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BDS 413: PROJECT PAPER

(INTERIOR DESIGN SPECIALIZATION)

APPLICATION OF BIOMIMICRY AND DECORATIVE FULANI PATTERNS FOR RECREATING A FUNCTIONAL GUEST RESTAURANT FOR ADULTS

A Case Study of the Aquarium Guest Restaurant

By:

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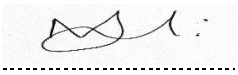
DECLARATION

I hereby declare that to the best of my ability, the research paper that I present to you is an authentic and original piece of work and has not been presented to this or any other academic examination towards any qualification. Furthermore, I wish to clarify that I have observed all the rules that appertain to the APA referencing style in all the peer-reviewed articles and internet resource materials that I have used.

JAMES MWANGI MURIITHI

Signature  Date :14/4/2020

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DEDICATION

I dedicate this to my lovely family. You have inspired me and enabled me to do my work as well as guided me well in the ways of the Lord. You have taught me great principles in life, independence and to believe in myself. You have given me support and enabled me to carry out my research by providing means that have made the process a success. You have also encouraged me to work smart and to the best of my ability. With that, I can’t thank you enough.

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God bless you all.

ABSTRACT

This research recognizes that nature is the best source of inspiration when it comes to design for it has evolved over the years successfully creating solutions to design problems. The research will sort to find out challenges at Aquarium guest home in relation to the restaurant area and using Biomimicry as a philosophy, give out recommendations which will lead to a more comfortable and functional design solution. Biomimicry as a concept is basically “Nature inspired design”. It is through Biomimicry that designers can copy from how nature solves its problems to design solutions using Biomimicry principles, elements, levels and approaches. Together with Biomimicry, the research will also delve into contemporary African art specifically the Fulani art patterns. The use of these patterns in the enhancement of the aesthetics of the components and systems proposed through Biomimicry design will form the basis of the integration of the two concepts. This will provide a solution to the problems affecting the interior architecture, furniture design, exhibition and display and landscape design of the area under investigation.

The research will also highlight some of the world-renowned designers applying biomimicry as a philosophy in their work and will also look more into Africa as a continent rich in Biodiversity. Nonetheless, it will provide exemplars of Biomimicry using the case study format and Fulani art examples under its discussion. The research will target the adults using the restaurant which comprises of the reception, dining area, bar area, seating area, washing area, kitchen, outdoor choma zone, and its landscape to help come up with a more functional design solution.

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List of Acronyms / Abbreviations

LED Bulbs – Light Emitting Diode Bulbs

UV– Ultra Violet

UK– United Kingdom

USA– United States of America

Operational Definition of Terms

Aesthetic: Concerned with the study of the mind and emotions in relation to the sense of beauty.

Biomimicry: Is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies.

Biodiversity: Variability amongst living organisms.

Contemporary: Modern- day characteristics associated with a particular trend in design, lifestyle of a society or a group with a common interest.

Design Process: A decision-making process that is involved in any design, whether it is architectural, graphic or something abstract like a business model or idea. It maintains that the ultimate goal of every design process, however is to meet the desired needs of a client and the end user. This requires the involvement of a standard objective in addition to the project criteria.

Interior Design: Is defined as a multi-faceted profession in which creative and technical solutions are applied within a space to achieve a built environment. These solutions are functional and enhance the quality of life and culture of the occupants and are stylish.

Qualitative: is a scientific method of observation to gather non-numerical data.

Quantitative: is a scientific method of observation to gather non-numerical data. Visual trait.

Sustainable Design: A group of people's characteristics, defined by everything from language, religion, cuisine, social habits, music, and arts. He refers to culture as a human capacity that t is universal.

CHAPTER 1: INTRODUCTION TO THE STUDY

1.1 Introduction

This chapter will give brief background information of the study, stating the problem, objective and emerging research questions giving significance, limitations and the scope of study of the same

1.2 Background of the Study

Gunther (2016, p. 15), states that interior design is a professionally conducted, practice-based process of planning and realization of interior spaces and the elements within. Interior design is concerned with the function and operation of the space, its safety and efficiency, its aesthetics and its sustainability. According to Kroes (2012, p. 302), the work of an interior designer draws upon many other disciplines, such as environmental psychology, architecture, product design and, aesthetics, in relation to a wide range of building spaces including hotels, corporate and public spaces, schools, hospitals, private residences, shopping malls, restaurants, theaters and airport terminals.

The word Biomimicry comes from Bios meaning life and Mimesis meaning to copy. It is all about being sensitive to the environment, minimizing carbon emission with designers trying to get new ways of recycling energy by observing and copying how nature solves its problems in designing solutions. Locally there is lack of application, especially in restaurants and guest accommodation joints. The Aquarium guest house was picked for the investigation because it has not paid attention to nature and inspirations from it in the designing of systems, components and facilities that are Biomorphic Forms & Patterns that can create spaces that are comfortable and captivating (Biomimicry Institute, 2020).

Ahmar (2011) provides a research that shows that views of nature have an impact on our psychology and physiology. Likewise, natural elements and even

representations of them using Biomorphic Forms & Patterns create spaces that are "comfortable and captivating. Connecting to nature in this way allows us to draw on geometric design patterns for inspiration. Avoiding right angles and straight lines for more organic movement within a space or using the Fibonacci series to create proportion are two examples of applied geometry in design. From large, 3-dimensional structures that evoke honeycombs to cosmetic details that mimic vine growth, Biomorphic Forms & Patterns bring nature to life and reduce stress within our environment. And, it works at a large or small scale. Geometry also comes into play through the biophilic design pattern of Complexity & Order. Rooted in research on fractal geometries, Complexity & Order concerns our responses to fractals in nature, art and architecture (Mc Harg, 2019, p. 13). In spaces that utilize Complexity & Order, we tend to feel less stress and more engagement. This is because they reveal rich sensory information similar to what we encounter in nature – the sweet spot between uninteresting and over-stimulating (Love, 2013, p. 119).

The goal of designing with this pattern for restaurants like the Aquarium guest resort is to create an enriching environment based on an understanding of the symmetries, fractal geometries and spatial hierarchies found in nature. The more complex a system is, the more ordered it becomes. The more ordered it is, the more at-ease we feel. Humans instinctively gravitate to visually interesting spaces. By understanding the mathematics behind complex design and using nature as a guide, we can bring more of what's outside into our built environment (Trott, 2012, p.321).

1.3 Statement of the Problem

Appealing livable spaces and environments require healthy, efficient and contemporary aesthetic designs to motivate the taskforce to work in them. The Aquarium guest restaurant has not adequately utilized its exterior and interior spaces to create nature inspired systems and components that are functional, aesthetically appealing and livable to its staff and clients.

1.4 Objectives of the Study

1.4.1 Main Objective

1. To investigate ways in which Biomimicry can be applied in the hotel's design and to propose other ways in which Fulani art patterns can be added in the aesthetic design look at the Aquarium guest restaurant.

1.4.2 Specific Objectives

1. To determine how Biomimicry has currently been applied in interior design, furniture design. Landscaping and exhibition and display in Aquarium guest restaurant.
2. To investigate different ways in which Biomimicry can be applied in design of Aquarium guest restaurant.
3. To propose ways in which contemporary Fulani art patterns can be applied in enhancing the aesthetics and decorations of the Aquarium guest restaurant.
4. To propose a functional design using Biomimicry that caters for the needs of the customers, staff and management at the guest restaurant.

1.5 Hypothesis

1.5.1 Null Hypothesis

There is no opportunity for integrating Biomimicry and Fulani art patterns in interior architecture, furniture design, landscaping and exhibition and display at the Aquarium guest restaurant.

1.5.2 Alternative Hypothesis

There is an opportunity for integrating Biomimicry and Fulani art patterns in interior architecture, furniture design, landscaping and exhibition and display at the Aquarium guest restaurant.

1.6 Research Questions

1. How can Biomimicry nature inspirations be combined with contemporary Fulani art patterns and be applied through landscaping design, furniture design, interior design and exhibition and display at the restaurant?
2. How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's interior and furniture design to create systems, components and models that are Biomorphic Forms & Patterns that can create spaces that are comfortable and captivating?
3. How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's landscape design to bring about more relaxing and functional recreational spaces that are environmentally responsible?
4. How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's exhibition and display to create display and exhibition systems and components that are captivating and attractive to the customers.

1.7 Significance of the Study

Being a guest restaurant, the beneficiaries will be the researcher and the staff under the hotel and lounge. The research will also provide guidelines to better innovation in the delivery of services at the restaurant to be studied and make it more relevant in as far as Biomimicry along with Fulani art in designing interior and landscape is concerned. The findings of the study should go a long way in providing other guest restaurants with better and improved innovation and diversification of their services while acting as a reference point.

1.8 Limitations of the Study

1. Financial and other resources: Not being able to employ some people to help in the collection of data/information. The money allocated was not be enough.
2. Time was also a limiting factor gauging on the extensiveness of the research required.
3. Sample size: Not being able to have a large pool of sample size of the population as the researcher would have wanted.
4. Most of the participants to the study may have limited or no idea about the meaning of Biomimicry and so more time taken to try and educate them on the same.

1.9 Scope of the Study

The scope of this study will basically revolve around the geographical, conceptual and content analysis of the Aquarium guest restaurant. The scope will clearly define the extent of content that will be covered by the means of the research in order to come to more logical conclusions and give conclusive and satisfactory answers to the research.

1.9.1 Geographical

The research was conducted in Nairobi and the case study was Aquarium guest restaurant in Westlands with the approval by the hotel's management. The researcher dealt with the restaurant and lounge areas of the Aquarium guest home in addition to the landscape around the guest home. The accommodation premises within the guest home were not covered.

1.9.2 Conceptual

The study concentrated on application of Biomimicry and Fulani art patterns in the guest restaurant with reference to furniture design, interior architecture, landscaping and human development and exhibition and display. This study was meant to utilize Biomimicry as the main philosophy by investigating and coming up with biologically devised recommendations and solutions. This philosophy was used to develop functional interiors inspired by a mixture of ancient pattern techniques and contemporary design to come up with aesthetically functional furniture, interior space, partitioning, color concept and exterior features in relation to the site under investigation. Fulani patterns were integrated with the main philosophy (Biomimicry) to enhance the aesthetics and improve the exhibition and display at the restaurant.

1.9.3 Content

The study relied mainly on primary sources. Additional information was acquired from secondary sources and ideas or concepts perceived were applied in the redesign of Aquarium guest restaurant.

1.10 Conclusion

In the initial stages of this dissertation, it was important for the researcher to understand the basics of the site to understand fully what was required to bring out better output considering the philosophies under discussion. This chapter has introduced us to design problems faced by restaurants that lack functional, aesthetic

and environmentally responsible spaces. It has then introduced the philosophy of Biomimicry and the aspect of Fulani art patterns as a way of solving the problems.

CHAPTER 2: LITERATURE REVIEW

2.1 Introduction

This chapter will review the Biomimicry design philosophy and give information on what authors have written about it. The chapter will also review contemporary Fulani art patterns and their use in decoration and improvement of aesthetics. According to the Biomimicry Institute (2020), Biomimicry is taking lessons from nature's form and processes and using them to solve design problems. It has found a growing interest from the built environment because of it being sustainable in nature and friendly to the environment but not a lot has been done in interior design. Nature and organisms encounter same conditions as people and have over the year's devised successful ways of dealing with various setbacks.

2.2 Review of Theoretical Literature

The theoretical literature review of Biomimicry and Fulani art Patterns will help establish what theories already exist, the relationships between them, to what degree the existing theories have been investigated, and develop new hypotheses to be tested.

2.2.1 Biomimicry

The analysis will focus on a Biomimicry as a theoretical concept or framework. This review will help in establishing whether there are appropriate theories and give a revelation as to whether the present frameworks are adequate in solving the emerging and new research problems or not.

2.2.1.1 Introduction to Biomimicry

According to the Biomimicry Institute (2020), Biomimicry (Biomimetic) is an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. Biomimicry takes its

inspiration from natural processes. It is an approach that searches for new ways of creating sustainable materials, products, services, and other solutions by learning how nature already works. As designers we have the job of coming up with new ideas and products in order to fulfill a particular need or function. What we have just recently begun to realize is that nature has already perfected and come up with all the answers. For as long as man has been on the earth, we have tried to figure out how to survive, using materials and different products to make our lives easier. However, we have never cared to understand that somewhere in nature something is doing it, making it, disposing it much better and more efficiently than we ever could (Attia, 2015, p. 54).

Hathcock (2017, p.67) observes that, on the sustainability aspect, the designs through the Biomimicry inspiration would produce adaptive, visually suitable and least energy consuming solutions. Nature also has changed its processes for the same problem. Their testimonial is the effective presence of that process emulated throughout the timeline. The consumption of resources is also optimized in the natural processes. Thus, sustainability is embedded in evolving designs from the nature. As per Popper (2014, p.93), nature has mastered productivity and disposal and figured out what works and does not in order to survive together in the most harmonious way. Biomimicry is just that. It takes the lessons and processes from nature in order to make the most efficient, sustainable, functional and aesthetically beautiful products. In other words, Biomimicry references nature in order to design things that just seem to make sense. The whole concept of getting inspired from nature brings with it ‘more than a million year of evolution’ it has gone through. The solutions that nature has produced for its various processes have been tested by the various forces of nature itself. With the addition of our research we can add to find the perfect design solution (Liyanage, 2010, p.102).

2.2.1.2 Principles of Biomimicry

Before biologist Janine Benyus, biomimetic design was an amorphous idea, without a singular guiding methodology or end goal. That all changed with the publication of Benyus's 1997 book Biomimicry: Innovation Inspired by Nature, which gave the world its first working definition of Biomimicry and introduced scientists, capitalists, and designers to the ingenious ways the Earth has thoroughly mitigated many design problems over its 3.8 billion-year development. For example, animals have had millions of years to develop innovative, energy-efficient solutions to the challenges of the living in the wild. Biomimicry allows designers to adapt the same solutions to the built environment but in a fraction of the time. "There are very deep methodologies around learning about nature, but not about learning from nature," explained Benyus in an interview for TED. "Biomimicry borrows nature's blueprints, recipes, processes, and ecosystem strategies and then comes up with design principles to solve our own problems." (Benyus, 1997 p.131).

Leon et.al, (2019, p.227), observes that the idea of looking to plants and animals to improve the functionality and sustainability of humanity's creations is gaining steam in today's architecture, design, and engineering industries. Mega-structures like Grimshaw Architects' Eden Project and Michael Pawlyn's Sahara Forest Project or Mick Pearce's Eastgate Centre demonstrate how biomimetic solutions can improve the efficiency, quality, and sustainability of buildings, which are desperately needed. "It's common sense to use the biomimicry approach," says David Oakey, a giant in the sustainable design movement and product designer exclusive to Interface. "Nature is basic—it recycles everything, rewards cooperation, banks on diversity, and adheres to the 'form follows function' mantra. If we want to make our built environment stronger and able stand up to the elements, we have to

design organically." (Sandzen, 2015. P.29). Geometry is an integral part of design from start to finish. Just think about it. Architects use geometry to study and divide space as well as draft detailed building plans. Builders and engineers rely on geometric principles to create structures safely. Designers apply geometry (along with color and scale) to make the aesthetically pleasing spaces inside. Applying geometry in design is unavoidable (Heerwagen, Mador & Kellert, 2013, p.13-14).

2.2.1.3 The Biomimicry Approach

In 2007, M. Pedesen Zari of Victoria University (New Zealand) examined the existing technologies in Biomimicry and stated that different approaches bring varied outcomes. While some use Biomimicry for sustainability others use it to invent new innovations. The approach falls into Problem and Solution based approaches.

Problem Based Approach – In this type of approach the designer looks to species in nature to try and solve design problems (Pedersen Zari, 2007). The steps form a nonlinear and dynamic pattern where by the results from later stages usually influence previous stages forming a basis with interactive feedback. (Pedersen Zari, 2007).

The human problem is first identified and then a solution is looked for by studying how nature solves similar problems. It is also referred to as "Top Down design approach" or "Design looking into biology approach". (Pedersen Zari, 2007).

The following two design processes can be used while implementing this approach:

1. **Process One**

Michael Helm's and Ashkok Goel's research in Georgia Institute of technology in 2006 at the design intelligence lab defined this approach in the following six steps:

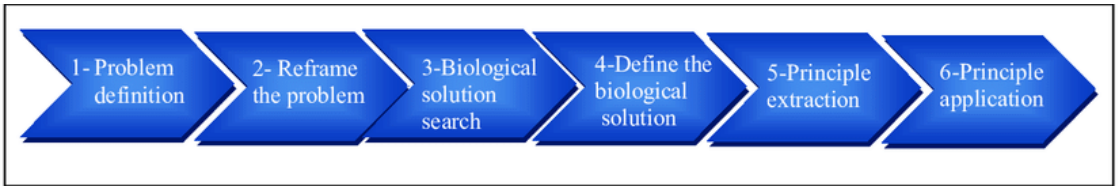

Figure 1: Michael Helm's and Ashkok Goel's Six Step Problem Based Approach (Source: https://www.flickr.com/photos/artsyscience/7113372687)

2. Process Two

In 2005, Carl Hastrich designer was able to solve everyday design challenges using examples copied from nature. Hastrich took steps from the normal design process, added biological steps to achieve biomimicry and copied one of nature's phenomena to achieve the spiral process. (Pearce ,2019, p.148)

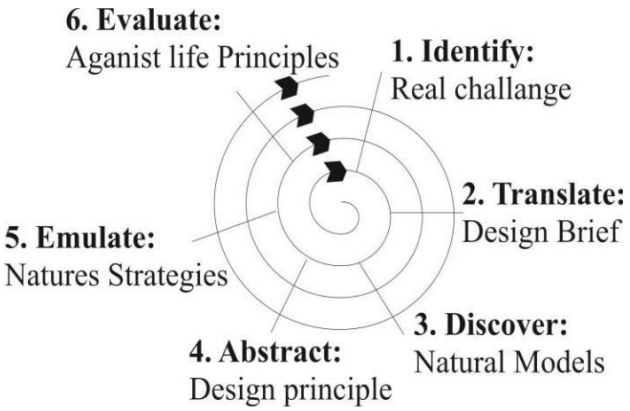

Figure 2: Carl Hastrich Spiral Process (Source: https://www.flickr.com/photos/artsyscience/7113372687)

Steps:

i. Identify: Create a list of functions of the design that one needs to solve

ii. Translate: Convert functions to be relevant in biological terms

iii. Discover: Come up with strategies that nature used to solve these issues

iv. Abstract: Convert biological strategy to engineering solutions that relate to design

v. Emulate: Use professional skills to design solutions with the strategies.

vi. Evaluate: Design solution against brief and then nature's solutions later reflect and plan next move. (Green, 2015, p.45)

Solution Based Approach – It is also known as 'The bottoms up Design' whereby the Biology influences the design. An observation in nature is made then it's application sort in the human world. The advantage of this approach is that biology may influence human based design and technology in ways never previously perceived while one of the disadvantages in a designer's point of view is that a biologist expertise must be sort before attempting to design (El-Zeiny, 2012, p.5).

Michael Helm's and Ashkok's research defined this approach in the following six steps:

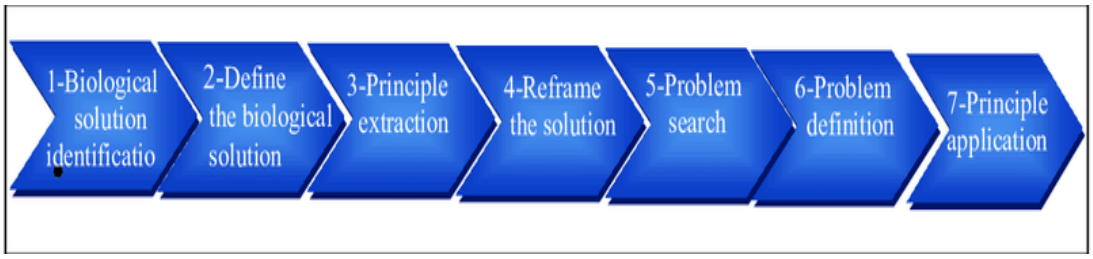

Figure 3: Michael Helm's and Ashkok Goel's Six Step Solution Based Approach.

(Source: https://www.flickr.com/photos/artsyscience/7113372687)

2.2.2 Fulani Art

Fulani artists are primarily known for decorated gourds, textiles, hairstyles and personal adornment. In terms of style and color, Fulani art commonly features geometric shapes as motifs and meticulous details-, especially in textiles and gourds, and the use of black, red, yellow and white. Important collections of Fulani art appear at the Fowler Museum at UCLA and the Musée de Bamako in Mali. Gourds decorated by Fulani artists range from those with a plain to an elaborate patterned surface. They

commonly take one of the four following shapes: globular, flattened globular; tubular; and bottle shaped (Malone, 2012, p.27).

Figure 4: Fulani art patterns expressed on their gourds (Source: https://www.britannica.com/topic/Fulani)

When decorating gourds, Fulani women use abstract motifs, such as circles, squares, triangles and lines, as well as figural motifs such as people, camels, and airplanes. There are two main methods of decoration: pyro-engraving and pressure engraving. Pyro-engraving involves burning lines into the surface of the gourd with a hot metal blade, while pressure engraving generally consists of using a Jalbal (an iron point). Pressure engraving designs created by pastoral Fulani generally take two forms: The first one is vertical arrangements of motifs around the outer edge area leaving the center free while the second one is a design divided into four equal parts, which means greater use of the gourd's surface area (Augustin, Bauer & Duignan, 2019, p.95).

Kaakel demonstrate that gourds are an important part of a woman's social and economic status. Kaakel is a way for women to display fifty or more gourds encased in wooden mesh supported by two wooden poles. Because gourds are lightweight and easy to transport, they provide an ideal art form for those who lead a nomadic lifestyle. In the Middle Niger area of Mali, there is a renowned class of male weavers

known as the Madoube. Men typically weave while women spin wool and cotton. One type of textile produced by the Madoube is called Khasa. These range in size from approximately 3.9 to 4.2 feet (1.2 – 1.3 meters) by six to eight feet (1.8 to 2.4 meters). Herders use Khasa to keep warm and ward off mosquitoes. The dominant color is white, but black, red and yellow are also used (Hamill, 2017, p.5).

Kereka are another form of textiles created by Madoube. They are suspended over the bed in a tent like fashion and are used as mosquito nets. The dominant color of kereka is red, but white, black, and yellow are also common. Typically, they measure approximately sixteen by six and a half feet (4.8 by two meters). There is a wide range of patterns, however, and many are based on similar geometric designs. Arkilla are also a type of textile used as a mosquito net that are hung by a bride's marriage bed. Cloths of this type, known as Arkilla kereka, are tent-dividers and marriage-bed hangings. Belongings of grandeur and refinement, they were the most costly textiles produced in the Niger River-bend region and were almost always woven on commission. This work was woven at Tillaberi in western Niger. Its aesthetic reflects the cosmopolitan engagement of weavers south of the Sahara with the formal vocabulary of North African textile traditions, and its patterns closely parallel those of Berber weavers.

Figure 5: The Arkilla Kerka cloth expressing the Fulani Patterns. Source: http://adireafricantextiles.blogspot.com

This fabric, probably woven of wool, is now composed of four strips, each about 13 inches wide (originally it probably contained six strips, as comparable examples do). The stretchy wool warps are heavy to lift during weaving, and considerable tension must be placed on them in order to beat down the weft; therefore, the cloth had to be sturdily constructed from strong yarns. The work's earthy palette of russet, dark brown, yellow, blue, and white is patterned with tapestry and supplementary-weft structures in weft-face bands. Each strip is subdivided into many horizontal registers, some solid, some featuring floating motifs. The areas of supplementary weaving result in a textile that has a distinct front and back. With its decorative designs exactly repeated and perfectly synchronized, the resulting cloth becomes a flawless continuum of dense pattern (Lafforgue, 2015, p255-269).

Figure 6: Fulani art patterns on the Arkilla Kerka Blankets (Source: https://discover.lenebjerre.com/trend/african-vibes)

Rovine (2018, p.269) strongly agrees that while adopting the visual motifs of its models, however, this work significantly differs from them in construction, revealing that West African weavers went to great lengths to translate into their own idiom the sensibility of North African trade cloths. According to Popper (2014, p.93), Berber women weave wool cloths for clothing on a wide vertical loom thought to be of pre-Arabic origin, and the geometric designs they produce occur in bands along the weft. However, in the western Sudan, an area that includes Niger, men weave wool textiles on double-heddle looms, and the long, narrow fabric that is produced is cut into strips that are stitched together to form the completed cloth. In order to reproduce the effect of the North African cloths, the weaver had to calculate accurately the distance between motifs so that they match up once the strips were aligned. West African weavers thus relied upon a technically more challenging method that of their models when re-creating Berber designs.

2.3. Profile of World Renown Designer

Nature’s ability to come up with solutions while conserving energy has inspired designers to save seek improved innovative solutions, especially architects who seek to apply new design techniques taking examples from nature. Inspired by its shape and function they gain new perspective and develop sustainable solutions that are not only aesthetic and creative but also functional and energy efficient.

2.31 Michael Pawlyn

Michael Pawlyn was born 30 September 1967. He is a British architect noted for his work in the field biomimetic architecture and innovation. After graduating in Architecture from The Bartlett, University College London, Pawlyn worked in London and Japan before returning to complete his studies at the University of Bath. He worked briefly as a researcher on television documentaries before joining Haworth Tompkins Architects. In 1997 Michael Pawlyn became part of the Grimshaw Architects' team to work on the Eden Project. This innovative scheme, conceived by Tim Smit, radically transformed a Kaolinite pit into a complex of adjoining Biomes that created sustainable environments for Rainforest and Mediterranean plant species.

