilized computer simulations and daylighting analysis to evaluate the distribution of natural light and its effects on visual comfort parameters such as illuminance levels and glare. The findings revealed that buildings with optimized orientations, such as those with ample south-facing windows, achieved superior visual comfort by providing sufficient daylight while minimizing glare.

Additionally, a study by (Kwon et al., 2019) focused on the relationship between building orientation and visual comfort in office buildings. Through extensive measurements and surveys, the researchers assessed the daylighting conditions and occupant satisfaction in different orientations. The results indicated that buildings with favourable orientations, such as those with minimized east and west exposures, demonstrated improved visual comfort due to reduced direct sunlight penetration and better control of glare.

In conclusion, building orientation has a significant influence on achieving visual comfort in library design. Properly orienting the building can optimize daylighting performance, leading to reduced glare, improved illumination, and enhanced visual comfort for library users.

2. Building Form

The form of a building plays a significant role in achieving visual comfort through daylighting strategies. The design and arrangement of building elements, such as façade composition, fenestration patterns, and interior layouts, can impact the distribution of natural light, influencing occupants' visual experience and comfort.

A study by (Tekce et al., 2020) examined the relationship between building form and visual comfort in office buildings. The researchers investigated different building shapes and analysed their daylighting performance using computer simulations and field measurements. The findings indicated that buildings with well-designed forms, such as those with shallow floor plans and ample window areas, achieved superior visual comfort by promoting even illumination levels and reducing glare.

Furthermore, research by (Alkama Djamel, 2023) explored the impact of building form on visual comfort in educational buildings. The study employed a combination of simulations, measurements, and occupant surveys to assess daylighting conditions and occupant satisfaction. The results demonstrated that buildings with optimized forms, such as those with carefully positioned atria or courtyards, improved visual comfort by facilitating daylight penetration and creating visually appealing interior spaces.

In summary, building form plays a crucial role in achieving visual comfort by influencing the distribution of natural light and controlling glare. Well-designed building forms optimize daylighting performance, contributing to enhanced visual comfort and overall satisfaction for building occupants.

3. Window Design and Placement

Window design and placement are critical factors in achieving visual comfort through daylighting strategies. The size, orientation, and arrangement of windows greatly influence the amount of natural light entering a building, as well as the distribution of light and control of glare within the interior spaces.

Research by (Reinhart & Walkenhorst, 2001) examined the impact of window design and placement on visual comfort in office buildings. The study utilized computer simulations and measurements to evaluate daylighting performance and occupant

satisfaction. The findings highlighted those well-designed windows, such as those with appropriate glazing properties and optimized placement, resulted in improved visual comfort by providing balanced daylight levels, reducing glare, and enhancing the visual connection with the outdoor environment.

Additionally, a study by (Ashrafian & Moazzen, 2019) focused on the relationship between window design and visual comfort in educational buildings. Through a combination of simulations, measurements, and occupant surveys, the researchers assessed the daylighting conditions and occupant satisfaction. The results indicated that windows with well-designed characteristics, such as low reflectance glazing and proper shading devices, played a vital role in achieving visual comfort by controlling glare and providing adequate illumination for different tasks and activities.

In summary, window design and placement significantly impact visual comfort by determining the amount and quality of natural light entering the building. By carefully considering factors such as glazing properties, orientation, and shading devices, designers can optimize daylighting performance, reduce glare, and enhance visual comfort for building occupants.

4. Shading Devices

Shading devices play a crucial role in achieving visual comfort through daylighting strategies in buildings. These devices, such as blinds, shades, louvers, and overhangs, help control the amount of sunlight entering the building, reducing glare and providing a comfortable visual environment for occupants.

Research by (Tabadkani et al., 2020) focused on the impact of shading devices on visual comfort in office buildings. The study employed computer simulations and measurements to assess daylighting conditions and occupant satisfaction. The findings demonstrated that properly designed shading devices effectively reduced glare and

provided optimal visual conditions by controlling direct sunlight penetration while maintaining desired daylight levels.

Furthermore, a study by (Koç & Maçka Kalfa, 2021) investigated the influence of shading devices on visual comfort in residential buildings. The research combined measurements, simulations, and occupant surveys to evaluate the impact of shading systems on daylight distribution and occupant satisfaction. The results highlighted that well-designed shading devices, such as adjustable blinds or exterior overhangs, significantly improved visual comfort by mitigating glare, providing shading when needed, and preserving the connection to the outdoor environment.

In summary, shading devices are essential elements in achieving visual comfort by controlling sunlight and glare. Properly designed and strategically placed shading devices optimize daylighting conditions, ensuring a comfortable visual environment for occupants.

5. Skylight

Skylights are instrumental in achieving visual comfort through daylighting strategies in buildings. They provide direct access to natural light from above, offering opportunities to introduce daylight deep into the interior spaces and create visually pleasing environments for occupants.

Research by (Al-Obaidi et al., 2017) examined the impact of skylights on visual comfort in educational buildings. The study utilized computer simulations and measurements to evaluate daylighting performance and occupant satisfaction. The findings indicated that well-designed skylights, strategically placed and appropriately sized, significantly improved visual comfort by increasing the availability of natural light, reducing the need for artificial lighting, and creating a pleasant and visually stimulating atmosphere for learning.

Furthermore, a study by (Shirzadnia et al., 2023) investigated the influence of skylights on visual comfort in office buildings. Through a combination of simulations, measurements, and occupant surveys, the researchers assessed the daylighting conditions and occupant satisfaction. The results demonstrated that properly implemented skylights enhanced visual comfort by providing a sense of connection to the outdoor environment, offering balanced daylight distribution, and reducing dependence on artificial lighting.

In conclusion, skylights play a vital role in achieving visual comfort by bringing natural light from above into the building. Thoughtfully designed skylights can improve daylighting performance, create visually appealing spaces, and contribute to the overall visual comfort and well-being of building occupants.

2.3.2.1 Benefits Of Daylighting in University Libraries

Extensive research has demonstrated the multifaceted advantages of daylighting, encompassing enhanced visual comfort, heightened productivity, and decreased energy consumption. According to (Dianagri et al., 2021), a carefully crafted daylighting system can create an inviting and visually stimulating learning environment, promoting increased student engagement and motivation and a study by (Mehta, 2020), found the implementation of daylighting strategies in university library spaces has been shown to enhance the perceived quality of these environments, contributing to student well-being and fostering academic success. Studies have consistently shown that daylighting has a positive impact on human well-being. Natural light exposure has been found to reduce stress, improve mood, and optimize circadian rhythms, highlighting the significant benefits of incorporating daylight into indoor spaces (Wirz-Justice et al., 2021). Recent research has emphasized the cognitive benefits of daylighting, as evidenced by a study demonstrating that exposure to daylight can enhance reading speed and comprehension. These findings highlight the potential of

incorporating daylighting strategies to optimize cognitive function (Shishegar & Boubekri, 2016).

Chapter Three

Methodology

3.1 Introduction

Research methodologies are the tools employed in any research work to gather data, investigate and analyse them. The case study approach was employed for this research work.

An action, event, or problem that involves a real or hypothetical circumstance and includes the intricacies you would meet in real life is called a case study. It can also be a record of building's problem and how they were solved. It entails a scrutiny of buildings, to note her type, background, facilities provided, functionality, materials used, management, services and maintenance etc

Case studies are a useful tool for illuminating the intricacies of real-world decision-making. While investigating a case study, you will analyse and apply knowledge, and reasoning to draw a conclusion"

3.2 Case Study Analysis

3.2.1 Case Study One; The Hebei University of Science and Technology Library

3.2.1.1 Background Information

Hebei University of Science and Technology (HEBUST) is a key provincial university located in Shijiazhuang, the capital city of Hebei Province, China. Established in 1958, HEBUST has grown to become a multidisciplinary institution renowned for its focus on science, engineering, and technology education.

The HEBUST Library serves as the main library on campus, providing extensive resources and support for the university community. It is an integral part of the university's academic infrastructure and plays a crucial role in facilitating research, teaching, and learning activities.

The library houses a diverse collection of books, journals, electronic resources, and other scholarly materials to support the various disciplines offered by the university. It caters to the needs of undergraduate and graduate students, faculty members, researchers, and staff members.

With the university's commitment to academic excellence and research innovation, the HEBUST Library continuously expands its collection and adopts advanced technologies to enhance access to information. The library embraces digital systems and databases, allowing users to search and access resources electronically. It provides computer workstations and internet connectivity for research and study purposes.

The HEBUST Library also serves as a hub for intellectual engagement and collaboration. It offers study rooms, meeting spaces, and designated areas for group work, fostering a sense of community and supporting teamwork among students and researchers.

The architectural design of the HEBUST Library reflects a modern and innovative approach. While specific details about the building's architectural style and features are not readily available, it can be assumed that the design emphasizes functionality, aesthetic appeal, and a conducive environment for study and research.

Overall, the HEBUST Library stands as a vital resource center within the university, providing access to knowledge and supporting the academic pursuits of the university's students, faculty, and researchers.

3.2.1.2 Description of the Building

With an area of 48,636m², the site of the Hebei University Library is located in the center of the new Beicheng Campus. The base of the building is designated for some offices, an archive, a network center, a convention center and an exhibitions center. This way, the West entrance is reserved for the offices and the network center while the East entrance is reserved for the convention center and the exhibition center. It serves as a hub of knowledge, learning, and research for the university community.

There are two entrances to the library: One from the North, on the ground floor, and one from the South on the second floor. The South entrance was put on the second floor to leave base undisturbed. The site's design extends the buildings functions into becoming a place where people can stay and take a break from the stress of their studies.

Site and Surrounding:

The South of the campus is designated to teaching buildings while the North and West are designated for living and sport buildings. The standard height of the other campus buildings is 24 meters, and most buildings are kept in grey or white tones. However, the buildings in the North are clad in bricks and, somehow, try to imitated the old campus. In the center, separating the functions, is a green belt which includes a park and the location of the new library. The library is surrounded by water that starts from the park in the West and runs all the way to the East gate. This gives it some distance from the teaching buildings and gives us the opportunity to create a nice landscape. The site is located right at the intersection of the 3 main axes which places the building in the middle of the view from each gate. This puts the library in a privileged situation and makes it easily accessible from the whole campus.

Building Borders

Both, the building outline in the North and the building outline in the South, are perpendicular to their axis. The building is offset from the waterfront is 50m and 45m from the street in the North. Similarly, the East/West outline is derived from the site and runs, mostly, parallel to the site border. We tried to control the width of the building so that it would be fully visible from two important viewpoints. One point was the North gate and the second point was the square in the South, between the teaching buildings.

Circulation:

Most important are the 4 elevators in the center that provide fast access to (being in the center) to every part of the building and create a strong "backspine" of our circulation system. However, elevators require waiting time and use energy, so developing an intricate system of public stairs to reduce the traffic for the elevators.

People Flow:

- 1) The main student flow comes either from the teaching area in the South across the pond and up the monumental stair to enter on the second floor, or from the dorms in the North to enter on the ground floor. Either way they will be received with a reception from where they can continue into the main library.
- 2) The West entrance is designated for the staff of the library offices, the network center and the archives.
- 3) The East entrance is reserved for the convention and exhibition center and is located as close to the East gate as possible to improve the accessibility of external visitors.
- 4) The underground car entrance is located on the North side and provides access to a garage with 99 parking spaces and space for 800 bicycles.

Function Layout:

The functions of the library have been separated into 3 main parts to improve circulation and guarantee ease of access. This reduces the main flow hitting the main South and North entrances. The main building with 30'000m² is reserved for the library while the large first floor, with around 10'000m² holds the secondary functions and is divided up into East and West.

The library offices are located on the South-West side of the base and reaches all the way to the library reception and the book check in/out area. The short distance improves the book processing time. The convention center, containing an auditorium (500 people), lecture hall (200 people) and a conference hall (100 people) is located on the East side close to the East gate to ensure good accessibility.

Library Functions:

The library, besides providing functions like an E-reading area, a periodical reading area and a leisure reading area, also contains a variety of study areas. The main focus was creating study spaces with a lot of natural lighting. Therefore, arranged them inside and around the two large atria as well as along the facade. To further improve the quality of the reading spaces along the facade, we created many "Loft" spaces where the ceiling was set back from the facade to generate double/triple height space. This not only adds more natural light for the reading area, but also moves the stacks further away from the natural light which is desirable considering the damaging effect of direct sunlight on books. Internally, the library is organized in a way so that the functions that are more frequented are on the lower floors while functions which are less frequented are on the top floors. This brings a great improvement in terms of circulation.

Materials used for Construction:

The library boasts a modern and sleek design, with a combination of glass, steel, and concrete elements. The basic structure is made of concrete column and beam structure connected with the shear walls of the cores. However, the use of a steel truss to span the two overhangs in the North and the South.

The exterior is characterized by clean lines and a sense of openness. The building stands as a prominent structure on the campus, drawing attention with its contemporary aesthetic.



Figure 3.1: Exterior view of the Hebei University of Science and Technology Library
Source: (Google search)

Main Entrance:

As visitors approach the library, they are greeted by a grand entrance featuring double-height glass doors that lead into a spacious and well-lit foyer. The entrance area serves as a transition between the outside world and the world of knowledge within the library.

Interior Layout:

The library's interior is designed to maximize functionality and provide a conducive environment for study and research. The layout is organized into different sections, each catering to specific needs and preferences.



Figure 3.2: Interior views of the Hebei University of Science and Technology Library
Source; (Google search)

Reading Areas:

The library offers a variety of reading areas, including traditional reading rooms, individual study carrels, and group study spaces. These areas are thoughtfully designed to provide comfort, ample natural light, and an atmosphere conducive to concentrated study.

Book Collections:

The library houses an extensive collection of books, journals, and other scholarly resources. The books are organized into different sections, with clear signage and easy-to-navigate shelves. The collection covers a wide range of subjects, supporting the diverse academic disciplines offered by the university.

Technology Integration:

The library embraces modern technology to enhance the learning experience. It provides computer workstations with internet access for research purposes. Additionally, the library

incorporates advanced digital systems for cataloguing, organizing, and retrieving books and other resources efficiently.

Special Collections:

The library may also house special collections, including rare books, manuscripts, and archives. These collections are carefully preserved and provide valuable resources for specialized research and academic exploration.

Study and Meeting Rooms:

To accommodate group projects and collaborative work, the library offers various study and meeting rooms equipped with multimedia facilities. These spaces encourage interactive learning and foster a sense of community among students and researchers

Quiet Zones:

Recognizing the importance of silence and uninterrupted study, the library design includes designated quiet zones where noise is minimized. These areas cater to individuals who prefer a serene environment for focused reading or contemplation.

Atrium and Common Areas:

The library design may incorporate an atrium or central open space that serves as a hub for social interaction, casual reading, or relaxation. Common areas with comfortable seating, coffee shops, and lounge spaces provide a welcoming atmosphere for students and faculty to engage in informal discussions and exchange ideas.

Overall, the Hebei University of Science and Technology Library stands as a testament to architectural innovation and provides a modern and inspiring environment for students, faculty, and researchers to pursue academic excellence and intellectual growth.

Natural Lighting & Ventilation:

The lower atria (floors 2-5) obtain their light through the structural glazing facade while the upper atria (floors 6-8) each have an additional skylight to provide a comfortable reading environment. Most of the facade, however, is using standard windows to ensure energy efficiency as well as to control the direct sunlight that enters into the building.

Besides the natural ventilation provided by the facade, addition of two shafts on the East side and the West side to provide fresh air for the toilettes and the fresh air rooms. The building is horizontally divided between the 5th and the 6th floor.

Façade:

The building façades were influenced by Ying and Yang principles. The buildings in the North of the library are made up of a lot of brick and, somewhat, try to imitate the style of the old campus. Hence, they used similar earthy material, terracotta.

The buildings in the South of the library use simple and plain colours. The architect tried to develop a fitting language for the main South facade to create a smooth transition. Choice fell on a pale natural stone that can create a similar image as the other buildings, yet is of higher quality.

With the twisting motion of the two types of the facade were we able to take up the two styles and connect the North with the South/old and new. We also took the interior into consideration, however, which is why the facade has a higher percentage of openings on the lower floors while it closes up towards the top. This action, once again, give more natural light where it is needed (study area) while it protects the books in the compact stacks on the upper floors.



Figure 3.3: Facade views of the Hebei University of Science and Technology Library
 Source: (Google search)

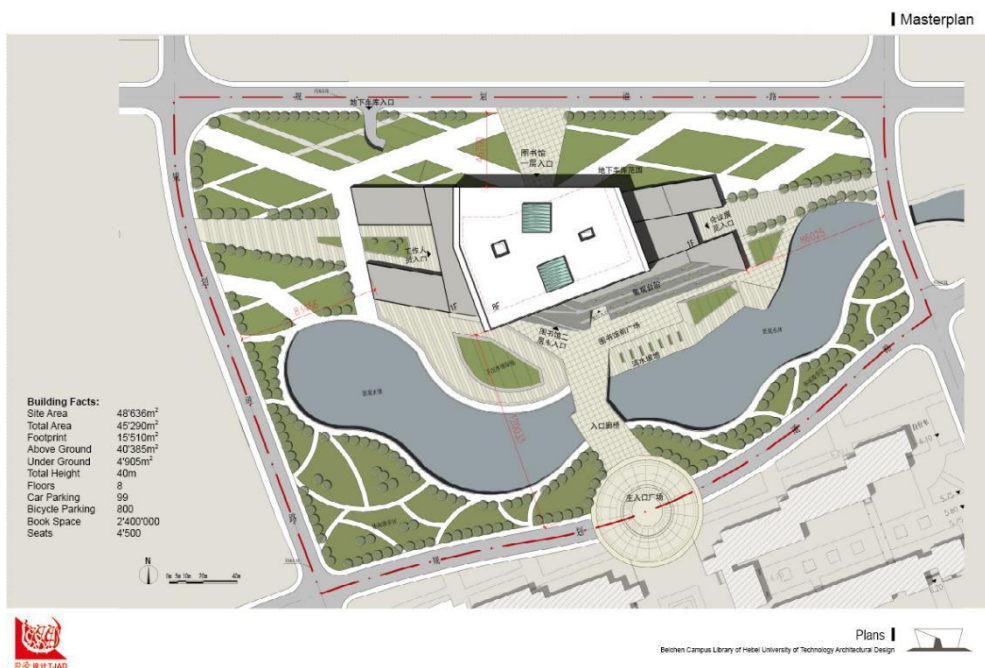


Figure 3.4: site plan of the Hebei University of Science and Technology Library
 Source: (Google search)

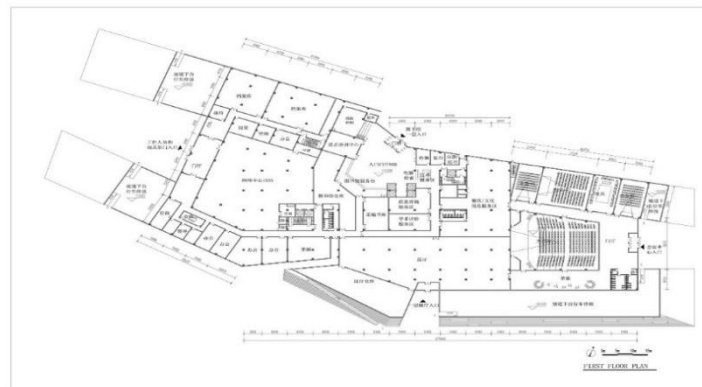


Figure 3.5: Ground Floor Plan of the Hebei University of Science and Technology Library

Source: (Google search)

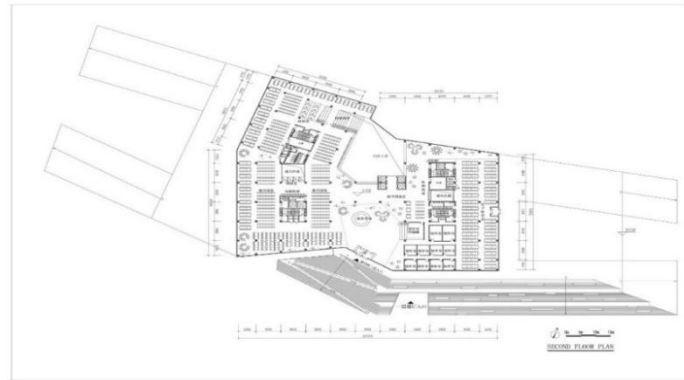


Figure 3.6: First Floor Plan of the Hebei University of Science and Technology Library
Source: (Google search)

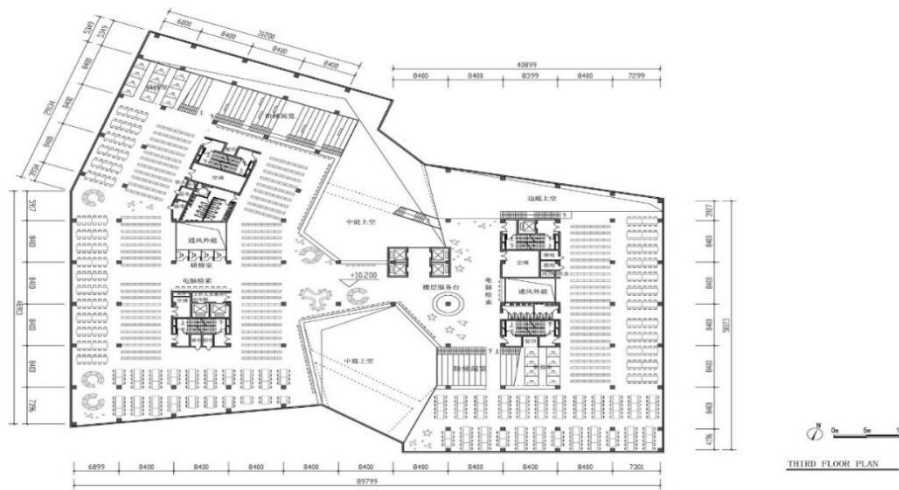


Figure 3.7: Second Floor Plan of the Hebei University of Science and Technology Library
Source: (Google search)

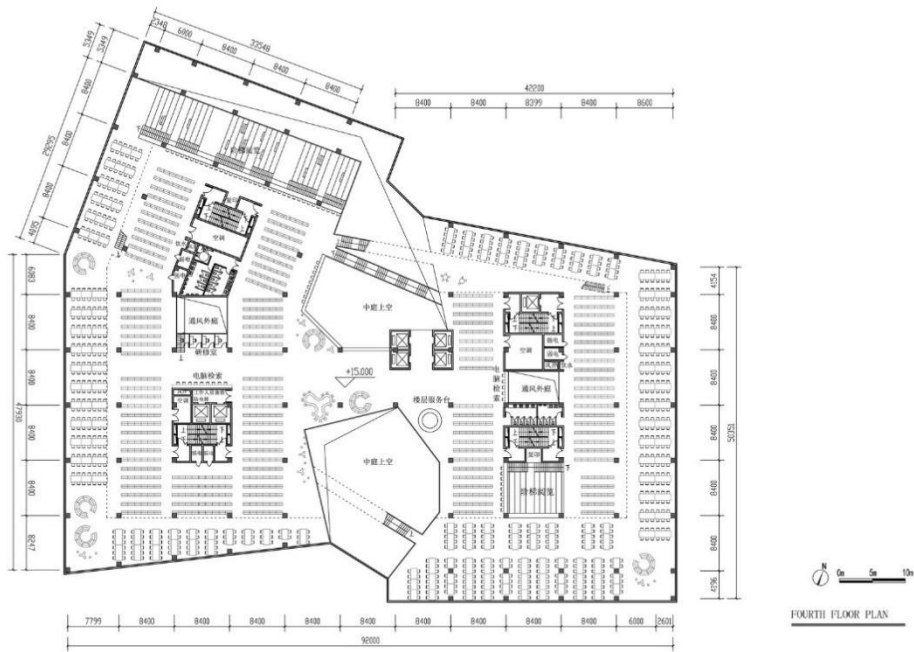


Figure 3.8 : Third Floor Plan of the Hebei University of Science and Technology Library
 Source: (Google search)

