North Dakota State University
Graduate School

Title

KIBERA PUBLIC SCHOOL: EMPOWERING KENYA THROUGH THE USE OF LOCAL MATERIALS AND LABOR

By

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MASTER OF ARCHITECTURE

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KIBERA PUBLIC SCHOOL: EMPOWERING KENYA THROUGH THE USE OF LOCAL MATERIALS AND LABOR

A Thesis
Submitted to the Graduate Faculty
of the
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By

CALEB MARTY SPRINGFIELD

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ABSTRACT

Kibera Public School seeks to empower the individuals living in Kibera Slum, Kenya, through the use of local materials and labor. Due to Kibera's substantial percentage of children who are not attending school, Kibera Public School provides an affordable, comfortable, safe, and sustainable environment for the students living in Kibera Slum, who cannot afford to attend a private school. Furthermore, this school is dependent on the use of local materials and labor and through the utilization of these resources, it provides the community of Kibera with valuable construction skills that can be used elsewhere and a sense of ownership in the school. This thesis examines the current conditions of school environments, in Kenya, showing how local materials and labor can be used to enhance the overall conditions of its schools affordably and sustainably.

ACKNOWLEDGMENTS

This thesis project would not have been possible without the help of my classmates, faculty, my family and friends, and God. I want to give a special thanks to my classmates for their unwavering support, input, and constant critique throughout the last year! I would not have reached the design solution that I did without your assistance and feedback. Thank you for welcoming me into your year so kindly, I am forever grateful for the friendships that I have made in the last two years. I can confidently say that I would not be the individual that I am without every single one of you, so thank you!

Regin, thank you for pushing me on throughout the semester and for your countless recommendations and feedback! I am grateful to have been your student twice during my time at NDSU and I am appreciative of your unique approach and authenticity.

Ron Ramsay, Jennifer Brandel, and Nick Wickersham, thank you for sacrificing your time to listen and brainstorm ideas with me throughout this thesis project! I am incredibly grateful for not only your insight but also for encouraging me during my thesis. I look up to you three as professors and am grateful for your life-changing influence on my college career.

Lastly, and most importantly though, I am utmost grateful to God for giving me the opportunity to take a gap year and the ability to get to go to Kenya and for blessing me with the experiences and memories that I made while I was there. Also, for giving me the ability to go to college and receive a Master of Architecture degree, I could not have done it on my own and I do not take it lightly.

DEDICATION

This thesis is dedicated to the numerous orphans and students, in Africa, but specifically those living in Kibera Slum—near Nairobi, Kenya—who do not attend school due to their lack of funds and proper infrastructure. May this thesis project start a conversation in an effort to help those living in poverty who cannot afford school and seek an education.

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1. INTRODUCTION

Figure 1.1 Aerial Shot of Slum Overcrowding (Pinterest, 2017)

How are the basic needs of individuals met through architecture? Culturally, we idolize the American dream and hold that as the pinnacle of success. We pride ourselves on the cars we drive and how expensive our homes are. While we are incredibly blessed to live in this country what about the 90% who are less fortunate (Smith 2007)? All around the world, companies are spending billions of dollars on skyscrapers while many individuals living in slums lack proper shelter, sanitation, and the means to attend school. But the question is, what role do architecture and design play in answering these problems?

With the rise of globalization, hundreds of countries from around the globe have become more connected, through the adoption and implementation of social, financial, and political

means. This has allowed countries to export and import goods, based on their relative ability to produce goods and services. A couple of advantages, such as technology, access to new cultures, advances in medicine, and higher standards of living, have resulted from the rise in globalization. On the other hand, a couple of disadvantages are the loss of national identity through a mix of cultures, an increase in the gap between rich and poor, and the exploitation of workers in developing countries. According to *Architecture for The Urban Poor,* the increase in the gap between rich and poor has been a result of urbanization which has also increased the number of students not being able to attend school (Mukeku, 2020).

Additionally, when considering developing countries, such as Kenya, there is a lack of adequate and proper infrastructure in Slums, especially when looking at the design of schools. Infrastructures lack appropriate ventilation and tend to smell bad and be poorly lit. This issue of adequate ventilation and poor environments is exhibited through the insufficient use of materials and the lack of access to the funds to acquire sustainable and structurally sound materials.

1.1. Problem Statement

Before the Middle Ages, the only materials available for building were materials from nature – wood, branches, leaves, animal skins, and dirt. Humanity would construct wooden huts with roofs made from animal pelts. These huts would shelter their communities from the elements. As climate conditions worsened, the need for more sturdy structures became necessary. Not until the Bronze Age did stone begin being used as a means of construction. Stonehenge and the Pyramids are two examples where stone was used. From stone, construction materials advanced to brick. Romans paved the path forward and began using concrete. From History, we can see the evolution of building materials and techniques used to create the built environment that we see now. Over time, western civilization began moving away from building

technologies using brick and began the quest to find a more efficient and new building solution to get the same result, or so they thought. Materials that make up the built environment today, or at least in wealthy areas, are primarily constructed from concrete, glass, and steel. Along with the advancement of building materials, the presence of social media and this idea of global culture has become widely advertised. Additionally, the American dream is culturally held as the pinnacle of success. What about the countries that are less fortunate and do not have an abundance of wealth to build better buildings?

1.1.1. Research Questions

The following questions drive the exploration of this thesis. Who is responsible for helping those living in Kenyan slums? What can be done to help individuals get out of poverty? Why is there such a large number of students not attending school? How can local materials be utilized in advancing design in slums?

1.1.2. Proposed Outcome

I hope that the results from this research help to influence the architectural designs of schools within Kenya. Through research, I hope to find ways to implement local materials into visually appealing designs, provide good passive elements, and be sustainable. The design proposal will consider a variety of design typologies such as public primary/secondary schools and community involvement. The research will consider land use maps and the site will take inspiration from the proximity of nearby local materials. The research will analyze current building methods used in the construction of school, in Kenya, and will determine how passive elements can be implemented to improve ventilation and sanitation in these environments. The use of passive elements such as ventilation enhances the comfort of the individuals who spend time in primary schools and their ability to focus. Lastly, the importance and use of local

materials in Kenya will be researched for sustainability. I expect that the research of local materials within a 50-mile radius will help to locate a site in Kenya.

1.2. Objective

Developing countries are incredibly resourceful with the limited resources that they have. Throughout history, local and natural resources have been used as building materials to house individuals and communities. From huts and teepees to log cabins in the woods, communities have used what is at their disposal to provide shelters and basic infrastructures. Good architecture should consider its context and the inspiration should derive from its surrounding environment. As architects, it is our role to make sure that we are considering all aspects of design including the environment, the monetary impact, and most importantly the community. Furthermore, we design for clients and should always be active listeners to clients' needs. While I have visited Kenya, I am not a local and want to understand its cultural history and why the built environment is the way that it is.