In 2007 he established Exploration Architecture to develop work that employs biomimicry as a guiding principal and brings together three lifelong passions - biology, design and the environment. At TED Salon London, November 2011, Michael Pawlyn became one of the small number of architects to have a talk posted to TED. His presentation, in which he describes how biomimicry could help transform architecture

and society, has been viewed over 1.5 million times. Exploration Architecture's work was exhibited in a solo exhibition, at The Architecture Foundation in 2014.

Some of Michal Pawlyn's selected projects on how design and architecture mimics nature include:

Boat for the Plastiki Expedition: This project, designed with client David de Rothschild, explored Cradle to CradleTM ideas to highlight solutions to plastic pollution in the ocean.

The Sahara Forest Project: demonstrates how biomimicry can help address a range of challenges by employing three components - saltwater cooled greenhouses, concentrated solar power (CSP) and desert revegetation technologies. Collectively these elements provide fresh water, land regeneration, the sequestering of carbon in soils, the closing the nutrient cycle and provides employment in deprived areas.

The Biomimetic Office: A sustainable office building designed with Yaniv Peer of Exploration, Arup Research & Development, Mace Cost Consultants and Professor Julian Vincent.

The Mountain Data Centre: A concept for ultra-low energy data centre based on principles of efficient branching systems in biology referred to as Murray's Law.

2.4 Design Exemplar

2.4.1 The Biomimetic Office Building, Munich, Germany by Michael Pawlyn

To Biomimetic Office Building designer, architect Michael Pawlyn, the natural world teems with models of brilliant design efficiency. Pawlyn's book, Bichuromimicry in Architecture, inspired and challenged architects, urban designers and product designers

to look to Nature for beautiful models of resource efficiency. It also called for them to move beyond sustainability, which Pawlyn characterized as “minimizing the negatives,” primarily of resource and energy consumption, versus the regenerative model that is Biomimicry.

Figure 7: Exterior and Landscape View of the Biomimetic Office, Munich, Germany. (Source: https://www.mnn.com)

The Biomimetic Office Building is the latest project undertaken by Pawlyn and his Exploration Architecture team. The design, which uses Biomimicry to rethink the workplace into a self-heated, self-cooled, self-ventilated, day-lit structure that is also a net producer of energy, will strengthen the case for Biomimicry by drawing a brighter line between restorative, responsible design and cost savings. In addition to Biomimicry, the project incorporates the principles of psychologist, Craig Knight, such as plants in the workplace, to address employee well-being, job satisfaction and productivity (El Zeiny, 2012, p.88)

"The design debate has shifted over the last 10 to 15 years from resource and energy saving to improved productivity," said Pawlyn. While upon completion the Biomimetic Office Building promises to be one of the world's lowest energy office buildings, energy costs are tiny compared to employee costs, such as salaries. And according to Pawlyn, design of The Biomimetic Office will maximize substantial human resource investments through gains in productivity of as much as 25 percent. This grounded, practical cost-benefit equation, however, belies the project's ingeniously fantastic soul. The building infrastructure, for example, is modeled on the bone structure of birds and cuttlefish. Everything about a bird must be light, strong and efficient to enable flight. While delicate, bird bones are actually far from fragile. In particular, their skulls are made from multiple layers of very thin bone. The layers lend strength without the added weight that could impede flight. Similarly, the layers that comprise cuttlefish bones vary to add reinforcement only where the animal needs it for movement, support or protection.

Figure 8: The Interior of the Biomimetic Office Building uses Biomimicry to rethink the workplace. (Source: http://www.interface human spaces.com)

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In bird skulls and cuttlefish bones, Pawlyn found that "complex forms that use minimal materials in exactly the right place," is often the operating principle in Nature, and their ingenuity was incorporated into key structural components of the Biomimetic Office Building, the floor slabs and columns. Sections of the floor that will be "working hard" by taking on more of the stress of the structure and weight will need denser concentrations of concrete. Columns and floor slabs earmarked for lighter duty can be hollow, their voids used for secondary purposes, such as, housing wiring or temperature control components. (Wilton and Howell, 2007, p.22-25).

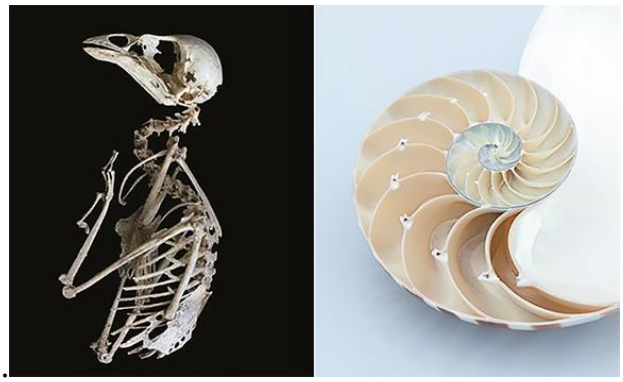


Figure 9: The building infrastructure is modeled on the bone structure of birds and cuttlefish. The glazed glass exterior nods to a mollusk's iridescent shell. (Source: http://www. Procedia social and behavioral sciences.com)

For further temperature control, the building design calls for intricate, identical shades, able to respond automatically and, if necessary, separately to changes in light the way plants such as the mimosa pudica, or sensitive plant, and Venus flytrap move in response to touch or other external stimulation. Another tropical plant variety, the epiphytic anthurium, which grows on other plants close to the rain forest floor and efficiently captures and makes use of scarce sunlight, is providing food for thought for a subsequent phase of the Biometric Office Building design. In consultation with work space designers and psychologists, biologists and even primatologists, Pawlyn and Exploration Architecture continue to seek innovative design solutions that draw upon the billions of years of wisdom found in Nature, challenging not just our thinking about the final product or outcome, but the very process by which we arrive there (Love, 2013, p.12).

2.5 Design Process

This research will attempt to identify the problem areas in design in relation to the research's problem statement and using the listed objectives interrogate each aspect of design in relation to interior, furniture, exhibition / display and landscaping at the site under investigation. It will then seek to use biomimicry to most of the design areas to solve the identified areas. The design will take a problem-based approach as opposed to solution based approach that requires a professional biologist before attempting to design to finding a viable solution using either the spiral process (Identify, Translate, Discover, Abstract, Emulate and Evaluate) or Michael Helm's and Ashkok Goel's six step approach of design (Problem definition, Reframe the problem, Biological solution search, Define the biological solution, Principle extraction, Principle application) where applicable. The standardized research process (Establishing a problem, Design Brief, Task schedule, Brief analysis, Research, Specifications, Idea generation, Solution, develop solution and Testing solution) will be used where the design does not mimic nature.

2.6 Analytical Review

Interior design does not have a lot of material on works that have been done using biomimicry, most of the examples that are there are Architectural in nature with engineering background in technological innovation. This research will seek to inspire design to move towards using the knowledge already available to us to improvise new interior elements that are functional and limit negative effects on the surrounding while looking at nature for solutions.

2.7 Conclusion

This chapter has introuced the concept of Biomimicry in design, which is basically “Nature inspired design”. It then proceeds to analyze the philosophy of Biomimicry by discussing its principles, elements, levels and approaches. Finally, it gives a profile of Michael Pawlyn as the design exemplar who has applied Biomimicry and an example of his work- The Biomimicry office building in Munich, Germany. The chapter has also reviewed Fulani art patterns that will be utilized by the reseracher for enhancement of the aesthetics and decoration of different elenments of the four design areas at the Aquarium guest resort. Africa is rich in biodiversity. This is the more reason why the concept of Biomimicry should be embraced by African designers to provide solutions for human challenges.

CHAPTER 3: RESEARCH DESIGN AND METHODOLOGY

3.1 Introduction

This research will investigate ways in which Biomimicry can be applied in the Aquarium guest restaurant design and analyze how contemporary African art has been brought out through design. It also determines how Biomimicry has been currently applied in the restaurant and proposes other ways in which contemporary African art that narrows down to Fulani art patterns can be incorporated in the design of Aquarium guest restaurant.

3.2 Research Methodology

The Researcher used action research methodology since it not only identifies a problem but goes further to help in presenting probable solution. Clarke (2015, p. 19), stated in a Higher Degree Seminar (HDR) seminar series on Research Models and Methodologies, that action research involves small scale interventions in the functioning of the real world and a close examination of the effects of such an intervention. This research is a congenital case study that dealt with Aquarium guest restaurant in Nairobi. The study will be mostly descriptive based on the research problem and research questions formulated. The researcher will also collect qualitative data. The qualitative data will contain personal accounts, observations, description and individual insights of the interviewees. The qualitative approach will be used in the direct observation, interviews and photography methods of data collection while the quantitative approach will focus on obtaining numerical findings and will be used in the surveys based on questionnaires.

3.3 Target Population

The people using the Aquarium guest restaurant will constitute the target population. The restaurant has 3 chefs, 5 waiters / waitresses, 2 security guards, and 2 cleaners. The estimated number of customers that visit the restaurant per week is 350 and therefore an estimated average of 50 customers per day.

Description	Frequency	Percentage
Customers	50	80.6
Waiters / Waitresses	5	8
Chefs	3	4.8
Security Guards	2	3.3
Cleaners	2	3.3
Total	62	100

Table 1: Showing the target population at the Aquarium guest restaurant (Source: Author, 2020)

3.4 Sample Population

As the population of people using the space per day is high, the researcher found it useful to use random sampling. This helped narrow down the population of a previously estimated 350 persons who visit the facility in a week. Random sampling was selected so that all samples of the same size had an equal chance of being selected from the entire population thus it is the best way to ensure that results are unbiased. The researcher however ensured that there was a balance in gender and users of the space in his selected sample.

Population Category	Frequency	Percentage
Customers	25	67.5
Waiters / waitresses	5	13.5
Chefs	3	8
Security Guards	2	5.5
Cleaners	2	5.5
Total	37	100

Table 2: Sample Population. (Source: Author 2020)

3.5 Sampling Method

Random sampling was used when giving open-ended survey questions to the staff and employees who work and visit the restaurant. This helped in giving a variety of answers to the questions asked in the open-ended survey. Purposeful sampling will be used when interviewing the staff at the restaurant.

3.6 Data Collection

Data will come from both primary and secondary sources for this study. Close-ended and Open-ended questionnaires will be the quantitative method used. The qualitative approach used is collecting data will be interviews, observation and visual methods like photography. Primary sources of data will be drawn from respondents in the field. Secondary sources of data will be acquired from books, magazines, newspapers and papers.

3.6.1 Questionnaires

Questionnaires will cover most of the sample population views and opinions. The research will target one Saturday afternoon since the flow of the people at the space is more during the weekend. The questions will be short, simple and to the point to avoid using unnecessary language or words. Two questionnaire templates will be used to conduct the research. The first one will target the customers while the second one will target the staff of the guest restaurant. This quantitative phase will combine the close ended (structured) and open ended (unstructured) questions. The questionnaires will be comprised of three parts:

a) General information section - Personal details of the respondent

b) Close ended section – Short questions with a Yes / No response and a very brief description.

c) Open ended section – More detailed answers to the provided questions will be expected from the respondents. Very few questions will be in this section to keep the process short and interesting.

3.6.2 Direct Observation

This will enable the researcher to understand the behavior and activities of the subjects in their natural environment to gain insight on how they relate to the space. According to (Billups, 2020, p. 201), observation is a systematic data collection method where the researchers use all of their senses to examine people in natural settings or naturally occurring. For this approach to be complete the researcher is required to play a

number of roles and use a number of techniques in order to blend in with their case subject (Maxwell, 2013, p. 34). The researcher will be in an actual situation and watch carefully how the restaurant routine operates and how the staff and customers interact with the space. On the basis of personal knowledge, skills and experience the researcher will collect the data without contacting the respondents. Observation methods can overcome some of the critics of quantitative research methods and can be useful when its subject cannot provide information or can only provide inaccurate information (Gunther, 2016, p.101).

3.6.3 Visual Methods of Data Collection (Photography)

According to Yin (2017, p. 9), this refers to collecting image–based data like photographs, painting, models, maps, diagrams and film in relation to the research. The researcher will seek to take photographs of the existing conditions of the site as the visual method of data collection. Photography has the upper hand in this study as it creates a permanent visual diary of direct observations of the site in context for either analysis or illustration during reporting or engaging others in your findings. Also, records observations that cannot be made directly by the evaluator. Therefore, photographs help in the insight of the perspectives of the area in context. (Galle, 2012, p. 16).

3.6.4 Interviewing

According to Galle (2012, p. 16), the main advantage of personal interviews is that they involve personal and direct contact between interviewers and interviewees, as well as eliminate non-response rates, but interviewers need to have developed the necessary skills to successfully carry an interview. The manager will be interviewed. A

short-structured form of questions will be presented to be answered in any way the respondent deems fit. This approach of predetermined questions will allow for a more flexible response. A set of multiple choices used will give the researcher an easier time during data analysis while the open-ended section will re enforce on the earlier attained knowledge. It will be best suited to keep the questions short and easy to understand and interpret.

3.7 Data Analysis Techniques

Data analysis will be based on its method of collection. Therefore, the analysis techniques will be account for qualitative and quantitative data.

3.7.1 Qualitative data

This method will be used to analyze data from the interviewing process and the observation imagery. This process will assist in the research to discover themes which will come from reviewing the literature. The methods mentioned above will go through content analysis based on notes taken during research. Sampled photos will be used and narrative provided while observations made will be noted.

Qualitative analysis will involve three steps. The first step will be categorization of data-A category can be a word or as short phrase that represents a theme or an idea. All categories need to be assigned meaningful titles. A wide range of non-quantifiable elements such as events, behaviors, activities and meanings will be coded. The second step will be identifying themes, patterns and relationships. In qualitative data analysis there are no universally applicable techniques that can be applied to generate findings. Analytical and critical thinking skills of researcher will play significant role in data

analysis in qualitative studies. The third step will be summarizing the data-At this stage the researcher will need to link research findings to hypotheses or research aim and objectives.

3.7.2 Quantitative data

For analysis of quantitative data, Microsoft Excel software was used. The table used was an excel sheet from which the excel software generated the bar charts and pie charts representing the analysis.

3.8 Data Presentation Techniques

Data presentation will be based on its method of collection. Therefore, the presentation techniques will be account for qualitative and quantitative data.

3.8.1 Qualitative Data

The approach that will be used in presenting findings from the qualitative analysis will be narrating and reporting the key findings under each main theme or category, using appropriate verbatim quotes to illustrate those findings.

3.8.2 Quantitative Data

The methods that will be used to present this data include: bar charts and pie charts. The visual information is usually self-explanatory but any text accompanying a table or chart will reference the key points the researcher wants to highlight.

Data Collection	Data Analysis	Data Presentation
Questionnaires	Microsoft Excel	Bar Graphs and Pie Charts
Direct Observation	Categorization and Narrative Analysis	Narration and Reporting of Key Findings

Interviewing	Categorization and Narrative Analysis	Narration and Reporting of Key Findings
Photography	Categorization and Narrative Analysis	Narration and Reporting of Key Findings

Table 3: Summary of the Data collection, analysis and presentation techniques

(Source: Author, 2020)

3.8 Conclusion

Research methodology included collection of both primary and secondary data. Most of the information was collected through structured survey questions and face to face interviews, observation and taking photos. The analysis of the data collected included the recordings from the interviews, photographs and notes. The ultimate goal of the researcher was to satisfy the client's needs. Researchers put the user in mind from the onset of the project to the end but should not also forget about the environment in which the user lives in. In doing so, the life of the user should not be endangered by the design but should be improved by putting sustainability into account.

CHAPTER 4: SITE ANALYSIS AND INTERPRETATION OF FINDINGS

4.1 Introduction

This chapter involves the investigation, introduction and elucidation of the collected data. It begins with the Climatic states of the site, Geographical examination of the site and after that Hotel structure. Under Climate, the researcher utilized graphical techniques to represent the atmosphere and temperature of the site. The chapter goes on with the photographic and Narrative examination of the collected data from the four territories of inside plan; Landscaping, Interior Architecture, Furniture and the Exhibition and Display. The dimension of sustainability of the materials and interior finishes has been featured in the section followed by the quantitative examination and presentation of the responses from the interviews and questionnaires.

Aquarium Guest Home is a newly opened guest house which operates under the brand name of the Aquarium Guest Resort Limited which also owns and manages the Aquarium Telagen Hotel along the Airport Road. Aquarium Guest Resort Limited is a subsidiary and wholly owned by the holding group company, Windsor Homes. The group is a housing, accommodation and home solution in Nairobi, with services extended to high class budget hotel accommodation, executive and exclusive guest house stay, full furnished rental apartments ranging from 1 bedroom to selling houses. For this research study, the researcher is only interested in the restaurant found at the guest home. The sleeping premises were not covered by the researcher.

4.2 Qualitative Analysis

This analysis will be narrative in nature. It will describe the experiences of the subjects of the study or use quotes and pieces of narratives to answer research questions or present themes that regard to the research study at the Aquarium guest restaurant.

4.2.1 Site Location

The facility is located in Westlands, along Westlands Roads between CFC Bank and the Standard Bank headquarters and in the neighborhood of African union regional office. Its location and proximity to prime amenities and major Nairobi's attraction like the all major international banking institutions, the museum, snake park, bureaus de change, shopping malls like Sarit Centre and Westgate mall, cinema halls, entertainment joints and eating places and availability of taxi services makes it a convenient location for any visitor or client who is seeking refreshments or a lounge to relax in or even accommodation.

Figure 10: Map of the Aquarium Guest Home (Source: www.googlemaps.com)

4.2.2 Climatic Conditions Analysis

This analysis will cover climate aspects like wind, rain/precipitation, temperature and sunlight at the area where the site is located.

4.2.2.1 Average temperatures and precipitation

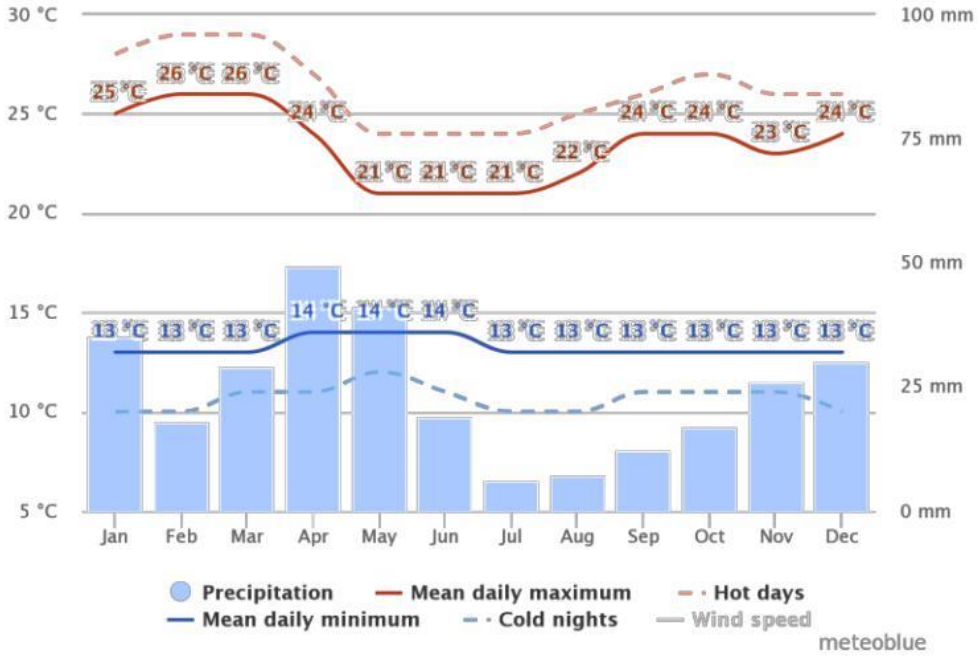


Figure 11: Temperature and Precipitation of the Site (Source: www.meteoblue.com)

The "mean daily maximum" (solid red line) shows the maximum temperature of an average day for every month for Chiromo and Westlands areas in Nairobi. Likewise, the average minimum temperature is shown in the "mean daily minimum" (solid blue line). Hot days and cold nights show the average of the hottest day and coldest night of the last 30 years of each month. You can expect the average temperatures for holiday planning and be prepared for hotter and colder days. Wind speeds are not shown by default, but at the bottom of the graph can be enabled.

The precipitation chart is useful to plan for seasonal effects. Monthly precipitations above 150 mm are mostly wet, below 30mm mostly dry. Note: Simulated precipitation amounts in tropical regions and complex terrain tend to be lower than local measurements

4.2.2.2 Cloudy, Sunny, and Precipitation Days

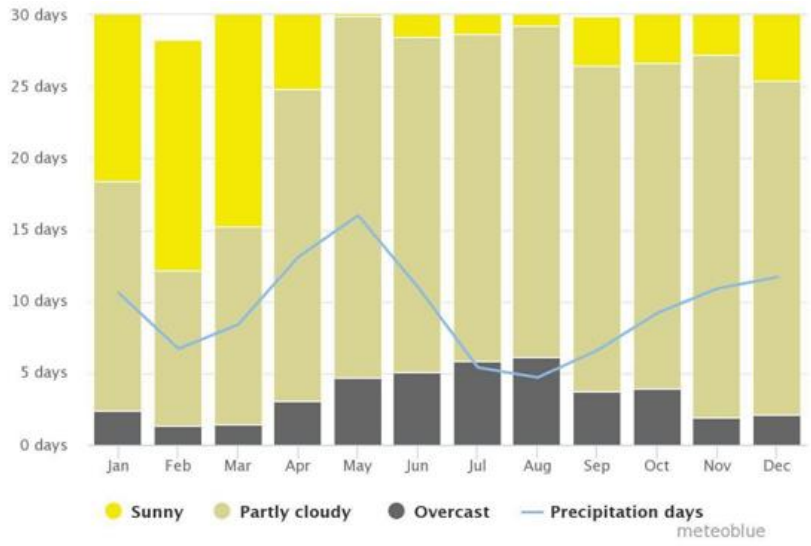


Figure 12: Cloud, Rainfall & Sun Analysis (Source: www.meteoblue.com)

The graph above shows the monthly number of sunny, partly cloudy, overcast and precipitation days. Days with less than 20% cloud cover are considered as sunny, with 20-80% cloud cover as partly cloudy and with more than 80% as overcast.

4.2.2.3 Maximum temperatures

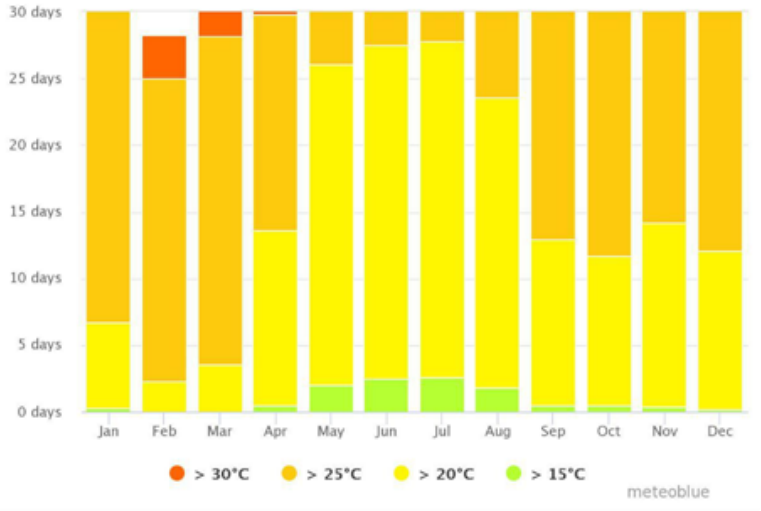


Figure 13: Maximum Temperature (Source: www.meteoblue.com)

The maximum temperature diagram above for Chiromo displays how many days per month reach certain temperatures.

4.2.2.4 Precipitation amounts

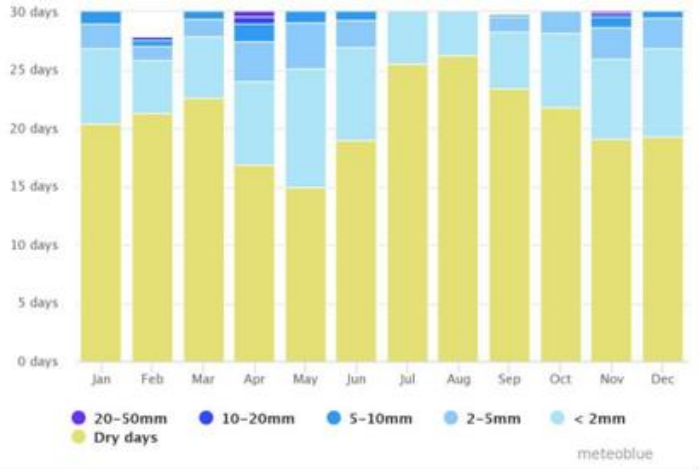


Figure 14: Rainfall / Precipitation (Source: www.meteoblue.com)

The precipitation diagram above for Chiromo shows on how many days per month, certain precipitation amounts are reached. In tropical and monsoon climates, the amounts may be underestimated.