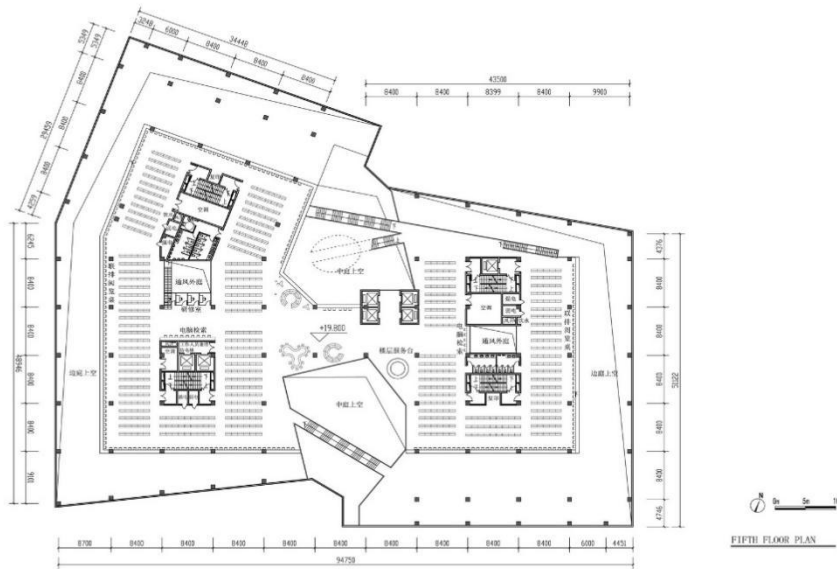


Figure 3.9: Fourth Floor Plan of the Hebei University of Science and Technology Library
 Source: (Google search)

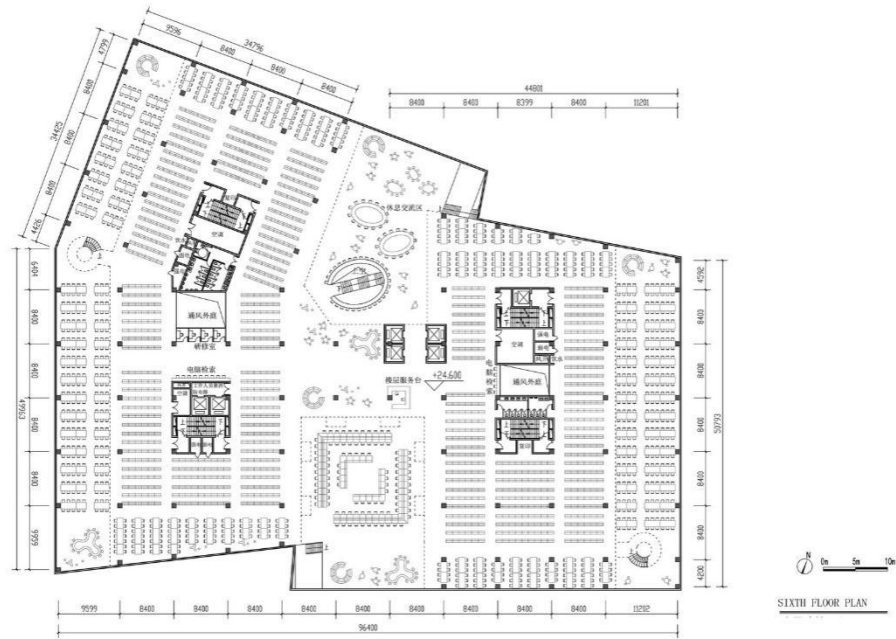


Figure 3.10: Fifth Floor Plan of the Hebei University of Science and Technology Library
 Source: (Google search)



Figure 3.11: Sixth Floor Plan of the Hebei University of Science and Technology Library
 Source: (Google search)



Figure 3.12: Seventh Floor Plan of the Hebei University of Science and Technology Library
 Source: (Google search)

Elevations

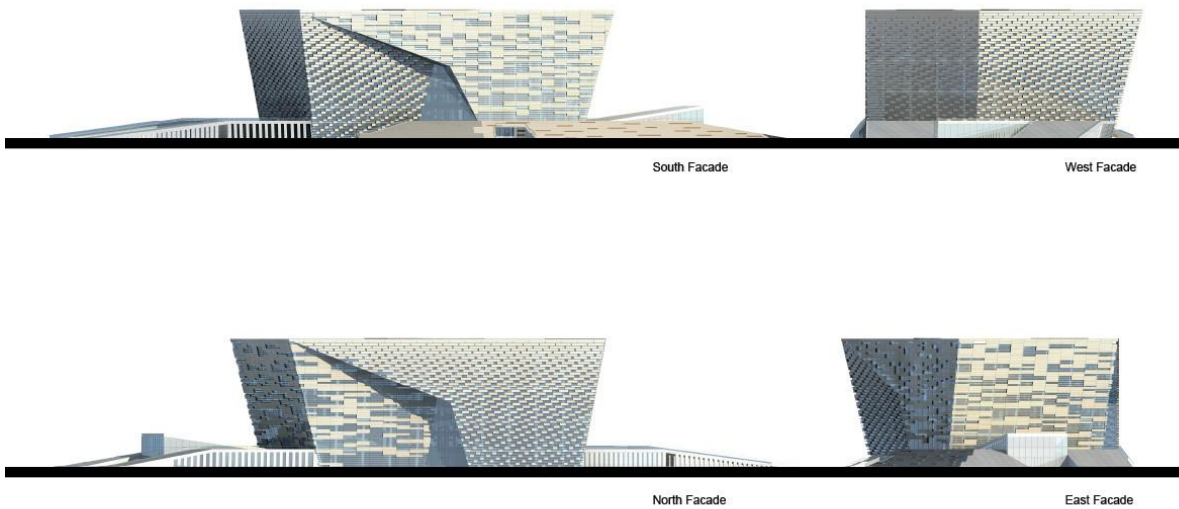


Figure 3.13: Elevations of the Hebei University of Science and Technology Library

Source: (Google search)

3.2.1.3 Building Appraisal

- 1) **Abundance of Natural Light:** The library design prioritizes the integration of natural light throughout the building. The extensive use of glass windows and open spaces allows ample daylight to permeate the interior. This abundant natural light creates a visually comfortable environment for users, reducing the reliance on artificial lighting during daylight hours.
- 2) **Well-Placed Windows:** The placement of windows is strategically considered to optimize the distribution of daylight within the library. Careful attention is given to the orientation of the building and the placement of windows to maximize the penetration of natural light while minimizing glare and shadows. This ensures a well-balanced and pleasant illumination for readers and users.
- 3) **Visual Comfort:** The architectural design takes into account the principles of visual comfort, ensuring that the natural light entering the library creates a pleasant and soothing atmosphere for users. Excessive glare is mitigated through the use of shading devices, such as blinds or sunshades, or the strategic placement of glazing to control the intensity of sunlight. This helps to prevent eye strain and enhances the overall reading and study experience.
- 4) **Daylight Integration:** The interior spaces of the library are organized and designed to optimize the distribution of daylight. Open floor plans, strategically placed reading areas, and study spaces near windows allow users to benefit from natural light while engaging in their activities. This integration of daylight into the design not only enhances visual comfort but also creates a connection between the indoor spaces and the surrounding campus environment.

- 5) **Energy Efficiency:** The emphasis on natural daylighting also contributes to the energy efficiency of the building. By reducing the reliance on artificial lighting during daylight hours, the library can significantly lower energy consumption and associated costs. This aligns with sustainable design principles, promoting environmental responsibility and resource conservation.
- 6) **User Well-Being:** Daylighting has been shown to have positive effects on human well-being and productivity. The library's design, with its ample natural light, creates a pleasant and uplifting atmosphere for users. Sunlight exposure has been linked to improved mood, increased alertness, and enhanced cognitive performance, all of which can positively impact the learning and research experience within the library.
- 7) Use of sustainable building materials; terracotta, bricks etc.

3.2.2 Case Study Two; University of Birmingham's Library

3.2.2.1 Background Information

The University of Birmingham's Library is a central facility on the Edgbaston campus of the University of Birmingham in Birmingham, United Kingdom. The library plays a crucial role in supporting the teaching, learning, and research activities of the university's students, faculty, and staff. The library has a long history that dates back to the establishment of the university itself. The University of Birmingham was founded in 1900, and the library has been an integral part of the institution since its early days.

The University of Birmingham's Library is one of the largest academic libraries in the United Kingdom. It houses a vast collection of academic resources, including books, journals, electronic databases, manuscripts, special collections, and multimedia materials. The library's collection covers a wide range of subjects and academic disciplines to support the university's diverse fields of study. The library's building is architecturally significant, featuring a modern

design that blends contemporary elements with the traditional red brick style prevalent on the university's campus.

The library's architecture reflects the university's commitment to innovation and provides a visually striking landmark within the campus. The library offers a range of facilities and services to meet the needs of its users. These include reading rooms, study areas, computer workstations, group study rooms, multimedia rooms, and dedicated spaces for special collections. The library also provides access to digital resources, online databases, and research tools.

The University of Birmingham's Library is home to several special collections and archives of historical and cultural significance. These collections include rare books, manuscripts, maps, archives, and other unique materials that support specialized research and contribute to the university's academic and cultural heritage.

The library's staff members are highly trained professionals who provide expert assistance and guidance to library users. They offer support in areas such as research skills, information literacy, academic writing, and citation management. The library also provides workshops, training sessions, and online resources to enhance the information literacy skills of its users.

The library promotes a sense of community and collaboration through the provision of spaces for group work, discussions, and events. These spaces foster interdisciplinary collaboration, knowledge exchange, and intellectual engagement among students, faculty, and researchers.



Figure 3.14: Approach view of University of Birmingham's Library

Source: (Google search)

3.2.2.2 Description of Building

The University of Birmingham's Library, located on the Edgbaston campus in Birmingham, United Kingdom, is an architecturally significant and iconic structure that serves as a central hub for learning, research, and academic resources.

The new Library has a contemporary aesthetic, with a high level of glazing maximizing views in and out to achieve optimum day-lighting to quiet perimeter study areas. Anodized aluminum fins and automatic blinds provide solar shading, adding a layer of detail to the elevations, with ceramic granite cladding to the cores. The importance of the south-east corner beside the University Centre is emphasized by the tower, orientated toward the landmark University clock tower.

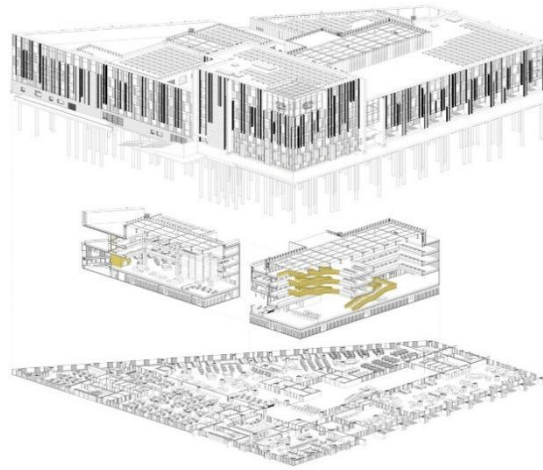


Figure 3.15: Aesthetic of University of Birmingham's Library

Source: (Google search)

Located on the Ground Floor are a café and an open plan atrium space which can be utilized for exhibition/events to showcase research at the University. Open access facilities take up half the ground floor atrium, the other half is populated with IT desks to make a vibrant circulation space. The reserve store is placed below ground on the sloping site, to keep overall height down and ensure ground floor activity. With some 62 kilometers of shelving, including 12km of open access bookshelves, the library provides a new home for the thousands of books and publications owned by the University.

Main entrance:

The library's main entrance welcomes visitors with a spacious foyer featuring large glass doors and an open and inviting atmosphere. The entrance area serves as a transition between the outside world and the knowledge within, setting the tone for a vibrant and dynamic learning environment.



Figure 3.16 Main Entrance of University of Birmingham's Library
Source: (Google search)

Interior Layout:

The library's interior is designed to provide a functional and user-friendly experience. The layout is organized into different levels and sections, each catering to specific needs and activities.

Circulation Pattern

Located on the Ground Floor are a café and an open plan atrium space which can be utilized for exhibition/events to showcase research at the University. Open access facilities take up half the ground floor atrium, the other half is populated with IT desks to make a vibrant circulation space. The reserve store is placed below ground on the sloping site, to keep overall height down and ensure ground floor.

Orientation

The new Library has a contemporary aesthetic, with a high level of glazing maximizing views in and out to achieve optimum day-lighting to quiet perimeter study areas. Anodized aluminum fins and automatic blinds provide solar shading, adding a layer of detail to the

elevations, with ceramic granite cladding to the cores. The importance of the south-east corner beside the University Centre is emphasized by the tower, orientated toward the landmark

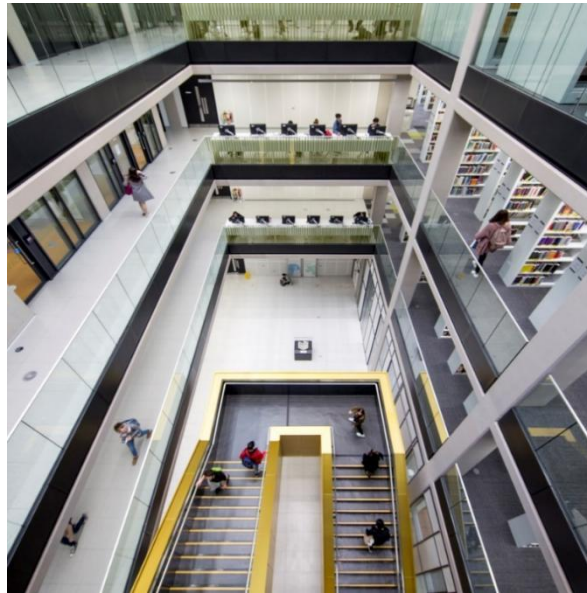


Figure 3.17: Interior of University of Birmingham's Library
Source: (Google search)



Figure 3.18: Interior of University of Birmingham's Library
Source: (Google search)

Reading Areas:

The library offers a variety of reading areas, including traditional reading rooms, study carrels, and open-plan spaces. These areas are designed to provide comfort, ample natural light, and a quiet atmosphere for concentrated study and research. The seating is arranged to

accommodate different preferences, offering options for individual study as well as collaborative work.

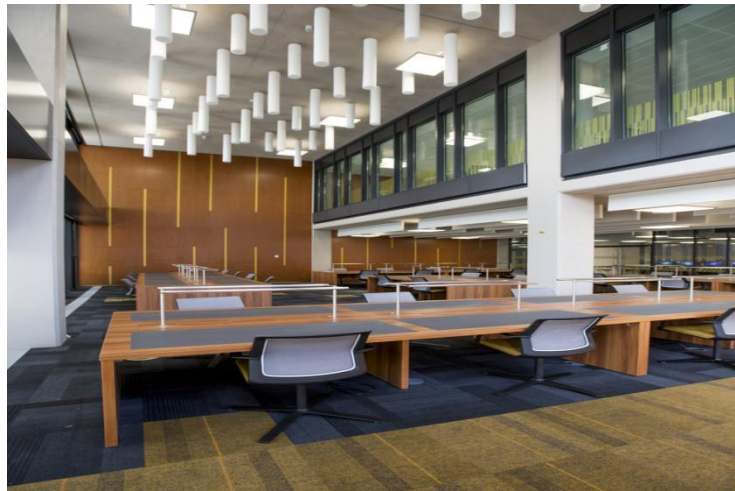


Figure 3.19: Reading Area of University of Birmingham's Library
Source: (Google search)

Book Collections:

The library boasts an extensive collection of books, journals, electronic resources, and multimedia materials. The books are organized in a systematic manner, with clear signage and user-friendly browsing systems. The collection covers a wide range of academic disciplines, supporting the university's diverse fields of study.

Exterior:

The library's exterior features a striking contemporary design that combines modern elements with the traditional red brick aesthetic that is characteristic of the university's architecture. The building stands as a prominent structure on the campus, with its distinctive shape and sleek lines creating a visually appealing and recognizable landmark.

The façade of the building was required to meet a variety of criteria. A balance needed to be achieved to utilize natural light but avoid overheating from solar gain. Active solar shading was integrated to control internal temperature, which creates a dynamic face to the building

that changes at different times of day. Feature anodized gold vertical fins add another layer of external solar shading and create a rhythm to the façade



Figure 3.20: Exterior View of University of Birmingham's Library
Source: (Google search)

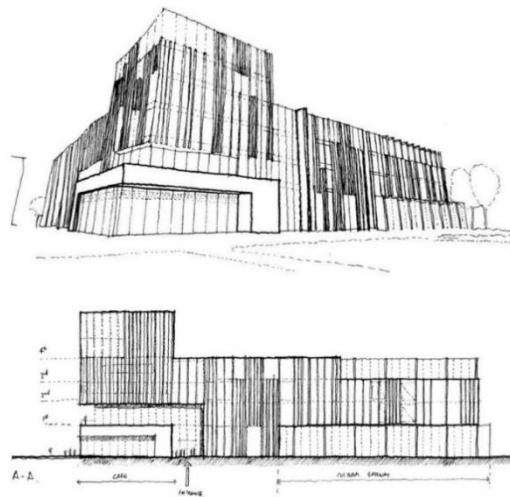


Figure 3.21: Facade Concept Sketch of University of Birmingham's Library
Source: (Google search)

Technology Integration:

The library embraces technology to enhance the learning experience. It offers computer workstations, access to online databases, and other digital resources. The integration of technology also extends to self-service kiosks, interactive displays, and digital information systems that provide users with efficient access to resources and information.

Special Collections:

The library may house special collections and archives of historical significance. These collections are carefully preserved and provide valuable resources for specialized research and academic exploration. They are often housed in dedicated areas or rooms within the library.

Study Spaces and Group Collaboration:

The library provides a range of study spaces to accommodate different learning preferences and collaborative work. These spaces include individual study rooms, group study rooms, and presentation rooms equipped with multimedia facilities. The library's design encourages active learning, collaboration, and knowledge sharing among students and researchers.

Atrium and Common Areas:

The library may feature a central atrium or open spaces that serve as social and communal areas. These spaces provide opportunities for relaxation, informal discussions, and events. Common areas may also include cafes or food services, allowing users to take breaks and recharge during their study sessions.

Acoustics

Two large atria and perimeter study spaces required treatment to ensure the acoustic criteria was met. The feature gold staircase in the center of the building acts as a large acoustic baffle, with insulated metal perforated panels wrapped around its structure, alongside insulated panels that line the perimeter of the slab edges in the atria.

Materials for Construction:

Concrete was specified for the structural frame so this could act as exposed thermal mass to help with energy efficiency. Large areas of soffit and all columns were to be exposed so a

detailed specification was produced to ensure that the highest quality finish was achieved alongside restrictions of number of blowholes and surface variations. On site, a clear Kiem wash was applied to the concrete throughout the building to help provide a consistent finish. Early design coordination was required to confirm lighting positions as these were cast into the slab, to be fed from the raised access floor above.

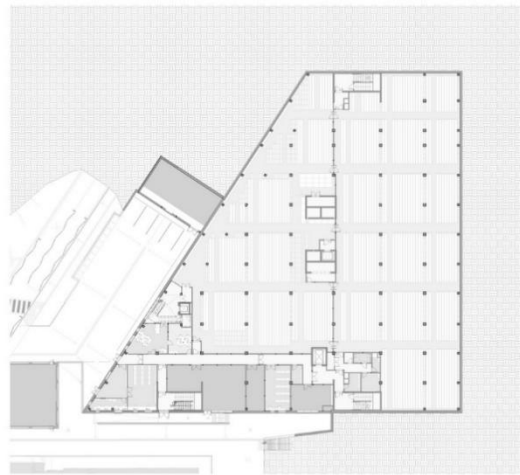


Figure 3.22: Basement Floor Plan of University of Birmingham's Library
Source: (Google search)



Figure 3.23: Ground Floor Plan of University of Birmingham's Library
Source: (Google search)



oeria

Figure 3.24: First Floor Plan of University of Birmingham's Library
 Source: (Google search)

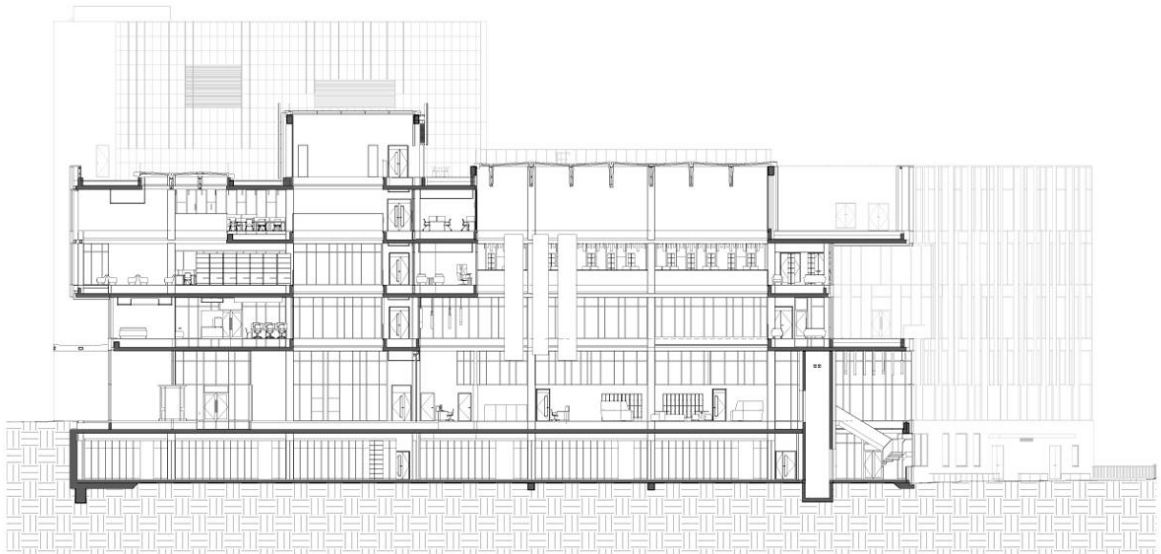


Figure 3.25: Section 1 of University of Birmingham's Library
 Source: (Google search)

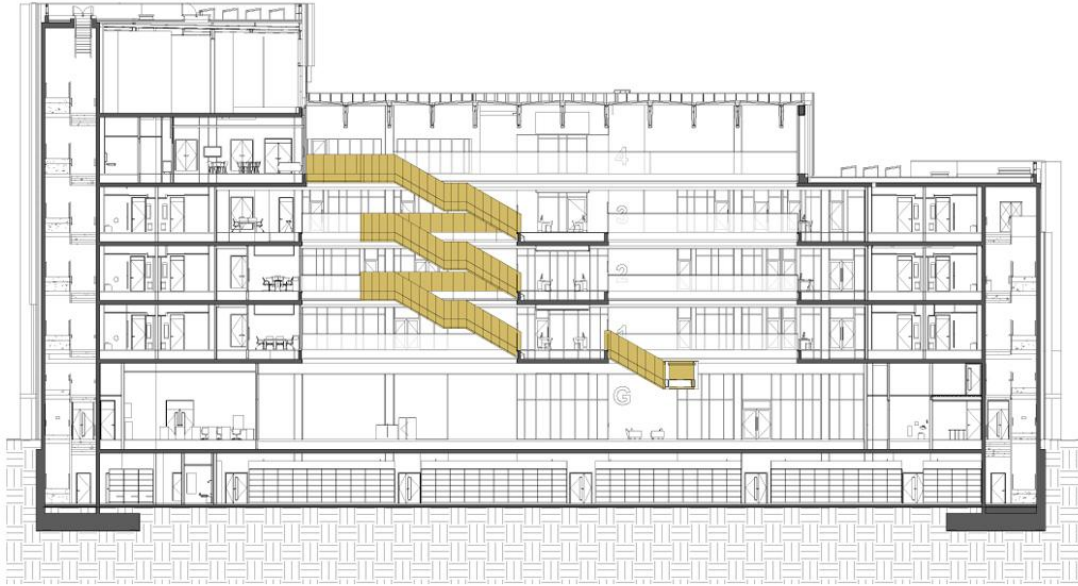


Figure 3.26: Section 2 of University of Birmingham's Library

Source: (Google search)

Do Not Copy, Lead City University



Figure 3.27: 3D Views of University of Birmingham's Library
 Source: (Google search)

3.2.2.3 Building Appraisal

- 1) **Iconic Design:** The library features a modern and visually striking design that stands out as a prominent landmark on the university campus. Its contemporary architectural style combines with traditional red brick elements, creating a unique and recognizable structure.