With that being said, this thesis will analyze the existing educational facilities and will seek to consider the existing building technologies and how the classrooms can be designed to better suit the students' academic advancement. There is a myriad of things regarding geography, land use, and culture that I need knowledge of to design a project in Kenya. The goal of this proposal is to develop a design solution, in Kenya, which considers and respects students of Kibera Slum and that uses local resources for its low monetary impact and the sustainability impact, through the use of local labor.

1.2.1. Aim

As someone who did not grow up in Kenya and is considered an outsider, I do not want this research project to come from a place of correction. Rather, I hope to honor and respect the

building technologies and materials already existing in Kenya and to propose a solution to create sustainable structures while engaging the community. The research in this thesis proposal aims to understand the benefits of using local materials for school classrooms, in Kenya, and the impact that these materials have on the students that inhabit the classrooms. More specifically, this thesis seeks to understand the reason there is a lack of individuals attending school in Kibera Slum.

1.2.2. Significance

This thesis research is imperative when considering the use of local materials in developing countries and how they can be used to provide sustainable and affordable building solutions. Africa, and other developing countries, have been creative with the resources that they have for centuries but recently have begun implementing more Westernized architecture into their built environment as a result from globalization (Ayna, 2011). Creative design solutions do not have to copy what other countries are doing. Individuality is beautiful and makes every culture unique. I desire to make this known and prove that it is a good thing. Utilizing the abundance of local resources minimizes the impacts on the environment, cuts back on cost, and brings a sense of power to its residents. This could be a pivotal move for the construction of schools in Kenya in providing better ventilation and comfort to their students. I hope that the research in this thesis will inspire Architects, who want to help developing countries, to listen to the people and the land, not to come in with an agenda and inform a country what needs to be changed. There is power in the use of local materials and developing countries could benefit from rammed earth construction because of its sustainable benefits.

2. BACKGROUND

2.1. Project Type

Figure 2.1 Kibera Slum Borders Nairobi Golf Course (Unequal Scenes)

2.1.1. History of Kenya

Going back in history, we see that Kenya was originally populated by farmers and herders. These Indigenous bush people had migrated from nearby regions. The small indigenous population of bush people was swelled by these migrants and makeup Kenya's dominant communities today.

2.1.2. Colonization of Kenya

In the late 1800s to mid-1900s, European colonization from Britain resulted in the violent oppression of Indigenous ethnic groups and the reallocation of their land to European settlers. This Large-scale involvement lasted until the First World War. European nations rushed to colonize as much African territory as possible. Furthermore, an influx of European settlers

precipitated a policy of land reallocation that allowed the expropriation of fertile land belonging to Africans. This process forced Indigenous people to either labor for those settlers who had claimed the area or drive them from their own land and to reserves controlled by the British. This period of colonial oppression and land reallocation left an impression on those it targeted.

In Payne's book, "*Urban Housing in the Third World,"* J. Weeks claims that the socioeconomic impact of colonialism took one or two basic forms. "Either colonial urban transformation, where bureaucracy and enterprise were imposed upon a pre-colonial area and by its control transformed the process of urbanization, or the second form which he referred to as the European urban creation, where urban areas grew up in an environment without any significant degree of urbanization in pre-colonial times" (Payne, 1977).

2.1.3. Urbanization in Kenya

Additionally, Kenya is facing an increasing growth of informal settlements in her urban centers. We see that as the rapid growth of urbanization so does the development and growth of slums (Mutisya, Yarime, 2011). Nairobi, the capital city of Kenya has grown from 11,500 inhabitants in 1906 to 3.1 million in 2009, with more than half living in informal settlements and slums which occupy less than 1% of Nairobi's area. In the article, *Understanding the Grassroots Dynamics of Slums in Nairobi: The Dilemma of Kibera Informal Settlements,* and according to UN-Habitat, more than 34% of Kenya's total population lives in urban areas, and of this, more than 71% is confined in informal settlements (Mutisya, Yarime, 2011). Additionally, according to UN-Habitat, the experience in these slums shows a strong link that people living in poverty are trapped in their present situation because they are excluded from the rest of society (Candiracci, Syrjanen, 2008).

According to the United Nations, with a rapid urbanization growth rate of 4% the population is projected to grow to five million by 2015 and more than eight million by 2025 (Mutisya, Yarime, 2011). This growth is not accompanied by equal socioeconomic and environmental development. The immense rates of urbanization can be linked to natural growth, challenging urban planning, and thereby causing environmental problems with far-reaching effects. “A low quality of housing and lack of basic infrastructure, sanitation, and clean water, lead to poor social and environmental conditions, high amounts of unemployment and low-income giving rise to conflicts,” says Smith & Hanson (Smith, Hanson, 2003). Not to mention the lack of supporting policies for effective urban planning and improvement. Ever since Nairobi’s inception, the government has failed to respond to the flight of slum dwellers even after it is classified as illegal.

The residents in these areas live under deplorable conditions with a lack of the most basic needs and social amenities and face many challenges such as clean water, sanitation, solid waste management, housing, schools, and hospitals. In 2009, Amnesty International stated that “the experience of slum-dwellers, starkly illustrates that people living in poverty not only face deprivation but are also trapped in poverty because they are excluded from the rest of the society, denied a say, and threatened with violence and insecurity” (Mutisya, Yarime, 2011).

2.1.4. Kibera Slum

Kibera Slum began in 1912 and has a population of more than 900,000, making it the largest slum in Kenya and the largest urban slum in Africa (Desgroppes, Taupin, 2011). As a result of World War 1, Kibera became a resettlement area for Nubian soldiers returning from service. According to UN-Habitat, Kibera was declared illegal by the Republic of Kenya,

however, the slum continued to grow from 6,000 in 1965, to almost a million today (Mutisya, Yarime, 2011).

While the government owns the land upon which Kibera stands, they continue to not acknowledge the settlement. Furthermore, no basic services, schools, clinics, running water, or lavatories are publicly provided and the services that do exist are privately owned. This leads to further denying the individuals who reside within the slum basic needs which aids their cycle of living in poverty. Kibera is divided into fourteen villages with varying populations. Makina, at 130,000 people, is the largest village by population. The next largest village, by population, is just below 100,000 inhabitants. Furthermore, the informal settlements of Kibera suffer from a host of challenges, especially when it comes to sustainability challenges. Within these challenges are access to clean water, sanitation, good housing, solid waste management, proper health care, security, and energy. In addition to these challenges, there is a lack of enough schools and educational centers and urban infrastructure.

Throughout Kibera, garbage, waste, human refuse, and soot, pollute the environment (Mutisya, Yarime, 2011). Additionally, according to Hodson and Marvin, the slum is contaminated with both human and animal feces as well as other sorts of wastes which are worsened by open sewage and lack of drainage systems (Mutisya, Yarime, 2011).