4.2.2.5 Wind speed

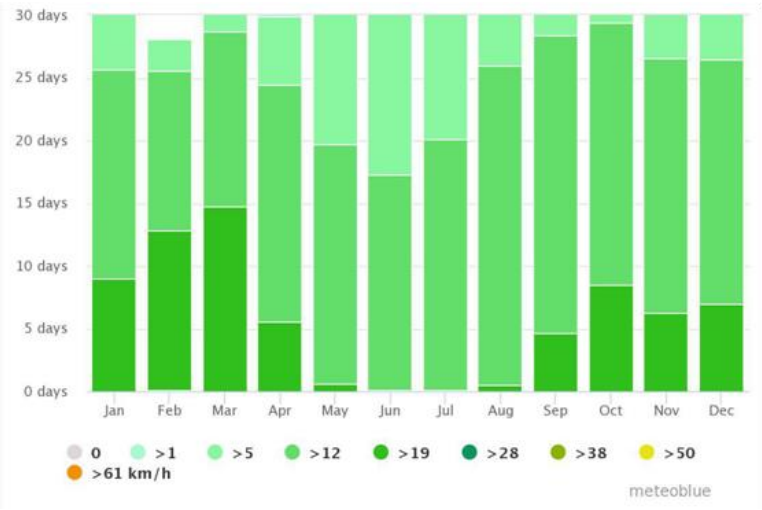


Figure 15: Wind speed (Source: www.meteoblue.com)

The diagram above for the analysis of wind speed for Chiromo area where Aquarium guest resort is located shows the days per month, during which the wind reaches a certain speed.

4.2.3 Analysis of Facilities

The guest home covers an area surrounded by plenty of dominating structural features. The facility is divided into two areas; the restaurant: which comprises of a sixty-seat capacity garden restaurant, a bar and choma zone and the accommodation block - with both deluxe double rooms and deluxe family rooms. Other amenities include a barber shop and a parking area situated next to the accommodation block. The

researcher's area of interest is the restaurant which comprises of a sixty-seat capacity garden restaurant, a bar and choma zone.

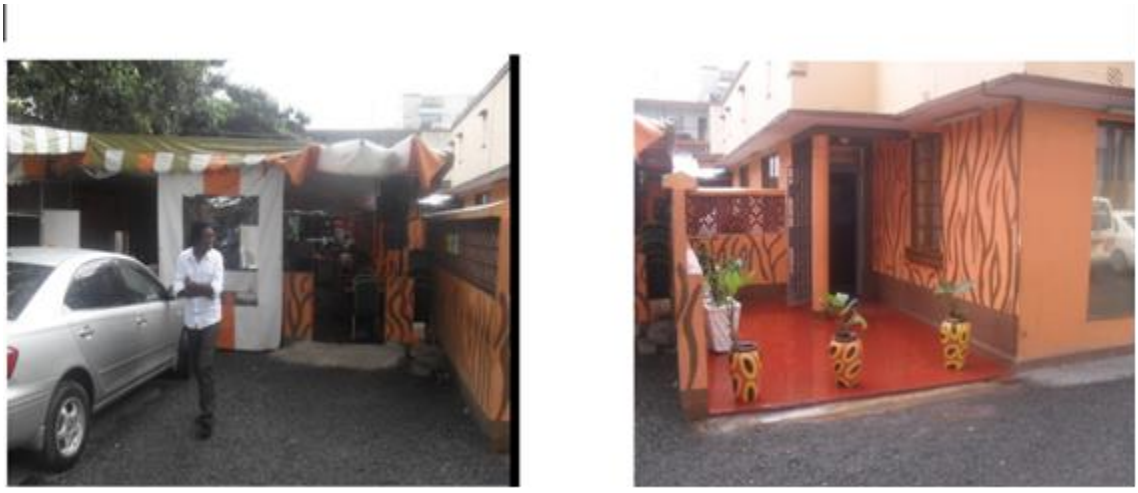


Figure 16: View of the Entrance Area and the Entry Door to the Restaurant (Source: Author)

4.2.3 Interior Architecture

The wall treatment, ceiling finishes and floor finishes will be analyzed. Components like doors, windows and curtains and furniture layouts are also a part of this analysis.

4.2.4.1 Wall Treatment

The walls of the restaurant are made of concrete. They have an orange paint finish with dark brown lines that resemble the Zebra lines throughout the walls that are adjacent to the accommodation block. On the other end, the wall is not painted possibly because the wall is also part of a perimeter fence.

Figure 17: Wall Treatment at the Dining Area (Source: Author)

The wall at the bar area is painted in red color and is made of concrete. The bar shelves are well stocked with beers and soft drinks served to customers. The general materials used to construct the bar counter are building stone and tiles with barstools arranged around it. The bar has arc like designed structures placed at the upper part of the bar for beauty with the major colors being red and white. However, the spacing within the counter is small especially with unpacked beer crates thus restricting free movement.

Figure 18: Treatment of Wall at the Bar Area (Source: Author)

4.2.4.2 Ceiling and Lighting

The ceiling of the restaurant has a white fabric material helping to allow passing of sunlight during the day. The fabric is suspended on black metallic beans that are suspended on a black metallic column. During the rainy season, this ceiling is not suitable as water accumulates on top of it making it to bulge downwards. This forces the workers at the restaurant to keep watching on it and drain the water once it accumulates so as to maintain the ceiling in its normal shape. Also, the fabric is susceptible to wearing out through tear. Likewise, due to its white color and fabric material, it gets dirty easily through dust particles.

On the part of lighting, the restaurant uses normal white LED bulbs that are fixed on the ceiling. These bulbs are evenly distributed on the ceiling with one main large LED light bulb at the centre.

Figure 19: Fabric Ceiling and Lighting at the Restaurant. (Source: Author)

4.2.4.3 Floor Finishes

The restaurant flooring has a screed finish and has white and dull patterns on it. These patterns are uneven and on the uneven surface, there is no particular flow or

complimentary trait in relation to the space. Despite the pre patterns that seem to increase its aesthetic value, the screed floor finish is slippery and wears out easily over a period of time.

The hotel manager referred to low costs and ease of construction as the principle reasons that the restaurant favored screed for the floor finish. Reasonably, screed is not the best decision while settling on an exquisite, popular and natural agreeable floor wrap up. Screed is slippery and gets cold during the night. Screed is also non-biodegradable and cracks over a period of time.

Figure 20: Uneven White Patterns on the Screed Floor Finish that is Slippery (Source: Author)

At the bar area, the restaurant flooring is covered with ceramic tiles. These tiles have no particular patterns on them. Likewise, they have uneven surfaces and no particular flow or complimentary traits in relation to the space. In addition to this, they are not evenly spaced out meaning that rhythm is not achieved due to lack of similarity in their arrangement.

Figure 21: Ceramic Tile Finishes at the Bar Area of the Restaurant (Source: Author)

The floor at the lounge / seating area is treated in almost the same manner as the general dining area with one major difference. First, the screed finish is painted in red paint instead of including the white patterns that were uneven at the other area.

Figure 22: Red Screed Floor Finish at the Seating Area. (Source: Author)

4.2.4 Exhibition and Display

Exhibition and display analysis will cover the bar and counter area and also study how different items are displayed at the two areas.

4.2.5.1 Reception / Counter and Lounge Area

The reception / counter area is area is totally wanting in many respects and does not portray a welcoming and inviting feeling towards a client. To start with, the first thing that grabs the attention of a client walking in through the main door is the three posters displaying the availability services of a local telecommunications company. The opportunity of positioning and enhancing the facilities brand recognition is dented as there are no more display materials supporting the facilities logo. Further, the reception has inadequate spacing requirements to cater for high traffic due to the number of people expected to walking past the reception, walking out from the rooms heading out and those seeking to wait at the lounge.

Also, the reception / counter desk is not sleek in design. Furthermore, the wood material used to make it is susceptible to scratch. Besides, the space accessible for the reception is not adequate. The people working should have enough workspace and capacity to finish all undertakings effectively and successfully, additionally more storage takes into account less mess and papers out in the open. The cashier at the counter area does not have an ergonomic seat and accomplices to keep him centered and comfortable. The lighting at the counter is dull. The lack of adequate lighting adorning the reception area makes it have less ambience. Subsequently, less ambience means that the creation of focal points is poor hence poor highlighting of objects at that area.

Lounge area is mostly unused and there are no paraphernalia that seek to promote other services that may be available within the facility and or the Mentor Group. A T.V. has also been placed just next to the main exit door raising concerns on safety from head

injuries. Behind the reception area is an area partitioned off to make room for the manager's office using ply wood. The restaurant has in turn created the sense of a small and squeezed reception space.

Figure 23: The Reception Area Showing the Counter Desk and Lighting (Source: Author)

Figure 24: The Lounge Seats Next to the Restaurant (Source: Author)

4.2.5.2 Bar Area Exhibition and Display

Normally displays are targeted at the clients that visits the guest homes but there is inadequate display within the facility to promote the facility and the available displays are of third-party companies i.e. soft drinks and alcoholic beverages. An entrance sign at the main gate is lacking while directional signs normally placed outside pointing to

various areas e.g. to the barber shop are missing. An attempt at contemporary African art is made by having what looks like strips of a zebra on the wall.

Figure 25: Display of Drinks at the Bar Area (Source: Author)

The bar also has fridges branded by various companies that are used to cool various drinks. There is provision for the display of various drinks with a permanently built in wall mounted cabinet. The shelves are wooden with glass at back so that a seemingly endless reflection of bottles can be seen. At edges of the shelves there are red wooden frames with assorted decorations. The work top is wooden with a clear varnish finish leaving the brown color of wood visible. However, the restaurant lacks an appealing exhibition and display. Focusing on the bar area, this space is a bit congested and cannot accommodate more. Inquiry from the restaurant manager, drinks have to be kept at the sore because of lack of enough space to accommodate them at the counter.

4.2.5.3 Television Display

The guest home has several televisions within the facility, three in the restaurant, two at the barber shop and one each in every deluxe room and reception. The televisions are large flat screens in the garden restaurant and normal 21-inch sets in other areas

placed up the wall making it uncomfortable for customers especially in the rooms. At the lounge area, relaxing visitors are completely unable to view the television.

Figure 26: Television Display at the Restaurant (Source: Author)

4.2.5.4 Decorations

For interior decorations, the restaurant has utilized paintings that are framed with frames coated with Bronze. The design of the indoor paintings seemingly shows little evidence of being inspired by nature's models, elements and systems in solving complex display problems. Furthermore, these framed paintings exhibit no sign of contemporary African art decoration.

Figure 27: Framed Wall Images / Artworks at the Restaurant (Source: Author)

4.2.5.5 Advertisements

Nonetheless, the restaurant also advertises products which are sold within through adverts that are framed at the walls. Again, these frames have not utilized Biomimicry

inspirations like nature's models, elements and systems in delivering the message to the consumers of the restaurant's products in addition to solving complex display problems. Furthermore, these framed advertisements are not decorated with any African art patterns making them less appealing.

Figure 28: A Display Advert for a Drink that the Restaurant Offers (Source: Author)

For example, in the advert above, metal has been used for this soft drink sticker's background which also serves to hold a mirror on the other side.

4.2.6 Furniture Design

Aquarium guest home has different types of furniture that vary from tables and chairs to wardrobes and kitchen cabinets depending on where and how they are used. There is furniture for the restaurant, reception and the deluxe rooms. The general materials used to make the furniture are wood, plastic and metal.

4.2.6.1 Dining Area Furniture

Figure 29: Part of the Restaurant's Furniture (Source: Author)

The table shown above accommodates up to four people on a normal meal. The table is cream with a black metallic support. The seat types shown in the figure above have cream metal frames a distinctive pattern created on sitting and leaning areas made of a hard plastic.

4.2.6.2 Bar Area Furniture

Another set of furniture is found at the bar section of the Aquarium guest home restaurant. In this case the table is made of a wine making barrel made mostly of wood and a strap of sheet metal. However, the barrel is constricting in usage. This is especially since it cannot hold as many items on its surface as compared to an ordinary table. Also, a person seating on the barstools around the barrel cannot rest on the barrel as one would on the bar counter while engaging in a conversation with another person. Lastly a person's knee would keep on bumping on to the protruding mid-section while bending the knee in a resting position when the foot is on the barstool.

Figure 30: Bar Area Furniture (Source: Author)

4.2.6.3 Choma Zone Furniture

Next, another set of tables and seats are found at the open end of the choma zone adjacent to the accommodation. Since their surface is made of a hard type of plastic, poor maintenance and exposure to extreme changes in weather patterns over time will cause a decrease of the furniture's lifespan. The table seats up to 4 people using white plastic seats. The plastic seats are sustainable since they are water resistant and their thickness allows for recycling hence suitable for outdoor furniture.

Figure 31: Outdoor Choma Zone Furniture (Source: Author)

4.2.6.4 Kitchen Furniture

The staff kitchen area leaves a lot to be desired because the space is small and with utensils all over. The area is covered with wall tiles just around the sink with yellow paint on its walls. The walls are also full of dust especially towards the ceiling thus becoming aesthetically un-appealing. The window is also small and does not allow adequate natural sunlight for lighting purposes during the day and adequate aeration of the room. The kitchen has inadequate storage facilities and lacks even a fridge for storage of perishable foods and a dry room.

Figure 32: Kitchen Area Furniture and Items (Source: Author)

4.2.6.5 Lounge / Seating Area Furniture

As earlier mentioned, this space lacks proper space planning according to acceptable standards. The space is rarely occupied and the television placed up on the wall next to the exit does not help matters either. A person or persons seating on the lounge chair is unable to properly see the screen. Further there is a potential for injury especially for tall person's head bumping onto the television set. The lounge table is small and seems to serve decorative purposes only.

Figure 33: Lounge Area Sofas and Coffee Table (Source: Author)

4.2.7 Landscaping Analysis

The area consists of paths, parking and walls while plants are mainly potted, fencing plants and trees. Trees also add to the garden shade and prevent direct sunlight especially around the parking area. Aquarium Guest restaurant is in an area that is surrounded by buildings with mixed use type of occupation.

4.2.7.1 Parking

There is designated parking area although there seems to be inadequate room for more parking spaces due to the high demand for parking spaces around the area. It is covered with finely grinded black ballast stone. The parking area lacks clear line marking, graphics and signage that indicate its purpose. Furthermore, the restaurant uses limited space of the outdoor area for parking which congests the compound. There is a specific area set aside for parking. There is also a telecommunication mast at the far end of the parking area. The parking is 23.5 meters long and 15 meters wide and is capable of accommodating around 15 vehicles. The parking area lacks clear line marking, graphics and signage that indicate its purpose.

Figure 34: Parking Lot with customers vehicles (Source: Author)

4.2.7.2 Drainage

The figure below shows a tree surrounded by construction waste namely chipped of building stone, a pile of sand and un-used drums probably put here after the facilities last renovations. This rather aesthetically un-appealing and screams of environmental mismanagement. The area poses a risk to members of the public and the waste interferes with the drainage of the parking area.

Figure 35: Ongoing Construction at the Site that Blocks the Drainage System (Source: Author)

4.2.7.3 Soft Landscaping

Wall mounted plants are a simple way of enhancing the green design of Aquarium Guest Homes and go a long way in increasing the vegetation in the facility especially with the limited ground cover available for landscaping. However further progress can be added by ensuring that there is more addition of different natural plants with different forms and shapes

Figure 36: Plants that have been Mounted on the Wall (Source: Author)

The potted plants below probably represent the only other notable attempt at intentionally depict contemporary African art at the landscape of the guest resort because they are painted in Zebra patterns that are a commendable way of enhancing an aesthetic appearance of any intended design. Also, wildlife is a great representation of African art and therefore the zebra patterns are an aesthetic inclusion. However, if there was an inclusion of more and broad African themes in the landscape, it would make it more appealing and attractive to the guests who visit the restaurant and the accommodation preemies. Besides, the researcher established that the use of color to create shapes also enhances the contemporary African art found on the adjacent zebra striped walls at the restaurant.

Figure 37: Potted Plants at the Entrance Painted with Black and Yellow Patterns (Source: Author)

4.2.8 Analysis of Interview Response from the Manager

After data collection through the personal semi-structured interview with the manager (Appendix 4), the researcher arranged the response into a narrative form. From that interview, the restaurant's manager was asked about some information about the inspirations or contemplations behind the current restaurant's design. His response was that the restaurant was not structured on any design theme or philosophy. The manager connected the restaurant's only attempt to include elements of African art with the inclusion of Zebra like line paintings on the interior and exterior walls since wildlife is symbolic with African art themes.

From the information gathered by the researcher, the restaurant's manager concurred that the materials and finishes utilized in designing the restaurant were not practical or cordial to the nature pointing attention to cost-related imperatives and absence of appropriate consultation as the causes. Also, the manager responded that design renovation at the restaurants happens after 3 months in landscape design, 2 years in interior architecture and furniture design and 2 years in exhibition and display. Under landscaping, the drainage

systems are checked for any flaws and the general landscape that includes the outdoor recreation zones, parking, soft landscaping and hard landscaping are manicured appropriately. For interior architecture, furniture design and exhibition and display components, the arrangement and designs of the components are change after 2 years.

Finally, the manager grasped the designer's recommendations of upgrading the space utilizing sustainable materials guided by the Biomimicry philosophy and enhanced with Fulani art patterns aesthetics. He valued the presentation of the African themed components through Fulani art patterns in the design since it will be utilized as valuing the African way of life in a better way. Furthermore, the manager favored situating the lounge seats far from the reception and at point with ambient lighting. Due to the high traffic experienced in the in the restaurant, the manager agreed to receiving complaints from the staff and customers who complained about the utilization of ceramic tiles which they said were extremely hard therefore making them uncomfortable to stand on.

4.3 Quantitative Analysis

A target population of 62 people was present at the restaurant during the research period. 50 people were counted as customers, 5 were counted as waiters / waitresses, 3 were counted as chefs, 2 were counted as cleaners and 2 were counted as security guards.

Description	Frequency	Percentage
Customers	50	80.6
Waiters / Waitresses	5	8
Chefs	3	4.8
Security Guards	2	3.3
Cleaners	2	3.3

Total	62	100

Table 4: Showing the target population at the Aquarium guest restaurant (Source: Author, 2020)

The sample population of 37 people was used to collect data using questionnaires from the restaurant's scope and areas of study. This was 60% of the target population. There were three sets of questionnaires (Appendix 2 and 3) that were issued to the two groups of respondents (customers and staff).

Population Category	Frequency	Percentage
Customers	25	67.5
Waiters / waitresses	5	13.5
Chefs	3	8
Security Guards	2	5.5
Cleaners	2	5.5
Total	37	100

Table 5: Sample Population. (Source: Author, 2020)

Out of the 37 questionnaires that were issued, 5 of them from the customers were not returned to the researcher. All the other 32 questionnaires were duly filled and returned to the researcher. This translates to 86% response rate which means that the research was successful.

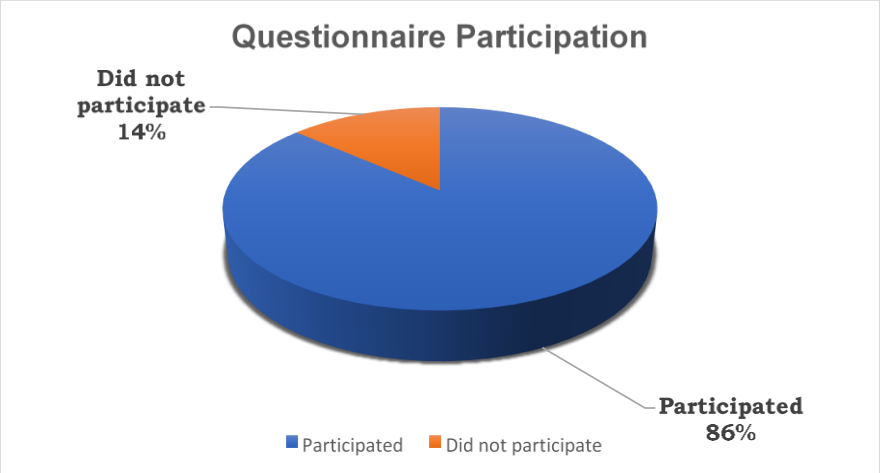


Chart 1: Showing the Questionnaire Participation (Source: Author)

The target population was mostly members with an average age of between 25 - 40 years of age. To gain insights into the current state of the restaurant, a questionnaire was presented to the customers and the staff (Appendix 2 and 3), which covered the aspects of interior architecture, furniture design, exhibition and display and landscaping of the restaurant. Their responses would guide as to where improvements were most necessary.

4.3.1 Customers' Questionnaire Analysis

From the 20 customers who returned the questionnaires, 13 of them rated the visiting experience as bad, 3 of them as okay, 2 of them as good and the rest 2 as amazing.

Chart 2: Rating the Visiting Experience of the Customers at the Restaurant (Source: Author)

Most of the customers (14) preferred visiting the Aquarium guest restaurant due to its location and accessibility. 4 of them gave their preference on the quality of services offered at the restaurant while only 2 based their preference on the design of the restaurant.

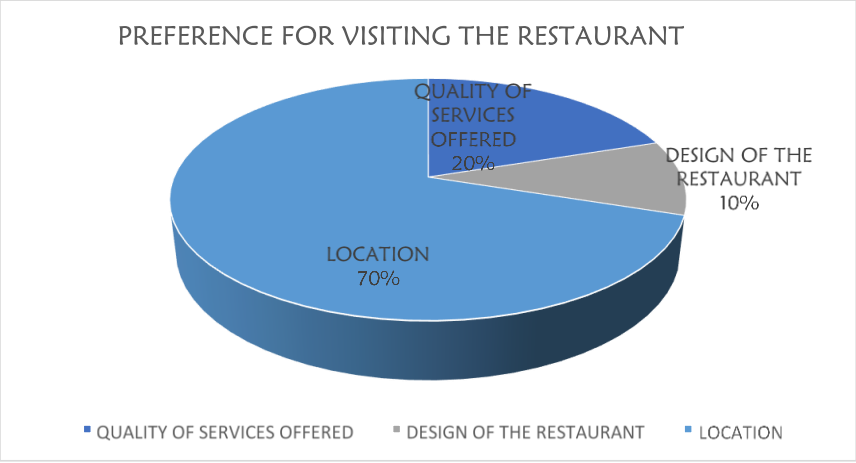


Chart 3: Showing the Customers' Preference for Visiting the Restaurant. (Source: Author)

When the question regarding whether the customers would recommend anyone else to visit the restaurant, only 7 customers of the 20 who returned the questionnaires were for the idea of giving recommendations to other guests to visit the restaurant. 13 were against the idea of giving recommendations to other guests to visit the restaurant.

Chart 4: Showing Percentage of Customers that would Recommend Visiting / not Visiting the Restaurant (Source: Author)

While comparing the general design of Aquarium guest restaurant and those of other restaurants that the customers have visited, only 1 of them termed it as superior. 12 customers described it as inferior while the rest 7 thought that the general furniture, interior architecture, exhibition and display and landscape designs were similar to others.

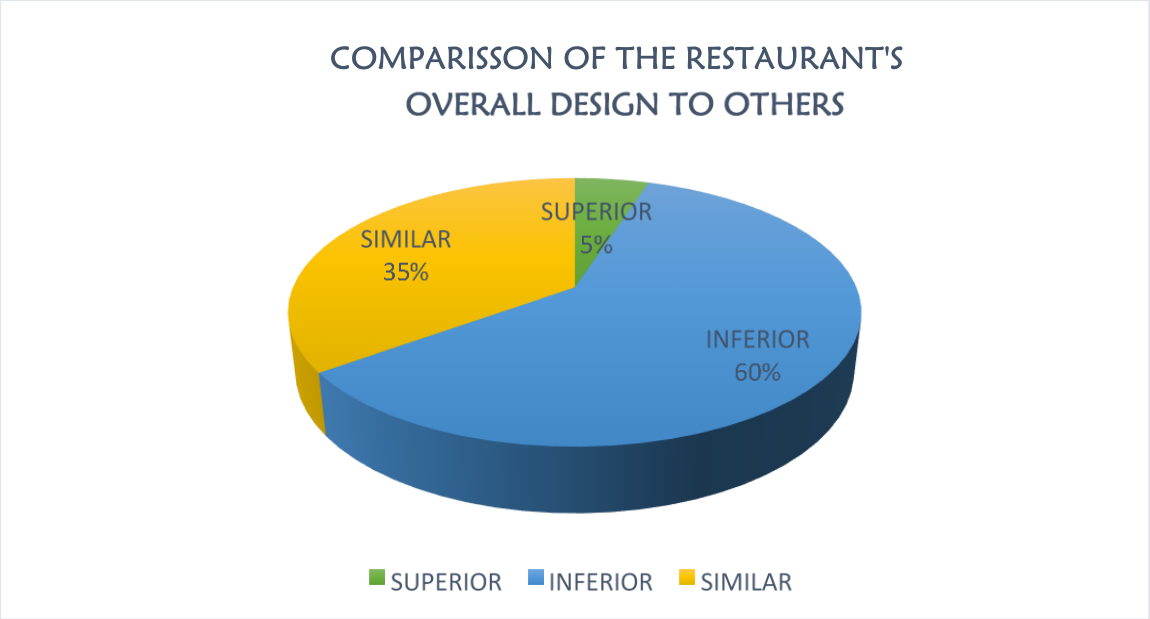
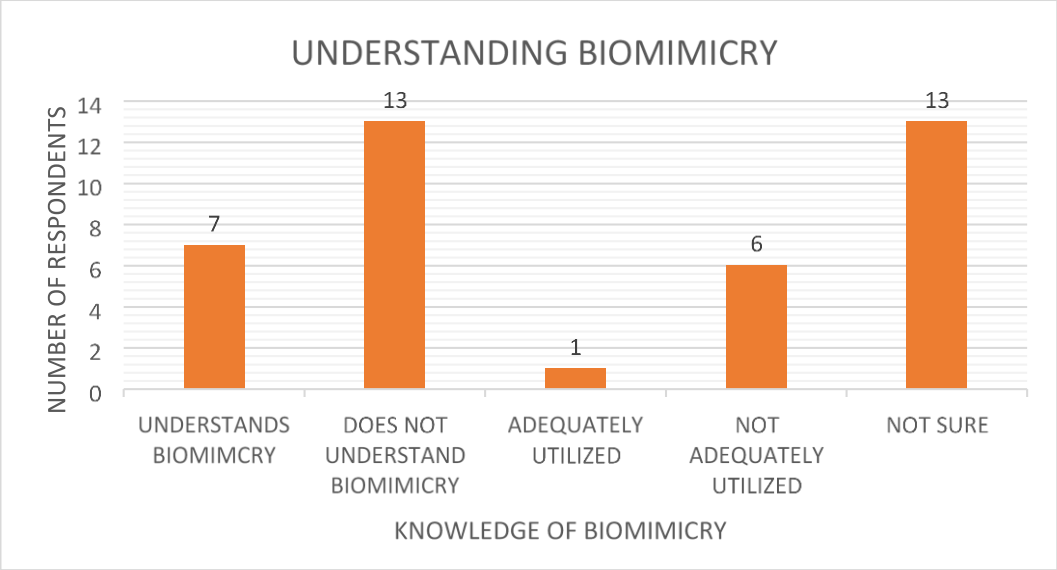


Chart 5: Customers' Comparison of the Restaurant's Design to others (Source: Author)

When the question on the understanding of Biomimicry and its use to create a new functional restaurant came up, 7 customers responded that they understood Biomimicry as an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. 13 customers responded that they did not understand Biomimicry or its use in design. 1 customer agreed that Biomimicry had been adequately utilized in designing of restaurants and other buildings in the country. 6 of them disagreed that its application was adequate while 13 were not sure about its utilization.