- 2) **Integration with Campus:** The library's design takes into consideration the overall campus layout and seamlessly integrates with the surrounding buildings and landscape. It maintains a cohesive aesthetic with other university structures while still making a distinctive architectural statement.
- 3) **Functional Spaces:** The library offers a variety of functional spaces to cater to the diverse needs of its users. It includes dedicated study areas, reading rooms, group collaboration spaces, multimedia rooms, and special collections areas. These spaces are designed to facilitate effective learning, research, and academic activities.
- 4) **Natural Light:** The library maximizes the use of natural light, creating a bright and inviting atmosphere for users. Large windows, skylights, and open spaces allow ample daylight to penetrate deep into the building, reducing the reliance on artificial lighting and providing a visually comfortable environment.
- 5) **Flexible Layout:** The library's layout is designed to be flexible, accommodating evolving needs and changing technologies. The spaces can be easily adapted for different uses, ensuring the library remains a versatile and future-proof facility that can respond to emerging academic trends and requirements.
- 6) **Technology Integration:** The library embraces technology to enhance the learning experience and facilitate access to resources. It provides computer workstations, access to online databases, digital collections, and interactive displays. The seamless integration of technology supports efficient research and information retrieval for library users.
- 7) **Sustainability Considerations:** The library incorporates sustainable design principles and features to minimize its environmental impact. This may include energy-efficient lighting systems, optimized insulation, water-saving fixtures, and the use of

sustainable materials. These sustainability measures align with the university's commitment to environmental stewardship.

- 8) **Social Spaces:** The library recognizes the importance of social interaction and collaboration in academic settings. It provides communal spaces, cafes, and relaxation areas where students and researchers can gather, interact, and exchange ideas, fostering a sense of community and academic engagement.

3.2.3 Case Study Three; Hezekiah Oluwasanmi Library, Obafemi Awolowo University, Ile-Ife, Osun State.

3.2.3.1 Background Information

The Obafemi Awolowo University Ile-Ife (formerly University of Ife) was established in 1962. The University commences academic activities at Ibadan the capital of the old western region where it inherited building and other infrastructure from the Ibadan campus, it was imperative for the University library to commence the immediate operation based on the collection of books and library building. In order to facilitate simple accessibility, the library relocated to a more advantageous permanent site building in the university master plan in October 1969.

The four-story structure, which had a total floor size of 42,000 square feet, was intended to hold 250,000 books and provide seating for 800 readers. Due to the significant growth in student enrolment, the building's capacity had been reached by 1980, necessitating a further enlargement with a 500,000-volume capacity. In August 1983, the additional addition was put into service, increasing the library's capacity to 2,500 people; the library was named after prof. Hezekiah Oluwasanmi (Vice Chancellor, 1966 - 1975) in honour of his effort to the growth of the library.

The library complex is located at the core academic environment, directly facing the access road to the University bounded to the right by the University senate building and the department of English language, also the left by lecture (amphitheatre) and the rear by the faculty of administration, the law and social sciences, also the library building is easily accessible from other area of the campus such as the hostel, over all the building is easily accessible by any prospective users.



Figure 3.28: Entrance Gate of Obafemi Awolowo University
Source: (Google search)

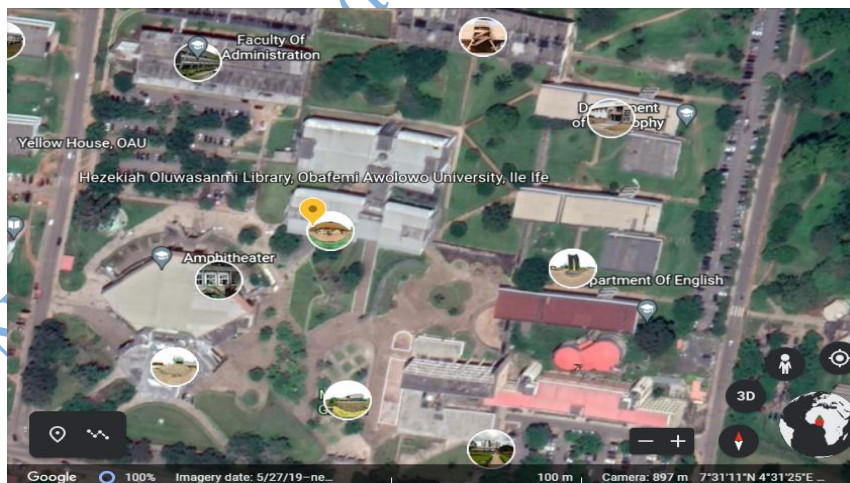


Figure 3.29: google map of Obafemi Awolowo University
Source: (Google search)

3.2.3.2 Description of the Building

The architectural design of the Hezekiah Oluwasanmi Library was influenced by the prevailing architectural style of the time it was built, designed by James Cubitt A. O. A.

Associates. It incorporates elements of modernist or contemporary design, reflecting the era and architectural trends.

The library is a multi-story building, accommodating the vast collection of resources and providing various spaces for study, research, and collaboration. It may have a well-defined entrance and a layout that allows for efficient circulation within the building.



Figure 3.30: Entrance of Obafemi Awolowo University

Source: (Researchers Field Work)

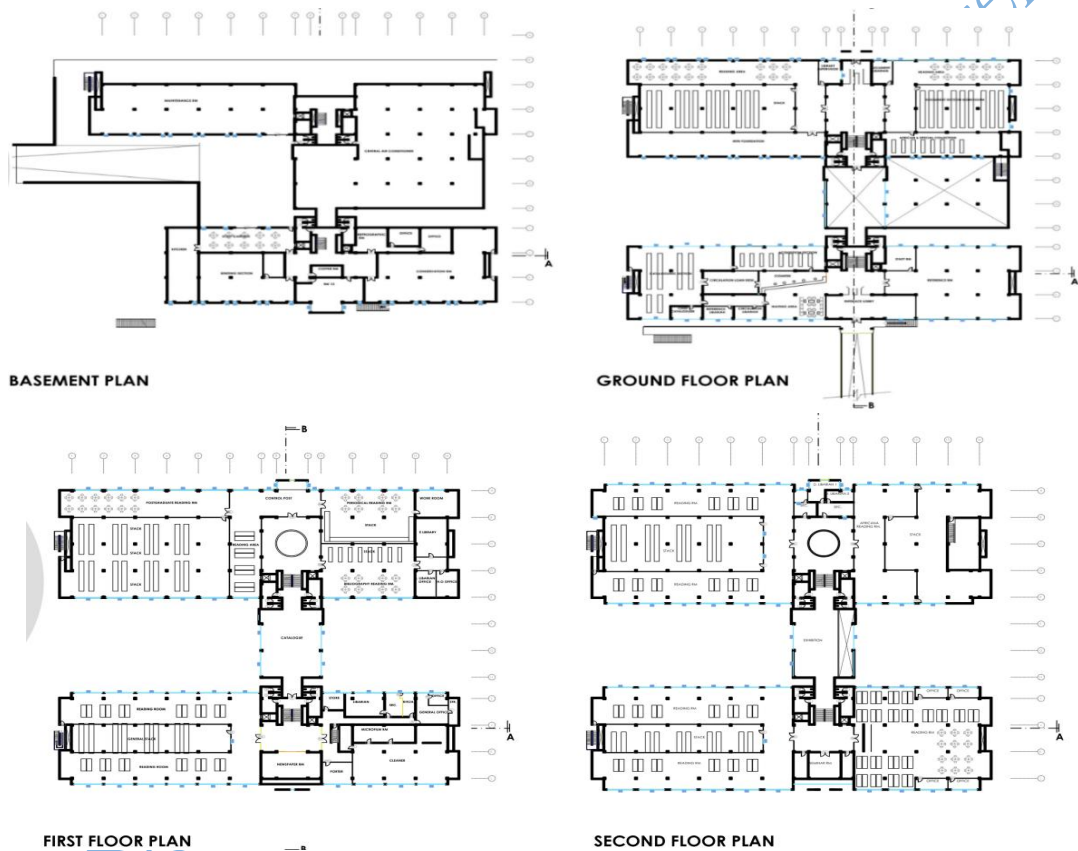
Façade and Materials: The library's façade may feature a combination of materials, such as concrete, glass, or stone cladding. The choice of materials can provide durability, aesthetics, and a visual connection to the surrounding campus environment.

Windows and Natural Light: Libraries often prioritize natural light to create a pleasant and inviting atmosphere. The Hezekiah Oluwasanmi Library incorporated the use of large windows, skylights to maximize the entry of natural light into the interior spaces, reducing the need for artificial lighting during the day.

Interior Spaces: The library's interior spaces are designed to accommodate a range of activities. It includes reading areas, study carrels, group study rooms, conference rooms, and specialized areas for rare books or special collections. The layout of these spaces would be aimed at providing comfortable and functional environments for users.

Shelving and Storage: The library have extensive shelving systems to house the collection of books and resources. These shelving units are typically arranged systematically, allowing for efficient organization, accessibility, and easy retrieval of materials.

Furniture and Fixtures: The library provide a variety of furniture and fixtures to support different user needs. This may include study tables, chairs, reading desks, computer workstations, reference desks, and seating areas for individual and group study.



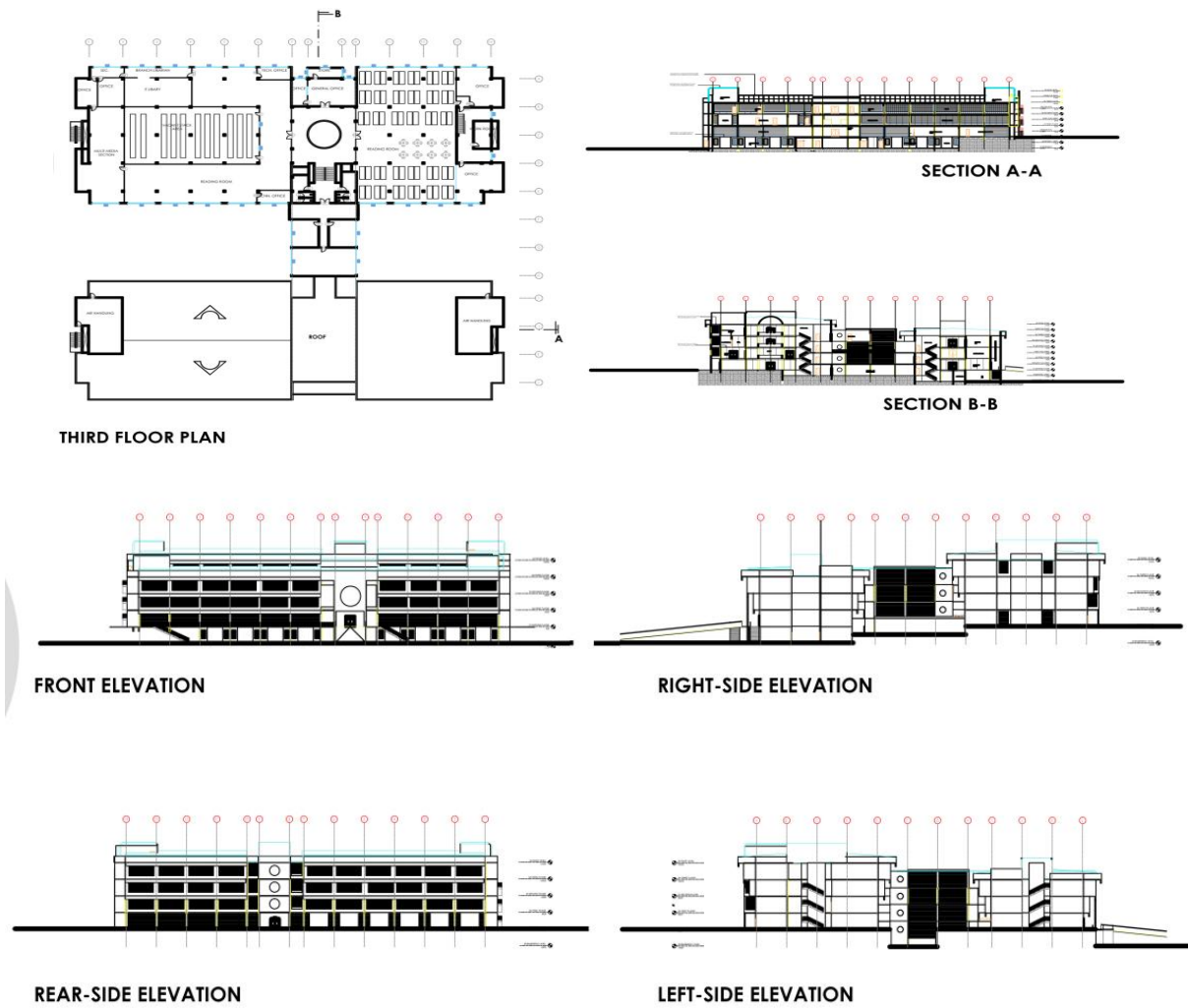


Figure 3.31: Floor, Elevations and Section plans of Obafemi Awolowo University
 Source: (Researchers Field Work)



Figure 3.32: Approach view of Obafemi Awolowo University
 Source: (Researchers Field Work)

3.2.3.3 Building Appraisal

- 1) **Good Orientation of Building:** The library is thoughtfully positioned to take advantage of natural daylighting and minimize glare, contributing to a more comfortable and energy-efficient environment.
- 2) **Aesthetically Pleasing Design:** The architecture of the library is aesthetically pleasing, blending harmoniously with the surrounding campus environment and creating an inviting atmosphere for users.
- 3) **Well-Defined Entrance and Accessibility:** The library features a well-defined entrance that is easily accessible for all users. Additionally, the provision of a ramp ensures smooth movement for individuals with mobility challenges, promoting inclusivity and convenience.
- 4) **Spacious and Comfortable Reading Spaces:** The library provides ample and well-organized reading spaces that accommodate a significant number of users. These areas are designed to offer comfort, suitable lighting, and a conducive environment for reading, studying, and research activities.
- 5) **Provision of Vertical Movement:** Vertical movement within the library is facilitated through the inclusion of features such as elevators, escalators, or stairs. This enables easy access to different levels of the library for users and staff and facilitates the efficient movement of books between floors.
- 6) **Effective Use of Shading Devices:** The library incorporates shading devices, such as blinds, curtains, or overhangs, to effectively control sunlight and glare. This ensures a comfortable visual environment for users, allowing them to engage in their activities without discomfort.

3.2.4 Case Study Four; Kenneth Dike Library University of Ibadan

3.2.4.1 Background Information

The library is named after Professor Kenneth Onwuka Dike, a renowned Nigerian historian and the first indigenous Vice-Chancellor of the University of Ibadan. Professor Dike made significant contributions to Nigerian history and played a crucial role in the development of the university. The Kenneth Dike Library was established in 1948, making it one of the oldest and most prestigious libraries in Nigeria. It serves as the central library and information resource center for the University of Ibadan. The Kenneth Dike Library contains over 3,000,000 volumes and seats 1,550 readers. It has over two million academic materials such as books, thesis and journals. The library was previously known as the Main Library and started with about 3600 volumes of book that was transferred from the library at Yaba Higher College. The Dike library was the first professionally managed library in the country manned with a professional librarian and reference and research services.

The library houses an extensive collection of books, journals, periodicals, research papers, theses, dissertations, and other educational resources. The collection covers a wide range of academic disciplines and supports the teaching, learning, and research activities of the university community. The Kenneth Dike Library offers a range of facilities and services to its users. These include reading rooms, study areas, computer workstations, group study rooms, multimedia resources, and access to online databases and digital resources. The library provides a conducive environment for academic pursuits and intellectual exploration.

The library's architectural design reflects a combination of functional spaces and aesthetically pleasing elements. It is designed to provide efficient use of space, easy navigation, and a welcoming atmosphere for library users. The library house special collections, rare books, archives, and manuscripts of historical and cultural significance. These collections contribute

to the preservation and promotion of Nigeria's cultural heritage and provide valuable resources for specialized research.

The library offers a range of services to support users in their academic endeavours. These services include reference assistance, information literacy training, interlibrary loan, document delivery, and research support. Librarians and staff are available to provide guidance and assistance to library users. The Kenneth Dike Library holds a central position in the academic life of the University of Ibadan. It serves as a hub for knowledge creation, dissemination, and intellectual engagement. The library plays a vital role in supporting the university's mission of providing high-quality education and conducting impactful research.

3.2.4.2 Description of Building

Size and Layout: The Kenneth Dike Library building is a sizable structure, designed to accommodate the library's vast collection and a large number of users. It consists of multiple floors, with each floor dedicated to specific functions and services.

- **Ground Floor:** Serials stack, rooms, Microfilm Reading area, General Office.
- **First Floor:** Reference stacks, Main reading area of Research Library, Control Desk, Reference Librarian's Desk, Bibliographic Hall, Cataloguing Section, Computer Application Unit, Africana and Publications Ordinance Collections, Carrel rooms, thesis and rare works collections, old newspapers, Government documents, Abstracts and Indexes Collection. – It seats 223 readers.
- **Second Floor:** Arts, Social Sciences Language and Law, Education, and Literature, Education and Library Science It seats 149 readers.
- **Third Floor:** University Librarian's Office Science, Technology, Pre-Clinical Medicine, Nursing and Pharmacy.

- **Fourth Floor:** Maps and Prints Manuscripts Science, Arabic Collection. Technology, Pre-Clinical Medicine, Nursing and Pharmacy, Agriculture, Forestry and Veterinary Medicine. Agriculture, Veterinary Medicine.

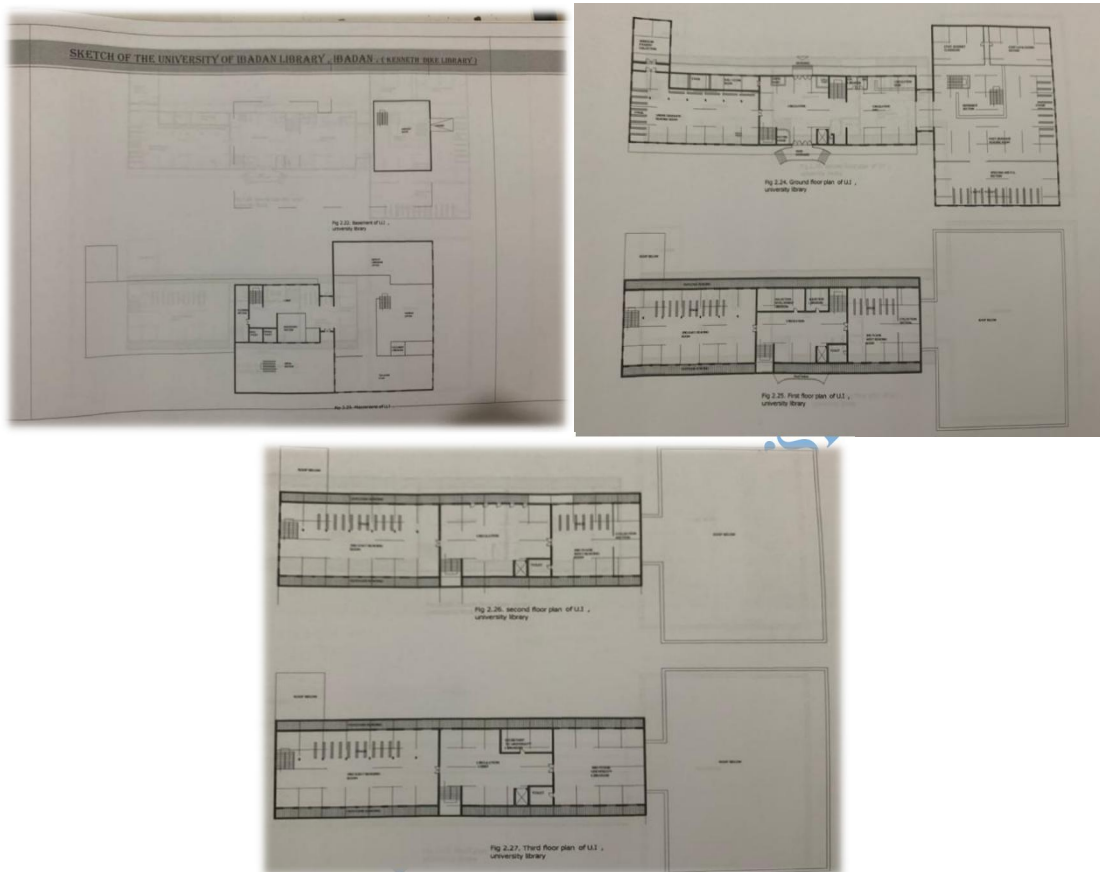


Figure 3.33: Floor plans of Kenneth Dike Library University
Source: (Researchers Field Work)

Entrance and Foyer: The library building has a well-defined entrance, with a spacious foyer or lobby area. This area may serve as a meeting point, information desk, and a place for users to gather and access general library services but no provision of alternative entrance for the physically challenged.



Figure 3.34: Entrance of Kenneth Dike Library University

Source: (Researchers Field Work)

Reading Areas and Study Spaces: The library provides a variety of reading areas and study spaces throughout the building. These spaces include traditional reading tables and chairs, individual study carrels, comfortable seating areas for quiet reading, and collaborative workspaces for group study.



Figure 3.35: Reading area of Kenneth Dike Library University

Source: (Researchers Field Work)

Special Collections and Archives: The Kenneth Dike Library include dedicated areas within the building specifically designed to house and preserve special collections, rare books, archives, and manuscripts. These spaces are carefully designed to ensure the proper preservation of these valuable resources and to provide controlled access for users.

Information Technology Infrastructure: This would include computer workstations, internet access, Wi-Fi connectivity, and other digital resources to facilitate research, access online databases, and utilize electronic resources.



Figure 3.36: E-Library of Kenneth Dike Library University

Source: (Researchers Field Work)

Administrative Offices and Support Facilities: The library building house administrative offices, staff workspaces, and support facilities. These areas are essential for library operations, cataloguing, acquisitions, technical services, and other administrative functions.

3.2.4.3 Building Appraisal

1. **Provision Of Lift for Vertical Movement of People with Disabilities:** The library includes lifts to ensure easy vertical movement and accessibility for individuals with physical disabilities, allowing them to navigate different levels of the library conveniently.
2. **Effective Location for Easy Access:** The library is strategically located to enable easy access for prospective users, ensuring its central position within the campus or easily reachable from other key areas.
3. **Effective Use of Perforated Block as Shading Devices:** The library utilizes perforated blocks as shading devices, which effectively control sunlight and glare while still allowing natural light to filter through. This helps create a comfortable visual environment within the library.
4. **Effective Design Flow and Space Allocation:** The library is designed with a well-planned layout and efficient flow of spaces. The allocation of different areas, such as reading rooms, study areas, and specialized sections, is carefully organized to optimize usability and user experience.
5. **Use of PVC Tiles in The Reading Room to Reduce Noise:** The library incorporates PVC tiles in the reading rooms, which help reduce noise levels and create a quieter environment for focused study and reading.

6. **Provision of Vertical Movement of Books Through Lift:** The library includes lifts or vertical transportation systems for the efficient movement of books between different floors or sections, ensuring easy access and organization of the library's collection.
7. **Spacious and Comfortable Reading Spaces:** The library provides ample, well-designed reading spaces that are comfortable and conducive to studying and research. These areas are carefully furnished to accommodate a significant number of users and promote a positive learning environment.
8. **Good accessibility to Various Units of The Library:** The library complex is designed with accessibility in mind, ensuring convenient access to various units, sections, or specialized collections within the library, allowing users to navigate and explore the library's resources efficiently.