2.1.5. Education in Kenya

According to Tomasz Huk, students' ability to learn is the classroom space itself (Huk, 2022). Classrooms that are poorly designed and lack proper ventilation and comfortable spaces for the students make it harder to focus and learn when it is poorly lit and smells bad. Additionally, J. Dewey, states that an effective school environment supports learning in harmony with real conditions in terms of the subject being taught and the method used: It serves as an

embryonic version of the real social and cultural space (Dewey, 1997). With that being said, classroom spaces impact the quality of education more than we think and poorly designed spaces can aid in students' behavior and learning problems (Mutisya, Yarime, 2011).

2.2. Project Issues

2.2.1. Lack of Schools in Kibera Slum

Currently, 43% of girls and 29% of boys do not attend school in Kibera Slum due to the lack of funds and the lack of sufficient schools in Kibera Slum (Faye, 2023).

2.2.2. Poor School Conditions in Kibera Slum

In the journal, *Toward Community-Based Architectural Programming and Development of Inclusive Learning Environments in Nairobi's Slums,* Dierkx mentions the case of Mukuru-Kayaba Primary School which is located in Nairobi (Dierkx, 2003). Dierkx, surveyed some of the students and asked their thoughts on their school and its environment. Student Julia says:

"The school is not secure because of the nearby factories, bars, and many destructive things… it is not well ventilated and built. It is unsafe for the children because there are roads near, and cars will easily knock down the children… the school does not have clean toilets. So, it makes the school have a bad aroma… it does not have trees, so it is very ugly and unwelcoming" (Dierkx, 2003).

Furthermore, there was a recommendation regarding teachers that:

"School buildings should be safe and attractive in the overall design and functional in layout; they should lend themselves to effective teaching, and to use for extra-curricular activities and, especially in rural areas as a community center; they should be constructed in

accordance with sanitary standards and with a view to the durability, adaptability and easy economic maintenance" (Dierkx, 2003).

Additionally,

"Most schools in Kenya and elsewhere in Africa do not meet these standards. Rather than fostering independence and a love of learning, schools hinder children's progress and potential" (Dierkx, 2003).

3. METHODOLOGY

This chapter of the thesis will explain, in detail, how the research and design process was completed. More specifically, it will describe the approach that was taken in answering the research questions. Following the approach, the types of data and how they were gathered will be explained. Next, an analysis will outline the methods and tools that were used to analyze the data. The key aspects of the research will then be summarized, and the relevance and importance of the research will be reinforced. Furthermore, this chapter will describe the project location on both a large scale and a small scale. This section will also mention the specific site demographics, nearby amenities, buildings, and zoning code information. To bring the methodology to an end, pertinent research and case studies will be discussed and will end by sharing how this information has informed initial thoughts on design and space programming.

3.1. Approach

Given the prominent issue of poverty in Kenya and thus the corresponding rate of students who are not attending school, the approach to solving this issue will focus on designing a public school in Kibera Slum – the largest urban slum in Africa. With this approach in mind, the following objectives of safety, affordability, and sustainability will be researched. To sustainably design and affordably build this public school, creating a stronger community, local labor, and materials will be imperative.

3.1.1. Data Collection

Qualitative data will be the main source of information collected in this thesis and supplemental quantitative data. Vernacular architecture is rapidly diminishing in Kenya and is being replaced by modern structures. Thus, to understand this shift in Kenyan construction, the history of architecture was researched. Case studies will also be analyzed to better understand

and observe the use and benefits of using local materials. Finally, the proximity and abundance of local materials to the selected project site will be collected.

It is important to note that a few major limitations of this thesis are observations, surveys, and questionnaires of local Kenyans. The desires and wants of the local community surrounding the project site are of utmost importance. However, due to a lack of time and resources, the steps required to live in Kibera Slum and interview/survey the community was not possible.

3.1.2. Analysis

Given the limitation stated previously, that resident living and community surveying will not be possible, case studies will be the main method and tool used to analyze. Furthermore, graphs and charts of local materials will be analyzed to determine what materials are located near the project site. Using a 30-meter radius around the proposed site to limit transportation of materials. Sun study and weather maps will be analyzed to determine the Azimuth and Altitude for efficient building orientation.

3.1.3. Conclusion

In conclusion, comfortability, safety, sustainability, and affordability are the key aspects of the research in this proposal. Safety is an important aspect to address due to the location of the project. Additionally, with the project being located in the largest urban slum (Desgroppes, Taupin, 2011), there are many safety and health aspects to consider. Furthermore, sustainability is considered with the material choice and the longevity of the material to be used. This aspect is researched with the location experiencing harsh climates. Finally, the cost of the project determines the likelihood of it being constructed. The abundance of rich clay and other local materials, as well as the knowledge and labor of the local community, will reduce construction costs and benefit the overall community of Kibera Slum.

To reiterate the importance and relevance of the research in this proposal, the construction of this public school will not only serve the current needs of the students and individuals who can't afford to attend private school but will assist the individuals who are born into poverty – giving them education and skills to get out of poverty. It will document the local materials of Kenya, while simultaneously understanding the immense history of and transformation of its architecture post colonization.

3.2. Kenya, Africa

Figure 3.2.1 Map of Africa Highlighting Kenya (Snazzy Maps)

Figure 3.2.2 The City of Nairobi Outlined (Google)

The project is located in East Africa, on the coast, in Kenya's capital city, Nairobi. Kenya has a total population of 47.5 million people (Faye 2023). Nairobi, the country's largest city, houses 4.397 million individuals in 269 square miles (Mutisya, Yarime, 2011). Furthermore, Nairobi is an incredibly dense, urban hub, consisting of a diverse population of people; experiencing drastic levels of wealth; and an abundance of poverty. Orphans alone make up a third of the individuals living in slums and teen pregnancy is a factor in girls dropping out of school (Faye 2023). Since Nairobi is located near the equator, seasons vary minimally. The climate is typically broken up into two seasons: wet season and dry season. The winter months tend to be very dry while the summer months can be very rainy. December-March tends to be the warmest months, April-May experiences heavy rainfall, July-October experiences dry cooler months, and October-December is considered the short rainy months. The following figures show Nairobi's proximity to the equator, as well as its climate.