Graph 1: Showing how the Customers Understand Biomimicry and its Application (Source: Author)

When the use of African themes like Fulani art patterns to design a functional restaurant came up, 13 customers responded that they recognized African themes like Fulani art patterns and had interacted with them differently on the designing of interiors, landscape, exhibition and display and furniture of different buildings and restaurants. However, 7 customers responded that they did not recognize African themed art patterns like Fulani artistic patterns and could not provide any evidence on their utilization in designing of interiors, landscape, exhibition and display and furniture of different buildings and restaurants.

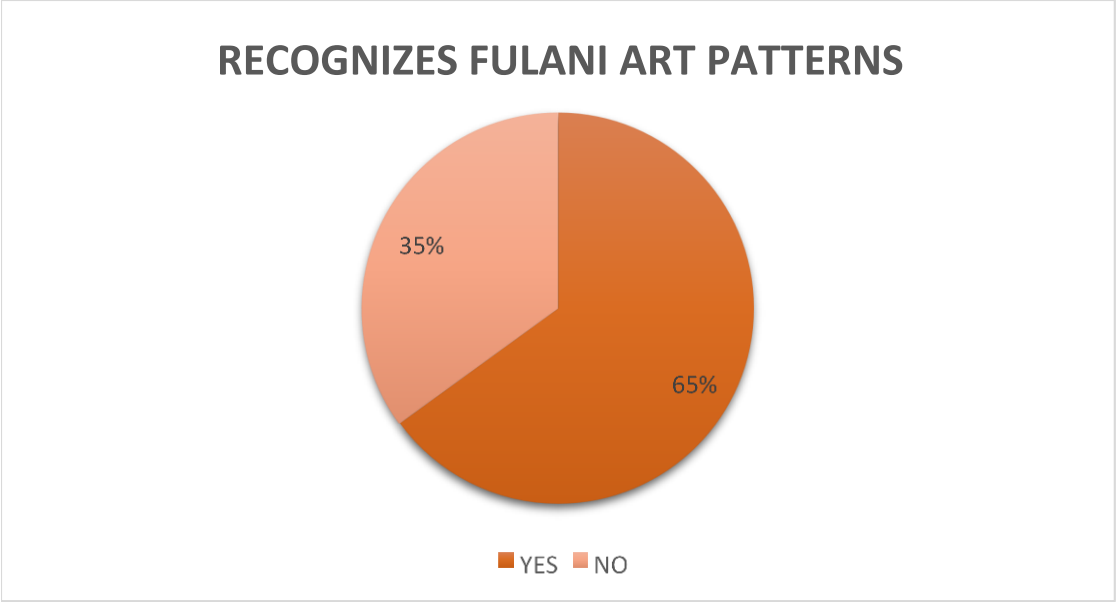
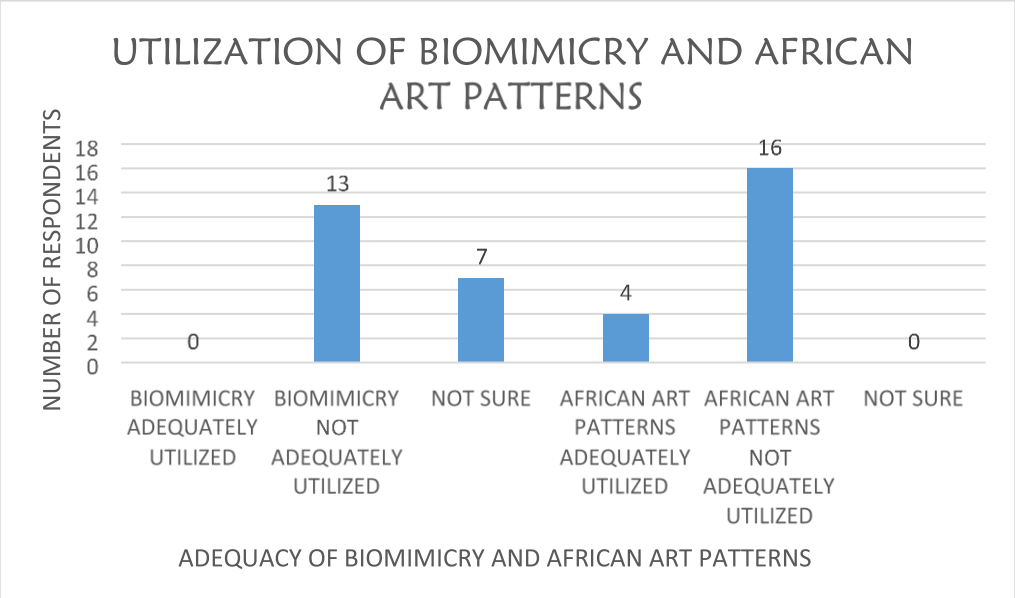


Chart 6: Customers' Understanding of Fulani Art Patterns and their Application (Source: Author)

Finally, the customers' sample population was mostly for the idea that the overall design of the Aquarium guest restaurant did not represent Biomimetic design. 13 of the customers responded that the restaurant's design did not mimic any of the nature's approaches to innovation in seeking sustainable solutions to solve the human and design challenges at the restaurant. However, 7 of them were not sure of whether biomimetic design was exhibited by the overall design of the restaurant. The researcher concluded that this indicated that the population was mostly for the idea of having a biomimetic design implemented in the overall re-designing of the restaurant.

Also, the customers' sample population was mostly for the idea of having an African themed design rather than a general one as it allows them feel at home while seeking services at a restaurant. From the 20 customers who returned the questionnaires,

16 of them thought that the application of African themed design was not adequate at the restaurant hence the need for more. Contrary, 4 customers thought that the application was adequate. The researcher concluded that most customers (16) preferred the African experience through Fulani art patterns which stands for 80% of the population, while the remaining 4 were for the satisfied that the current design was adequate interpreting to 20%



Graph 2: Showing Customers' Thoughts on whether Biomimicry and Fulani Art Patterns are used Adequately at the Restaurant and whether there is need to utilize them. (Source: Author)

4.3.2 Staff Questionnaire Analysis

From the 12 staff members who returned the questionnaires, 7 of them rated the working experience at the restaurant as bad, 2 rated it as okay, 2 as good and only 1 as amazing.

Chart 7: Rating the Working Experience of the Workers at the Restaurant (Source: Author)

For most workers (8), the location, proximity and accessibility of the restaurant was their preference for working there. 3 workers preferred the quality of the services offered at the restaurant as their motivation behind working at the restaurant. Only 1 worker was motivated by the design of the restaurant in working there.

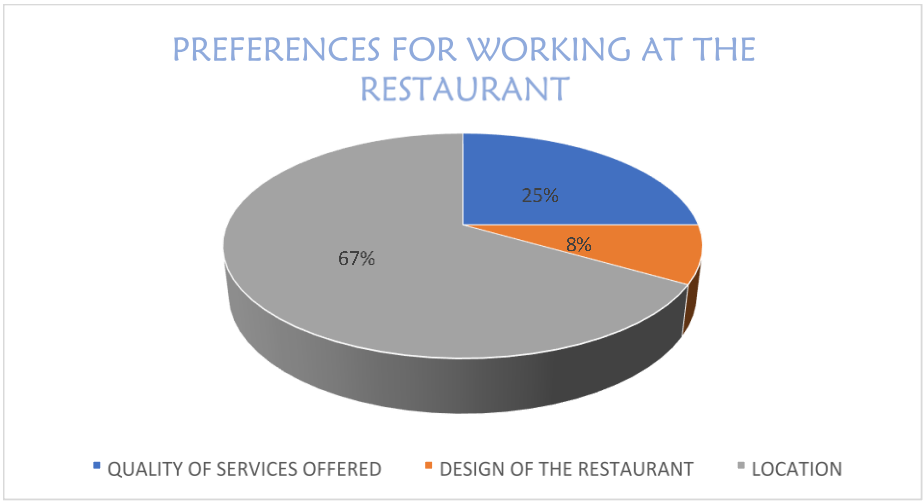


Chart 8: Showing the Workers' Preference for Working the Restaurant. (Source: Author)

When the question regarding whether the staff would recommend anyone else to visit or work at the restaurant, only 5 staff members of the sample population were for the idea of giving recommendations to other people to visit the restaurant and seek services there. The rest 7 were against the idea of giving recommendations to other people to visit the restaurant and seek services there.

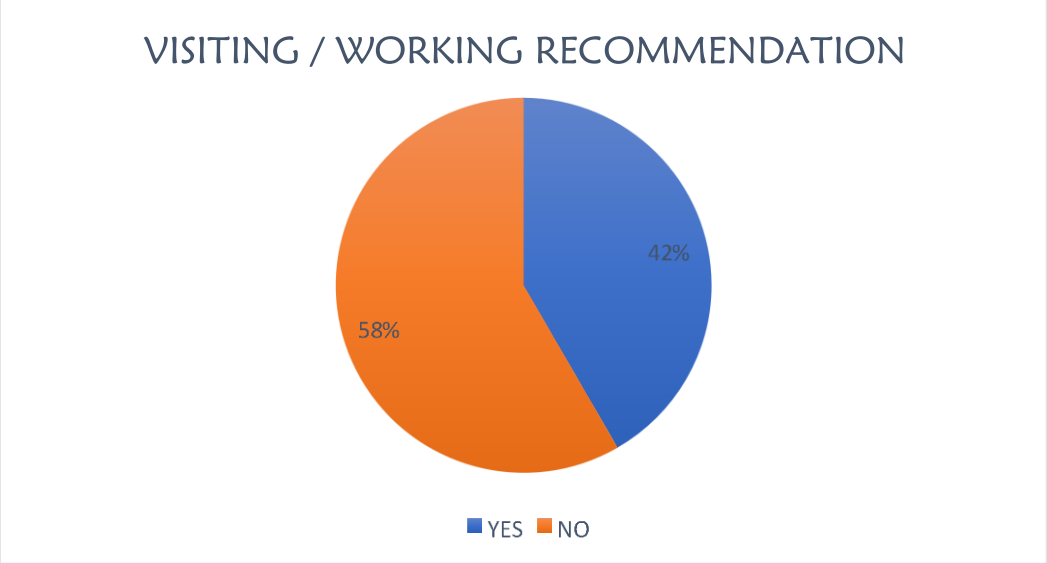


Chart 9: Showing Percentage of Workers that would Recommend Working / Visiting / not Working/ not Visiting the Restaurant (Source: Author)

While comparing the general design of Aquarium guest restaurant and those of other restaurants that the workers might have worked at or visited, 2 thought that it as superior to others. 7 workers described it as inferior while the rest 3 thought that the general furniture, interior architecture, exhibition and display and landscape designs were similar to others.

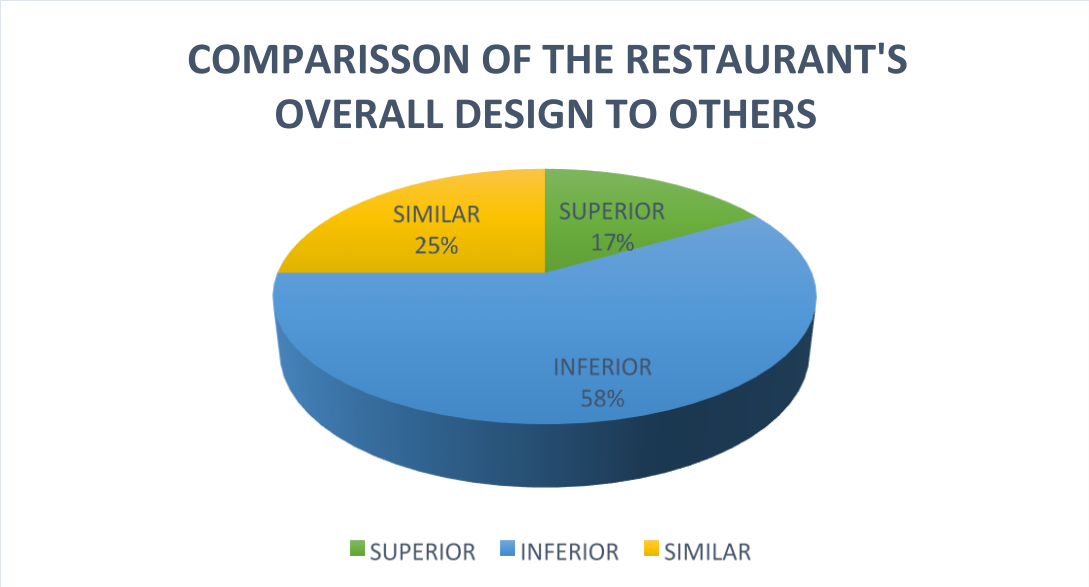
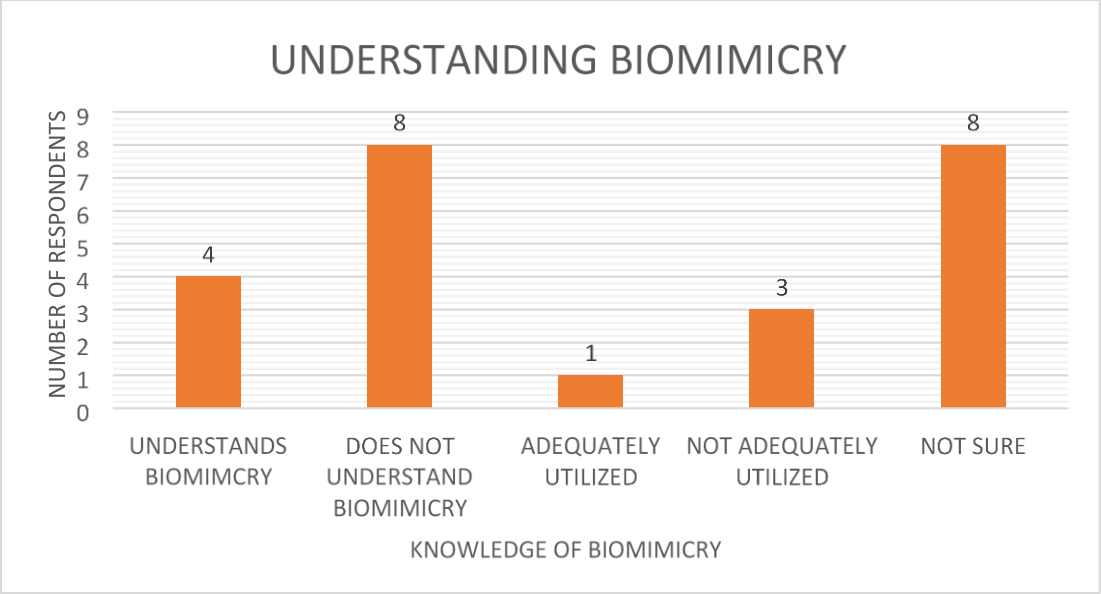


Chart 10: Workers' Comparison of the Restaurant's Design to others (Source: Author)

When the question on the understanding of Biomimicry and its use to create a new functional restaurant came up, 4 workers responded that they understood Biomimicry as an approach to innovation that seeks sustainable solutions to human challenges by emulating nature's time-tested patterns and strategies. 8 workers responded that they did not understand Biomimicry or its use in design. Only 1 staff member of the sample population agreed that Biomimicry had been adequately utilized in designing of restaurants and other buildings in Kenya. 3 of the staff members disagreed that its application was adequate while 8 were not sure about its utilization.



Graph 3: Showing how the Workers Understand Biomimicry and its Application (Source: Author)

When the use of African themes like Fulani art patterns to design a functional restaurant came up, 8 staff workers responded that they recognized African themes like Fulani art patterns and had interacted with them differently on the designing of interiors, landscape, exhibition and display and furniture of different buildings and restaurants. However, 4 staff workers responded that they did not recognize African themed art patterns like Fulani artistic patterns and could not provide any evidence on their utilization in designing of interiors, landscape, exhibition and display and furniture of different buildings and restaurants.

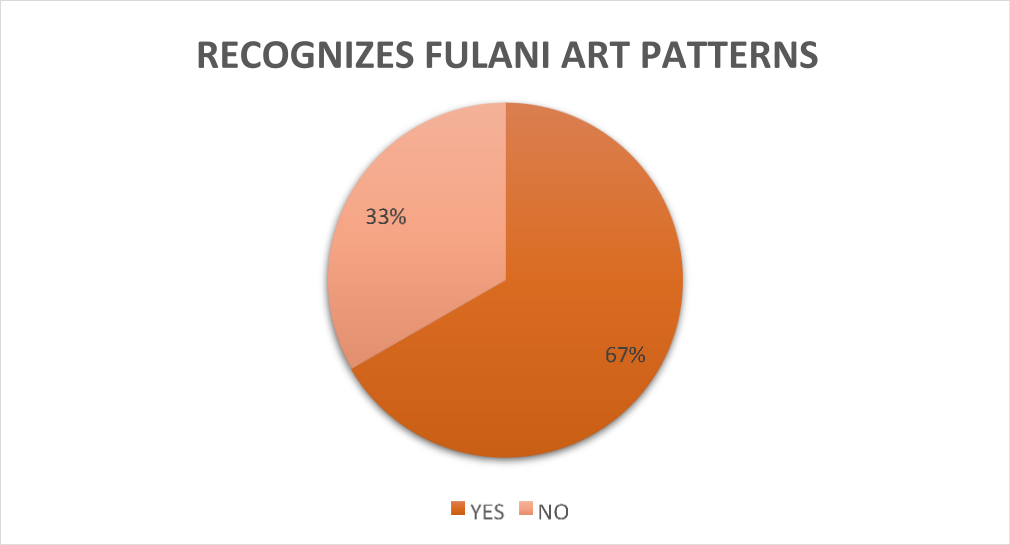
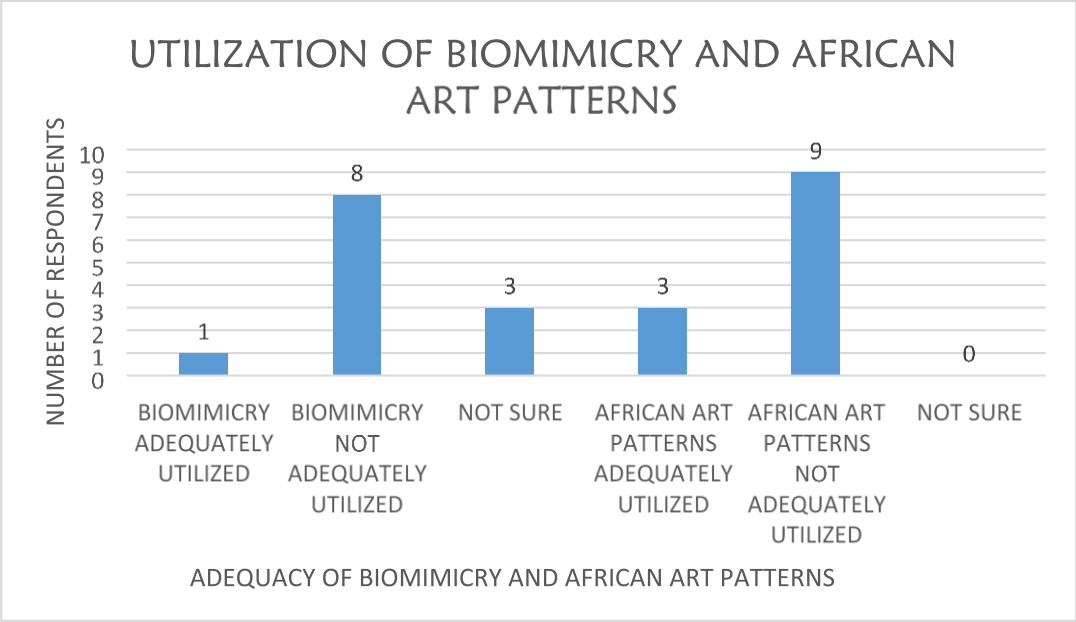


Chart 11: Workers' Understanding of Fulani Art Patterns and their Application (Source: Author)

Finally, the workers' sample population was mostly for the idea that the overall design of the Aquarium guest restaurant did not represent Biomimicry design. 8 of the workers responded that the restaurant's design did not mimic any of the nature's approaches to innovation in seeking sustainable solutions to solve the human and design challenges at the restaurant. 1 worker was satisfied that the overall design represented a certain extent of Biomimetic design. However, 3 of them were not sure of whether biomimetic design was exhibited by the overall design of the restaurant. The researcher concluded that this indicated that the population was mostly for the idea of having a biomimetic design implemented in the overall re-designing of the restaurant.

Also, the workers' sample population was mostly for the idea of having an African themed design rather than a general one as it allows them feel at home while working there. From the 12 workers who returned the questionnaires, 9 of them thought that the

application of African themed design was not adequate at the restaurant hence the need for more. Contrary, 3 workers thought that the application was adequate. The researcher concluded that most workers (9) preferred the African experience through Fulani art patterns which stands for 75 % of the population, while the remaining 3 were for the satisfied that the current design was adequate interpreting to 25 %.



Graph 4: Showing Workers' Thoughts on whether Biomimicry and Fulani Art Patterns are used Adequately at the Restaurant and whether there is need to utilize them. (Source: Author)

4.4 Presentation of Findings / Answers to the Research Questions

1. **How can Biomimicry nature inspirations be combined with contemporary Fulani art patterns and be applied through landscaping design, furniture design, interior design and exhibition and display at the restaurant?**

After research, the researcher has found out that Biomimicry can be used as an explorative tool for design problem-solving at the restaurant by integrating the ecological / natural solutions into the design. Through this exploration, components and systems in the landscaping design, furniture design, interior design and exhibition and display design at the restaurant will utilize natural forms, functions and processes.

Based on decorative African art patterns, African art patterns like Fulani art patterns need to be included in the design style. The ethnic designs and motif patterns derived from the textiles such as the Fulani's Arkilla Kerka cloth can be incorporated at the four areas of designing the restaurant through painting or addition of components that have them in order to improve the overall aesthetic appearance through decoration.

2. **How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's interior and furniture design to create systems, components and models that are Biomorphic Forms & Patterns that can create spaces that are comfortable and captivating?**

The researcher found out that Furniture and Interior architecture have always been a symbolic aspect of the life style and cultural richness of colors, shapes and forms and different people all have their different preferences. After researching and studying how interiors can affect human emotion and action, the next suitable step to take is towards

the design elements. To influence others to admire nature, it only seems plausible to integrate Biomimicry into the furniture and interior architecture forms. Therefore, in this day and age, it is prime time for the restaurant's management to reconnect back to the natural world in ways which the modern-day millennial will understand and embrace – this is where Biomimicry design comes into play.

Furthermore, the researcher found out that the interior architecture and furniture design should reflect the picture of the world by using natural materials and finishes at the redesigning of the restaurant. At the same time the application of decorative African patterns like Fulani art patterns is also welcomed. The colors at the furniture and interior finishes should be warm and hot whereas the tone should be maintained as natural.

3. **How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's landscape design to bring about more relaxing and functional recreational spaces that are environmentally responsible?**

   After research, the study found out that although landscape architecture has created design components and systems that utilize natural form, function and process independently, it rarely creates designs that utilize them collectively. Aquarium guest restaurant can utilize the concept as a potential design tool in generating new ideas for the redesigning of the landscape. The research found out that this can be achieved through creating landscape systems and components that perform closer to the natures modelling. This modelling should be derived from natural form, function and processes which are implemented in design solutions.

In incorporating decorative African art into the landscape design utilizing patterns like Fulani patterns, the researcher discovered that different components at the landscape of a site can be enhanced aesthetically through incorporating motifs and designs like Fulani Art patterns. In soft landscaping, components such as flower pots and litter bins can be decorated using these patterns. In hard landscaping, rocks located at the sides of pathways can be decorated using these patterns.

4. **How can Biomimicry and Fulani art patterns be applied in Aquarium guest home's exhibition and display to create display and exhibition systems and components that are captivating and attractive to the customers?**

For the creation of captivating exhibition and display systems and components at the restaurant, the researcher found out that the design process should utilize Biomimicry and how nature and the forms and processes in the natural world inspire design. Furthermore, the proposed designs should incorporate a Biomimetic exhibition that is inspired by the forms and concept of the design and the fundamental idea of the exhibition itself.

In terms of African art, the exhibition and display systems should incorporate the link between the design and culture. The application of Art patterns like the Fulani art patterns on the exhibition and display components should include features such as originality, coloring, dynamic energy, expression and contrast. Also, Africa being a rich source of materials like wood, stone, papyrus and many more, the designer should utilize them based on the aim that the exhibit is being targeted for.