3.2.5 Case Study Five; Abubakar Tafawa Balewa University Library

3.2.5.1 Background Information



Figure 3.37: Entrance Gate of Abubakar Tafawa Balewa University Library

Source: (Researchers Field Work)

Abubakar Tafawa Balewa University (ATBU) is a federal university located in Bauchi, Bauchi State, Nigeria. The university is named after Sir Abubakar Tafawa Balewa, the first Prime Minister of Nigeria. The ATBU Library is the main library on the university campus

and serves as a central resource center for academic and research activities. Here is some background information about ATBU's Library:

The ATBU Library was established to support the academic mission of the university and to provide a wealth of resources to its students, faculty, and researchers. The library has evolved over the years to cater to the growing needs of the university community.

The library houses a diverse collection of academic materials, including books, journals, periodicals, research papers, theses, dissertations, and electronic resources. The collection covers various academic disciplines and supports the university's undergraduate and postgraduate programs.

The ATBU Library offers a range of facilities and services to its users. These facilities include reading areas, study spaces, computer labs, group study rooms, multimedia resources, and access to online databases and digital resources. The library's facilities are designed to create a conducive environment for learning, research, and intellectual exploration.

The architectural design of the ATBU Library is likely influenced by contemporary styles and functional requirements. The building is designed to accommodate the library's collection and to provide spaces for individual study and collaborative work.

The library has embraced technology to enhance user experience and access to information. It likely features computer workstations, internet access, Wi-Fi connectivity, and other technological amenities to facilitate research and information retrieval.

The library offers various services to support users in their academic pursuits. These services include reference assistance, information literacy training, interlibrary loan, document delivery, and research support. Librarians and staff are available to provide guidance and support to library users.

The ATBU Library plays a critical role in supporting the university's academic mission and fostering intellectual growth and development. It serves as a hub for knowledge creation, dissemination, and research activities on campus.

3.2.5.2 Description of Building

The Abubakar Tafawa Balewa University (ATBU) Library is a remarkable institution located in the heart of the university's campus in Bauchi, Nigeria. With its imposing structure, the library serves as a focal point for intellectual exploration, research, and academic growth.

The library's architectural design is a blend of contemporary elements and functional efficiency. As one approaches the entrance, a sense of scholarly gravitas permeates the air, inviting students, faculty, and researchers into a world of knowledge and learning. The well-defined entrance foyer serves as a welcoming space, where visitors can seek information, access library services, and receive guidance from helpful librarians.



Figure 3.38: Entrance of Abubakar Tafawa Balewa University Library
Source: (Researchers Field Work)

Inside the library, a spacious and well-organized interior awaits. Natural light streams through large windows, infusing the space with warmth and brightness. The interior is

thoughtfully designed, featuring reading areas with comfortable seating and individual study carrels that allow users to delve into their studies undisturbed.



Figure 3.39: Large Windows to throw Light in Abubakar Tafawa Balewa University Library

Source: (Researchers Field Work)

The library's vast collection is a treasure trove of academic resources. Rows of neatly arranged bookshelves house a diverse range of books, covering various academic disciplines. Journals, periodicals, research papers, theses, and dissertations line the shelves, offering a wealth of information for scholars and researchers.

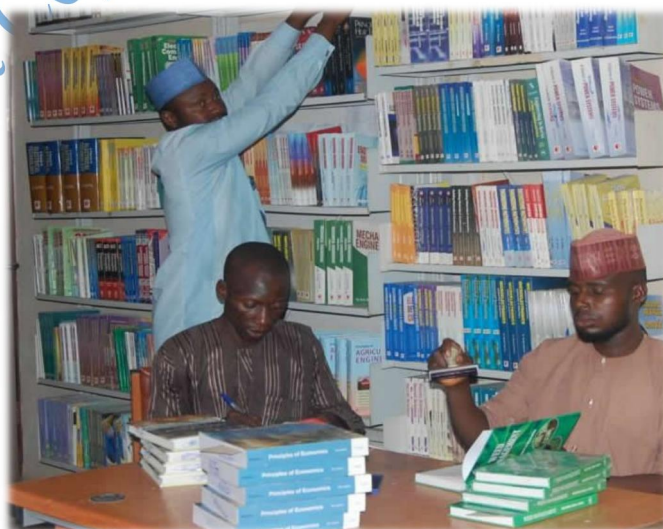


Figure 3.40: Rows of Arranged Bookshelves in Abubakar Tafawa Balewa University Library

Source: (Researchers Field Work)

In line with modernity, the ATBU Library has integrated technology seamlessly into its services. Computer workstations and Wi-Fi connectivity abound, enabling students to access online databases and electronic resources with ease. These technological amenities facilitate research, support information retrieval, and keep the university community connected in a digital age.

The library also prides itself on preserving its heritage and treasures. Dedicated spaces are carefully designed to house special collections, rare books, archives, and manuscripts. These areas serve as sanctuaries of history and culture, meticulously preserving invaluable resources for future generations to explore and cherish.

Beyond its role as a repository of knowledge, the library functions as a vibrant hub of academic life. Knowledgeable librarians and staff offer a range of services, including reference assistance, information literacy training, interlibrary loan, document delivery, and research support. Their dedication to helping users navigate the sea of information ensures that students and faculty find the support they need in their scholarly pursuits.

The Abubakar Tafawa Balewa University's Library stands as a symbol of the university's commitment to education and research. It embodies the spirit of inquiry, the pursuit of knowledge, and the transformative power of learning. As students immerse themselves in its vast collection, they embark on a journey of intellectual exploration, enriched by the library's resources and the enduring legacy of knowledge that it upholds.



Figure 3.41: Reading area of Abubakar Tafawa Balewa University Library
Source: (Researchers Field Work)

3.2.5.3 Building Appraisal

- 1) **Flexible Space Arrangement:** The library's design incorporates a flexible space arrangement that allows for versatile use of its interior. It features movable furniture, partition walls, or modular shelving systems that can be adjusted to accommodate various activities, such as group study sessions, individual reading, and research projects. This flexibility enhances the library's adaptability to changing user needs and ensures efficient use of available space.
- 2) **Organized Entry and Exit Systems:** The library's entry and exit systems are carefully organized to facilitate a smooth flow of library users. Clearly marked entrances and exits, along with strategically placed service desks and security checkpoints, ensure a well-organized and orderly movement of people within the library.
- 3) **Pleasant Indoor Climate for Library Materials:** The library's architectural design and climate control systems are carefully planned to maintain a suitable indoor climate for preserving library materials. Proper temperature and humidity levels are maintained to protect books, documents, and other resources from deterioration, ensuring their longevity and usability for future users.

- 4) **Effective Sun Shading Techniques:** To optimize daylighting and minimize glare and heat gain, the library employs effective sun shading device. These techniques include exterior sunshades, interior blinds that help control the amount of sunlight entering the building. By managing solar heat gain, the library creates a comfortable and energy-efficient indoor environment for users.
- 5) **Efficient Space Zoning:** The library was designed with efficient space zoning, dividing different areas based on their specific functions. Quiet study zones, collaborative workspaces, computer labs, and reading areas may be carefully organized and separated, providing users with suitable environments for their respective activities. This zoning helps maintain an organized and conducive atmosphere for various types of library users.

3.2.6 Case Study Six; Timothy Olagbemiro Library, Bowen University, Iwo, Osun State.

3.2.6.1 Background Information

Bowen University, Iwo, Osun State, founded in 2001, initially commenced academic activities at Iwo, utilizing buildings and infrastructure from the defunct Baptist College Iwo. The University library, recognizing its essential role, started operations immediately by utilizing the former Baptist College's library building. In January 2012, the library relocated to a more suitable and purpose-designed building at the University's permanent site for convenience.

The first phase of the University Library is a two-story building covering 9,000 sq. m, designed to accommodate 65,000 books and provide seating for 1100 readers. The proposed second phase is planned to be identical to the present first phase, unless otherwise decided.

The library's operating hours are 8.00 a.m. to 9.00 p.m. from Monday to Saturday, and on Sundays, it is open from 3.00 p.m. to 9.00 p.m.

Additionally, the institution houses specialized libraries, including a Law library for the College of Law and a Medical Library for Medical and paramedical students of the College of Health Sciences at the University Teaching Hospital in Ogbomoso, Oyo State. In recognition of his dedicated efforts in fostering the library's growth, the library was named after Prof. Timothy Olagbemi, who served as Vice Chancellor from 2003 to 2013.

The library complex is strategically situated at the heart of the academic environment, directly facing the University Worship Centre. To the right, it is bordered by the spaces designated for the faculty buildings, while on the left, it is adjacent to the Sports ground. At the rear, it is positioned near the proposed University printing press and the existing Parent forum building. Moreover, the library building enjoys convenient accessibility from various areas of the campus, including the hostels.

3.2.6.2 Description of the Building

Architect: Mobolaji Adeniyi Associate

Year: 2011

Capacity: 1100



Figure 3.42: Entrance Gate of Timothy Olagbemi Library

Source: (Researchers Field Work)

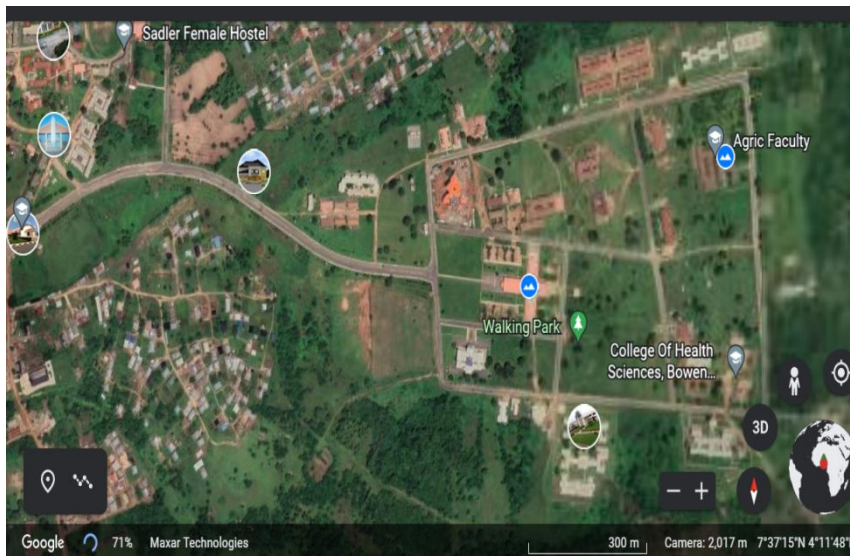


Figure 3.43: Google map of Timothy Olagbemi Library
Source: (Researchers Field Work)

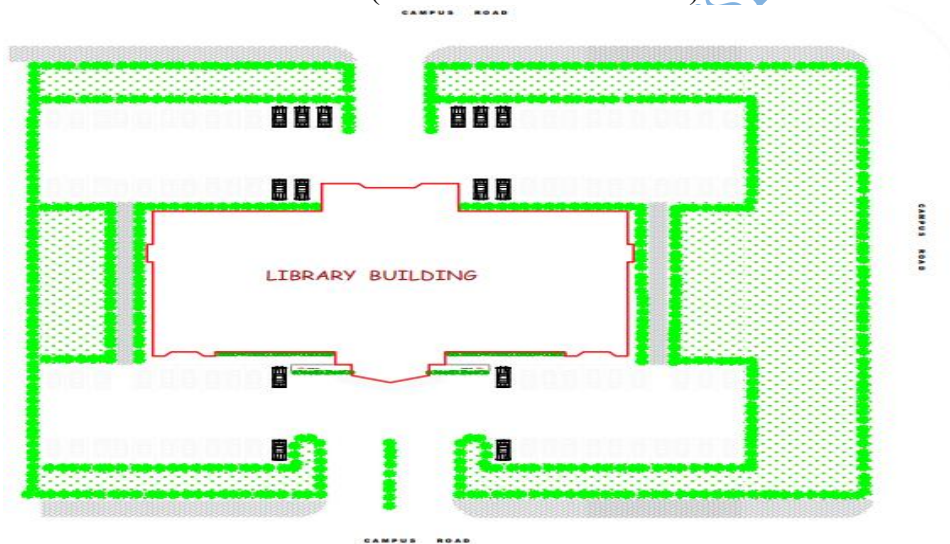


Figure 3.44: Site plan of Timothy Olagbemi Library
Source: (Researchers Field Work)

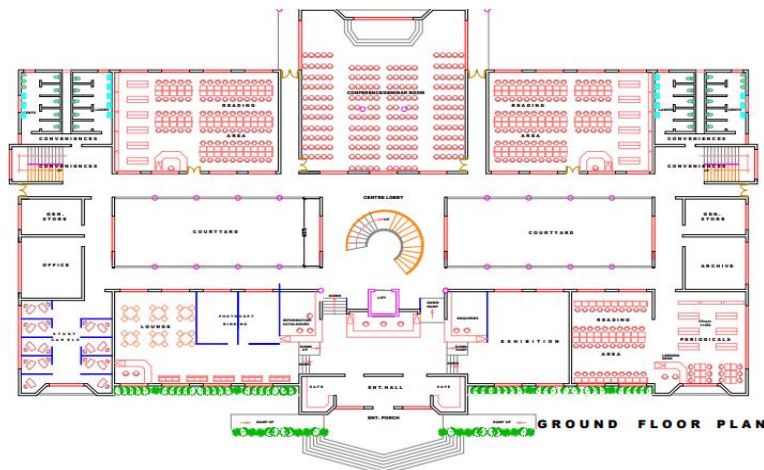


Figure 3.45: Ground floor plan of Timothy Olagbemi Library
Source: (Researchers Field Work)

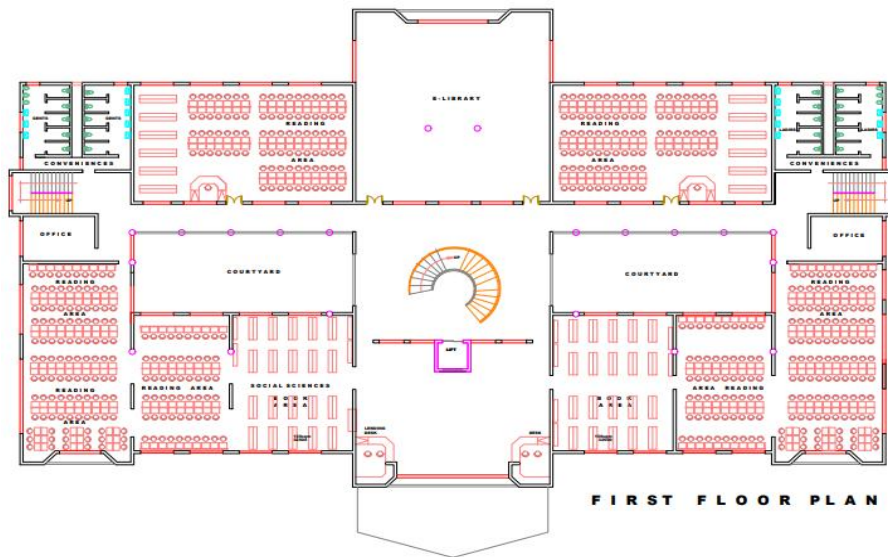


Figure 3.46: First floor plan of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.47: Second floor of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.48: Approach view of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.49: Left and Rear view of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.50: Aerial view of Timothy Olagbemi Library
Source: (Google search)



Figure 3.51: Interior view of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.52: Stair case area of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.53: Book shelves of Timothy Olagbemi Library
Source: (Researchers Field Work)



Figure 3.54: Reading area of Timothy Olagbemi Library

Source: (Researchers Field Work)



Figure 3.55: Furniture used in Timothy Olagbemi Library

Source: (Researchers Field Work)

3.2.6.3 Building Appraisal

1. **Good Orientation of the Building:** Clear signage and proper orientation within the library help users navigate the space without getting lost or feeling disoriented.
2. **Provision of Vertical Movement of the Users and Books Through a Lift:** The inclusion of a lift is a positive aspect, especially for users with mobility challenges or when transporting heavy books between different floors.
3. **Effective Design Flow and Allocation of Space:** A well-designed library should have a logical flow, with different sections organized in a user-friendly manner. Adequate space allocation for study areas, bookshelves, computer stations, and other facilities is essential for a comfortable and productive environment.
4. **Well-Defined Entrance to the Library Complex:** A clear and distinct entrance helps users easily identify the library and makes it welcoming to visitors.
5. **Effective Location that Enables Easy Access of Prospective Users:** The library's location should be strategically chosen, allowing easy access for students, faculty, and researchers. Ideally, it should be centrally located on the campus, making it convenient for everyone to visit.

6. **The Accessibility to the Various Units of the Library Is Good Enough:** Easy accessibility to different areas within the library is crucial for efficient use of resources. Users should be able to access various sections and services without confusion.
7. **Aesthetically Pleasing Design:** An aesthetically pleasing library can create a positive and inspiring atmosphere for users, enhancing their overall experience and encouraging them to spend more time in the library.
8. **Usage of Regular Modules, Thereby Creating Rooms for Flexibility of Space:** Employing regular modules in the design allows for flexibility in space utilization. This enables the library to adapt to changing needs and requirements over time.
9. **The Use of Linoleum in the Reading Room to Reduce Noise:** Linoleum flooring can be an effective choice in reading rooms to minimize noise disturbances, promoting a quiet and focused study environment.

3.3 Case Studies Deduction

1. proper orientation is essential for a library to ensure sufficient natural lighting.
2. Libraries are typically constructed using regular shapes, predominantly combinations of rectangles.
3. The design should include functional circulation routes that are easily accessible for all users.
4. The structure should be modular, allowing for quick expansion or adjustments to accommodate changes in the collection and user requirements.
5. Vertical movement of books and accessibility for all users should be facilitated through the inclusion of lifts and escalators.
6. Ramps and stairs should be equipped with handrails for improved accessibility.

7. The design should consider the height of chairs, desks, and bookshelves in reading rooms.
8. Convenient access to the library should be provided for all users, with appropriate parking facilities nearby.
9. Adequate and functional restroom facilities should be available for all users.
10. Consideration should be given to the design of stairs, steps, and landings to accommodate individuals with physical disabilities.
11. Passageways and doors should be wide enough to accommodate wheelchair users.

Chapter Four

Site Analysis and Design Synthesis

4.1 Study Area

4.1.1 Site Location

The proposed location is within Lead City university, along the major road that goes through the campus, opposite the chapel building, Ibadan, Oyo state Nigeria.

The location of the site is a big contributing factor to me picking this design. It is easily accessible by the students of the campus and has a flat topography. The access roads are also well defined as it just loops off the major road in the institution. It is also located in between the academic area and the hostels for both students staying on and off campus.

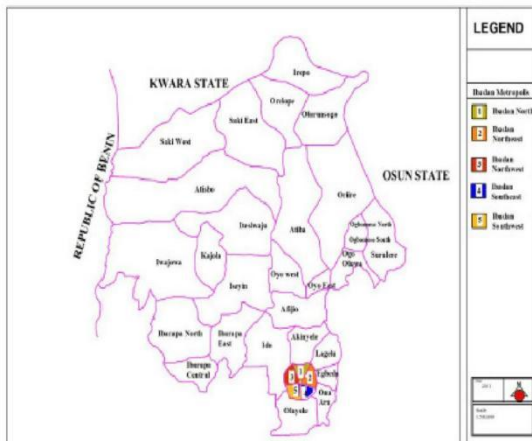


Figure 4.1: Google map of Ibadan City Proposed Site

Figure 4.2: Google map of

Source: (Google search)

4.1.2 Site Selection Criteria

Site analysis to determine the existing features on site that will in anyway affect a proposed design is very important and should be done at the commencement of the design process.

The site has already been assigned for the university library.

4.2 Project Analysis and Design Synthesis

A University Library is considered a public building, meaning it must be accessible to everyone, regardless of age or physical limitations. To ensure the library's design is efficient and organized, various factors need to be considered, such as the needs of the population it serves and how well it addresses social, physiological, and educational demands. The design

must also adhere to specific guidelines to control and limit certain aspects of the project, including site restrictions to minimize drainage issues and achieve harmony.

A properly located building can enhance functional efficiency and visual comfort. The design, layout, direction, and materials used in the building can impact the level of comfort and overall cost. Physical access to the library is crucial for all users and is considered a significant achievement in utilizing these facilities.

Therefore, it is essential that every type of library is fully integrated into the educational society, with a strong emphasis on making libraries physically accessible to all.

4.2.1 Brief Analysis

- a) Entrance Porch
- b) Reception
- c) Sentry (Security Post)
- d) Cloak/Locker Room
- e) Circulation Area
- f) Acquisition Unit
- g) Catalogue Unit
- h) E-Library
- i) Multimedia (Audio Visual) Unit
- j) Delivery Bay
- k) Newspaper/Lounge
- l) Archive
- m) Exhibition Hall
- n) Bindery Department
- o) Reading Rooms

- p) Reference Unit
- q) Secretaries' Office
- r) Kitchenette
- s) Board Room
- t) Conveniences

4.2.2 Brief Development

In the library project design, creating a comfortable environment that caters to users' educational, physiological, protective, and social needs requires careful consideration of various factors, with one key aspect being the organization and utilization of space. Restrictive guidelines can also impact the site design, making it essential to adhere to these limitations. Properly locating the building can lead to harmony, enhanced functionality, and reduced drainage issues. The orientation, layout, design, and materials chosen for the building significantly influence the level of comfort experienced by users and can also impact cost reduction. Therefore, a thoughtful and well-planned approach to these elements is crucial in ensuring the success of the library project.

4.2.3 Design Criteria

When planning for an inclusive building design, numerous technical factors and design guidelines must be taken into account to create an accessible built environment. The graphic illustrations encompass both vertical and horizontal access requirements for all building types, addressing the technical and architectural aspects of implementing these measures.

Designing a functional and comprehensive library entails careful considerations that impact the overall building. These considerations include:

- a) Site selection,
- b) Space requirements,

- c) Structure - Utilizing economical structural spans and spacing modules,
- d) Daylighting and Ventilation (through natural means),
- e) Acoustic - Incorporating sound absorptive materials,
- f) High-performance features (green architecture),
- g) School population.

By considering these factors, architects and designers can create libraries that are not only functional but also accessible and environmentally friendly, meeting the needs of the building occupants and promoting a sustainable approach to construction and design.

4.2.4 Conceptual Development

Designing a library building involves considering several factors to create a functional, aesthetically pleasing, and user-friendly space.

The conceptual development for the university library's building form revolves around an innovative daylighting strategy. The primary objective is to harness natural light as a central design element, creating a sustainable, energy-efficient, and inspiring space for learning, research, and community engagement and also provide comfort for users. The design draws inspiration from the library's role as a beacon of knowledge and seeks to establish a harmonious connection between its users and the surrounding environment.



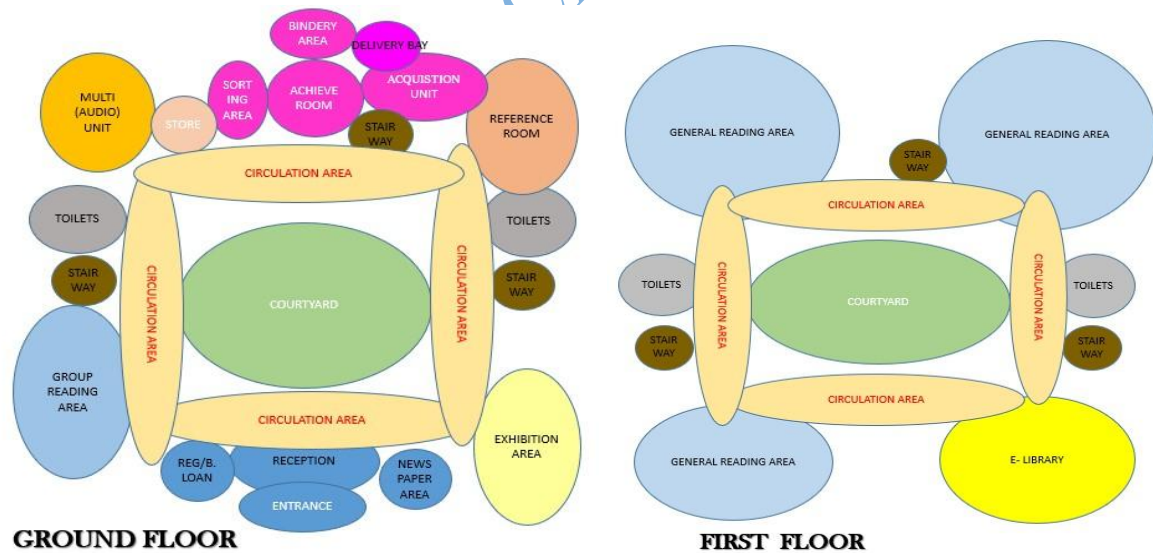
Figure 4.3: Building Footprints
Source: (Verma et al., 2021)

4.2.5 Functional Relationship

The functional relationship chart provides a visual representation of the connections between different spaces within the facility. This chart allows the designer to quickly identify which spaces are related and which are not, facilitating the strategic placement of related spaces in close proximity while isolating those that are unrelated. Moreover, it aids in the zoning of spaces and enhances the overall functionality of the design.