Figure 3.2.3 Kenya's Relation to the Equator (Snazzy Maps)

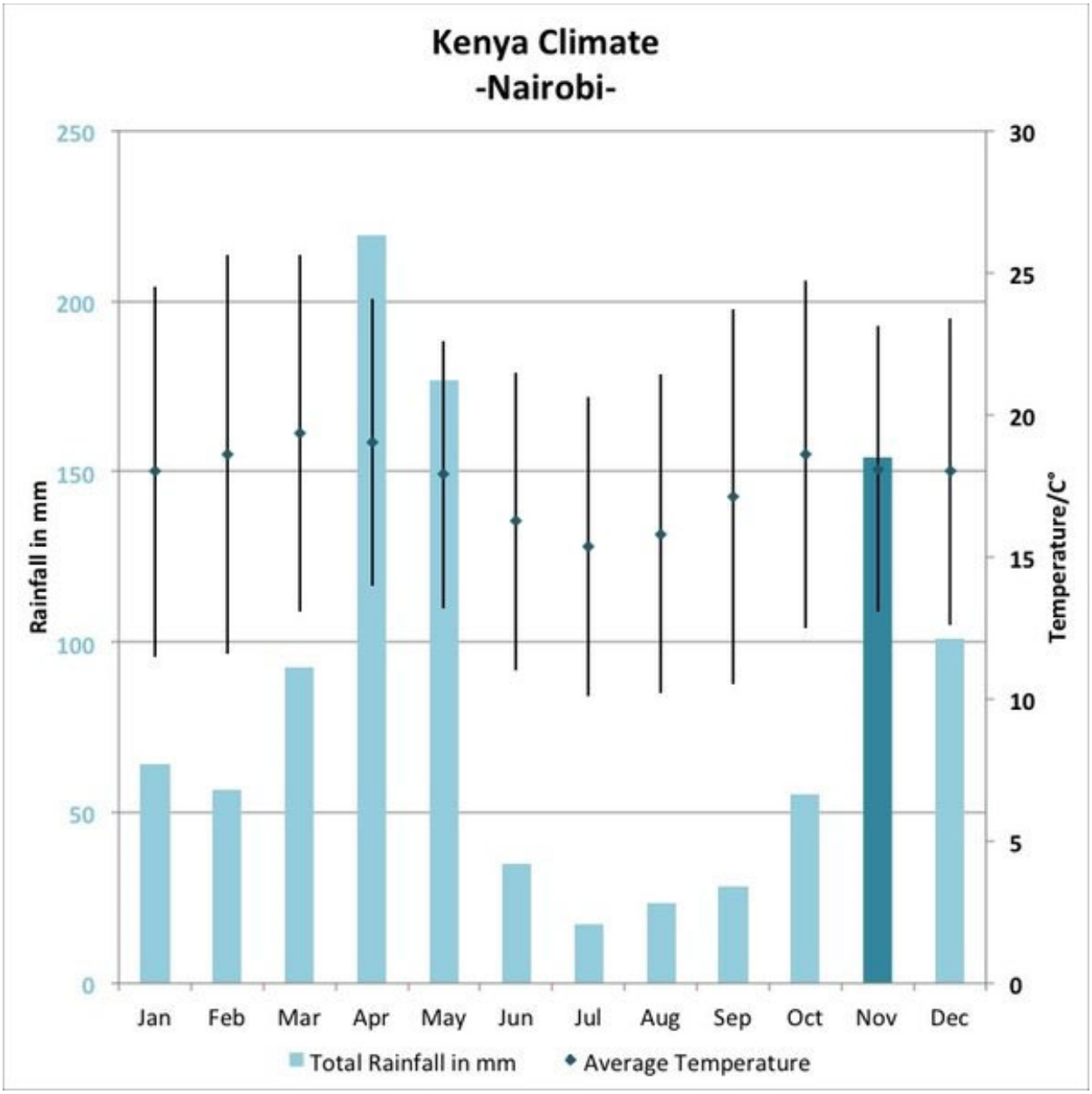

Figure 3.2.4 Graph of Kenya's Climate (Expert Africa)

3.3. Kibera Slum, Nairobi

Figure 3.3.1 Outline of Kibera Slum (Google)

Nairobi has approximately 2.5 million slum dwellers, in about two hundred settlements. This project can be found in the neighborhood of Kibera Slum, which houses 300,000 slum dwellers (Faye, 2023). This is the largest urban slum in all of Africa and is Northwest of Nairobi National Park. Kibera Slum is a shanty town where shelters utilize metal sheets, branches, and any other materials that can be found to construct four walls and roofs. The streets and ground in the majority of the slums are covered in trash/recycling which leads to poor sanitation and pollution—as Figure 3.3.3 below shows. Business stands are placed on both sides of the streets where locals set up shops and sell a variety of products such as food and clothing. Currently, there are no public schools in Kibera Slum, and over 100,000 orphans. Most individuals living in the slums survive on less than $2 a day and lack proper hygiene (Faye, 2023).

Figure 3.3.2 Kibera Slum Building Structures (Bowdery, 2021)

Figure 3.3.3 Garbage and Plastic Pollute Kibera Slum (Barnett, 2012)

Figure 3.3.4 New Building Construction in Kibera (Google)

Figure 3.3.5 Child in Kibera Slum Next to Sewage (Hirsch, 2017)

3.4. Soweto East Zone, Kibera Slum

Figure 3.4.1 Image of Soweto East Zone Neighborhood (Google)

Figure 3.4.2 Image of Existing Conditions on Specific Site for Kibera Public School (Google)

Figure 3.4.1 shows the exact site which is located on the Southeast side of Kibera Slum, right above the Nairobi Dam. Currently, the site is labeled as a waste disposal, and a dumping site, and is consumed with plastic and trash as seen in Figure 3.4.2 above. While this dump site is an open plot of land, it is also part of the "Kibera Soweto East Zone B" for the Slum Upgrading program.

There is a slight slope from the North of the site to the South and East of the site. Furthermore, along the southern border of the site, the Ngong River flows East to West. Figure 3.4.3 shows some of the amenities nearby: several churches, public/private water drinking stations, a bar, a religious primary school, an art center, private toilets, and many other local small businesses. Figure 3.4.4 shows the population density of Kibera Slum. Currently, there is a small section on the west side of the site that is occupied but Kibera Public School would interfere with that.