4.5 Conclusion

This chapter has analyzed the Aquarium guest restaurant from the data obtained from observation, interviewing and questionnaires using spatial and analysis of response respectively. It has then given a summary of the findings.

The researcher concluded that Aquarium guest restaurant has paid attention to a certain degree to African contemporary art. However, the authenticity of the African contemporary art used is still in question and is probably left to the discerning eye of the target audience to decide. In the case of applying Biomimicry, it is now clear that indeed there has not been any energy and effort put in place so that customers, staff, management and shareholders can benefit from Biomimicry concepts and ideas. A lot of room thus remains for the implementation of Biomimicry in the restaurant as far as interior design, landscaping design, exhibition and display and furniture design are concerned.

CHAPTER 5: SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

5.1 Introduction

This chapter will summarize the data obtained, identify a design approach to be used, and propose solutions to solve the identified design areas within the Aquarium guest restaurant, recommend materials and some of nature's form, process and ecosystem that can be used to attempt to achieve a favorable result.

In this chapter, the researcher outlines major recommendations that would allow Aquarium guest home to exhibit deliberate Biomimicry in most of its design together with contemporary African art. Biomimicry and contemporary African art should be effectively be implemented the guest restaurant's interior architecture, landscaping design, exhibition and display and furniture design. The implementation of these recommendations will go a long way in benefiting the clients, staff and share holders of Aquarium guest restaurant.

5.2 Summary of Data Analysis/ Findings

After collecting data through different kinds of research methodologies and analyzing the said data, the researcher was able and confidently so, to get an insight concerning the problem statement and come up with conclusions. The analysis of the data obtained from the questionnaires shows that majority of the respondents did not like the current design, materials, finishes and colors used for the restaurant's furniture, interior architecture, landscaping and exhibition and display. It was therefore apparent that there

was need for redesigning the four areas using the researcher's proposed concepts. Since the users of the restaurant are African adults who understand the nature and African continent at large, a design theme that was nature-oriented and African-themed would be appreciated.

Analysis of the responses received showed that most users of the restaurant were not comfortable with the Zebra- like pattern wall treatment and finishes. There was a complaint that the patterns were dull against the orange background that they had been painted on. Also, the red painted walls located on the Choma zone and a part of the dining area were not appreciated by a majority of the customers and workers. Even the manager agreed that there was no inspiration behind the red wall treatment and that cost-saving was the principle factor considered in their decoration.

The ceiling and lighting as per the analysis of responses by the researcher, needs to be improved since most respondents did not give a positive response. The researcher discovered that the fabric ceiling was easier to smear and quickly settled dust particles. Also, incase water gets inside the ceiling, it is easily pulled out of its fixtures. The restaurant's users complained that the windows were too small to allow in adequate natural light. Also, the fluorescent and LED bulbs did not emit enough light hence the lack of enough lighting ambience caused by the lack of highlighting at the focal points at different spaces within the restaurant. Therefore, there was need to increase the size of the windows in order to allow in more natural light and use hidden lights in strategic places to create an ambiance that compliments the design and suit the users.

The responses received regarding furniture, which is probably the most important aspect of the restaurant's interior architecture, were mainly negative. From observation, the dining tables made of wine making barrels made of wood and a strap sheet metal could not hold many items on the top surface. The other set of dining table and seats that were cream in color were bulky and caused difficult in movement during cleaning and arrangement. For the choma zone furniture, their surfaces made of hard plastic decreased their lifespan due to exposure to harsh weather conditions as they were located at an outdoor space that did not have a shade.

For exhibition and display, the counter and bar area are the two main areas concerning this. From analysis, the reception / counter desk is not sleek in design. Furthermore, the wood material used to make it is susceptible to scratch. Besides, the space accessible for the reception is not adequate and the desk is not accompanied by an ergonomic chair where the receptionist / cashier can sit while tired. The lighting at the counter is dull. The lack of adequate lighting adorning the reception area makes it have less ambience. Subsequently, less ambience means that the creation of focal points is poor hence poor highlighting of objects at that area. Focusing on the bar area, this space is a bit congested and cannot accommodate more. Inquiry from the restaurant manager, drinks have to be kept at the sore because of lack of enough space to accommodate them at the counter.

To sum up the landscaping design analysis and findings, black cotton soil is predominant at the area. Evergreen trees align most of the perimeter walls, hedges are used to partially fence at some ends and shrubs grow at certain points. Decorative plants

are planted in pots and vases and placed within the compound with grass as the background cover except for the parking and pathways. The parking is covered with finely grinded black ballast stone. The parking area lacks clear line marking, graphics and signage that indicate its purpose. The land slops slightly towards the south (front of the restaurant building) but otherwise the land where the building lies is relatively flat. Most of the storm water runs into open and closed drainage with culverts used where there is a footpath / walkway across. Most of the electric poles supplying the restaurant with electricity are outside the fence on the southern perimeter wall with one pole in the compound covered with glass meaning that some cables run underground.

5.3 Recommendations

Research was conducted on the philosophy driving the whole research-Biomimicry, its applications in buildings like restaurants and the Fulani art patterns inspiration to enable the researcher get a better view of how to redesign the Aquarium guest restaurant. The researcher therefore recommends the following in redesigning the design areas under study in order to achieve the objectives of this research:

5.3.1 Interior Architecture

The interior of the restaurant is the most frequented area by the customers. Therefore, it needs to be made a natural environment by ensuring that it has good indoor environmental quality. To ensure this, the following should be implemented.

5.3.1.1 Floor Finishes

The researcher recommends an Entropy for Interface floor finish, which is the world's first biomimetic carpet tile. The carpet tile is designed based on the way the

random but beautiful ways pebbles amass in a riverbed and leaves blanket the ground in a forest to create a something unique. Entropy is revolutionizing the flooring industry because it features carpet tiles with random, non-directional patterns and gradations of colors for the first time. Again, Biomimicry proves that its codes can make the interior architecture of a building as hospitable to life as the natural world (Imani & Donn, 2017, p.2).

Figure 38: Biomimetic Entropy Carpet Tiles Floor Finishes. (Source: http://www.interface human spaces.com)

With these tiles with intentional color variations, the need for consumers to purchase large quantities of "attic stock" in order to ensure matching replacement tiles is removed. That capacity certainly takes nature's focus on economy to heart. The carpet's tile design also channels the gecko, a reptile who uses more than a million tiny foot hairs

to stick to surfaces at any angle. The design borrows the strategy in order to create a glue-free carpet installation system that involves less mess and increased flexibility, mimicking nature's ability to solve a design problem efficiently and creatively. The gecko-inspired carpet tiles also reduce interface's environmental footprint to one that's 90% less wasteful than traditional adhesives. (Mazzolini, 2017, p.95).

Figure 39: An example of Adhesive-free Installation with Biomimetic Entropy Carpet Tiles Floor Finishes. (Source: http://www.interface human spaces.com)

5.3.1.2 Ceiling and lighting

The ceiling and lighting at the restaurant tend to lack a design theme inspiration and are in poor condition hence the researcher proposes the reinstallation of the ceiling with the use of a Biomimetic ceiling made of wood. The ceiling will have nest-like or egg-like volumes encircling the dining spaces that will act as a separation of the spaces

from the rest of the restaurant while also acting as sculptural installations. The nest-like circles will be organic and natural in their appearance.

Figure 40: Nest-like Volumes on the Ceiling Encircling the Dining Spaces. (Source: www.designboom.com/architecture)

Furthermore, the bulbous forms on the ceiling will add more detail to the space which is enclosed. Lighting is the most essential part of interiors which makes a place either dull or bloomy. It basically provides what designers refer to as ambience or the mood of a space. The researcher therefore recommends that the ceiling be fitted with LED lights occupying the circumference of the nest-like volumes. On the other parts, circular LED bulbs should be fitted and spaced appropriately. This will allow light to filter through the organic structures therefore casting shadows and patterns onto the monochromatic surfaces.

Figure 41: Showing the Nest-like and Bulbous Forms of the Ceiling and the Proposed Light Fixtures Installation. (Source: www.designboom.com/architecture)

5.3.1.3 Wall Treatment

To deal with the lack of color scheme on the walls of the restaurant, the researcher proposes two options for the wall treatment. The first one is to have a wall design painted in a white background and enhanced through dark Fulani art patterns and motifs derived from the Fulani gourds or the Arkilla Kerka cloth on the foreground. This will create contrast between the dark and light colors due to the underlying levels of lightness.

The second option that the researcher proposes is the use of hexagonal honey-comb like patterns on the wall. A bold hexagonal design will appeal to the trendy clients by channeling the sweet honey comb motif. This will create a design that is appealing and striking. Also, the patterns will have contrasting black and yellow beehive symbols to

help define the space and therefore offer a high level of visual impact on the interior spaces.

Figure 42: Wall painted with motifs derived from Fulani artistic Arkilla Kerka cloth. (Source: www.britannica.com).

Figure 43: Hexagonal black and Yellow Honey-Comb Like Patterns on the Wall. (Source: www.pinterest.com).

5.3.1.4 Window Treatment

The researcher recommends that clerestory windows be included in the redesigning of the restaurant. Clerestory windows are vertical windows close to a wall's top. They highlight a room and illuminate the ceiling. The reflected ceiling light is a soft, indirect light and sky-lighting imitation. They also allow light to penetrate deeper into the room than standard height-set windows, especially when combined with adjacent light-colored overhangs and light-colored ceilings (Booth, 2011, p.33).

Figure 44: Clerestory lighting through windows (Source: sustainability.williams.edu)

5.3.1.5 Doors

Currently glass doors with metal are been used for safety purposes but are not of aesthetic value. The researcher proposes sliding glass door for the main entrance within the building whereas for the kitchen, the researcher recommends a hand carved door made of mahogany. The sliding glass door is aesthetic, easy to operate and spacious therefore allowing a large traffic of people to flow at one time. The kitchen door will be sturdy, tough, durable and hard to dent since mahogany is a hard wood.

Figure 45: Proposed Main Entrance Doors for Main Entrance and Kitchen (Source: www.pintrest.com)

5.3.2 Exhibition and Display

5.3.2.1 Bar Area Exhibition and Display

The bar area at Aquarium guest restaurant is the main exhibition and display area. It is made of basic rectangular shelves stacked with drinks (See Figure 25). The basic shelves can be replaced by thicker wooden shelves with special highlighting lights. In between the shelves a feature wall section with Fulani inspired carvings can be placed. The counter top can be made of natural leathered granite to create a beautiful natural finish.

Figure 46: An Example of Proposed Exhibition and Display at the Bar Area. (Source: restaurantandbardesignawards.com)

To take care of the problem of light on the beverage shelves, the researcher proposed for the establishment of task lights on the racks and cupboards as appeared on figure below. This will empower users to distinguish their preferred drinks on the racks from a distance consequently sparing them the hustle of straining. On the display, names of drinks will be displayed to make it easier for the guests to identity what they want. The pockets of the display wall will be inspired by a motif from the Arkilla Kerka cloth Print.

Figure 47: Bar Display unit Lighting (Source: http://zero7beach.blogspot.com)

5.3.2.2 Counter Display Unit / Reception Desk Exhibition and Display

In solving the lighting ambience at the display counter unit area, the researcher recommends that pendant lights be hanged at the top of the display unit. The display unit area should solve this problem by utilizing pendant lights that are inspired by nature's processes and components. This will make sure that the lighting is directly below the counter top and the display chambers at the display unit. For the counter top, the researcher recommends granite to create a beautiful natural finish. Furthermore, the display chambers should be made of glass. Glass is transparent and allows clear visibility of the displayed items. The rest of the display unit should be made of oak wood. Behind the display unit, the researcher recommends that a wall painting of particular Fulani art

theme be put at the wall. This will capture the attention of the customers purchasing items and paying for their tickets at the display unit where the receptionist / cashier is located.

Figure 48: Exhibition and Display Unit at a Restaurant (Source: www.pinterest.com)

Figure 49: Examples of Biomimetic Pendant Lights for Hanging at the Counter Display Unit Area (Source: www.pinterest.com)

5.3.3 Furniture Design

For recommendations in furniture design, the researcher relied on Biomimicry philosophy for solving the existing furniture design and layout challenges. The researcher therefore recommends possible furniture samples influenced by microorganisms, plants

or animal skeleton structure, designed precisely or amended and produced with macro or micro-size inspiration from the nature. By acknowledging that materials and forms in nature have begun to find themselves a place particularly in furniture design, the researcher therefore sought to propose different furniture designs for the restaurant. The examples below represent the kinds of furniture designs that the researcher recommends the Aquarium guest restaurant to implement.

5.3.3.1 Lounge Area Furniture Design

The researcher recommends the following possible Biomimetic furniture designs for the lounge area:

Figure 50: The Armchair, that is an Exact Copy of a Lily Flower. Can be Used as a Seat for the Restaurant's Lounge Area. (Source: www.science direct.com)

Figure 51: The Mantis Table inspired by Body Parts and Joints of the Mantis. Can be Used as Coffee Table for the Restaurant's Lounge Area. (Source: www.science direct.com)

5.3.3.2 Dining Area Furniture Design

The researcher recommends the following possible Biomimetic furniture designs for the dining area:

Figure 52: "The Tree Table". A Table of Forged and Welded Steel with an Exact Figure of a Tree. Can be Used as a Dining Table at the Restaurant. (Source: www.science direct.com)

Figure 53: "Bone Chair" Inspired by Bone Structure under Osteoporosis. Can be used as a Dining Chair at the Restaurant. (Source: www.science direct.com)

5.3.3.3 Bar Area Stool Design

The researcher recommends the following possible Biomimetic furniture design for the bar stools:

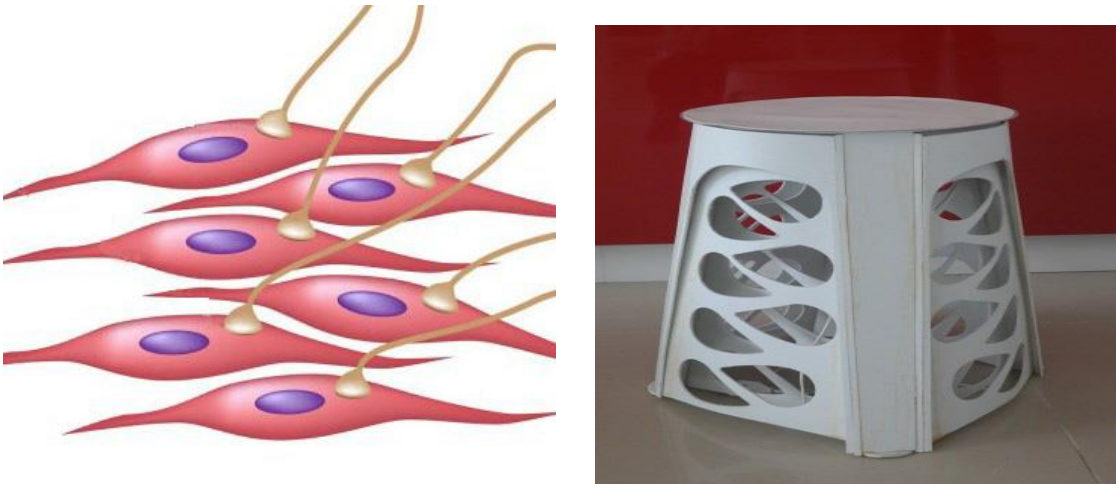


Figure 54: A Stool Inspired by "Smooth Muscle Cell" Form. The Design is Completed by Using the Same Gaps on the Surface. Can be Used as a Bar Stool for the Restaurant if Constructed at the Standard Bar Stool Height (Source: www.science direct.com)

5.3.4 Landscaping

Landscapes have the potential to provide spaces for contemplation and retreat as well as places for exercise and sensory stimulation. It provides a calming effect hence enabling one to enjoy the serenity (Andrea, 2015 p.22). The researcher will recommend a landscape design for the restaurant that is guided by Fulani art decorative patterns and Biomimicry philosophy. Biomimicry will make the landscape sustainable while the Fulani art decorations will enhance the African theme and make the customers visiting the restaurant and the workers feel at home.

5.3.4.1 Pathways

The researcher recommends wider pathways to be created to allow room for people to move around well and to allow more than one person to walk comfortably without any inconvenience. These pathways should be made of pebble mosaic with a pattern that reflects the Fulani art motifs either from the Fulani gourds / calabashes or the Arkilla Kerka cloth.

Figure 55: A pebble Mosaic Walkway. The Mosaic should have Fulani Art Motifs Shown on the Right. (Source: www.istockphotos.com)

Figure 56: Fulani Calabash with Art Motifs. These Motifs can be Implemented on the Pathway Shown on the Left. (Source: www.istockphotos.com)

5.3.4.2 Outdoor Relaxing and Recreation Zones

Given that not all customers would like to be inside the restaurant, the researcher recommends the creation of an outdoor recreation area that is not present at the restaurant. This will enable those people who prefer outdoor dining and relaxing enjoy the environment surrounding the restaurant. With this in mind, the researcher proposes outdoor relaxation zones with furniture components and systems that are Biomimetic in

nature. This can be achieved through creating landscape systems and components that perform closer to the natures modelling. This modelling should be derived from natural form, function and processes which are implemented in design solutions. The researcher therefore recommends the following possible solutions:

Figure 57: An organic Architectural Relaxing Zone. Inspired by the Onion Form. (Source: www.pinterest.com)

Figure 58: Outdoor Seating Area that is Curvenous in Nature. Takes its Inspiration From Nature's Curvenous Forms (Source: www.pinterest.com)

Figure 59: Hammock Seating Chair. Allows Users to seat and Relax their Backs. (Source: www.pinterest.com)

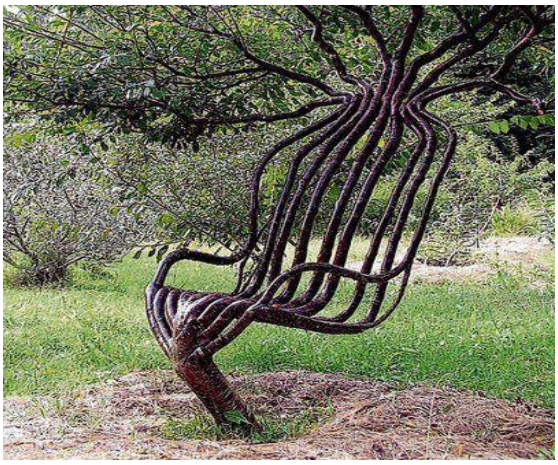


Figure 60: A Tree Chair inspired by the Tree form. Good for Providing Shading and Comfortability. (Source: www.pinterest.com)

5.3.4.3 Parking

For the parking lot, the researcher recommends that the parking be fitted with a shade. The shade should mimic natural systems in its design. Not only will the shade improve the aesthetic appearance of the parking area but it will also protect the vehicles below from harsh weather conditions like wind, hail, ultraviolet rays and rain. In mimicking the patterns from nature in creating the canopy, this will be an energy efficient strategy as it will lead to the reduction of energy. This is through protection from the sun and heat and its ability to maintain a cooler environment for vehicles which reduces the amount of energy needed to cool it down from the hot sun.

Figure 61: Biomimetic Car Park Shading for Efficient Energy Saving. (Source: www.COBEarchitects.com)

5.3.4.4 Soft Landscape Materials

Vegetation plays a significant role in the overall aesthetics of a landscape. Depending on the type of vegetation chosen, they create a feeling of nature in an environment, evoke emotions and feelings, and capture moods and also beautifying the outdoor environment through their qualities such as form, color and texture (Bjere, 2019, p.167).The researcher recommends improvements to be made in consideration to carpet grass, flower pots, shrubs, perennial trees and other ground covers to improve the beauty of the existing landscape mainly through Fulani motifs.

Figure 62: Flower Pots Decorated with Fulani Art Motifs. (Source: www.istock.com)

Figure 63: Possible Shrubs and Lawn Design that can be Enhanced through Fulani Art Motifs. (Source: www.pintrest.com)

5.3.4.5 Hard Landscaping

Landscape architects and gardeners recommend that hard landscaping materials should be used to improve the landscape by design. (Pawlyn, 2016 P.109). From research, the researcher only found stone as the only hard landscaping at the site. However, the stone designs were not aesthetically appealing.

Bearing this in mind, the researcher recommends that hard landscaping at the restaurant should be improved through the introduction of a stone fountain that is inspired by natural systems and components and enhanced through Fulani art motifs. Also, concrete rock pavements are proposed for implementation at the site. The rocks should have the Fulani art motifs as their decoration.

Figure 64: Showing a Proposed Rock Fountain and the Art Patterns that Should be Painted on its Rocks. The Patterns Should be from Fulani Art Motifs. (Source: www.landscapeidea.com)

5.4 Conclusion

The researcher was able to confirm the alternative hypothesis that there is an opportunity for Biomimicry in interior design, furniture design, Landscaping and exhibition and display in the guest restaurant. Also, the researcher found out that there is an opportunity for the application of contemporary Fulani art patterns for the improvement of the aesthetics of the guest restaurant in the four areas. From this conclusion the researcher has recommended use of Biomimetics or biomimicry in the imitation of the models, systems, and elements of nature for the purpose of solving complex design problems affecting the clients and staff who access the furniture, interior, exhibition and display points and the landscape of the Aquarium guest house.

5.5 Suggestions for Further Study

This research was not exhaustive and has therefore opened up various opportunities for further research. The researcher recommends that a study of what makes a work of art "authentic" especially concerning contemporary African art be undertaken. This will help set a measurable standard that can be recognized across the world of art knowledge. Likewise, more research should also be undertaken on the use of African inspirations on landscaping, as this was a problem for the researcher. Also, more research needs to be carried out on the field of Biomimicry design so that designers can understand more on the utilization of the philosophy as an approach to innovation in

seeking sustainable solutions to design challenges by emulating the nature's tested patterns and strategies. Finally, more study needs to be carried out in order to come up with a design process that can be used to achieve both biomimicry or the normal design without the need to change the design steps.

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Appendices

Appendix 1: Letter of Introduction

I am a student at The University of Nairobi investigating how Biomimicry and contemporary African art through Fulani art patterns can be integrated to create a functional restaurant for adults. The Aquarium guest restaurant has been preferred as the most pertinent site of study. My appeal to carry out this study in your facility was considered administratively and approved thereof. Consequently, you have been chosen among the reliable respondents to provide the essential information which can facilitate the achievement of our objectives. You are kindly asked to cooperate by courteously providing responses in the attached questionnaire and interview checklist. The principles guiding this study demand absolute anonymity and confidentiality. It is therefore in the best interest of this study that you are cordially requested to offer your responses to the best of your understanding and knowledge on every event being investigated. I am looking forward to your cooperation as I hope to receive responses that are detailed with maximum accuracy.

Yours Sincerely,

.....

Appendix 2: Questionnaire Guide to the Customers

University of Nairobi

School of the Arts and Design

This questionnaire is intended to aid in the research of the use of Biomimicry and Fulani art patterns in interior architecture, furniture design, exhibition and display and landscape design at the Aquarium guest restaurant.

Part A: Demographics

Instructions: Kindly tick appropriately where necessary

Sex

Male [ ] Female [ ]

Age Group

Below 25 [ ] 26-30 [ ] 31-35 [ ] 36-40 [ ]

41 and above [ ]

Duration

How long have you been visiting the Aquarium guest restaurant?

Less than 1 year [ ] 1-2 years [ ] 2-3 years [ ] 3-4 years [ ]

5 years and beyond [ ]

Part B: Your Input

Instructions: Kindly tick appropriately where necessary

1. Rate your visiting experience in Aquarium Guest Restaurant?

Bad [ ] Okay [ ] Good [ ] Amazing [ ]

2. What motivates you to visit the Aquarium Guest Restaurant?

Location [ ] Quality of services offered [ ] Design of the restaurant [ ]

Any Other……

3. Would you recommend anyone to visit Aquarium Guest Restaurant?

Yes [ ] No [ ]

Give a reason……

……..

4. Have you visited any other restaurants in Kenya?

Yes [ ] No [ ]

If yes, please state the name / names and give reasons……

……

……

5. How would you compare the general design of Aquarium Guest Restaurant and those of other restaurants that you have visited?

Superior [ ] Similar [ ] Inferior [ ]

Part C: Your Perspective

6. Have you heard of the term 'Biomimicry'? Yes [ ] No [ ]

If yes, what do you understand by 'Biomimicry'?.....

……..

7. Do you think Biomimicry has been adequately utilized in designing of restaurants and other buildings in Kenya? Yes [ ] No [ ] Not sure [ ]

If yes, how and if no, what areas need improvements?.....

……

8. What is your understanding of an African inspired design in interior designing, furniture designing, exhibition and display and landscaping design?.....

……

……..

9. Are you familiar with Fulani artistic Patterns? Yes [ ] No [ ]

If yes, have you interacted with Fulani art inspired interior architecture, landscape, exhibition and display and furniture designs and what was it like?.....

……

……

10. In Your opinion does the overall design at Aquarium restaurant represent:

Biomimetic Design Yes [ ] No [ ] Not Sure [ ]

African art inspired theme Yes [ ] No [ ]

Any other design theme / concept Yes [ ] No [ ]

Please describe your choices above.....

……

……

……

11. Would you like to participate in a follow up interview? Yes [ ] No [ ]

If yes, please indicate your Name and Contact below

Name……. Contact……

Appendix 3: Questionnaire Guide to the Staff

University of Nairobi

School of the Arts and Design

This questionnaire is intended to aid in the research of the use of Biomimicry and Fulani art patterns in interior architecture, furniture design, exhibition and display and landscape design at the Aquarium guest restaurant.