Key considerations for an effective building design include:

- 1) Separation of various types of traffic (e.g., vehicular, staffs, students) from one another.
- 2) Orienting buildings to ensure maximize comfort and convenience.
- 3) Emphasizing orderliness, functionality, aesthetics, and unity in the design.
- 4) Incorporating green areas with both soft and hard landscaping elements.
- 5) Providing ample parking spaces for users.



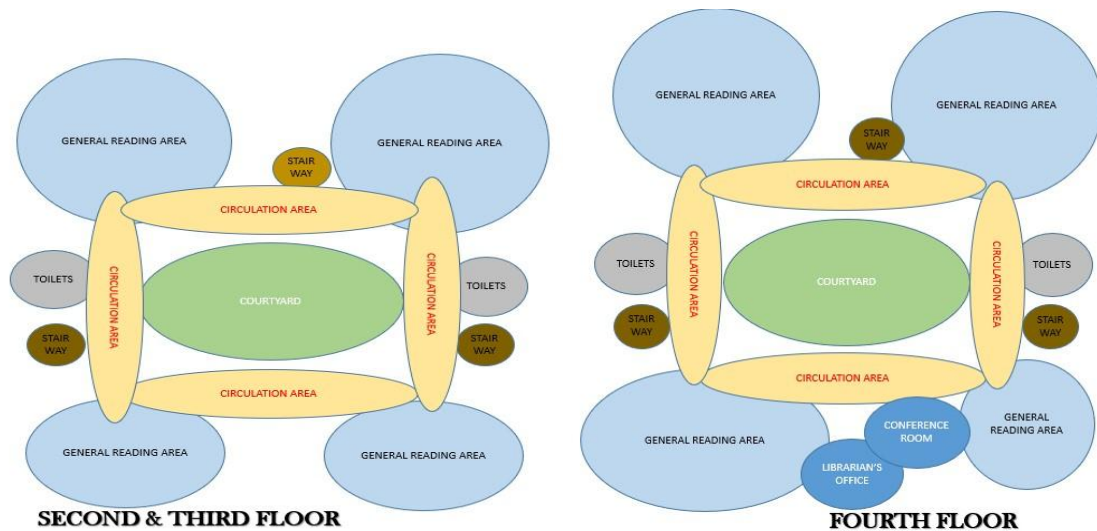


Figure 4.4: Bubble diagram of design

Source: (Researchers Field Work)

4.2.6 Space Allocation/ Schedule of Accommodation

The allocation and scheduling of spaces in a building are a direct result of the functional requirements of each space and its hierarchical importance in relation to other proposed areas. For a public building like a library, it is essential to ensure unobstructed movement and facilitate the free flow of users, equipment, materials, and services. This approach minimizes traffic congestion, prevents accidents, and enhances the overall efficiency of services, leading to increased user satisfaction.

In a library, the core activities primarily revolve around studying. Therefore, the design should account for accommodating the library collection, administrative elements, and readers. As a result, library services can be broadly categorized into three types: Administrative services, which handle the management aspects; Primary services, focusing on reader-oriented facilities; and Supporting services, providing assistance and supplementary functions to facilitate smooth library operations. By thoughtful space allocation and organization of services, a library can effectively serve its users and fulfil their diverse needs.

Table 4.1: Schedule of Accommodation

S/N	Spaces	Square Area m ²	Capacity	unit
1.	Entrance Pouch	90		1
2.	Reception	61		1
3.	Sentry (Security Post)	61		1
4.	Cloak Room/Locker Room	29		2
5.	Circulation Unit	742		5
6.	Acquisition Unit	70		1
7.	Catalogue Unit	168		1
8.	Delivery Bay	34		1
9.	Store Room	38		1
10	Achieve	120		1
11	Bindery Department	39		1
12	Sorting Unit	104		1
13	Newspaper/Journal Area	77		1
14	Multi-Media (Audio Visual) Unit	360		1
15	Exhibition Room	288	56	1
16	Group Reading Area	288	208	1
17	Reading Room 1	618	194	4
18	Reading Room 2	644	208	4
19	Reading Room 3	593	208	4
20	Reading Room 4	450	166	3

21	Reading room	296	150	1
22	References Room	339	37	1
23	Registration Unit/Book Loan	77		1
24	E-Library	389	224	1
25	Conveniences	34		20
26	Secretary Office	37		1
27	Conference Room	38		1
28	Liberian's Office	52		1

Source: Researcher's fieldwork, (2023).

4.2.7 Construction Methods and Materials

The location of the library project plays a vital role in determining the building method and material selection. As a facility accommodating diverse activities and a large number of people, modern and strong building materials are anticipated. To ensure structural integrity and safety, a certified structural engineer will oversee the design of columns, beams, and reinforcements. Comprehensive analyses will assess the facility's bearing capacity on the soil and its ability to withstand wind forces. Reinforced concrete and steel will be the primary structural materials due to their strength and versatility.

Finishes for the interior spaces will be carefully selected, considering factors like thermal insulation and acoustic design. These choices will regulate indoor temperatures and create a conducive environment for reading and studying. The intended usage of each space will dictate the appropriate finishes, ensuring functionality and aesthetic appeal.

By thoughtfully incorporating contemporary materials, expert structural management, and careful selection of finishes, the library project will be both visually appealing and

functionally efficient, providing a comfortable and engaging space for a multitude of educational and social activities.

A. Pre-Construction Operations

Before the commencement of construction, the contractor and relevant organizations undertake preliminary activities. These tasks include identifying health and safety considerations specific to the project, ensuring on-site documentation, and securing facility access. To promote effective coordination and understanding among all involved parties, it is recommended to hold a pre-construction meeting. The purpose of this meeting is to acquaint everyone with the various procedures, such as contractor submittals, sampling and testing, construction surveys, outside agency inspections, payment requests, claims and disputes management, handling unforeseen job conditions, and addressing change order requests. The pre-construction meeting facilitates clear communication and collaboration throughout the construction process, contributing to a successful library project implementation.

B. Substructure

The foundation constitutes the majority of the building's substructure. The construction site has favourable soil conditions, with firm and well-compacted soil, high load-bearing capacity, and rock boulders beneath the surface layer. Due to these factors, a standard strip foundation is the most suitable choice. The foundation materials are of high quality, offering chemical resistance and sufficient compressive strength to effectively support the building's weight and prevent any differential settlement.

During the substructure stage, the following operations are primarily carried out:

- i. **Site Clearing:** Obstacles within the building area are removed to prepare for subsequent operations, ensuring no trees or vegetation remain on the construction site.

- ii. **Site Hoarding:** A protective barrier is installed around the site's perimeter using corrugated galvanized zinc sheets mounted on a timber framework. This increases security and safeguards equipment and materials.
- iii. **Removal of Topsoil:** Topsoil is excavated from the building area and preserved in other areas for landscaping purposes. Typically, the topsoil is removed to a depth of 150 mm.
- iv. **Setting Out:** Building measurements from the design plans are transferred to the actual site during the "setting out" process. Existing reference points, such as nearby roads, are used, and a Theodolite is employed for higher accuracy.
- v. **Excavation to Trenches:** Excavators dig trenches to the prescribed depth specified by the structural engineer after completing the setting out process. The trenches are inspected and approved before installing the blinding layer.
- vi. **Casting of Blinding, Foundation Footing, and Column Bases:** Deep concrete piles are driven into the ground, each with a pile cap. Foundation footing and column bases are laid, taking into account the site's slope and reinforcement specifications provided by the structural engineer.
- vii. **Laying of Foundation Blockwall:** Foundation block walls are constructed using 230mm stretcher-bonded sandcrete blocks, which are filled with concrete to enhance durability and strength.
- viii. **Hardcore Filling:** A 300mm thick layer of tightly packed and even weathered rock serves as the hardcore filling.
- ix. **Damp Proofing:** The foundation area is covered with three plies of bituminous felt as damp proofing to prevent water from rising up to the floor slab.

- x. **Casting of In-situ Ground Floor Slab:** The ground floor slab is built to the recommended thickness by the structural engineer and reinforced for added strength. It undergoes review and approval by a structural engineer before construction begins.

C. Superstructure

The building will be constructed as a concrete framed structure, where reinforced concrete will be utilized for columns, beams, and slabs. The walls will be made of Sand Crete and non-flammable light partitions. Fire-rated doors will be installed, and the building will have a ceiling. The flooring will generally consist of linoleum, vitrified floor tiles with a non-slip surface, and other materials with different textures in various areas. To ensure safety, fire-resistant finishes will be applied.

In addition to these measures, mechanized anti-fire equipment will be installed to complement the fire safety efforts. The superstructure comprises five key components, which are floors, walls, doors & windows, waffle ceiling, and roof.

- i. **Floors:** The floors will adhere to the appropriate specifications based on the structural requirements. They must be strong enough to withstand pressure and prevent moisture seepage. Desired characteristics include heat and sound absorption, fire resistance, ease of maintenance, aesthetic appeal, comfort, safety, and cleanliness. The flooring will consist of reinforced concrete floor slabs, and the finishing options will include PVC tiles, marble tiles, vitrified tiles, ceramic tiles, and cement screed.
- ii. **Walls:** The walls play a vital role in the building's aesthetics and appearance. They are designed with considerations for wind, dust, and animal protection. In addition to being resistant to moisture, the walls will provide thermal and acoustic insulation, as well as fire resistance, ensuring strength and stability. For both interior and exterior walls, 225mm sandcrete hollow blocks will be utilized. In specific restroom areas,

150mm hollow sandcrete bricks will be used. Stair walls will be constructed with thick concrete to enhance fire protection and facilitate safe evacuation in case of emergencies.

- iii. **Doors and Windows:** The height of both internal and external doors will vary from 2100mm to 2400mm, and their widths will vary, ranging from 750mm to 1800mm, based on the specific requirements of each area.
- iv. **Roof:** The roof must fulfil several essential functions, including strength, stability, durability, fire resistance, and, on occasion, sound insulation, lighting, and ventilation. The type of construction used for each unit will be determined by its span and characteristics. The roof will be a space frame structure supported by steel and reinforced concrete columns, covered with 60mm thick insulated aluminium roof panels. The dominant roof design will be a mono slope shed-type, equipped with a 600mm roof gutter to facilitate proper roof drainage.

4.2.8 Building Services

For the building to be used as efficiently as possible, utility services must be offered. Important among these are, circulation, ventilation, lighting, water supply, electricity supply, and sewage disposal and fire protection.

1. Circulation

This passage describes the circulation aspects of the proposed library building. It highlights the flow of visitors around the site, with designated entry points for both vehicles and pedestrians. The design of the library takes into account the need for smooth movement of people and equipment between different floors.

Circulation is a crucial factor in the design of libraries, and this building has been carefully planned to accommodate this aspect. Ample space has been provided to ensure that

employees and students can move freely and easily throughout the facility, both vertically and horizontally. The design aims to create a layout that allows for seamless navigation within the library, enhancing the overall user experience.

2. Ventilation

Ventilation in buildings can be achieved through either natural or artificial means. Natural ventilation relies on external factors like temperature differences or breezes to allow air to circulate within the building. On the other hand, artificial ventilation involves the use of systems to treat the air within enclosed spaces to maintain desired levels of temperature, humidity, and air movement.

In the case of the library building, a combination of both natural and artificial ventilation methods will be employed. This approach ensures effective cooling and airflow throughout the facility. Natural ventilation will take advantage of favourable weather conditions to let fresh air circulate, while artificial ventilation will be facilitated by a central air-conditioning system and extractor fans. By using this dual approach, the library can maintain a comfortable and conducive indoor environment for its users regardless of external weather conditions.

3. Water Supply

The water supply system for the library building will be established using a direct connection to the existing water mains, which are connected to designated water reservoirs servicing the entire university library. This direct connection ensures a consistent and reliable water supply for the library.

To further guarantee continuous access to water, a borehole will be drilled, and an electricity-operated pump will be installed. This borehole and pump combination serves as a backup

source, ensuring water availability even in cases where the main water supply may be interrupted.

In addition to the direct supply and backup source, storage cisterns will be strategically placed throughout the building as needed. These cisterns will store water for various purposes and distributions within the library, providing an efficient way to manage water usage and meet the demands of the facility. This comprehensive water supply system design ensures that the library will have a stable and sufficient water supply to meet its needs effectively.

4. Lighting

In library design, lighting plays a crucial role due to its significant physiological and psychological impact on people. Adequate and well-planned lighting can positively influence the overall experience of library users.

Natural daylight, in particular, holds several benefits for occupants. The presence of natural light is associated with a sense of well-being and can contribute to a more pleasant and inviting atmosphere in the library. Exposure to natural light has been shown to enhance mood, productivity, and concentration, making it conducive for reading, studying, and other activities within the library.

The orientation and layout of the library have been carefully considered to maximize access to natural daylight. The design incorporates features such as large windows, skylights, or light wells strategically positioned to allow ample sunlight to permeate the interior spaces. By promoting the use of natural daylight, the library aims to create a more comfortable and enjoyable environment for its users, ultimately enhancing their overall experience and satisfaction while using the facility.

5. Electrical Systems

The library building will be connected to the electricity lines of the Ibadan Electricity Distribution Company (IBEDC) from the town. To ensure that each level and space within the property receives the required power, a well-designed distribution network will be installed. The wiring system will be carefully planned and constructed in accordance with all electrical engineering and service engineer criteria to guarantee safe and efficient electricity supply throughout the building.

The type of wire cable used in the electrical system will be chosen for its strong conductivity and good resistance, ensuring minimal power loss and efficient transmission of electricity.

To prepare for potential power outages, the library will be equipped with a backup power source in the form of a generator. In the event of a power failure from the main grid, the generator will immediately kick in, providing the necessary power to keep essential services running within the library. This backup power solution ensures that critical operations can continue uninterrupted even during electricity disruptions, ensuring the library's functionality and service to its users.

6. Fire Protection

Fire protection is a critical aspect of ensuring the safety of a library building, considering the significant number of people and valuable materials it houses. The ultimate goal of fire protection measures is to prevent fires from starting and spreading, control the dissemination of smoke, and enable the safe evacuation of individuals in the event of an emergency.

To achieve comprehensive fire protection, a combination of active and passive precautions will be implemented. Active safety measures are those that automatically respond to a fire, such as heat-activated sprinklers. These sprinklers release a controlled amount of water to suppress the fire at its source. Additionally, heat and smoke detectors will be strategically

placed throughout the building to promptly identify signs of fire or smoke, triggering alarms to alert occupants and emergency response teams. The installation of a reliable fire and smoke alarm system will further enhance safety measures.

Passive safeguards focus on the construction and layout of the building to minimize the spread of fire. These include using fire-resistant materials for the structure, casings, and coatings, as well as incorporating fire doors and windows to compartmentalize the building and restrict the fire's progression. Providing clear and accessible exits is also vital in facilitating the safe and efficient evacuation of individuals during a fire emergency.

By combining both active and passive fire protection measures, the library will be well-equipped to handle potential fire incidents effectively, ensuring the safety of everyone inside and preserving the valuable contents of the building.

7. Sewage Disposal

The library building provides convenient access to facilities for the proper handling, storing, and collection of trash to ensure regular and efficient waste disposal. These facilities are strategically located throughout the building and adhere to all fire safety and public health regulations. To maintain a clean and hygienic environment, library users will be educated on the correct techniques for trash disposal. It is essential for them to dispose of garbage in an appropriate manner, following the designated waste disposal procedures.

Each floor will have a big container to collect waste individually. Library users will deposit their trash in these containers, and when needed, the waste will be brought to a central collection station located on the main floor. Moreover, to further streamline the waste disposal process, each floor will be equipped with a garbage chute, allowing users to easily dispose of their waste through these designated openings.

By implementing these waste disposal measures, the library ensures a clean and organized environment for users, promoting a positive and welcoming atmosphere while adhering to all relevant regulations for fire safety and public health.

8. Acoustic

In library design, creating a conducive acoustic environment is of paramount importance. Room acoustics play a crucial role in determining the fundamental dimensions, shapes, and finish materials of a specific area. It also involves the strategic placement and layout of surfaces that either reflect or absorb sound, depending on the intended purpose and occupancy of the room (Hansen, 2021).

The reading rooms in the proposed library will receive special attention regarding acoustic considerations. To control sound within these spaces, absorptive materials will be utilized. These materials, such as fibrous materials, volume resonators, foam, and acoustic tiles on the walls and ceiling, help to absorb sound waves, reducing echo and noise levels. This ensures that the reading rooms offer a quiet and peaceful atmosphere, conducive to focused study and reading.

In other areas of the library, different acoustic strategies will be applied. For instance, curved surfaces made from hard building materials like concrete, gypsum board, wood, glass, and masonry will be used to manage sound reflections and create an environment suitable for communication and interaction. These materials help in directing sound in desired ways, allowing for effective communication without excessive noise interference.

By carefully addressing acoustic considerations in library design, the proposed building will offer distinct spaces tailored to their respective functions, ensuring a harmonious and comfortable environment for users throughout the facility.

9. External Works:

After the removal of the external scaffold and construction hoist, as well as the dismantling of the tower cranes and the closing of floors at crane positions, the next stage of the project will involve starting the external works. This includes the establishment of the sewage treatment plant, the installation of kerbs, and the implementation of both soft and hard landscaping to enhance the surroundings.

- a) **Plant:** Plant designs for the area around the building encompass a variety of elements, such as lawns, trees, shrubs, ground cover, and seasonal plants. Introducing extensive planting can significantly improve the environment and contribute to efforts in controlling and eradicating harmful pathogens and pests.

Strategic grass and tree planting around the building proves to be an effective means of regulating heat gain into the structure. By absorbing solar radiation from the external environment, the grasses and leaves contribute to a noticeable reduction in heat transfer. Their natural processes aid in cooling the air temperature, fostering a more pleasant airflow around the vicinity. Furthermore, these plants provide comforting shade, creating a peaceful and tranquil ambiance that enhances the overall aesthetic appeal of the surroundings. In addition to this, they act as buffers to reduce airborne noise, capturing dust particles, and purifying the air. Moreover, the foliage helps diminish sun glare, providing a sense of visual privacy to the building's occupants.

By incorporating a thoughtful and diverse planting design, the area surrounding the building can become an inviting and environmentally friendly space that enhances the overall well-being of its users.

- b) **Side Walk and Roadways:** As part of the project, there will be the construction of new pavements for the roadways, curbs, and street walkways. This involves laying down fresh surfaces to provide smoother and safer pathways for vehicles and pedestrians. The installation of curbs will also be undertaken to define the edges of the roadways and

walkways, guiding the flow of traffic and ensuring proper separation between pedestrian areas and vehicular lanes. These improvements to the road infrastructure aim to enhance accessibility, safety, and overall aesthetics of the area.

- c) **Parking:** As per the school's standard practice for car parks, all parking lots should be constructed using interlocking materials. Interlocking paving stones or blocks are commonly used in parking lots due to their durability, stability, and ease of maintenance. This type of paving system ensures that the parking area remains stable and can withstand the weight and movement of vehicles.
- d) **Drainage:** The site will gather all surface runoff, draining it underground. Proper grading will facilitate water flow away from buildings. Minimizing impermeable surfaces will reduce runoff, promoting a sustainable and resilient environment.

Do Not Copy, Lead City University, Nigeria

Chapter Five

Conclusion and Recommendation

5.1 Project Appraisal

The purpose of this research was to develop a university library that prioritizes visual comfort through effective daylighting strategies. To attain this goal, a range of design techniques were employed during the planning phase. These strategies encompassed the optimal orientation of the building, thoughtfully designed building form, strategic window placement and design, efficient use of shading devices, and the incorporation of skylights. Through the implementation of these measures, the university library will successfully attain a high level of visual comfort for its occupants.

5.2 Conclusion

In university of today, libraries play an important role in the educational factor. However, daylighting strategies play a crucial role in enhancing visual comfort within a university library setting. Through the implementation of various design techniques, such as proper building orientation, thoughtful building form, well-placed and designed windows, effective shading devices, and the integration of skylights, the library can create an environment that is conducive to learning, reading, and studying.

5.3 Recommendations

To create an optimal learning environment in the university library, I strongly recommend prioritizing daylighting and energy-efficient design principles. To achieve this, consider the following key recommendations:

- i. **Building Orientation:** Ensure the longer side of the library building faces the east-west orientation. This strategic orientation allows the library to benefit from abundant natural light throughout the day. Not only will this reduce reliance on artificial lighting, but it will also promote a well-lit and inviting atmosphere, enhancing the overall learning experience.
- ii. **Building Form:** When planning the library's form, consider adopting designs such as square, L-shaped, U-shaped, linear and thin, or long and narrow. Each form offers unique advantages in terms of daylighting and spatial efficiency. Choose a design that optimizes the distribution of natural light while creating functional and adaptable spaces for students and staff.
- iii. **Window Design and Placement:** Carefully design and position windows to maximize daylight penetration. Place windows on the east-facing facade to capture the morning sun, creating a welcoming and energizing environment. For west-facing windows, implement appropriate glazing and shading solutions to control glare and prevent excessive heat gain during the afternoon.
- iv. **Shading Devices:** Implement effective shading devices, such as overhangs, fins or brise-soleil, to mitigate glare and solar heat gain. These devices can be particularly beneficial for west-facing windows, ensuring a comfortable and pleasant reading environment throughout the day.

By following these recommendations, the university library can achieve a harmonious balance between daylighting, energy efficiency, and user comfort. The library will

become a beacon of knowledge and a space that fosters productivity and well-being for all its users, enriching the learning experience and contributing to a sustainable campus environment.