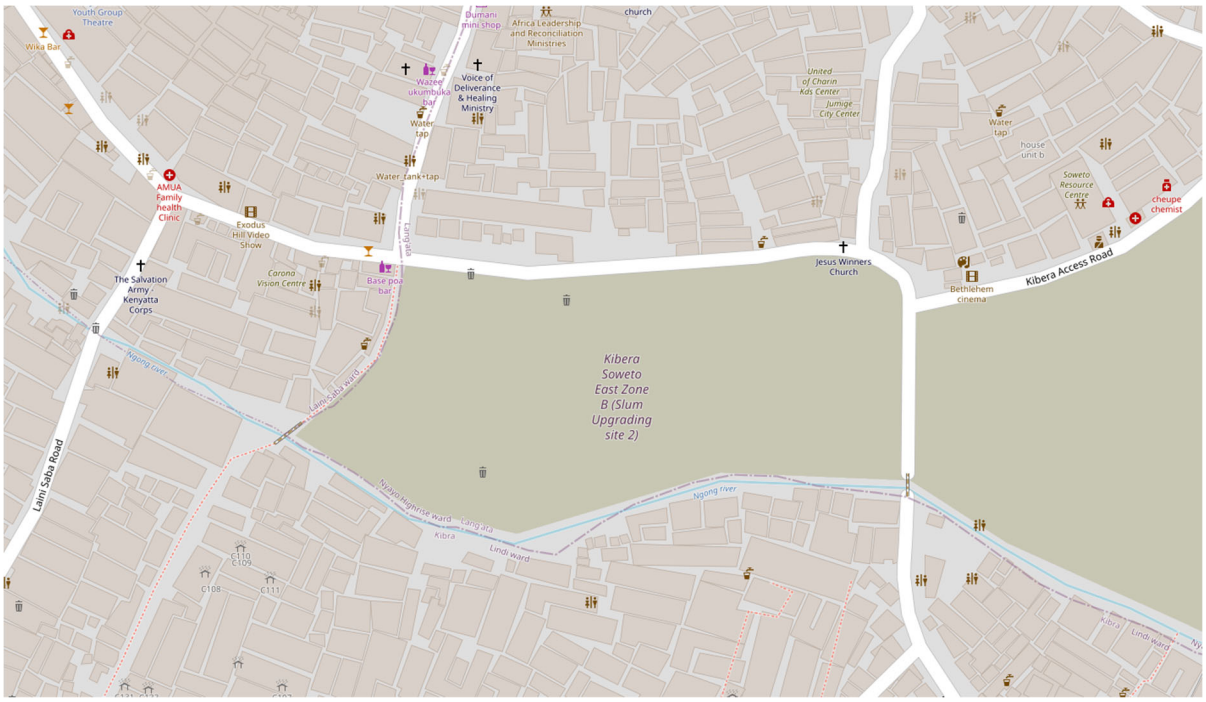

Figure 3.4.3 Image of Specific Site Context (Google)

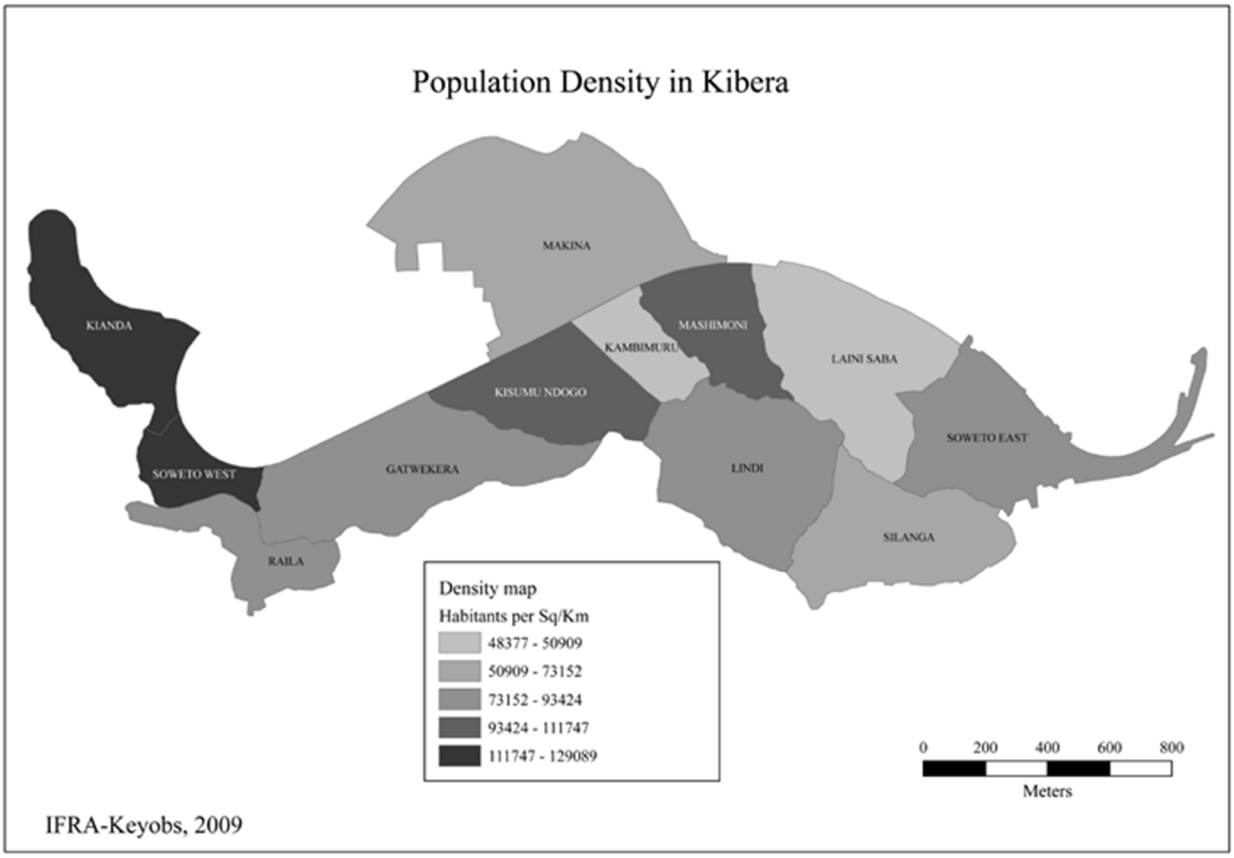

Figure 3.4.4 Map of Population Density in Kibera Slum (Desgroppes, & Taupin, 2011)

3.5. Any Other Pertinent Research

After heavily studying the design philosophy that MASS Design Group utilizes, it is important to note the expectations of the project. In the book, *Design for Good*, their design philosophy involves community involvement from start to finish (Cary, 2017). The use of local materials not only affects the individuals who inhabit a space, but it also has a positive impact on the environment. It is imperative to note that if this project were to be executed, living in the country where the project takes place and being immersed in the culture would be the first step in completion. Additionally, surveying the local community, which would be affected by the construction, would be prioritized. Lastly, the project would use local labor and materials to reduce the overall cost and increase the project's sustainability.