Part A: Demographics

Instructions: Kindly tick appropriately where necessary

Sex

Male [ ] Female [ ]

Age Group

Below 25 [ ] 26-30 [ ] 31-35 [ ] 36-40 [ ]

41 and above [ ]

Category

Chef [ ] Waiter / Waitress [ ] Cleaner [ ] Security Personnel [ ]

Other (Kindly clarify) .....

Duration of Service

How long have you been employed in your present facility?

Less than 1 year [ ] 1-2 years [ ] 2-3 years [ ] 3-4 years [ ]

5 years and beyond [ ]

Have you been working in your current position throughout your tenure?

Yes [ ] No [ ]

Part B: Your Input

Instructions: Kindly tick appropriately where necessary

1. Rate your working experience in Aquarium Guest Restaurant?

Bad [ ] Okay [ ] Good [ ] Amazing [ ]

2. What motivates you to work at Aquarium Guest Restaurant?

Location [ ] Quality of services offered [ ] Design of the restaurant [ ]

Any Other……

3. Would you recommend anyone to visit Aquarium Guest Restaurant?

   Yes [ ] No [ ]

   Give a reason……

   ……..

4. Have you visited /worked in any other restaurants in Kenya?

Yes [ ] No [ ]

If yes, please state the name / names and give reasons……

……

……

5. How would you compare the general design of Aquarium Guest Restaurant and those of other restaurants that you have visited / worked for?

   Superior [ ] Similar [ ] Inferior [ ]

Part C: Your Perspective

Instructions: Kindly tick appropriately where necessary

6. Have you heard of the term 'Biomimicry'? Yes [ ] No [ ]

If yes, please give a short description of your understanding…….

……

……

7. Do you know of any African theme Art Patterns like Fulani art patterns applied in the designing of a restaurant? Yes [ ] No [ ]

If yes, please name the location…….

8. In Your opinion does the overall design at Aquarium restaurant represent:

Biomimetic Design Yes [ ] No [ ] Not Sure [ ]

African art inspired theme Yes [ ] No [ ]

Any other design theme / concept Yes [ ] No [ ]

Please describe your choices above.....

……

……

……

9. Would you like to participate in a follow up interview? Yes [ ] No [ ]

If yes, please indicate your Name and Contact below

Name……. Contact……

Appendix 4: Interview Guide for the Manager

1. What was considered in the design of the Aquarium guest restaurant?.....

……

2. What is your take on the type and nature of the materials used in the design of the restaurant and their level of sustainability?.....

……

3. What factors influenced the choice of the current materials used to design the restaurant?.....

……

4. How often does the restaurant's management redesign or renovate the restaurant? Which specific areas are often redesigned? And why?.....

……

5. Would you recommend for the renovation and redesigning of the restaurant with Biomimicry design and Fulani Art theme patterns? Yes [ ] No [ ]

If yes,

Specify the areas that need to be redesigned…….

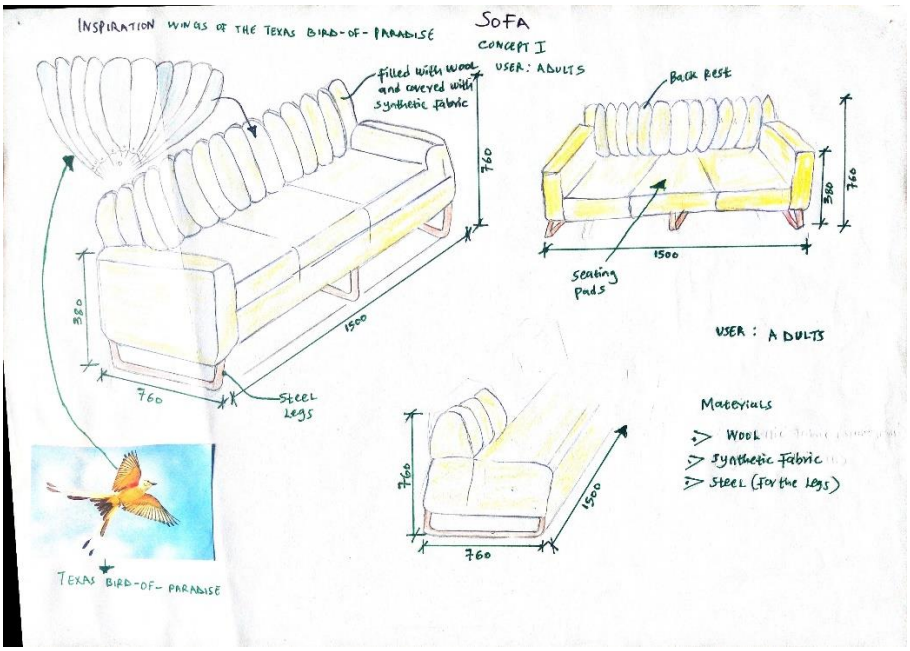
What features and components of the hotel would you like to retain their original design and why?.....

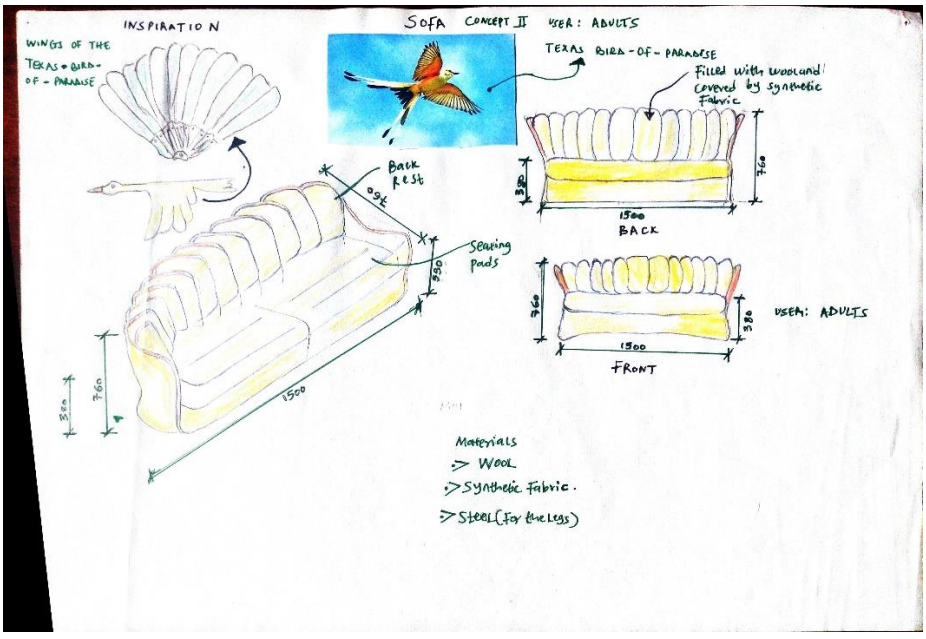
6. State any elements/areas that you would like to be introduced in the restaurant design as far as the Interior architecture, furniture design, exhibition and display units and the landscape design of the restaurant are concerned……

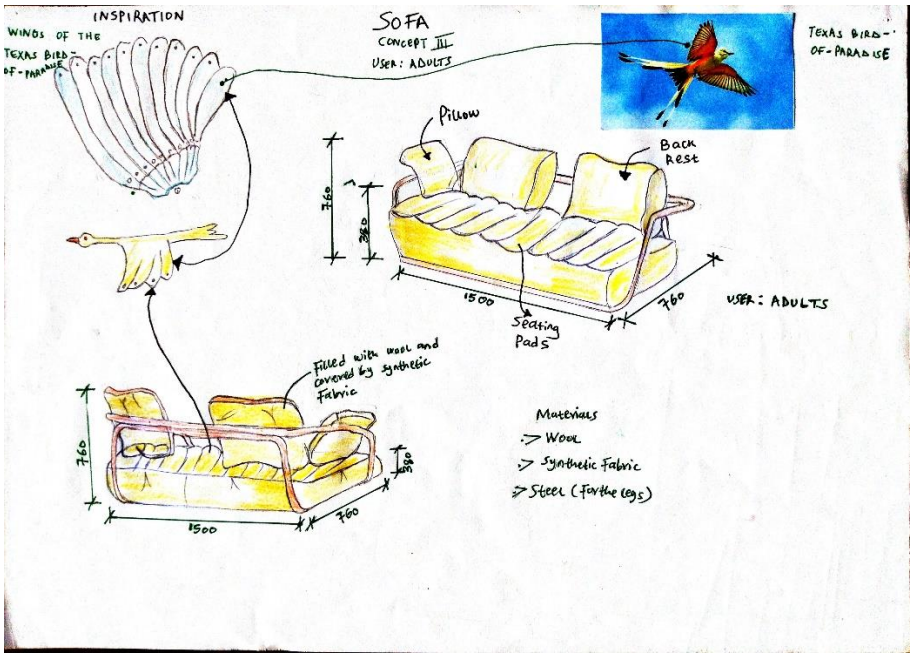
Appendix 5: Conceptualization

Furniture Design Concepts

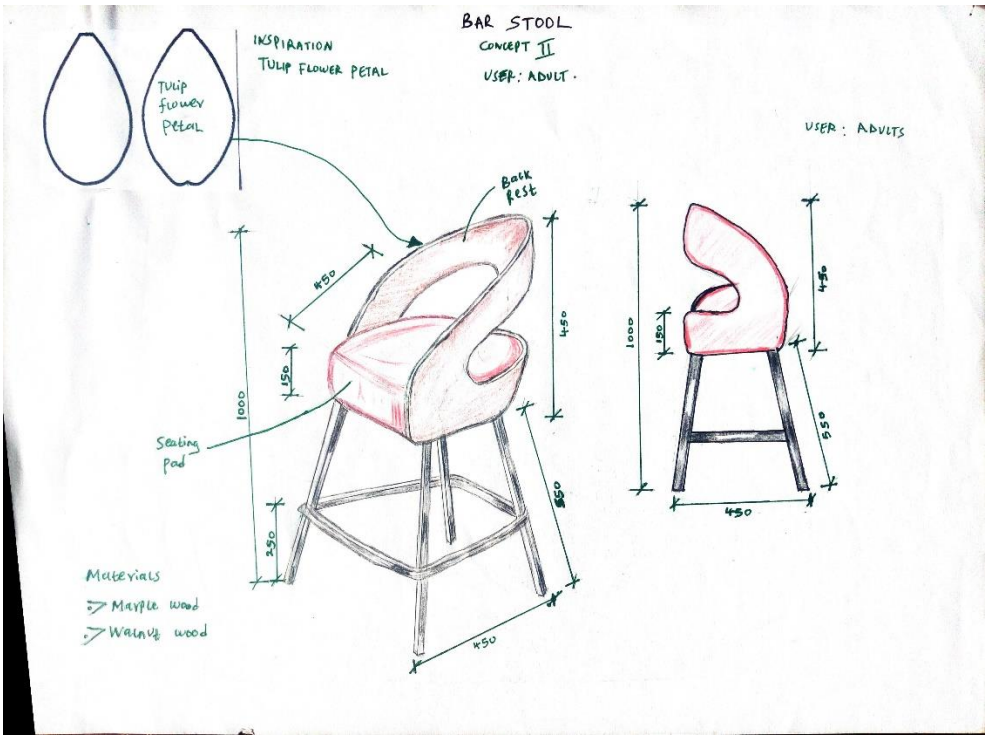
Sofas

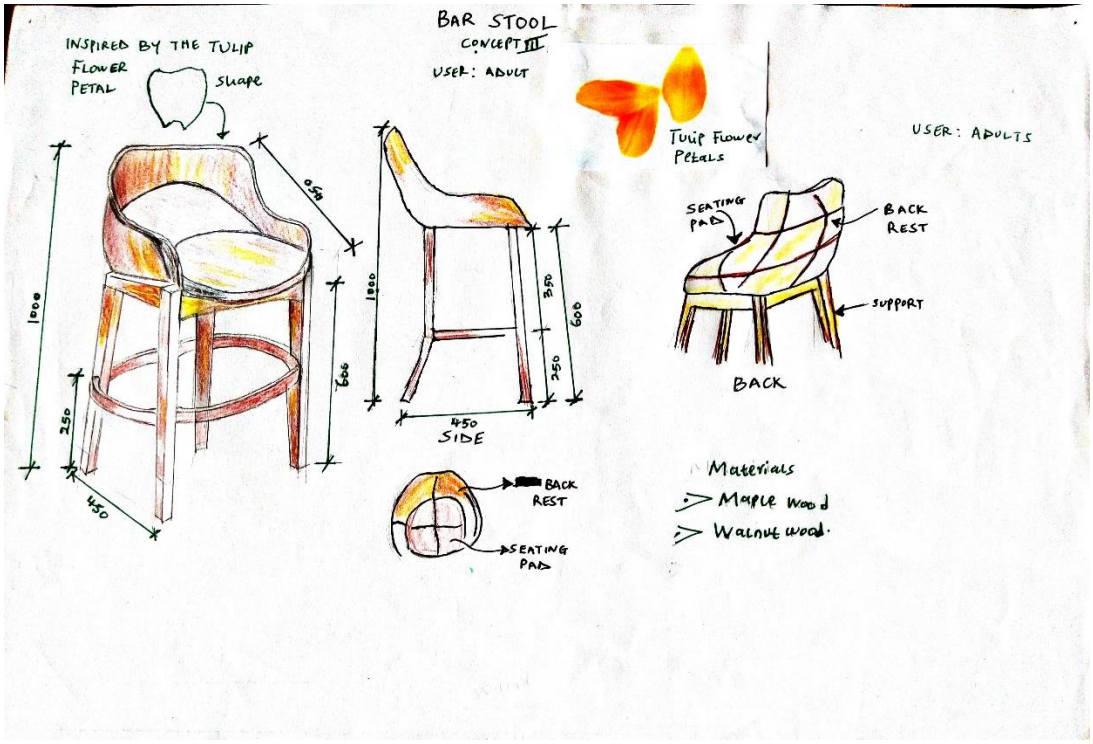


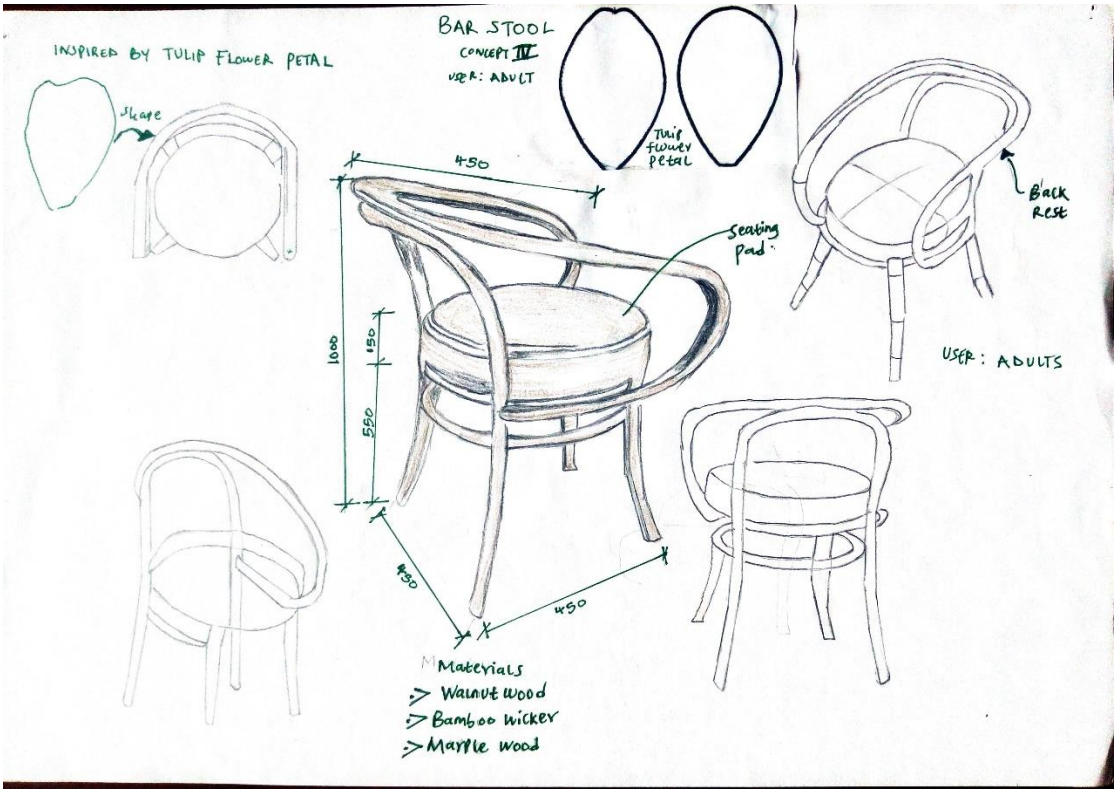



INSPIRATION
WINGS OF THE TEXAS BIRD-OF-PARADISE
SOFA
CONCEPT III
USER: ADULTS
TEXAS BIRD-OF-PARADISE
Pillow
Back Rest
760
360
1500
760
Seating Pads
USER: ADULTS
Filled with wool and covered by synthetic Fabric
760
360
1500
760
Materials
Wool
Synthetic Fabric
Steel (for the legs)

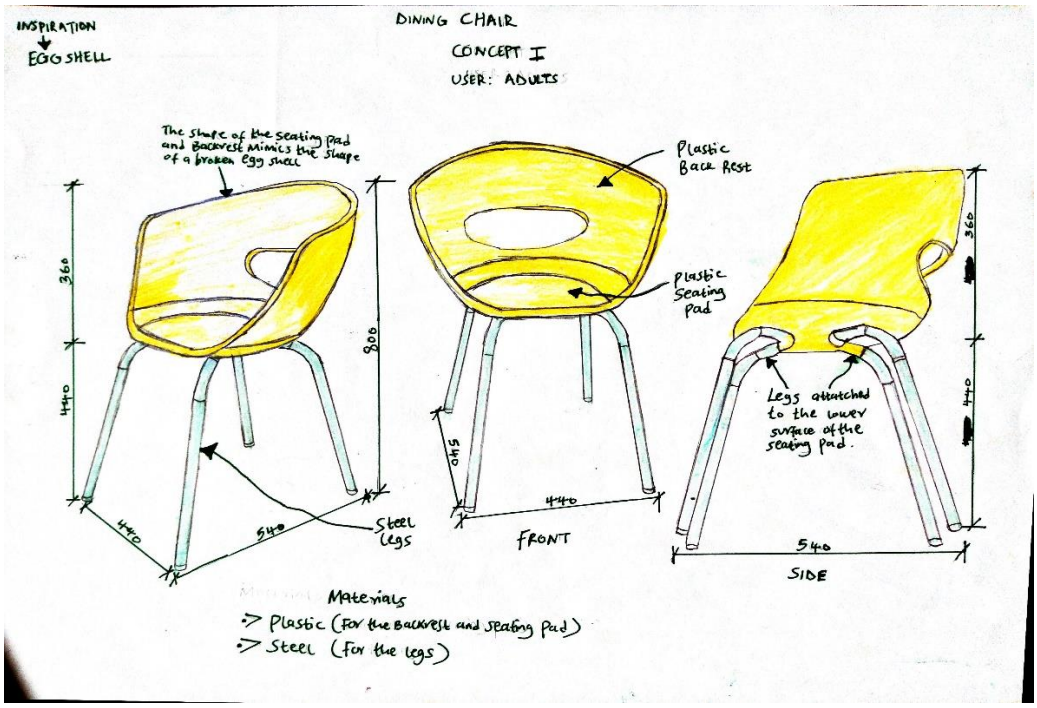
Bar Stools

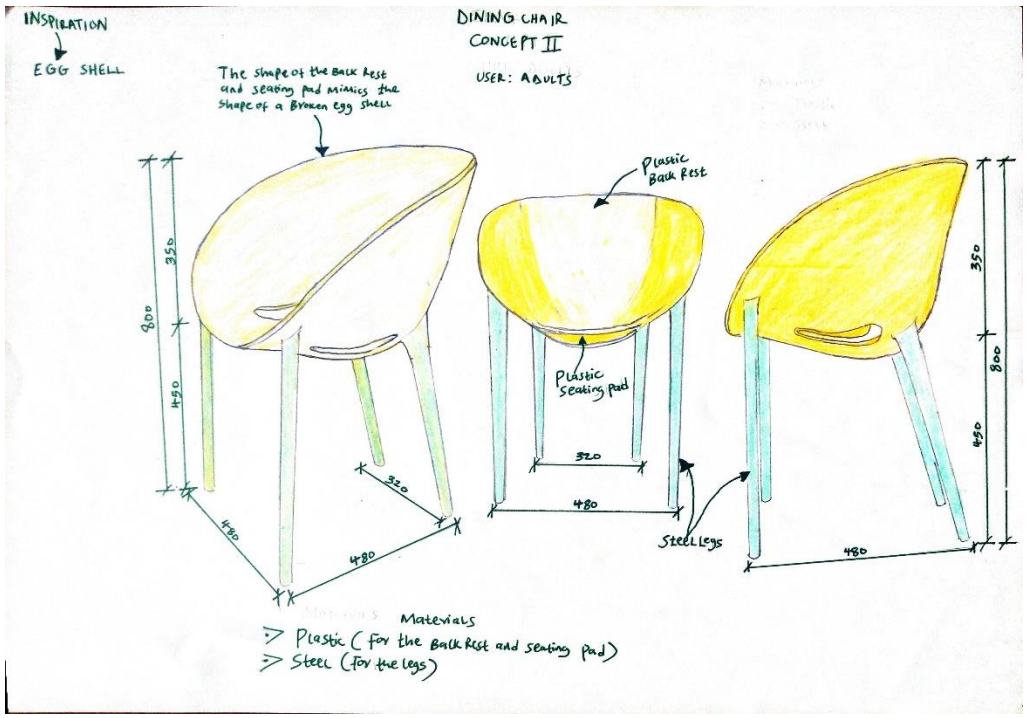

BAR STOOL
CONCEPT II
USER: ADULT.
INSPIRATION
TULIP FLOWER PETAL
Tulip Flower Petal
USER: ADULTS
Back Rest
450
150
1000
450
Seating Pad
250
450
450
1000
150
450
550
450
Materials
Maple wood
Walnut wood

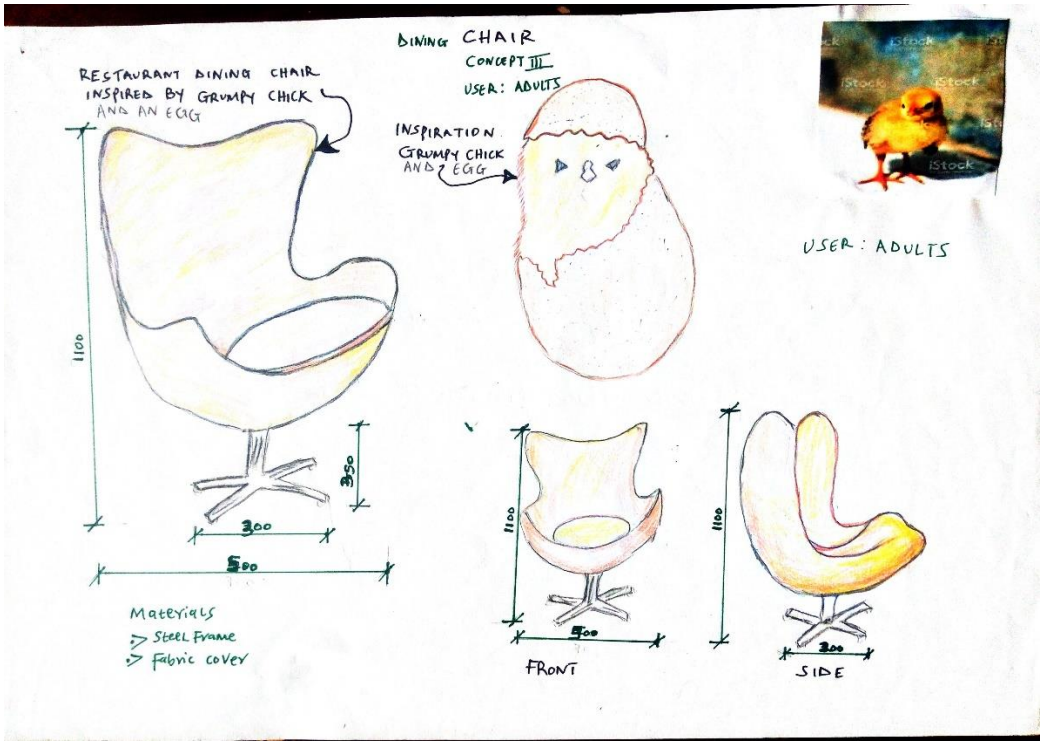

BAR STOOL
CONCEPT III
USER: ADULT
INSPIRED BY THE TULIP FLOWER PETAL
shape
Tulip Flower Petals
USER: ADULTS
SEATING PAD
BACK REST
SUPPORT
BACK
SIDE
BACK REST
SEATING PAD
Materials
Maple wood
Walnut wood.