References

- A.M. Muhammad and I.G. Aliyu. (2021). *Validation of Openstudio Simulation Tool for Passive Indoor Environmental Comfort in Midrise Office Buildings in Temperate* *Validation of Openstudio Simulation Tool for Passive Indoor Environmental Comfort in Midrise Office Buildings in Temperate Dry*. December.
- Aderonmu, P., Adesipo, A., Erebor, E., Adeniji, A., & Ediae, O. (2019). Assessment of Daylighting Designs in the Selected Museums of South-West Nigeria: A Focus on the Integrated Relevant Energy Efficiency Features. *IOP Conference Series: Materials Science and Engineering*, 640(1). <https://doi.org/10.1088/1757-899X/640/1/012034>
- Al-Obaidi, K. M., Ismail, M. A., Munaaim, M. A. C., & Abdul Rahman, A. M. (2017). Designing an integrated daylighting system for deep-plan spaces in Malaysian low-rise buildings. *Solar Energy*, 149, 85–101. <https://doi.org/10.1016/j.solener.2017.04.001>
- Alkama Djamel, A. A. (2023). *Optimizing Visual Comfort in School Buildings Through Parametric Design* *Optimizing Visual Comfort in School Buildings Through Parametric Design Abstract: I . Introduction Visual comfort in school buildings is one of the defining parameters influencing*. June. <https://doi.org/10.37896/pd92.3/9234>

- Allan, A. C., Garcia-hansen, V., Isoardi, G., Smith, S. S., Allan, A. C., Garcia-hansen, V., Isoardi, G., Smith, S. S., Allan, A. C., Garcia-hansen, V., Isoardi, G., & Smith, S. S. (2019). The Journal of the Illuminating Engineering Society Subjective Assessments of Lighting Quality : A Measurement Review Subjective Assessments of Lighting Quality : A Measurement Review. *LEUKOS*, 00(00), 1–12. <https://doi.org/10.1080/15502724.2018.1531017>
- Anugrah, M. P., & Munawaroh, A. S. (2017). Assessment Of Natural Lighting And Visual Comfort Of Library.(Case Study: Library Of Universitas Bandar Lampung And Universitas Teknokrat Indonesia). *International Conference on ...*, 4(October 2017), 416–427.
- Anumah, J. J., & Anumah, L. (2017). Building Orientation; Enhancing Nature with Nature. ©*Journal of Applied Sciences & Environmental Sustainability*, 3(7), 29–35.
- Aram, R., & Alibaba, H. Z. (2018a). *INVESTIGATION OF THE EFFECTS OF DAYLIGHT IN A UNIVERSITY INVESTIGATION OF THE EFFECTS OF DAYLIGHT. December.*
- Aram, R., & Alibaba, H. Z. (2018b). Investigation of the effects of daylight in a university library. *Journal of Architectural and Planning Research*, 35(4), 343–356.
- Arndt, D., Kronbichler, M., & Maier, M. (2021). *The deal . II finite element library : Design , features , and insights.*
- Ashrafian, T., & Moazzen, N. (2019). The impact of glazing ratio and window configuration on occupants' comfort and energy demand: The case study of a school building in Eskisehir, Turkey. *Sustainable Cities and Society*, 47(January), 101483. <https://doi.org/10.1016/j.scs.2019.101483>
- Awad, J., & Abd-rabo, L. (2019). Daylight and Energy Performance Optimization in Hot -

- Arid Regions. *Procedia Manufacturing*, 44(2019), 237–244.
<https://doi.org/10.1016/j.promfg.2020.02.227>
- Baker, N., & Steemers, K. (2003). Energy and Environment in Architecture. In *Energy and Environment in Architecture*. <https://doi.org/10.4324/9780203223017>
- Bakmohammadi, P., & Noorzai, E. (2020). Optimization of the design of the primary school classrooms in terms of energy and daylight performance considering occupants' thermal and visual comfort. *Energy Reports*, 6, 1590–1607.
<https://doi.org/10.1016/j.egyr.2020.06.008>
- Bakr, S., & Nagy, G. (2020). Enhancing Users' Comfort in Existing University Libraries in Egypt Through Daylight Strategies. *Fayoum University Journal of Engineering*, 3(2), 40–52. <https://doi.org/10.21608/fuje.2020.204946>
- Bakr, S., Nagy, G., City, E. S., & City, E. S. (2020). ENHANCING USERS ' COMFORT IN EXISTING UNIVERSITY LIBRARIES IN EGYPT THROUGH DAYLIGHT STRATEGIES. *Fayoum University Journal of Engineering*, 40–52.
- Bladek, M. (2021). *Student well-being matters : Academic library support for the whole student How does access to this work benefit you ? Let us know !*
- Brémond, R., & Brémond, R. (2020). The Journal of the Illuminating Engineering Society Visual Performance Models in Road Lighting : A Historical Perspective Visual Performance Models in Road Lighting : A Historical Perspective. *LEUKOS*, 00(00), 1–30. <https://doi.org/10.1080/15502724.2019.1708204>
- Buchanan, G. R., McKay, D., & Makri, S. (2019). *City , University of London Institutional Repository*. 34(2019), 51–79. <http://openaccess.city.ac.uk/1189/>
- Burrows, C., & Hill, S. (2019). *Accessibility And Academic Libraries: A Comparative Case*

Study. <https://ir.lib.uwo.ca/etdhttps://ir.lib.uwo.ca/etd/6114>

- Corrall, S., & Jolly, L. (2019). Innovations in Learning and Teaching in Academic Libraries: Alignment, Collaboration, and the Social Turn. *New Review of Academic Librarianship*, 25(2–4), 113–128. <https://doi.org/10.1080/13614533.2019.1697099>
- Dianagri, A. T., Sari, W. E., & Harsitanto, B. I. R. (2021). Simulation of Natural Daylighting Optimization in College Library. *Journal of Physics: Conference Series*, 1858(1), 6–13. <https://doi.org/10.1088/1742-6596/1858/1/012030>
- Ebenehi, A. E. (2015). *USE OF DAYLIGHTING STRATEGIES FOR LIGHTING ENERGY COST*.
- Fakhari, M., Vahabi, V., & Fayaz, R. (2021). A study on the factors simultaneously affecting visual comfort in classrooms: A structural equation modeling approach. *Energy and Buildings*, 249, 111232. <https://doi.org/10.1016/j.enbuild.2021.111232>
- Favero, F., Lowden, A., & Bresin, R. (2023). *Study of the Effects of Daylighting and Artificial Lighting at 59 ° Latitude on Mental States , Behaviour and Perception*. 1–21.
- Flores, R. M., De Leon, S. V., & Valerio, M. G. (2021). Library space design framework: A conceptual analysis. *Asia-Pacific Social Science Review*, 21(2), 240–249.
- Flynn, J. E., Fies, A. I. A., Hendrick, C., Spencer, T., & Martyniuk, O. (2013). *A Guide to Methodology Procedures for Measuring Subjective Impressions in Lighting A guide to methodology procedures for measuring subjective impressions in lighting*. April 2015, 37–41. <https://doi.org/10.1080/00994480.1979.10748577>
- Gkaniias, E., Risse, B., Mangan, M., & Webb, B. (2019). From skylight input to behavioural output: A computational model of the insect polarised light compass. *PLoS Computational Biology*, 15(7), 1–30. <https://doi.org/10.1371/journal.pcbi.1007123>

- Hansen, C. H. H. and K. (2021). Noise Control. *Noise Control: From Concept to Application*, 8686. <https://doi.org/10.1201/9780429428876>
- Heng, H. Bin, & Rueda, L. (2022). *Libraries for Children and Young Adults*. 1–19.
- Hughes, C., & Boss, S. (2021). How Rural Public Libraries Support Local Economic Development in the Mountain Plains. *Public Library Quarterly*, 40(3), 258–281. <https://doi.org/10.1080/01616846.2020.1776554>
- IEA. (2010). *Daylight in Buildings, Energy Conservation in Buildings and Community Systems Programme*. http://www.iea-ebc.org/Data/publications/EBC_Annex_29_PSR.pdf%0Awww.iea-shc.org
- Igbo, H. U., Ibegbulam, I. J., Asogwa, B. E., & Imo, N. T. (2022). Provision of digital information resources in Nigerian university libraries. *Information Research*, 27(3). <https://doi.org/10.47989/IRPAPER936>
- Iommi, M. (2018). Daylighting performances and visual comfort in Le Corbusier's architecture. The daylighting analysis of seven unrealized residential buildings. In *Energy and Buildings* (Vol. 184, pp. 242–263). Elsevier B.V. <https://doi.org/10.1016/j.enbuild.2018.12.014>
- Ismayilov, K., Ismayilov, N., & Mammadova, V. (2019). Library information services in academic libraries of Azerbaijan: a comparative study. *Library Management*, 40(6–7), 461–477. <https://doi.org/10.1108/LM-08-2018-0069>
- Kaminska, A. (2020). Impact of building orientation on daylight availability and energy savings potential in an academic classroom. *Energies*, 13(18). <https://doi.org/10.3390/en13184916>
- Kaushik, A., Arif, M., Ebohon, O. J., Arsalan, H., Rana, M. Q., & Obi, L. (2021). Effect of

- indoor environmental quality on visual comfort and productivity in office buildings. *Journal of Engineering, Design and Technology*. <https://doi.org/10.1108/JEDT-09-2021-0474>
- Khanna, S., Bansal, J., Sood, S., & Tiwari, D. (2018). Journal of Academic Librarianship : A Bibliometric Analysis. *International Journal of Library Information Network and Knowledge*, 3(2), 123–133. www.slp.org.in
- Kilic, D. K., & Hasirci, D. (2011). Daylighting Concepts for University Libraries and Their Influences on Users' Satisfaction. *Journal of Academic Librarianship*, 37(6), 471–479. <https://doi.org/10.1016/j.acalib.2011.07.003>
- Klain Gabbay, L., & Shoham, S. (2019). The role of academic libraries in research and teaching. *Journal of Librarianship and Information Science*, 51(3), 721–736. <https://doi.org/10.1177/0961000617742462>
- Knoop, M., Stefani, O., Bueno, B., Matusiak, B., Hobday, R., Wirz-Justice, A., Martiny, K., Kantermann, T., Aarts, M. P. J., Zemmouri, N., Appelt, S., & Norton, B. (2020). Daylight: What makes the difference? *Lighting Research and Technology*, 52(3), 423–442. <https://doi.org/10.1177/1477153519869758>
- Koç, S. G., & Maçka Kalfa, S. (2021). The effects of shading devices on office building energy performance in Mediterranean climate regions. *Journal of Building Engineering*, 44(January). <https://doi.org/10.1016/j.jobe.2021.102653>
- Kompier, M. E., Smolders, K. C. H. J., van Marken Lichtenbelt, W. D., & de Kort, Y. A. W. (2020). Effects of light transitions on measures of alertness, arousal and comfort. *Physiology and Behavior*, 223, 112999. <https://doi.org/10.1016/j.physbeh.2020.112999>
- Kong, Z., Zhang, R., Ni, J., Ning, P., Kong, X., & Wang, J. (2022). Towards an integration of

- visual comfort and lighting impression: A field study within higher educational buildings. *Building and Environment*, 216(March).
<https://doi.org/10.1016/j.buildenv.2022.108989>
- Konstantzos, I., Sadeghi, S. A., Kim, M., Xiong, J., & Tzempelikos, A. (2020). The effect of lighting environment on task performance in buildings – A review. *Energy and Buildings*, 226, 110394. <https://doi.org/10.1016/j.enbuild.2020.110394>
- Korsavi, S. S., Zomorodian, Z. S., & Tahsildoost, M. (2016). Visual comfort assessment of daylit and sunlit areas: A longitudinal Field survey in Classrooms in Kashan, Iran. *Energy & Buildings*. <https://doi.org/10.1016/j.enbuild.2016.06.091>
- Kurniasih, S., Musdinar, I., & Rachmanto, B. N. (2020). *Daylight Intensity of Reading Room with Shading Device's Opening (Case Study: The Library of Universitas Budi Luhur, South Jakarta)*. 192(*EduARCHsia* 2019), 109–117.
<https://doi.org/10.2991/aer.k.200214.016>
- Kwon, M., Remøy, H., & van den Bogaard, M. (2019). Influential design factors on occupant satisfaction with indoor environment in workplaces. *Building and Environment*, 157(April), 356–365. <https://doi.org/10.1016/j.buildenv.2019.05.002>
- Lakhdari, K., Sriti, L., & Painter, B. (2021). Parametric optimization of daylight, thermal and energy performance of middle school classrooms, case of hot and dry regions. *Building and Environment*, 204(January), 108173.
<https://doi.org/10.1016/j.buildenv.2021.108173>
- Leccese, F., Salvadori, G., Tambellini, G., & Kazanasmaz, Z. T. (2020). Application of climate-based daylight simulation to assess lighting conditions of space and artworks in historical buildings: the case study of cetacean gallery of the Monumental Charterhouse of Calci. *Journal of Cultural Heritage*, 46, 193–206.

<https://doi.org/10.1016/j.culher.2020.06.010>

Lee Fallin, B. (hons) P. C. (2020). *Reading the Academic Library : an exploration of the conceived , perceived and lived spaces of the Brynmor Jones Library at the University of Hull. April.*

Li, D. H. W. (2010). A review of daylight illuminance determinations and energy implications. *Applied Energy*, 87(7), 2109–2118.
<https://doi.org/10.1016/j.apenergy.2010.03.004>

Li, S., Jiao, F., Zhang, Y., & Xu, X. (2019). Problems and Changes in Digital Libraries in the Age of Big Data From the Perspective of User Services. *Journal of Academic Librarianship*, 45(1), 22–30. <https://doi.org/10.1016/j.acalib.2018.11.012>

Mehta, D. (2020). A Review on Challenges of Daylight-Based-Classroom-Studies and their Methodology Regarding Architectural-Design-Process. *International Journal of Innovative Research in Science Engineering and Technology*, October 2020.
<https://doi.org/10.15680/IJRSET.2020.0910092>

Mohamedali, A. (2017). *A Methodology for Daylighting Optimisation in Academic Libraries : Case Study of EMU Main Library. March.*

Nasrollahi, N., & Shokry, E. (2020). Parametric analysis of architectural elements on daylight, visual comfort, and electrical energy performance in the study spaces. *Journal of Daylighting*, 7(1), 57–72. <https://doi.org/10.15627/jd.2020.5>

Natalia G Vasquez et al. (2022). *Effects of indoor lighting conditions and window views on occupants ' well-being and behavior : a systematic review . Effects of indoor lighting conditions and window views on occupants ' well-being and behavior : a systematic review .* <https://doi.org/10.1088/1755-1315/1099/1/012053>

- Onuorah, A. R. (2021). Influence of Story Books at Children's Library on Reading Culture of Pupils in Public Primary Schools. *Library Philosophy and Practice*, 2021, 1–19.
- Opara, G. C., Ugwuogu, U. O., & Oliver, C. U. (2018). National library : Conceptual explanation , historical development , functions and organizational structure national library; Conceptual. *Anatomy of Libraries and Information Centers*, September, 67–80. https://www.researchgate.net/publication/327780977_National_Library_Conceptual_explanation_Historical_development_functions_and_organizational_Structure#fullTextFileContent
- Osibona, O., Solomon, B. D., & Fecht, D. (2021). *Lighting in the Home and Health : A Systematic Review*.
- Othman, A. R., & Mazli, M. A. M. (2012). Influences of Daylighting towards Readers' Satisfaction at Raja Tun Uda Public Library, Shah Alam. *Procedia - Social and Behavioral Sciences*, 68, 244–257. <https://doi.org/10.1016/j.sbspro.2012.12.224>
- Owusu-Ansah, C. M., Rodrigues, A. da S., & van der Walt, T. B. (2019). Integrating digital libraries into distance education: A review of models, roles, and strategies. *Turkish Online Journal of Distance Education*, 20(2), 89–104. <https://doi.org/10.17718/tojde.557742>
- Pilechiha, P., Mahdavinejad, M., Pour Rahimian, F., Carnemolla, P., & Seyedzadeh, S. (2020). Multi-objective optimisation framework for designing office windows: quality of view, daylight and energy efficiency. *Applied Energy*, 261. <https://doi.org/10.1016/j.apenergy.2019.114356>
- Rafi, M., JianMing, Z., & Ahmad, K. (2019). Technology integration for students' information and digital literacy education in academic libraries. *Information Discovery and Delivery*, 47(4), 203–217. <https://doi.org/10.1108/IDD-07-2019-0049>

- Rahman, M. S. (2020). Challenges and Initiatives of Digital Library System and Institutional Repository: Bangladesh Scenario. *The Eastern Librarian*, 25(1), 1–23.
- Ranganathan, S. R. (1951). *Philosophy of library classification*. 133.
- Reinhart, C. F., & Walkenhorst, O. (2001). Validation of dynamic RADIANCE-based daylight simulations for a test office with external blinds. *Energy and Buildings*, 33(7), 683–697. [https://doi.org/10.1016/S0378-7788\(01\)00058-5](https://doi.org/10.1016/S0378-7788(01)00058-5)
- Richard, E., & Foundations, R. G. (2020). *Foundations of Library and Information Science*. 5th Ed. Chicago: Neal-Schuman. 627 Seiten. 47(1), 174–176. <https://doi.org/https://doi.org/10.1515/bfp-2022-0079> Zu
- Saraswati, R. S., Wibawa, B. A., Saputra, B. E., Path, P., Increasing, I., Safety, T., Prihatiningrum, A., Anom, P., & Seftyarizki, D. (2021). *The Role of Artificial Lighting in Architectural Design: A Literature Review*. *The Role of Artificial Lighting in Architectural Design: A Literature Review*. <https://doi.org/10.1088/1755-1315/665/1/012008>
- Saunders, L. (2019). Core and more: Examining foundational and specialized content in library and information science. *Journal of Education for Library and Information Science*, 60(1), 3–34. <https://doi.org/10.3138/jelis.60.1.2018-0034>
- Sengupta, E., Blessinger, P., & Cox, M. D. (2020). Introduction to Designing Effective Library Learning Spaces in Higher Education. *Introduction to Designing Effective Library Learning Spaces in Higher Education*, 21(1), 1–9. <https://doi.org/https://doi.org/10.1108/S2055-364120200000029001>
- Shafavi, N. S., Zomorodian, Z. S., Tahsildoost, M., & Javadi, M. (2020). Occupants visual comfort assessments: A review of field studies and lab experiments *International*

- Commission on Illumination Degree of Eye Opening. *Solar Energy*, 208(May), 249–274.
<https://doi.org/10.1016/j.solener.2020.07.058>
- Sharifabadi, S. R. (2006). How digital libraries can support e-learning. *Electronic Library*, 24(3), 389–401. <https://doi.org/10.1108/02640470610671231>
- Shirzadnia, Z., Goharian, A., & Mahdavinejad, M. (2023). Designerly approach to skylight configuration based on daylight performance; toward a novel optimization process. *Energy and Buildings*, 286(March), 112970. <https://doi.org/10.1016/j.enbuild.2023.112970>
- Shishegar, N., & Boubekri, M. (2016). Natural Light and Productivity: Analyzing the Impacts of Daylighting on Students' and Workers' Health and Alertness. *International Journal of Advances in Chemical Engineering and Biological Sciences*, 3(1). <https://doi.org/10.15242/ijacebs.ae0416104>
- Ślipek, M., M, S. K., Zukowska, D., & Kolarik, J. (2017). Visual Comfort Evaluation in Residential Buildings : a Simulation-Based Study. *Luxeurpopa*, September.
- Steffy, G. (2002). *Architectural lighting design*.
- Su, X., Zhang, L., Liu, Z., Luo, Y., Lian, J., & Liang, P. (2020). Daylighting performance simulation and analysis of translucent concrete building envelopes. *Renewable Energy*, 154, 754–766. <https://doi.org/10.1016/j.renene.2020.03.041>
- Tabadkani, A., Roetzel, A., Li, H. X., & Tsangrassoulis, A. (2020). A review of automatic control strategies based on simulations for adaptive facades. *Building and Environment*, 175(January), 106801. <https://doi.org/10.1016/j.buildenv.2020.106801>
- Tekce, I., Artan, D., & Ergen, E. (2020). An empirical study of visual comfort in office buildings. *Smart Innovation, Systems and Technologies*, 200(September), 319–331.

https://doi.org/10.1007/978-981-15-8131-1_29

Verma, A. A., Iyengar, S. R. S., Setia, S., & Dubey, N. (2021). An open source library to parse and analyze online collaborative knowledge-building portals. *Journal of Internet Services and Applications*, 12(1). <https://doi.org/10.1186/s13174-021-00142-x>

Wirz-Justice, A., Skene, D. J., & Münch, M. (2021). The relevance of daylight for humans. *Biochemical Pharmacology*, 191, 114304. <https://doi.org/10.1016/j.bcp.2020.114304>

Xue, J., Wang, Y., & Wang, M. (2021). Smart design of portable indoor shading device for visual comfort—a case study of a college library. *Applied Sciences (Switzerland)*, 11(22). <https://doi.org/10.3390/app112210644>

Yousefi, S. (2022). *Analysis of Persian Wikipedia Articles in the Field of Library and Information Science. 1*, 103–122.

Appendix

Presentation Drawing

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY, IBADAN, OYO STATE.

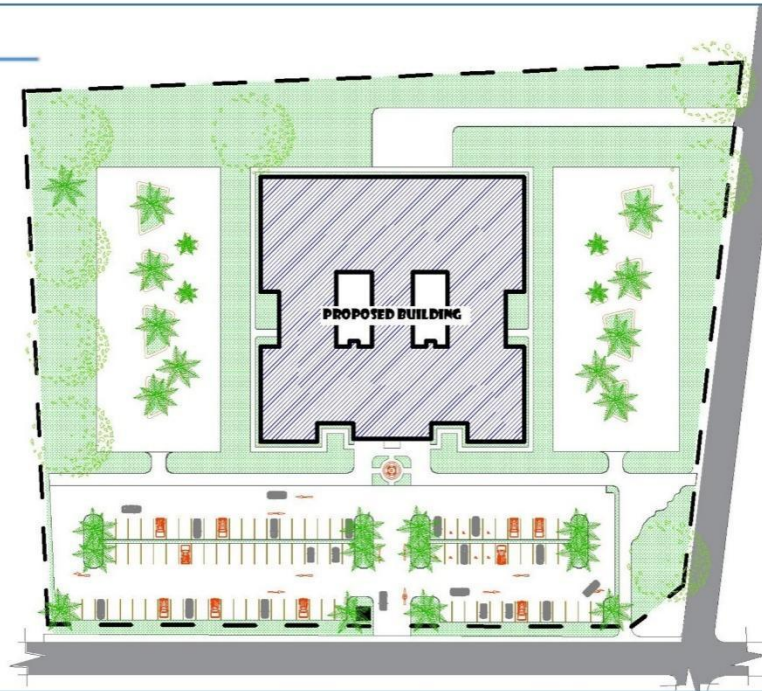


PRESENTED BY
FAYOMI, DANIEL OLUWADAMILARE
 LCU/PG/002816

CRITICS:
 DR. ARC ADEDIRE FUNMILAYO M.
 DR. ARC OBALEYE OLUDARE J.
 ARC. AJIOLA S. OLUWAKEMI



SITE PLAN



NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

29

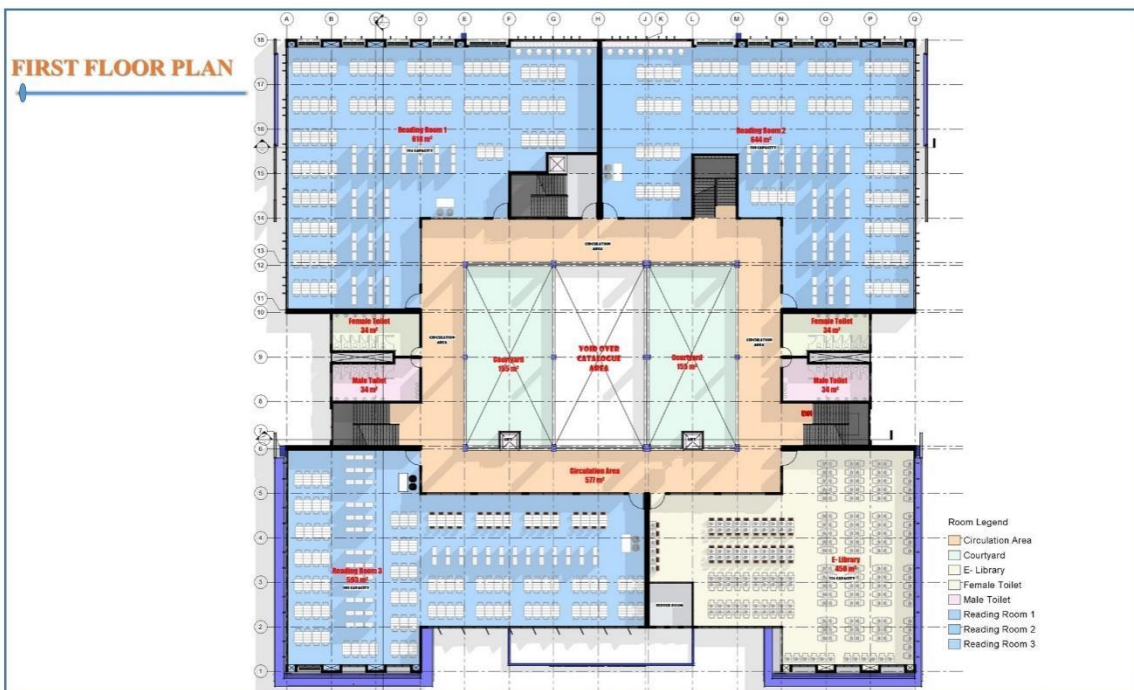


NAME: FAYOMI, DANIEL OLUWADAMILARE
MARTIC NO: LCU/PG/002816
COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUWARE J.
 • ARC. AJIOLA S. OLUWAKEMI