3.6. Precedents/Case Studies

3.6.1. Maternity Waiting Village / MASS Design Group

Figure 3.6.1.1 Mothers in the Courtyard of Maternity Waiting Village (Silva, 2020)

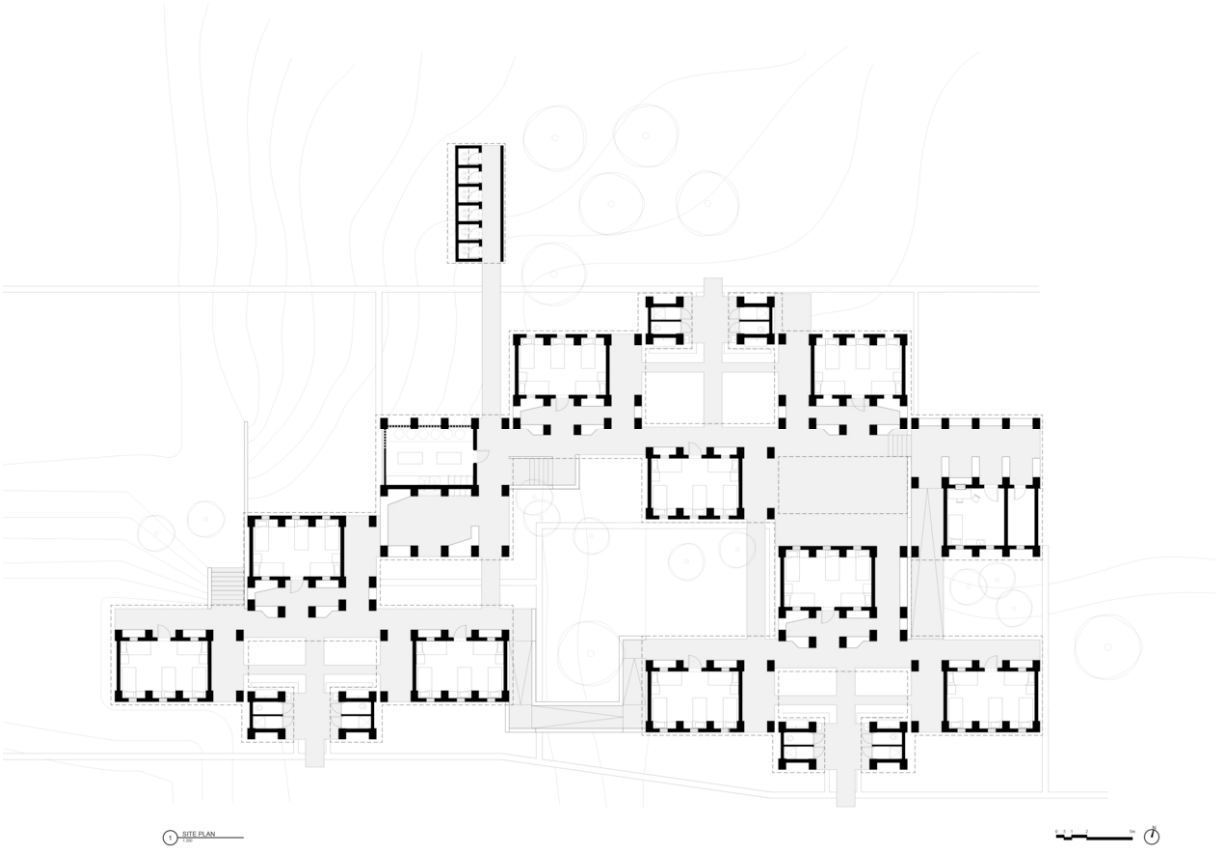

Figure 3.6.1.2 Floor Plan of Maternity Waiting Village (Silva, 2020)

The Maternity Waiting Village is a project in Malawi designed and built by MASS Design Group. The inspiration and concept of the project beautifully resemble the typical Malawi villages (Silva, 2020). Several “hut” structures interlock one another and circle together to form common spaces between the buildings, enhancing the interaction of the community. Large overhangs can be witnessed around the site and serve as shading from the sun. On page 241 of the book, Design for Good, John Cary writes that one of MASS's goals and a common theme for their projects is an immersive approach (Cary 2017). This approach utilizes interviews and in-depth on-site time. This approach helps the individuals to identify specific design needs and implement what is important to the clients.

This project was selected as a case study due to its overall inspiration, specifically the way that the project took inspiration from its cultural history and modeled the orientation of the buildings after that. Additionally, the design philosophy is also an important and applicable approach that will be implemented in this project.

3.6.2. Gando Primary School / Francis Kéré

Figure 3.6.2.1 Exterior Photo of Gando Primary School (Cardenas, 2016)

This project was built in Burkina Faso and is a primary school that uses local labor and materials for cost efficiency. The classrooms feature adequate natural light from both sides of the room. Additionally, the roof has a large overhang to provide shading to the students and the separation of the roof and ceiling helps with circulating natural ventilation.

This project was chosen as a case study because of its unique roof and the way that Francis decided to attach the structural elements. Lastly, the abundance of natural light in the

classroom is of importance to this thesis and will be of inspiration to the final design.

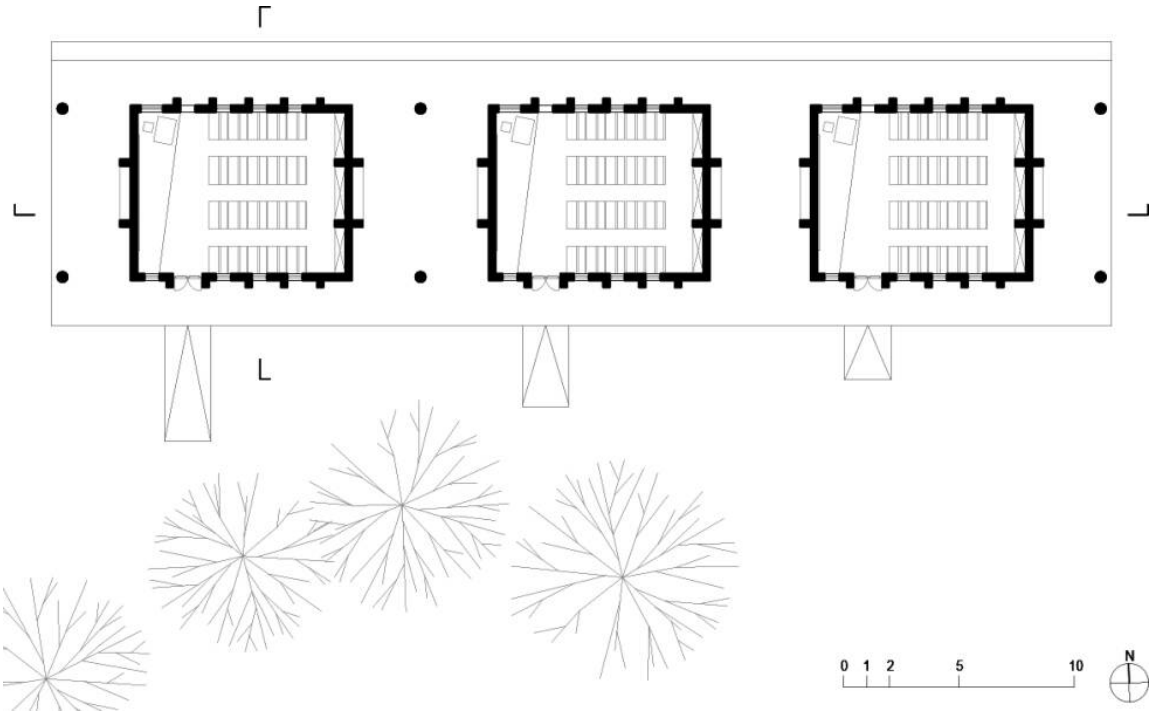

Figure 3.6.2.2 Floor Plan of Gando Primary School (Cardenas, 2016)