BAR STOOL
CONCEPT III
USER: ADULT
INSPIRED BY TULIP FLOWER PETAL
shape
Tulip flower petal
Back rest
Seating pad
USER: ADULTS
Materials
Walnut wood
Bamboo wicker
Maple wood

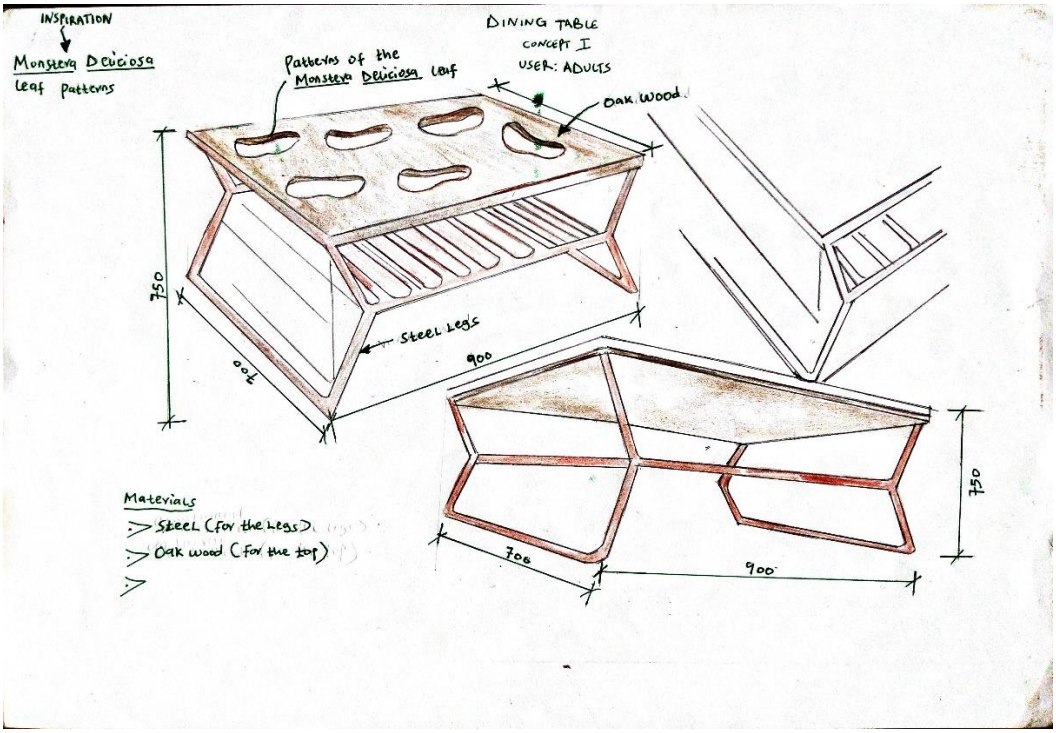
Dining Chairs

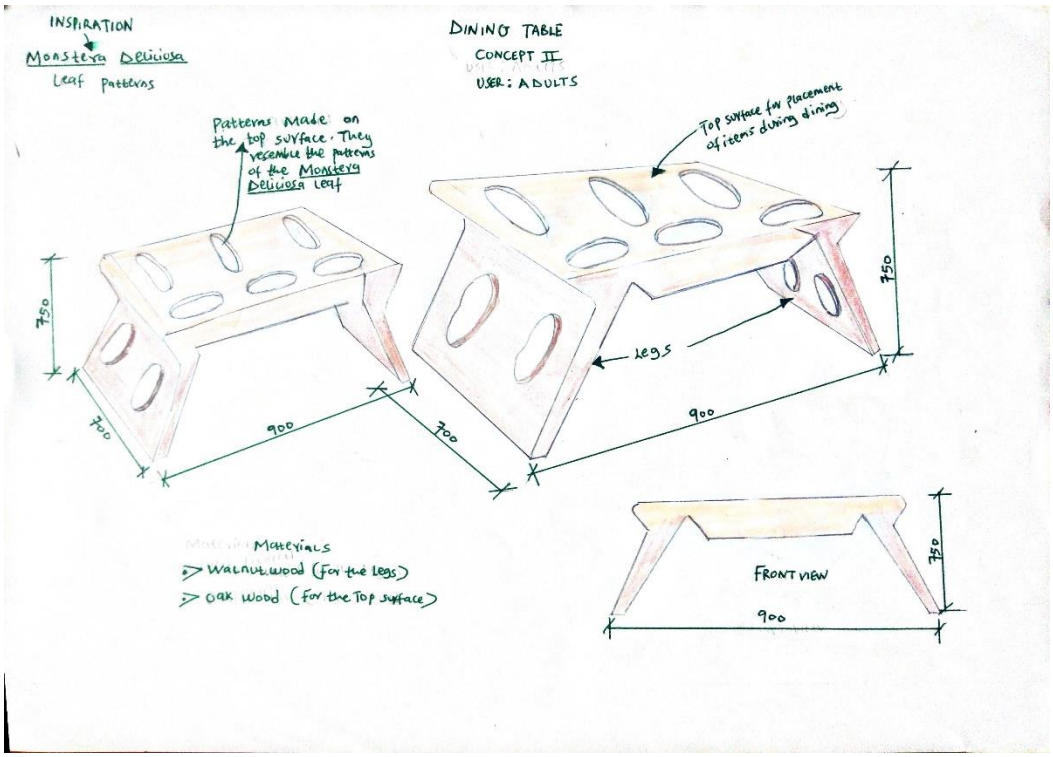




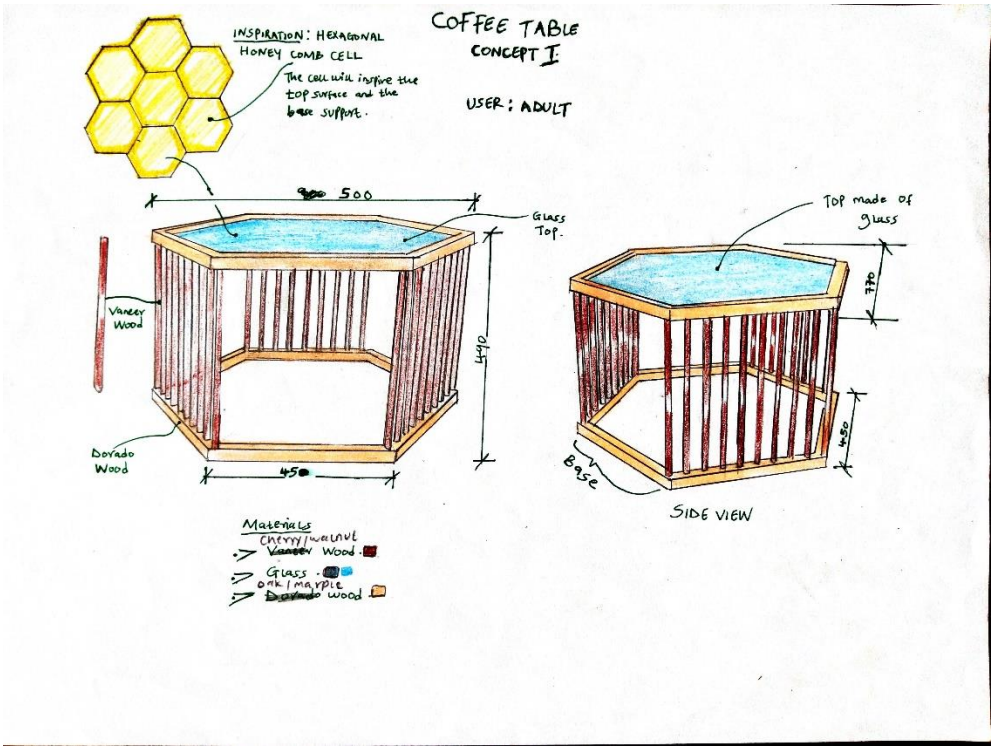


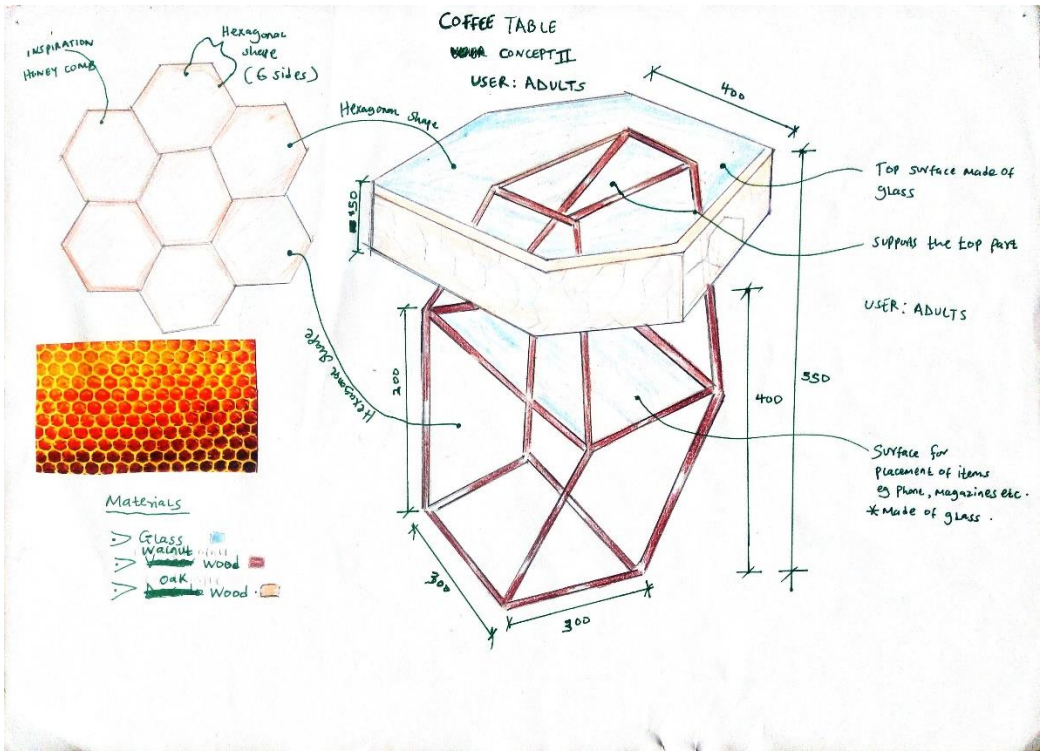
Dining Tables

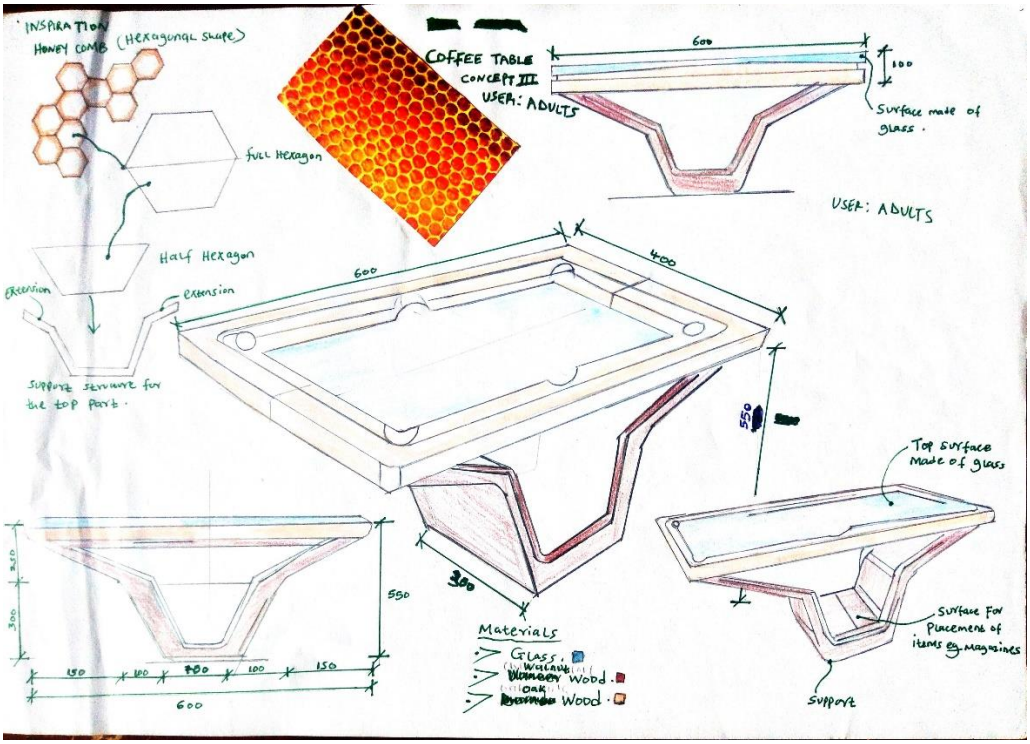




Coffee Tables

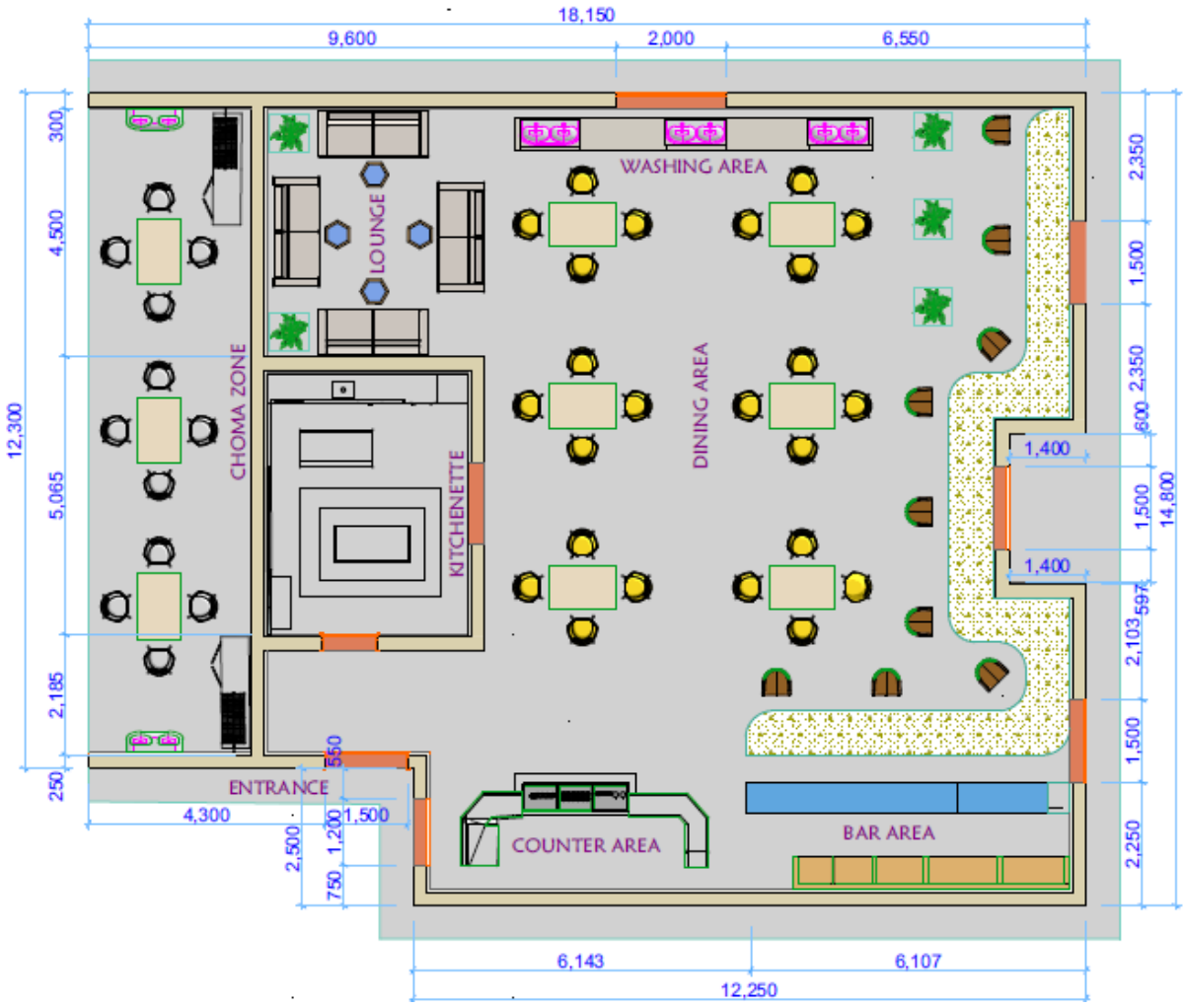



INSPIRATION
HONEY COMB
Hexagonal shape (6 sides)
COFFEE TABLE
CONCEPT II
USER: ADULTS
Hexagonal shape
400
Top surface made of glass
150
supports the top part
USER: ADULTS
Hexagonal shape
200
400
550
Surface for placement of items eg Phone, magazines etc.
*made of glass.
Materials
Glass
Walnut Wood
Oak Wood
300
300

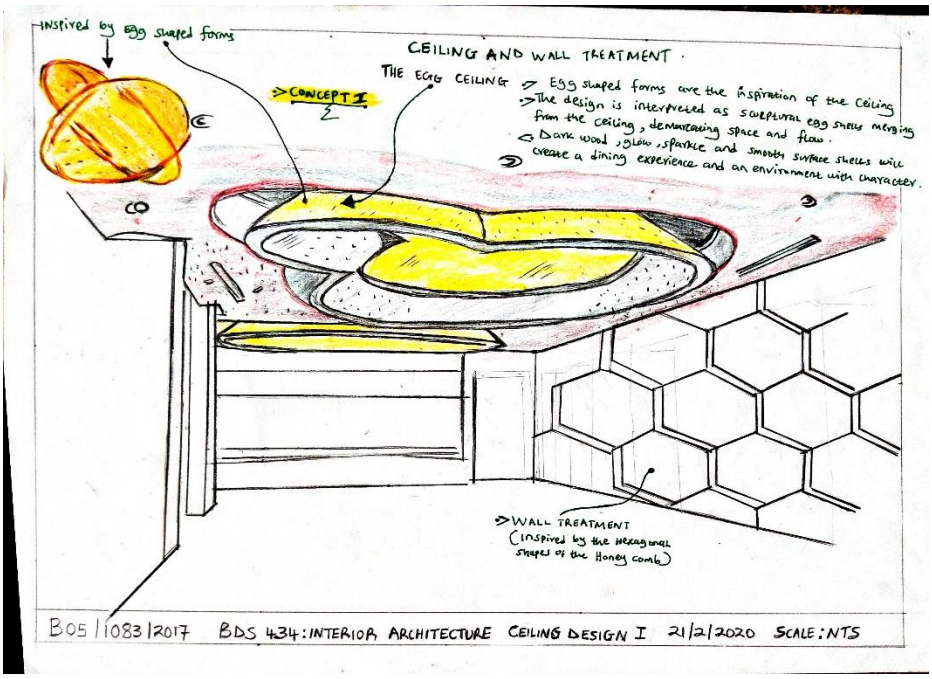

INSPIRATION
HONEY COMB (Hexagonal shape)
COFFEE TABLE
CONCEPT III
USER: ADULTS
600
100
Surface made of glass.
USER: ADULTS
full Hexagon
Half Hexagon
extension
extension
600
400
Support structure for the top part.
550
Top surface made of glass
300
Surface For Placement of items eg. Magazines
Support
Materials
Glass
Wood
Wood
150
100
300
100
150
600