30

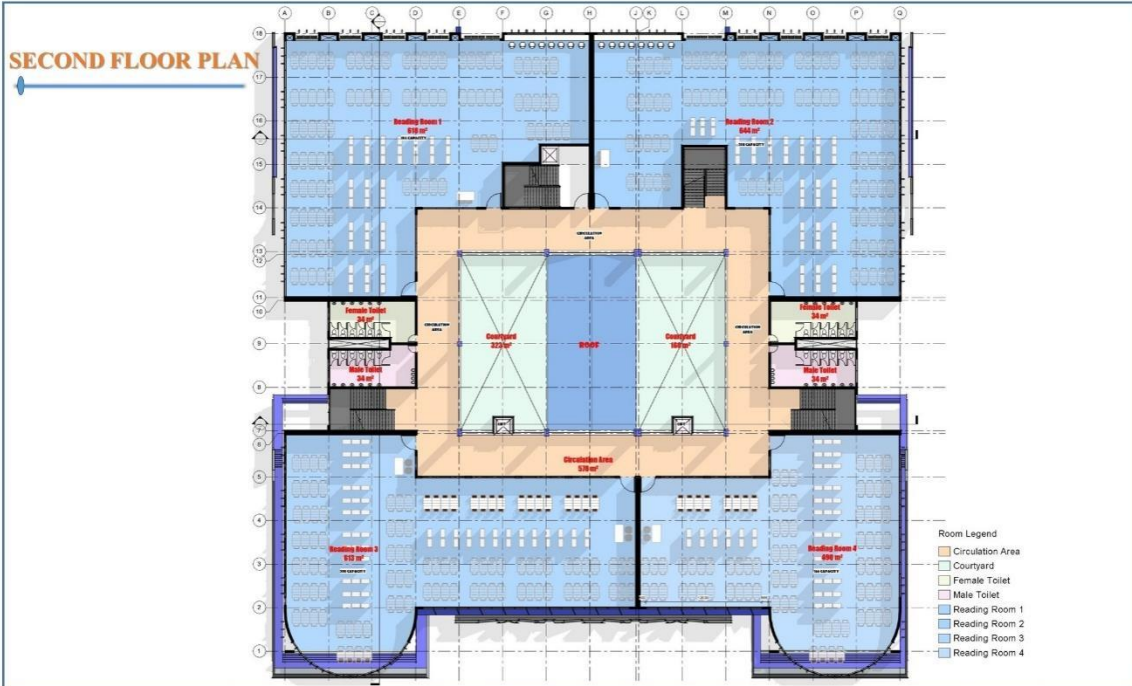


NAME: FAYOMI, DANIEL OLUWADAMILARE
MARTIC NO: LCU/PG/002816
COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUWARE J.
 • ARC. AJIOLA S. OLUWAKEMI

31

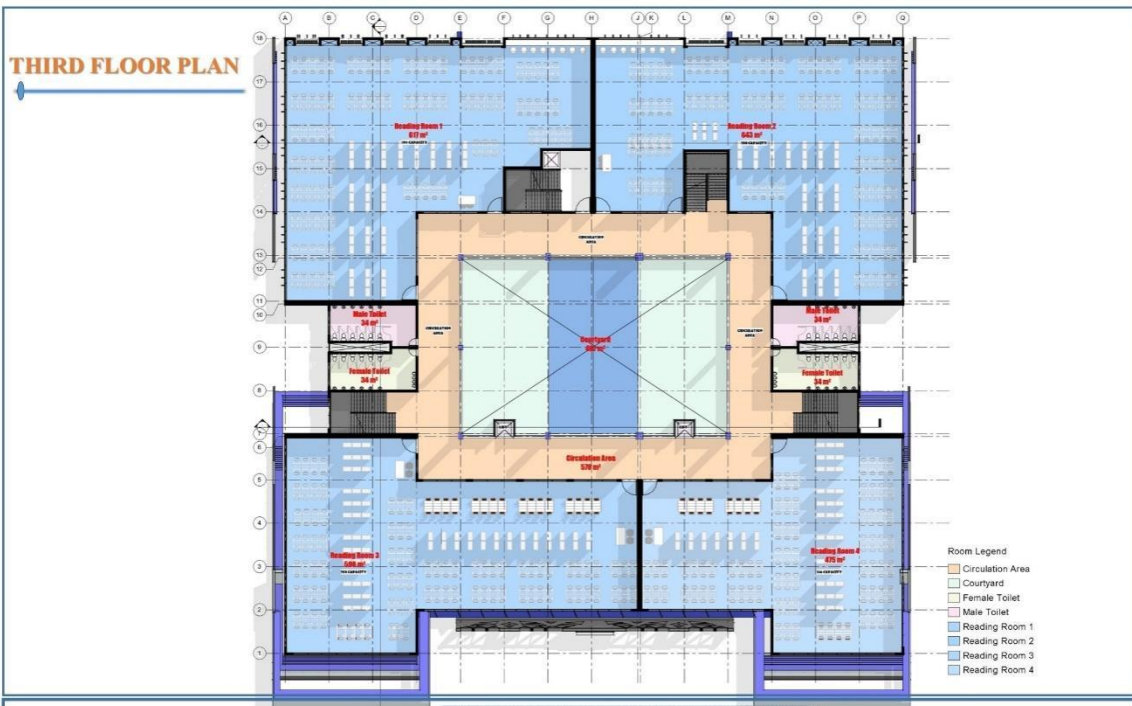


NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

32

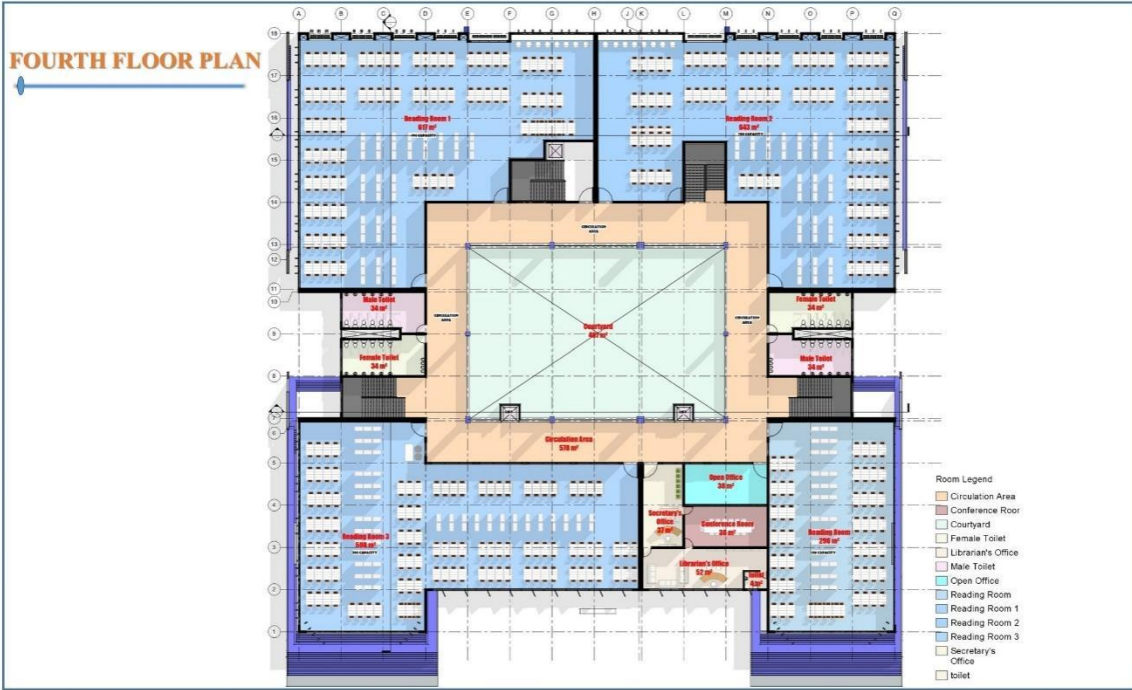


NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

33



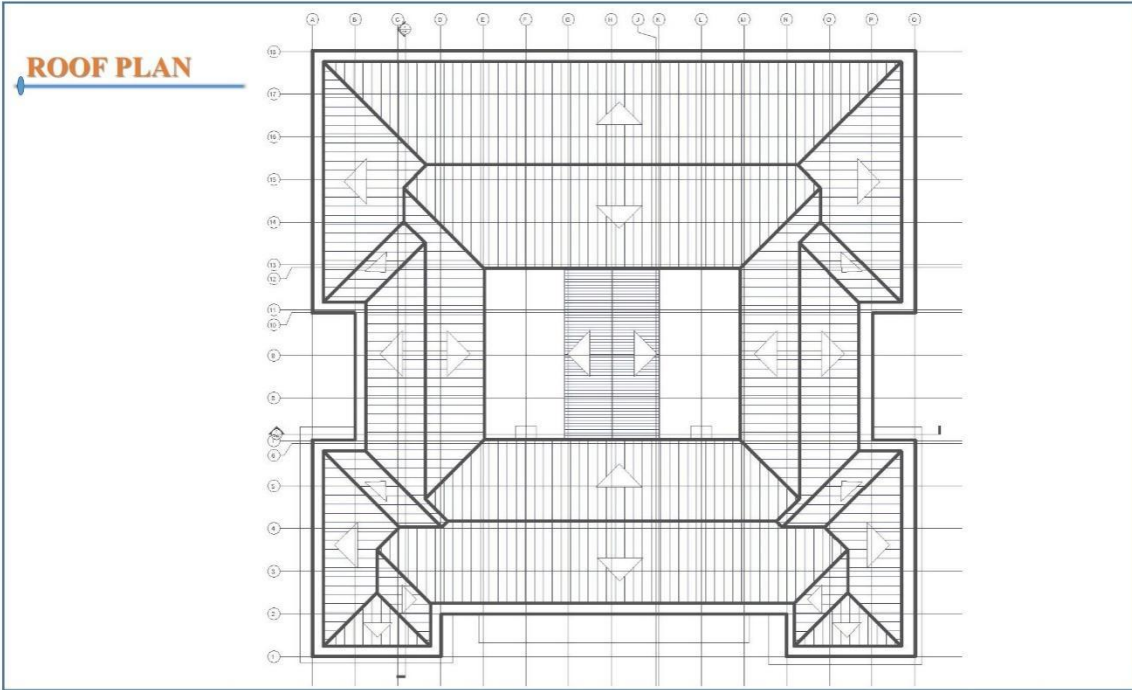
FOURTH FLOOR PLAN

NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

34



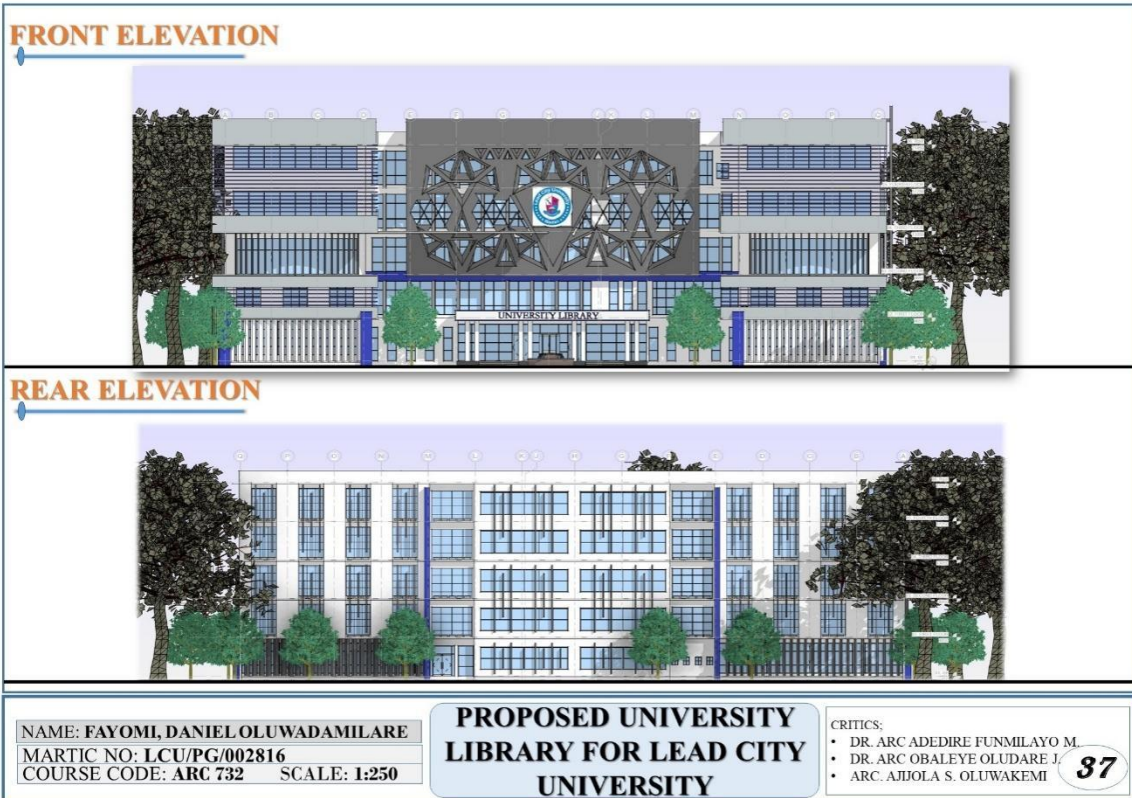
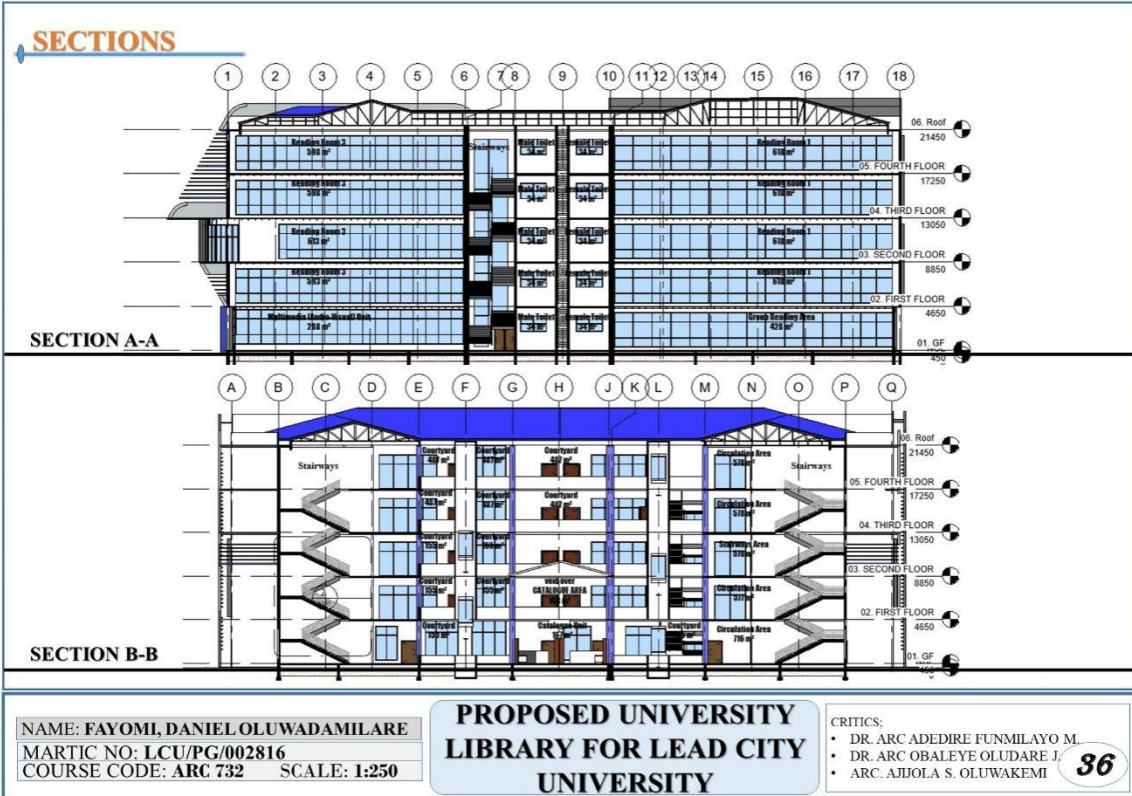
ROOF PLAN

NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

35



RIGHT ELEVATION



LEFT ELEVATION



NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

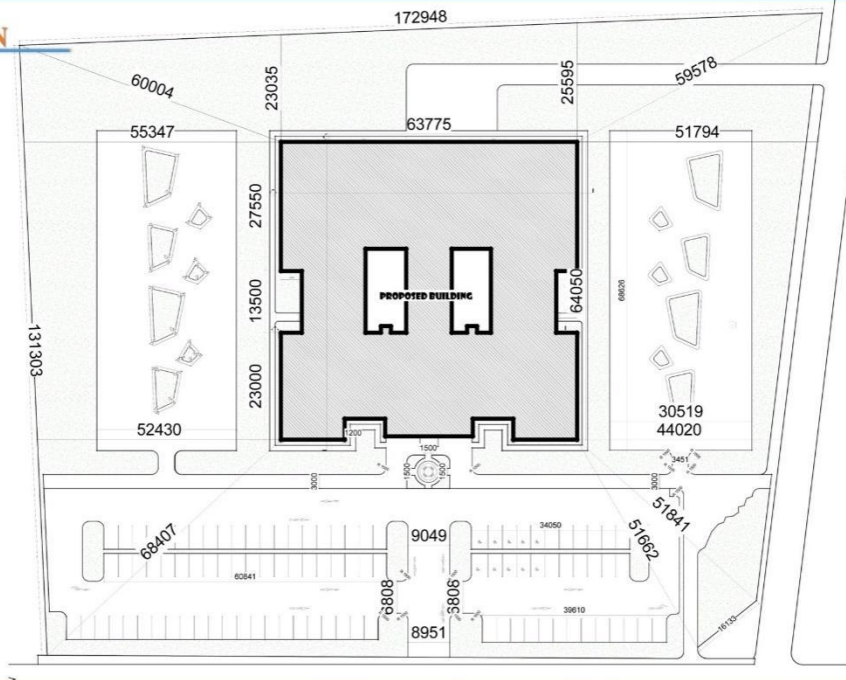
**PROPOSED UNIVERSITY
 LIBRARY FOR LEAD CITY
 UNIVERSITY**

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

38

City
Working Drawings

SITE PLAN

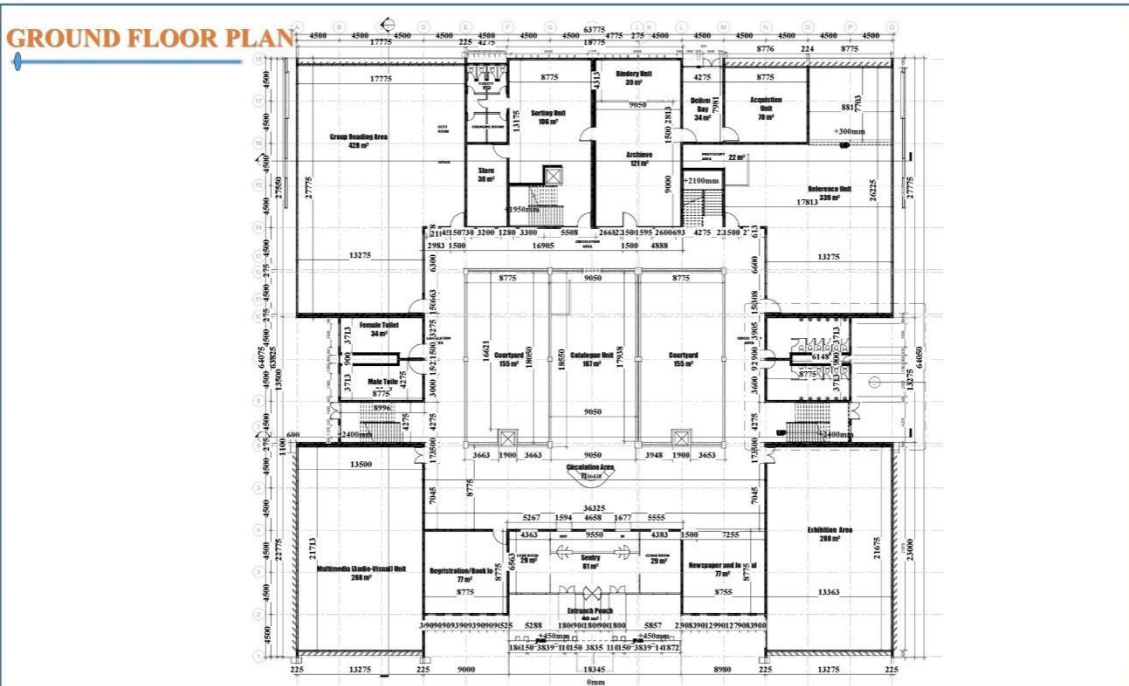


NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:500**

**PROPOSED UNIVERSITY
 LIBRARY FOR LEAD CITY
 UNIVERSITY**

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

39

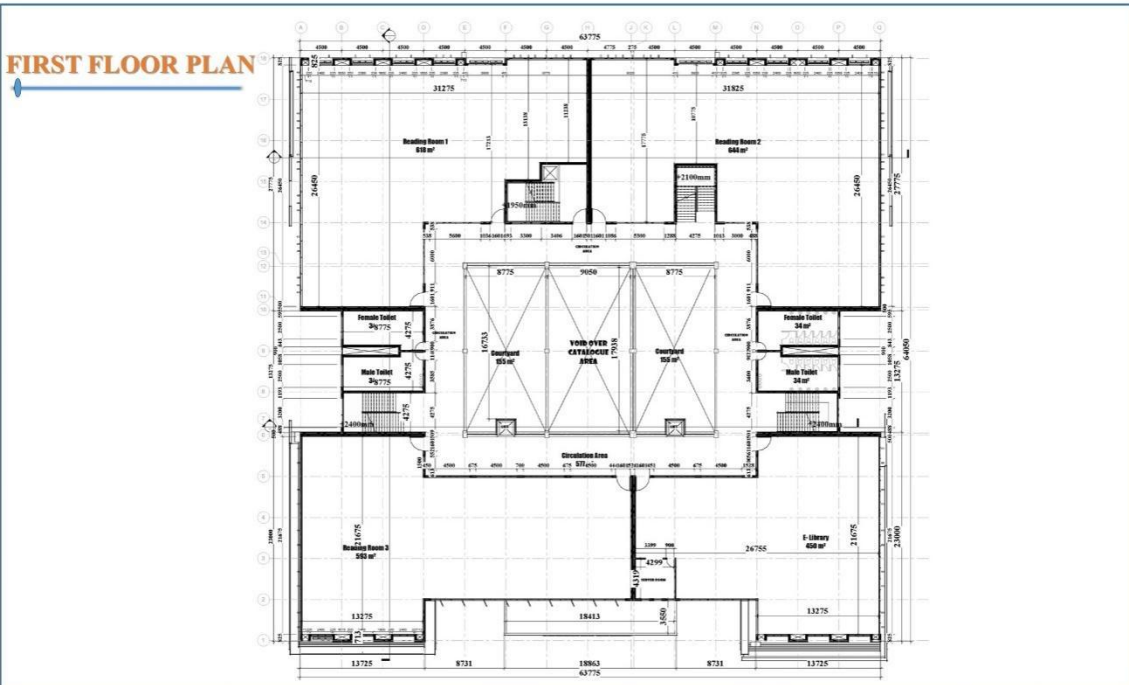


NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

40



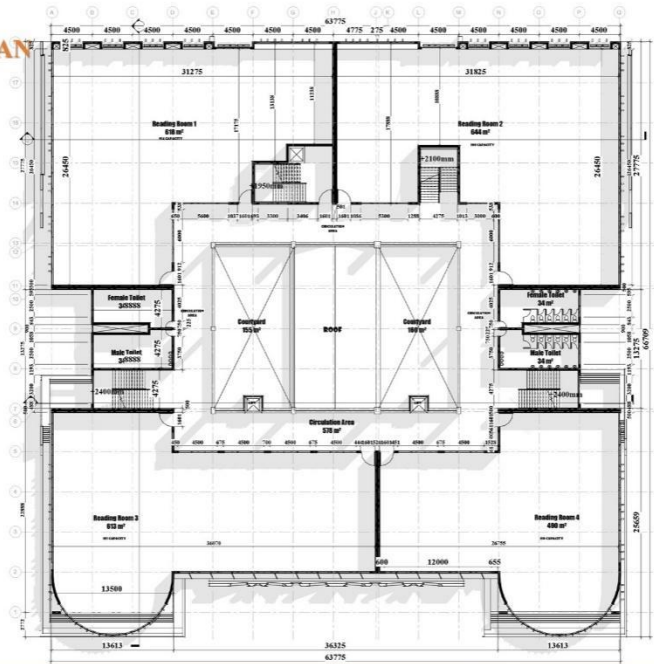
NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