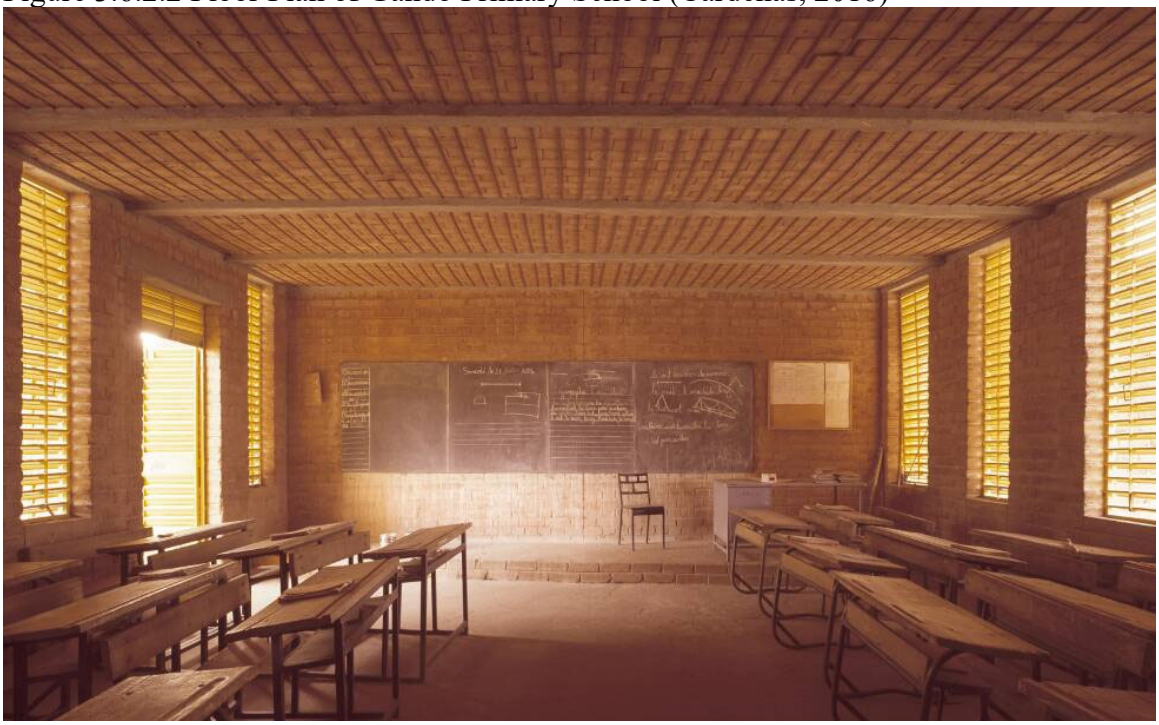

Figure 3.6.2.3 Interior Rendering of Gando Primary School (Cardenas, 2016)

3.6.3. Umubano Primary School / MASS Design Group

Figure 3.6.3.1 Exterior of Umubano Primary School (MASS Design Group, 2011)

Umubano Primary School is located in Rwanda and was designed by MASS Design Group. The project takes inspiration from the hilly landscape that surrounds the site. Local resources and materials were used in the construction of this project and helped with reducing the overall construction cost. The building uses natural ventilation strategies through the design of the roof structure.

This project was selected as a case study due to its unique approach to reducing energy consumption. This is achieved in the way that the roof structures were designed to allow diffused lighting into the building. The use of local materials and local expertise is also an important aspect of this design and will once again be utilized in the final design of this thesis proposal.

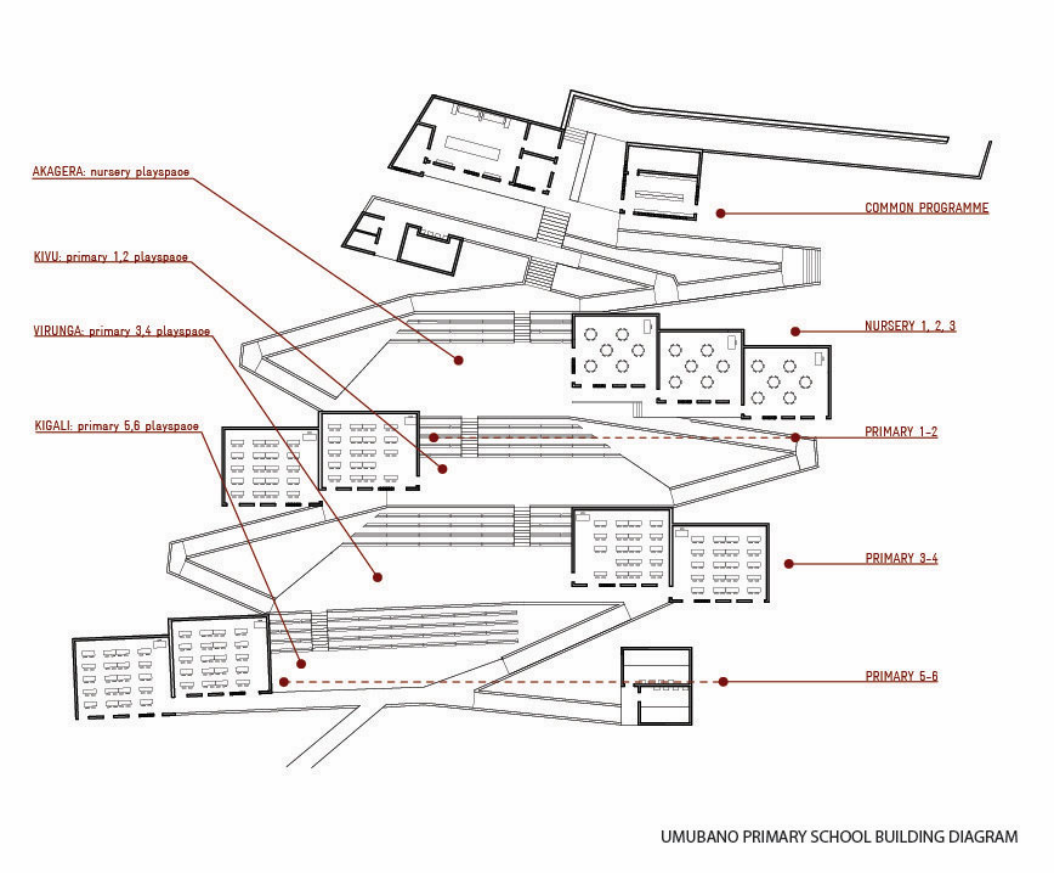

Figure 3.6.3.2 Floor Plan of Umubano Primary School (MASS Design Group, 2011)

Figure 3.6.3.3 Interior Rendering of Classroom (MASS Design Group, 2011)