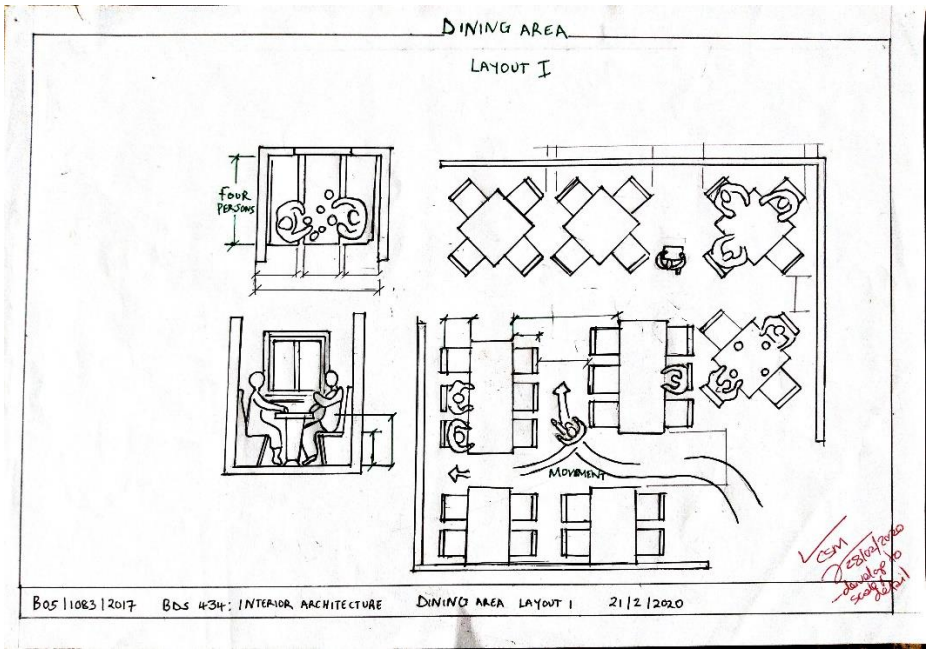
Interior Architecture Concepts

Proposed Interior Architecture Layout

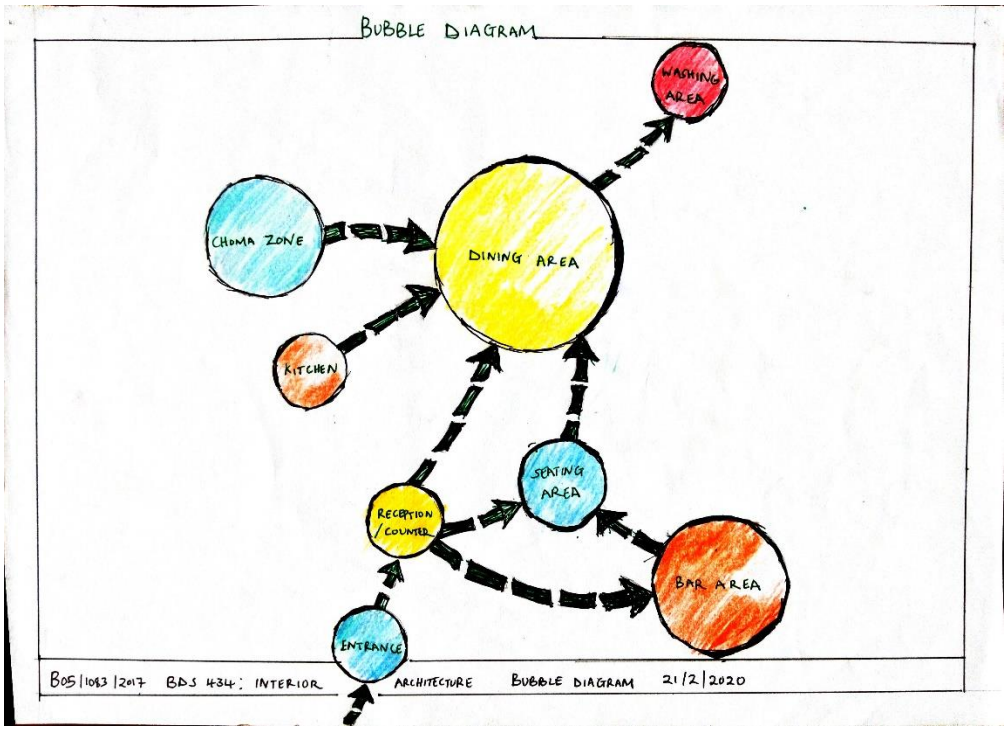


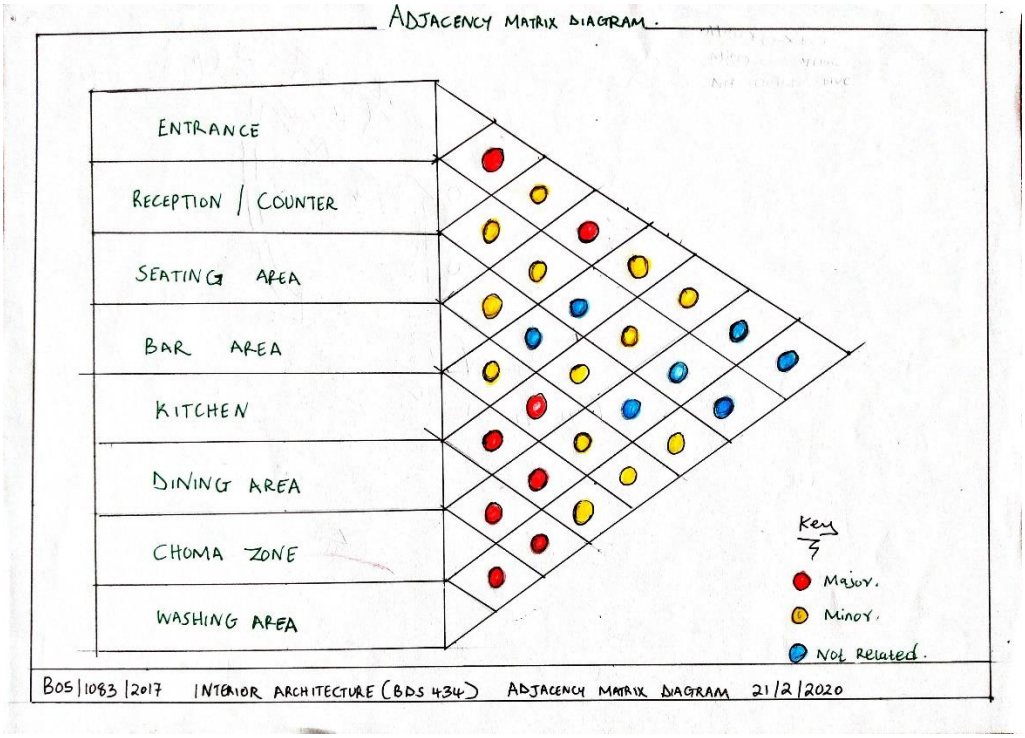
Ceiling and Wall Treatment





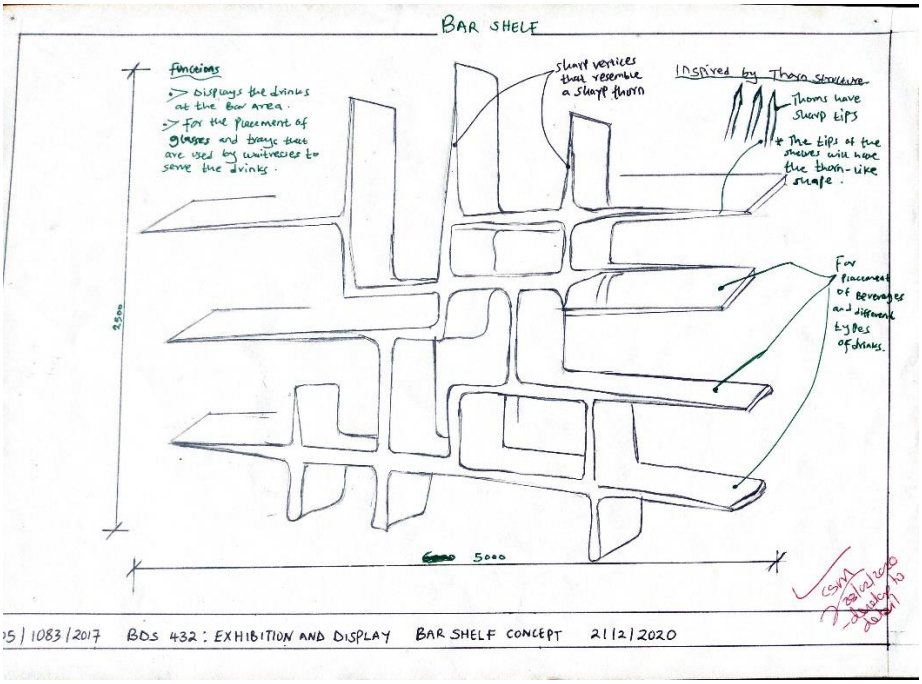
Bubble and Matrix Diagrams

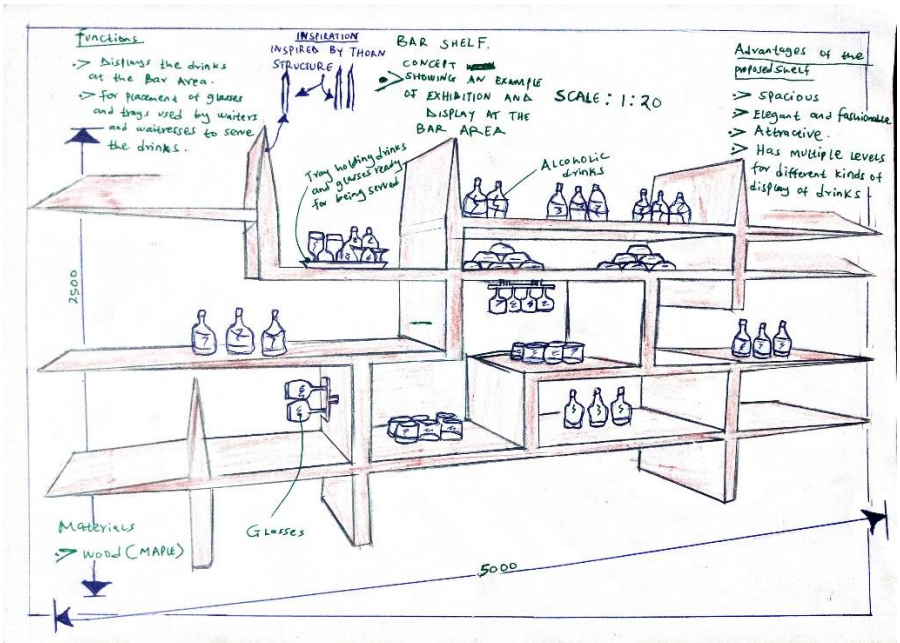


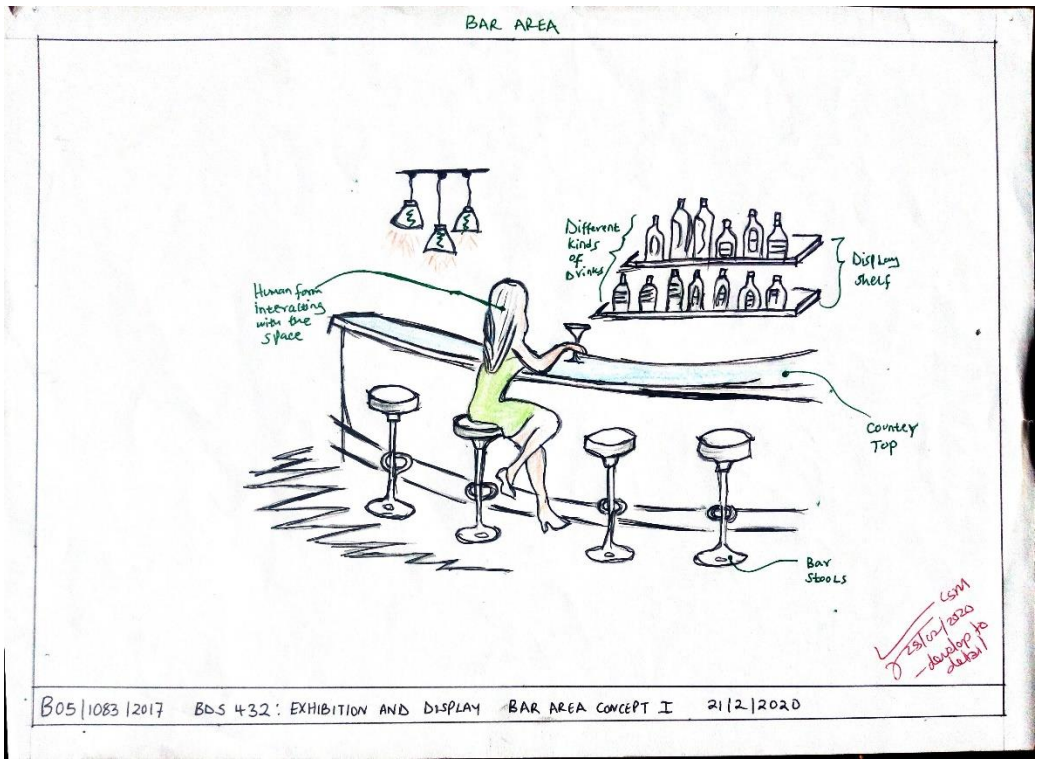


Exhibition and Display Concepts

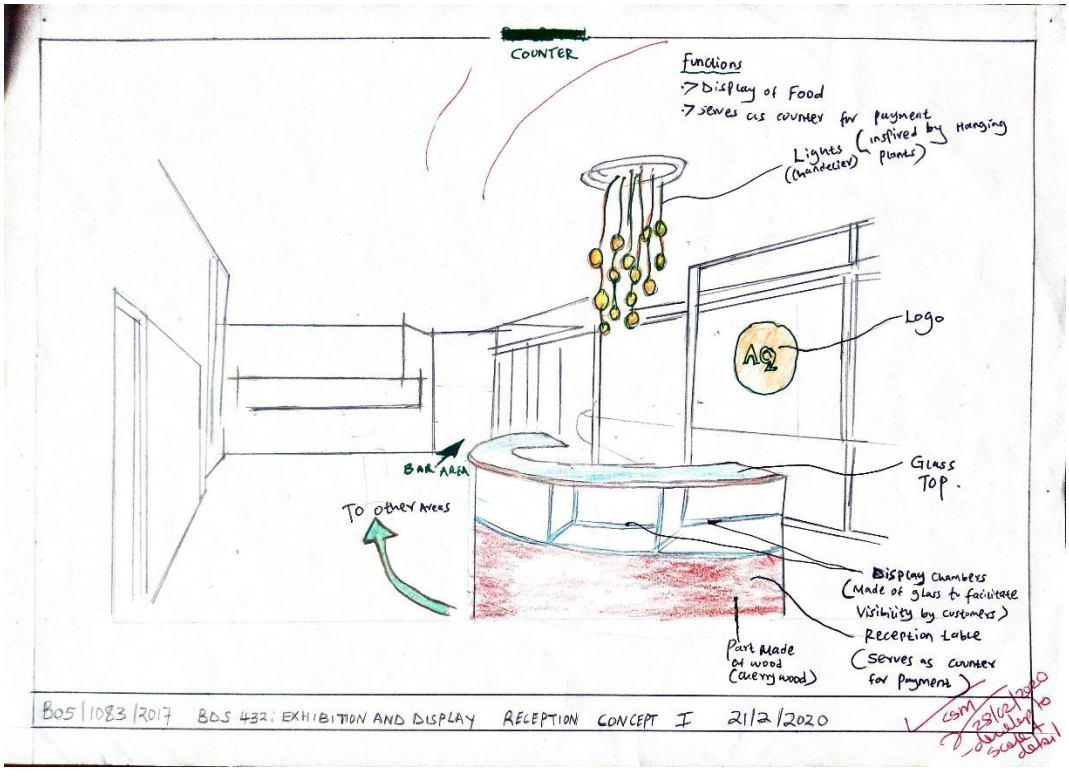
Bar Shelves and Bar Area Exhibition and Display

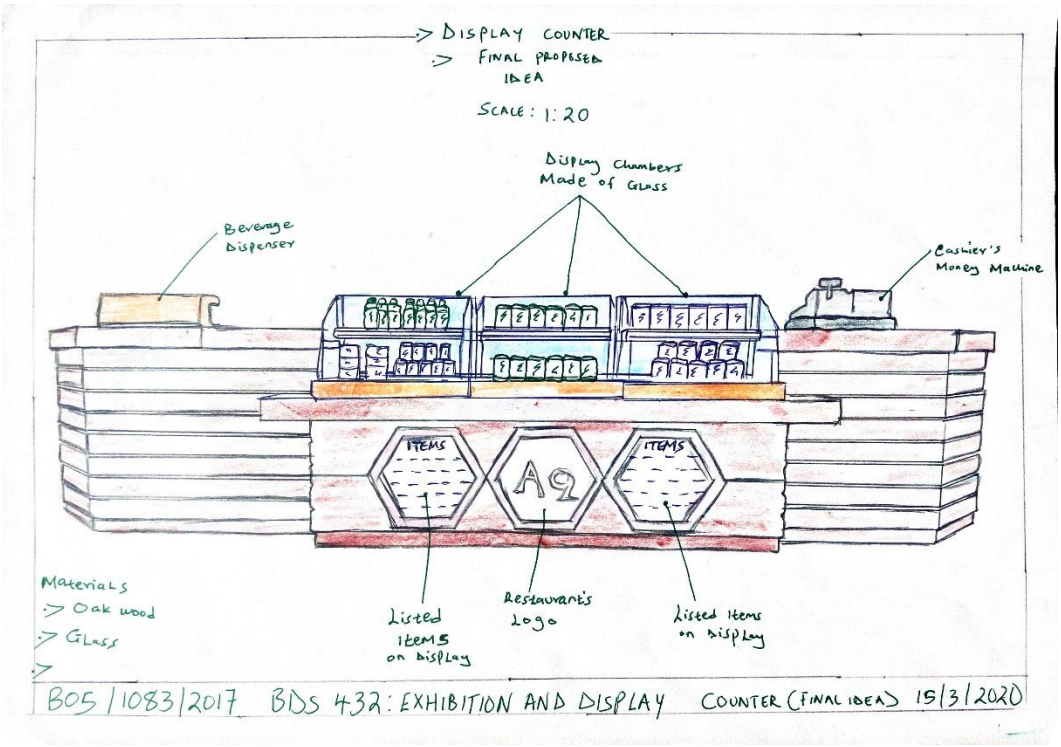




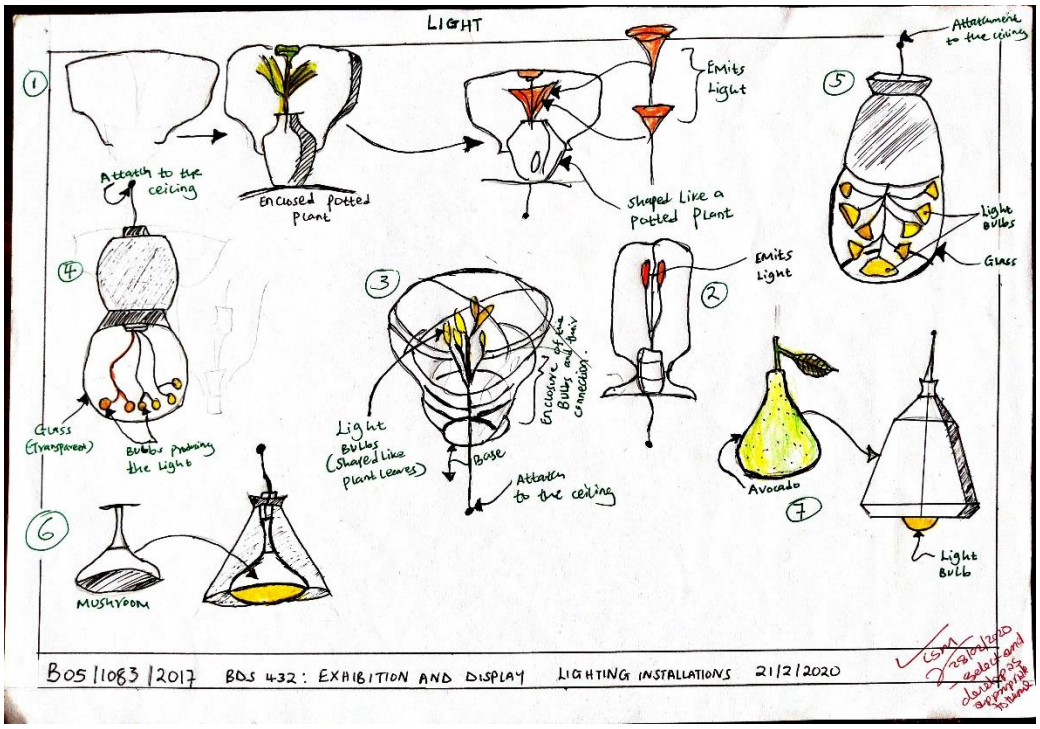


Counter / Reception Area Exhibition and Display





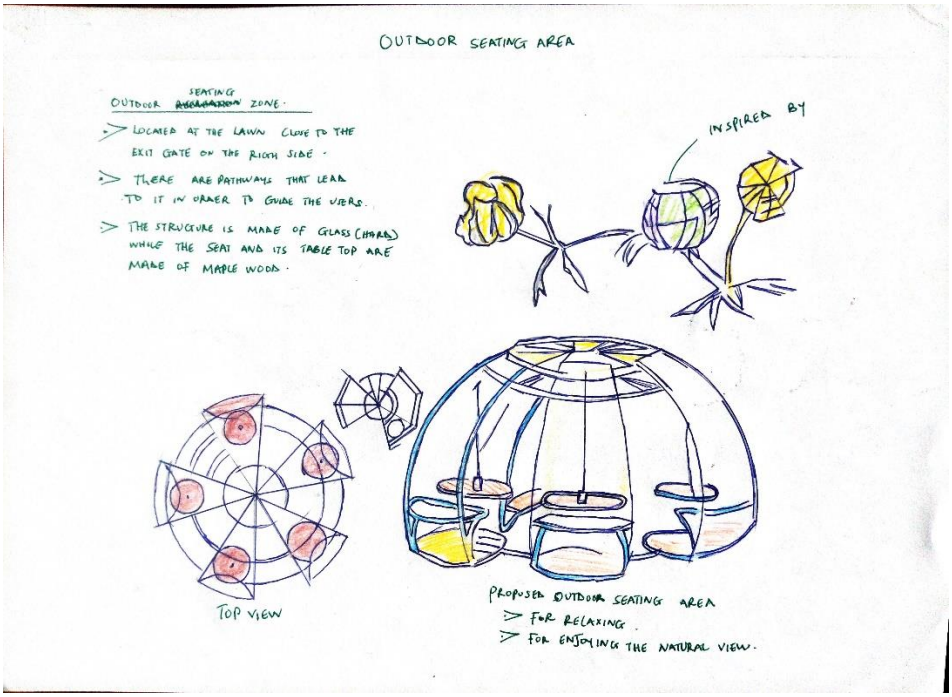
Proposed Light Fixture Installations

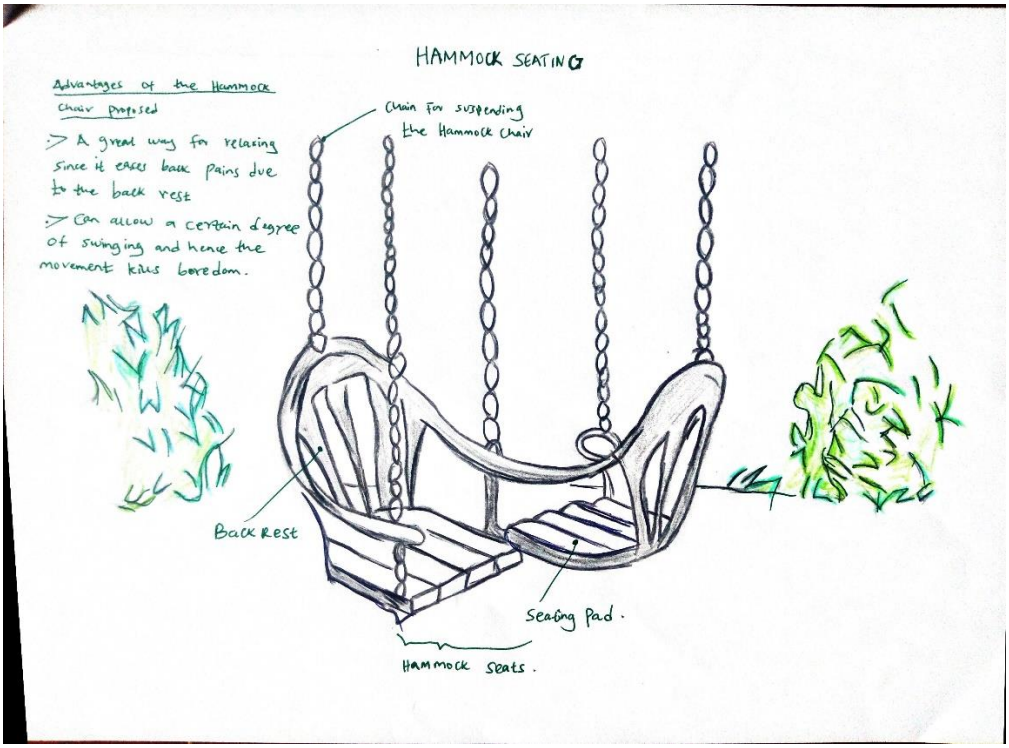


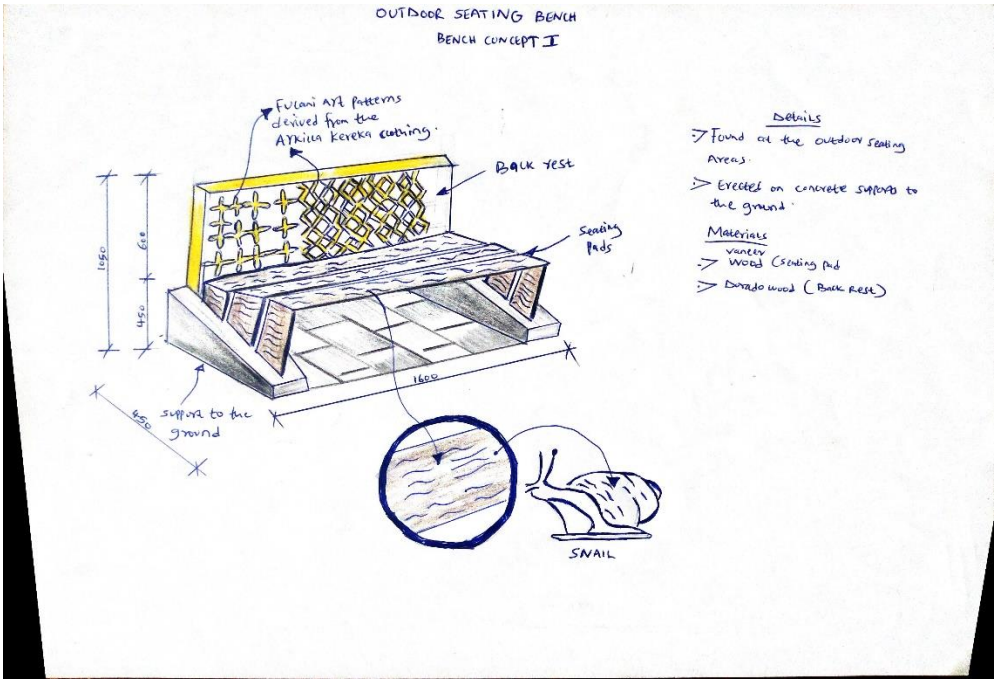
Landscaping Concepts

Master Layout of Proposed Landscape Design

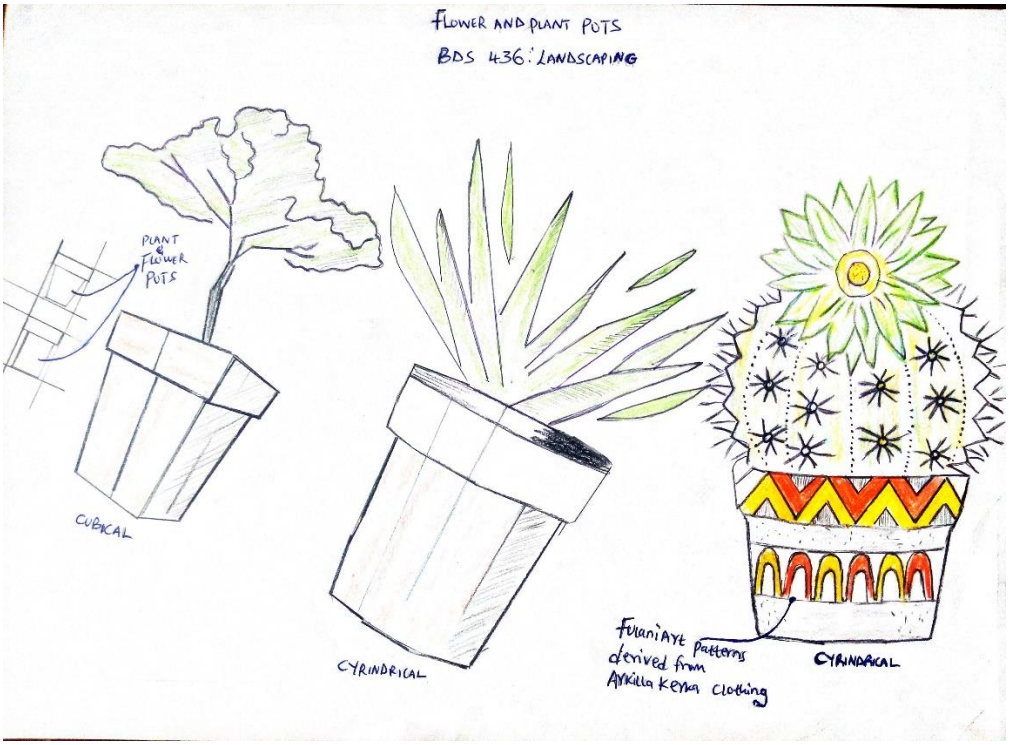
Outdoor Seating Area Concepts



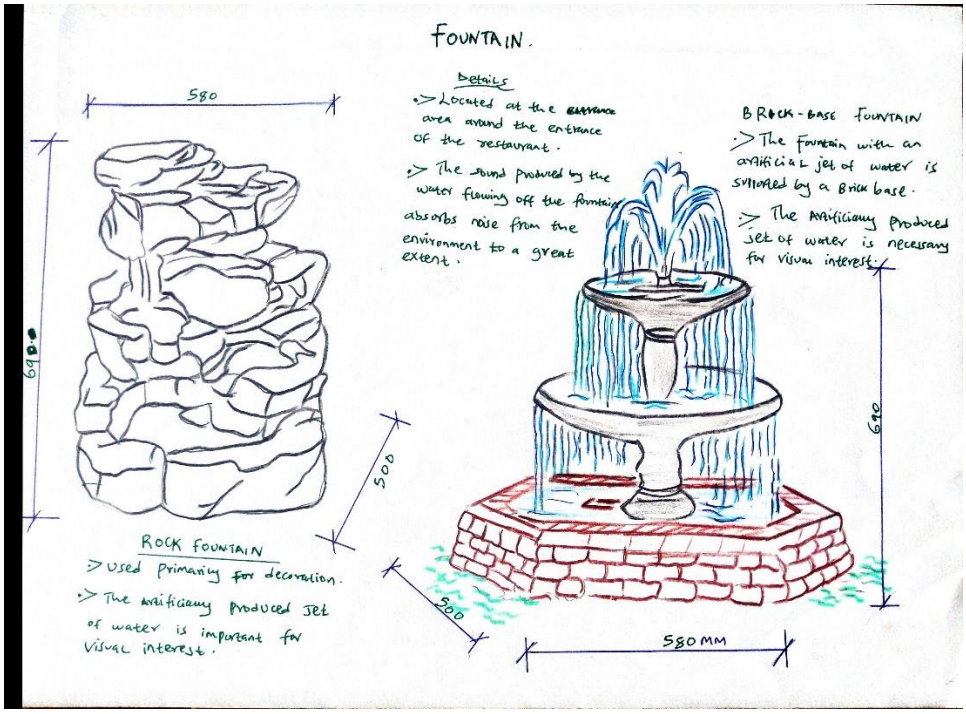




Soft Landscaping



Hard Landscaping



Outdoor Umbrellas for Recreation Zones