41

SECOND FLOOR PLAN



NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

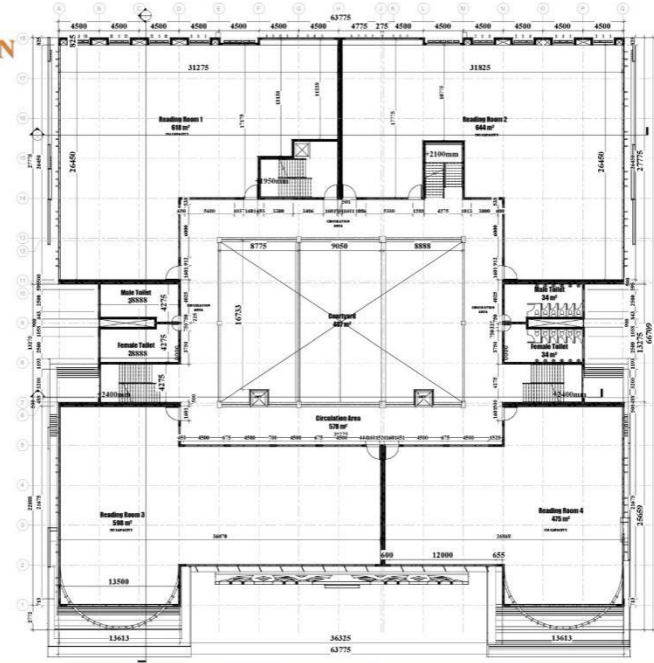
PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

42



THIRD FLOOR PLAN



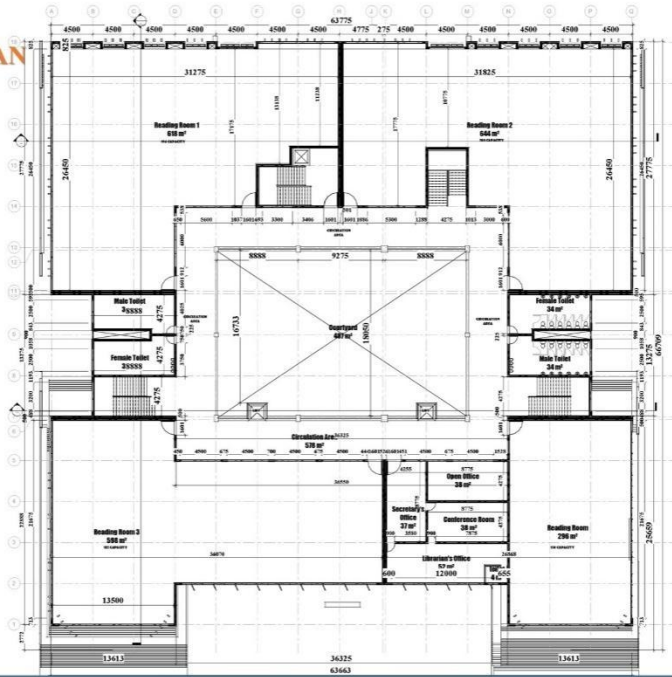
NAME: FAYOMI, DANIEL OLUWADAMILARE
 MARTIC NO: LCU/PG/002816
 COURSE CODE: ARC 732 SCALE: 1:250

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

43

FOURTH FLOOR PLAN



NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

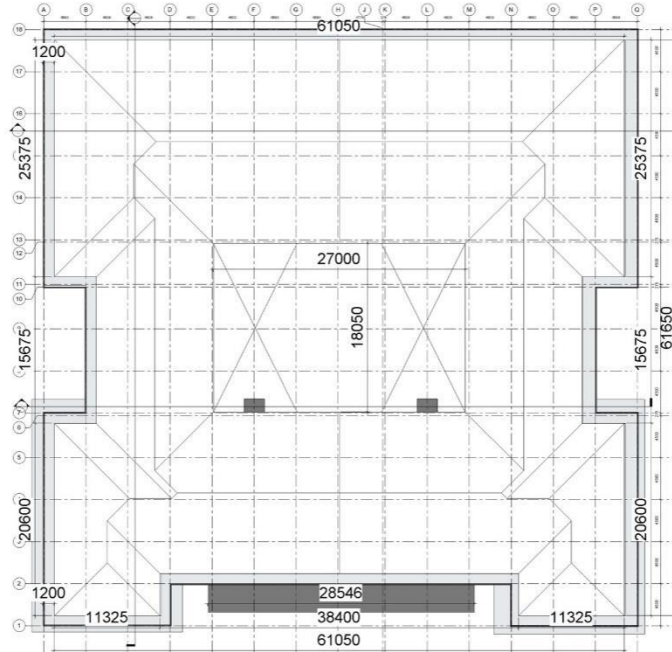
PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

44



ROOF PLAN

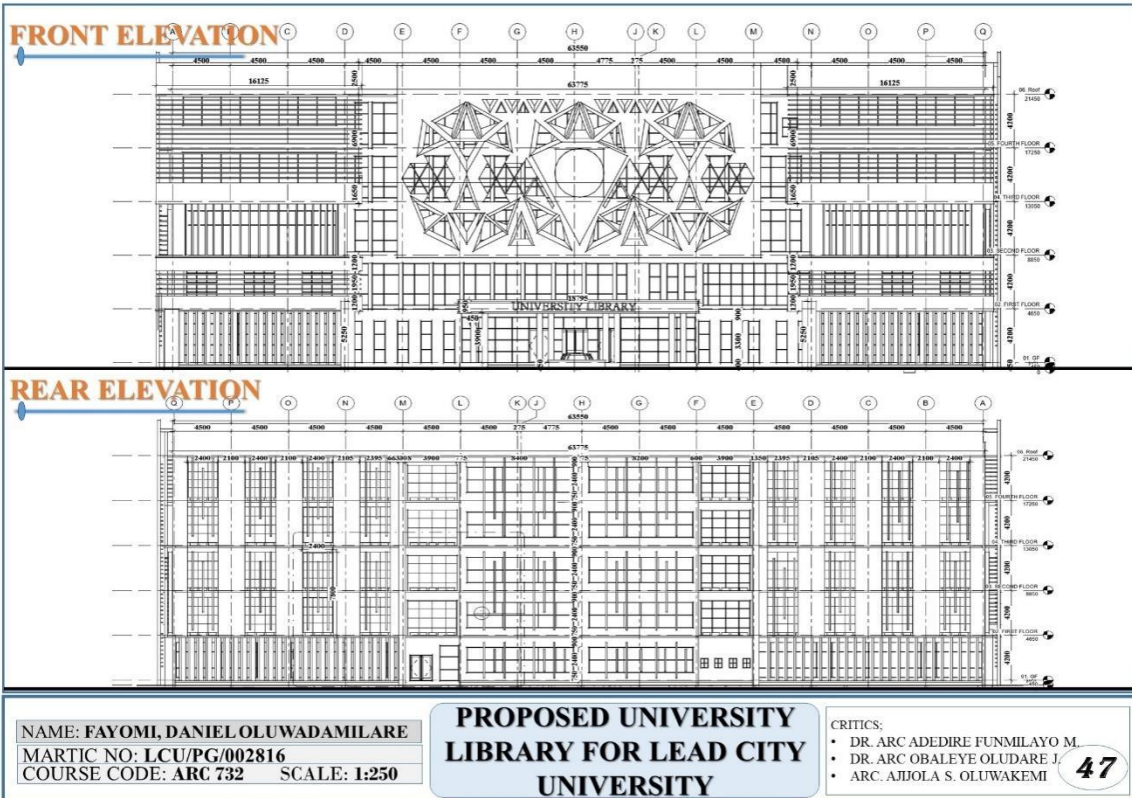
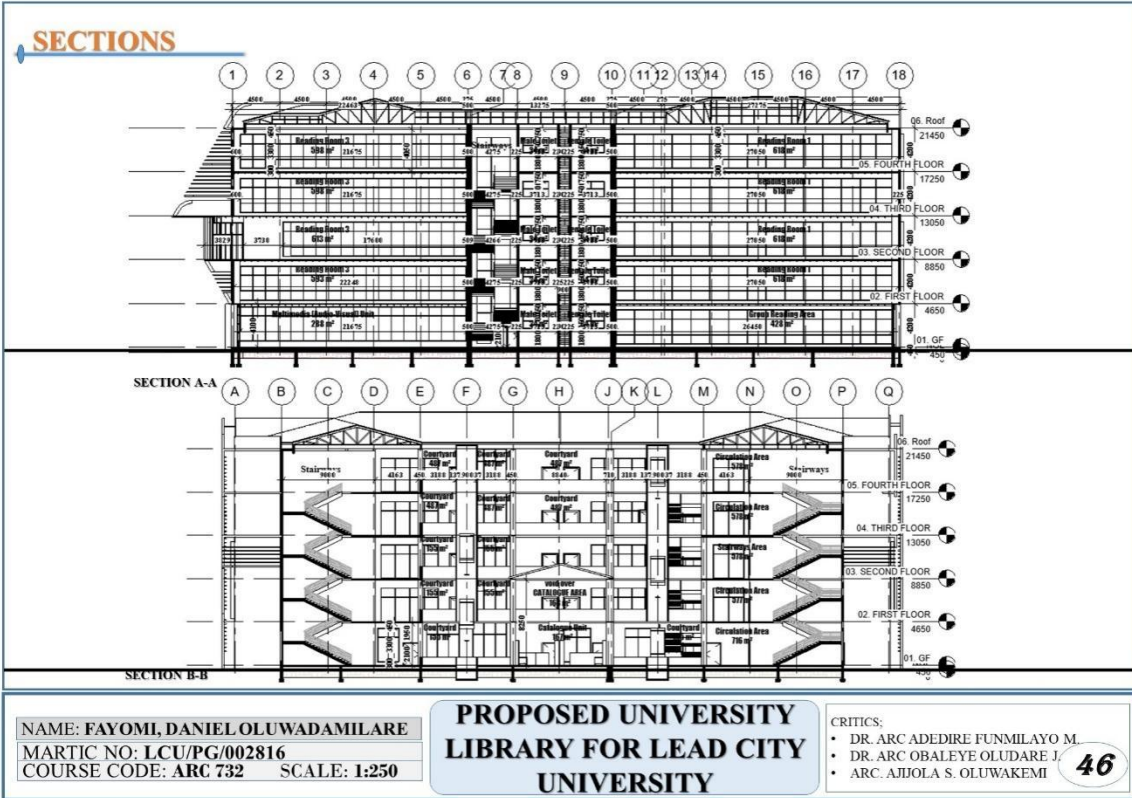


NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

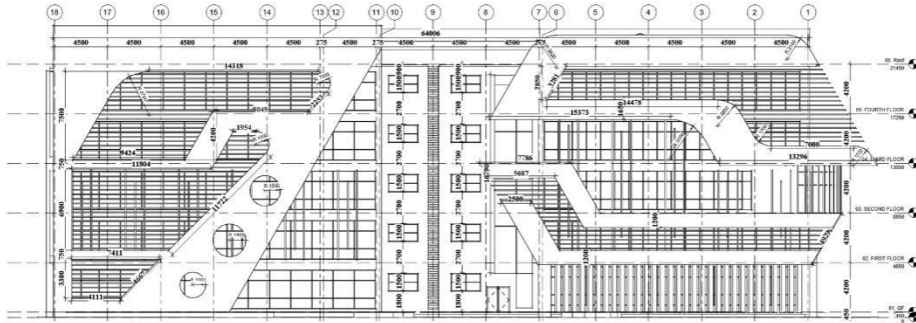
PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

45



LEFT AND RIGHT ELEVATION



NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **1:250**

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

48

INTERIOR VIEWS



NAME: **FAYOMI, DANIEL OLUWADAMILARE**
 MARTIC NO: **LCU/PG/002816**
 COURSE CODE: **ARC 732** SCALE: **NTS**

PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY

CRITICS:
 • DR. ARC ADEDIRE FUNMILAYO M.
 • DR. ARC OBALEYE OLUDARE J.
 • ARC. AJIOLA S. OLUWAKEMI

49

3D Views

EXTERIOR VIEWS

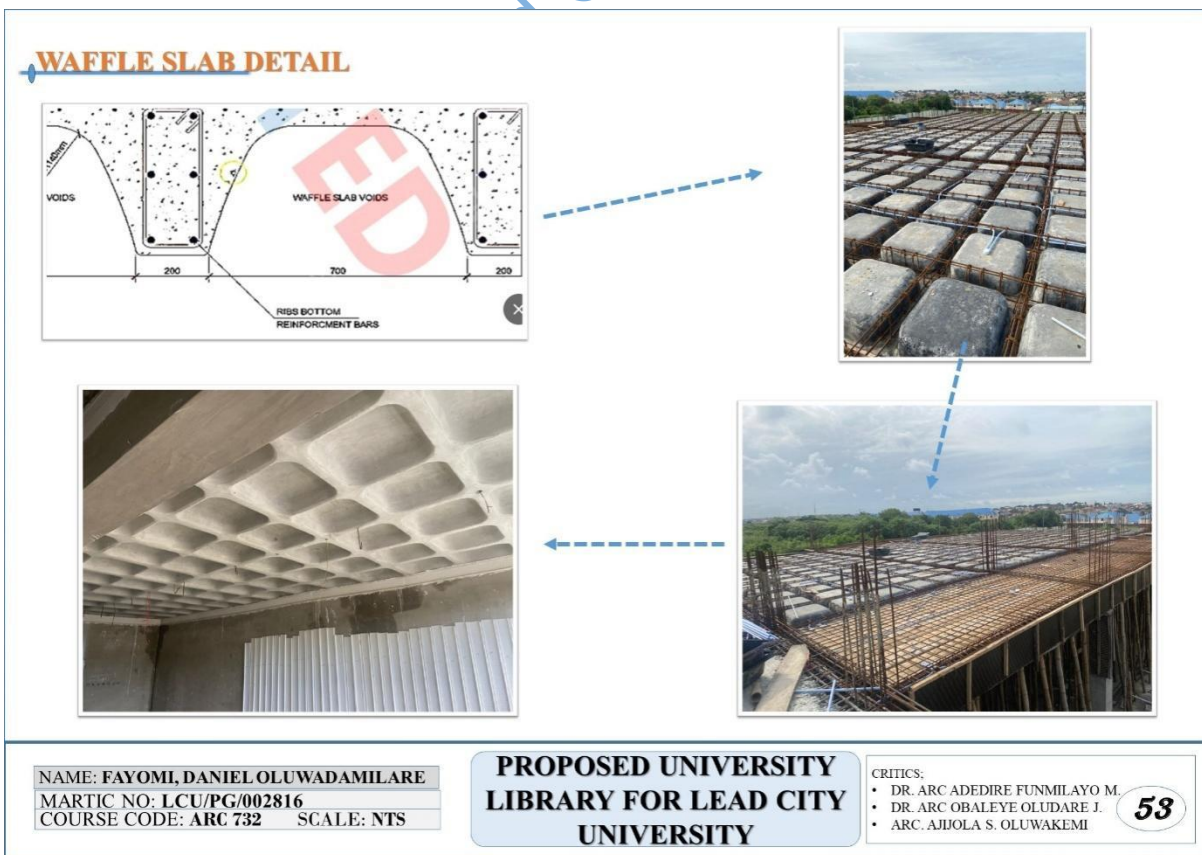
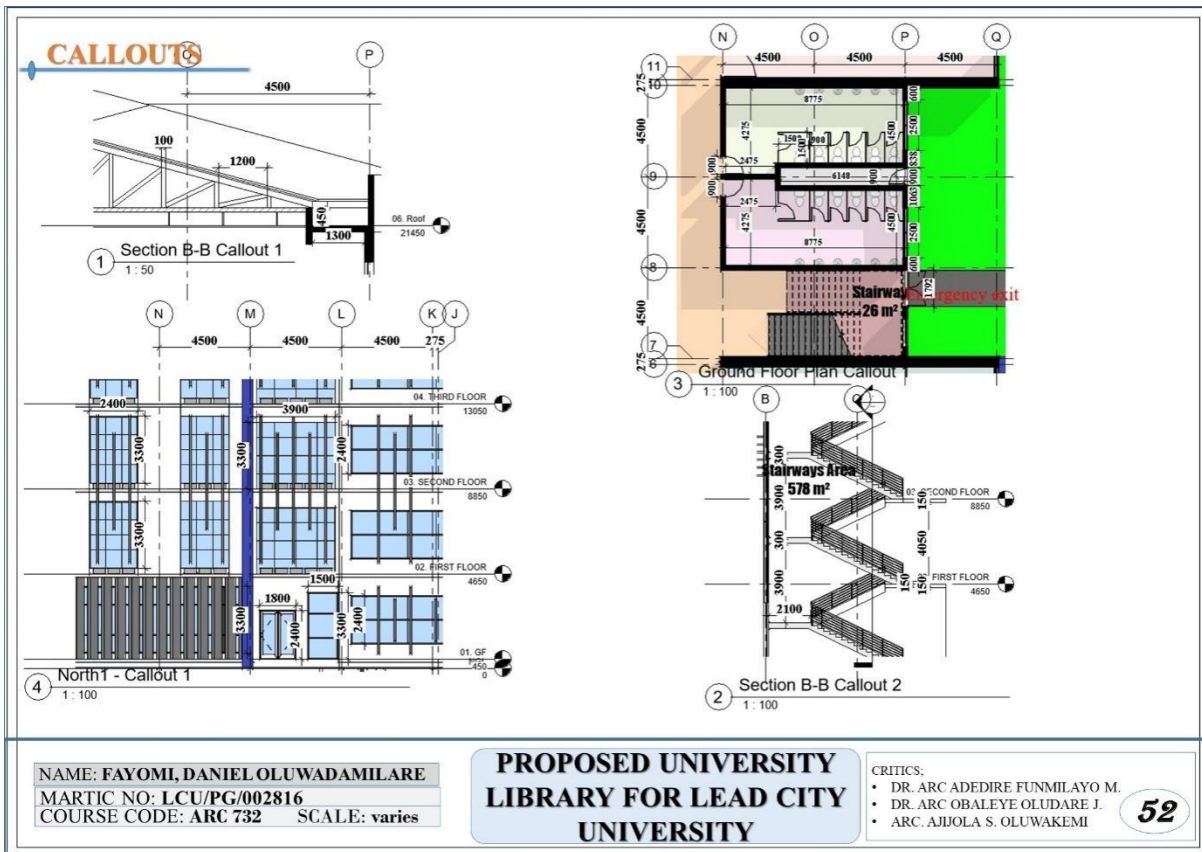
NAME: FAYOMI, DANIEL OLUWADAMILARE MARTIC NO: LCU/PG/002816 COURSE CODE: ARC 732 SCALE: NTS	PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY	CRITICS: • DR. ARC ADEDIRE FUNMILAYO M. • DR. ARC OBALEYE OLUDARE J. • ARC. AJIOLA S. OLUWAKEMI	50
---	---	--	-----------

LCU

EXTERIOR VIEWS

NAME: FAYOMI, DANIEL OLUWADAMILARE MARTIC NO: LCU/PG/002816 COURSE CODE: ARC 732 SCALE: NTS	PROPOSED UNIVERSITY LIBRARY FOR LEAD CITY UNIVERSITY	CRITICS: • DR. ARC ADEDIRE FUNMILAYO M. • DR. ARC OBALEYE OLUDARE J. • ARC. AJIOLA S. OLUWAKEMI	51
---	---	--	-----------

Details



Student's Biodata

A. Personal Data

Full Name: **FAYOMI Daniel Oluwadamilare,**

Address: 9, Feyi Adewebi Street, Ibeshe, Ikorodu, Lagos State.

Email Adress: fayomidamiilare00@gmail.com

Phone Number: 08149484419

Date of Birth: 2nd April 2000,

Place of Birth: Ikorodu, Lagos state

Nationality: Nigerian

Marital Status: Single

Name of Next of Kin: **FAYOMI** Olutayo Gabriel

Address: 9, Feyi Adewebi Street, Ibeshe, Ikorodu, Lagos State.

B. Educational Background

i. Institutions attended with Dates

Lead City University, Ibadan, Oyo State.	2021 – till date
Lead City University, Ibadan, Oyo State.	2018 – 2021
Landmark College Secondary School, Ikorodu, Lagos state.	2009 – 2015
Great Omega Nur/Pry School. Ibeshe, Ikorodu, Lagos state.	2007 – 2009

ii. Qualifications with Dates

Bachelor of Science	2021
---------------------	------

National Examinations Council	2015
Secondary School Certificate Examination	2015
Primary School Leaving Certificate	2009

C. Work Experience with Dates

Decent Design and Construction Limited, Abeokuta, Ogun state Abeokuta, Ogun State.	2020 – 2023
I-KLASS integrated services Ibadan, Oyo State.	2021 & 2023
ADEBOYE Design Consultants (SWIES) Fadeyi, Lagos State	2019(June –September)
Lekan Lawal and Associates (SWIES) Obanikoro, Lagos State	2019(June –September)

D. Publications:

Use of Daylighting Strategies in Selected University Libraries.

Daniel Oluwadamilare FAYOMI¹, Adenike Abiodun OLUGBESAN², Funmilayo
Mokunfayo ADEDIRE³ and Adebayo Moses AKINYEMI⁴.

^{1 2 3 4}Department of Architecture, Lead City University, Ibadan, Oyo State, Nigeria.

¹Corresponding author E-mail: fayomidamilare00@gmail.com T: +234-8149484419.

Signature

Date

University compliance form

This is to certify that thesis by Fayomi Daniel Oluwadamilare with Matriculation Number LCU/PG/002816 in the Department of Architecture, Faculty of Environmental Design and Management, Lead City University, Ibadan is in full compliance with the approval of the University's format and style.

Signature

Date

Do Not Copy, Lead City University, Nigeria

FAYOMI_DANIEL_OLUWADAMIL ARE_MSc.docx LCU LIBRARY

by Fayomi_daniel_oluwadamilare_msc.docx
Fayomi_daniel_oluwadamilare_msc.docx

Submission date: 12-Sep-2023 07:23PM (UTC+0100)

Submission ID: 2164315594

File name: FAYOMI_DANIEL_OLUWADAMILARE_MSc.docx (17.28M)

Word count: 24034

Character count: 146969

FAYOMI_DANIEL_OLUWADAMILARE_MSc.docx LCU LIBRARY

ORIGINALITY REPORT

7%

SIMILARITY INDEX

7%

INTERNET SOURCES

0%

PUBLICATIONS

3%

STUDENT PAPERS

PRIMARY SOURCES

1

engineering.mu.edu.iq

Internet Source

4%

2

alltutorialswiz.blogspot.com

Internet Source

2%

3

www.archdaily.com

Internet Source

1%

Exclude quotes Off

Exclude matches < 1%

Exclude bibliography On