3.6.4. InsideOut School / Andrea Tabocchini & Francesca Vittorini

Figure 3.6.4.1 Exterior Photo of InsideOut School (Tapia, 2020)

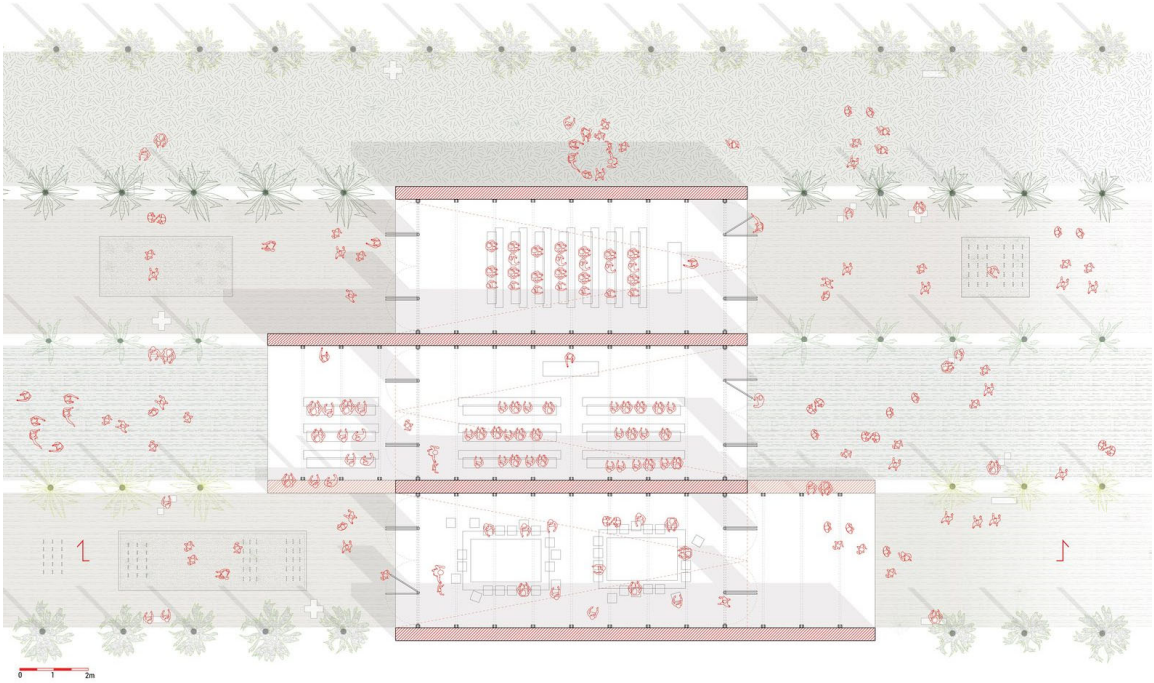

Figure 3.6.4.2 Floor Plan of InsideOut School (Tapia, 2020)

Figure 3.6.4.3 Photo During the Construction of InsideOut School (Tapia, 2020)

This project was completed by Andrea Tabocchini and Francesca Vittorini and is located in Ghana. This school project used the local materials that were available on-site – earth, wood, and vegetation. The rammed earth walls are used as the wall between classrooms. Four walls are used to create three separate classrooms. The earth from the site was used to construct the rammed earth wall and thus creates a beautiful connection between the built and natural environments.

This project was studied for inspiration because of its use of natural materials, and the simple yet elegant design. Similar materials and structural systems will be used for the proposed

thesis project. Lastly, the use of local labor and the potential that this allows when considering vernacular-inspired architecture is displayed through this project.

3.6.5. Burkina Institute of Technology / Francis Kéré

Figure 3.6.5.1 Exterior Photo of Burkina Institute of Technology (2020)

This project is located in Burkina Faso and was designed by Francis Kéré. The Burkina Institute of Technology has five classrooms and a meeting room that all circle around a central courtyard. The roof structure has a rhythmic repetition to it and allows for the circulation of air to pass through the buildings. The building itself is constructed from local materials on-site.

This case study was chosen for its unique approach to creating natural air flow, its use of local materials, and the central courtyard. The proposed thesis project seeks safety and rest in its response to the surrounding environment and this case study does an impressive job of creating a safe and inviting gathering space. Additionally, using clay, wood, and metal creates a visually

appealing and welcoming environment that does not look out of place. These will be considered in the final design of this thesis.

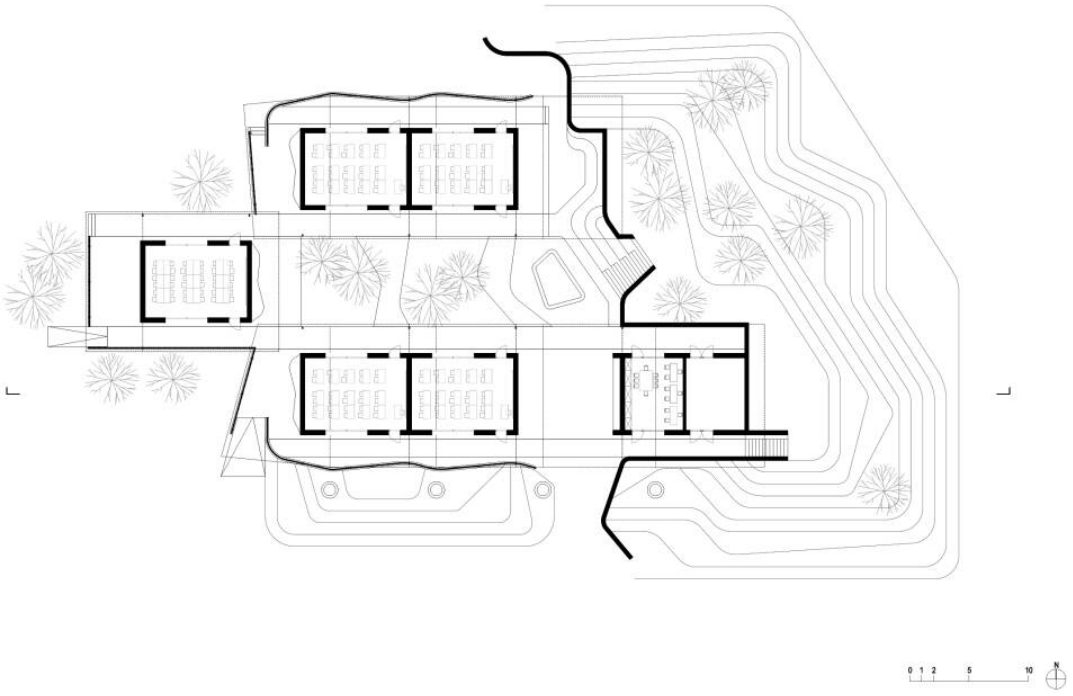

Figure 3.6.5.2 Floor Plan of Burkina Institute of Technology (2020)

Figure 3.6.5.3 Courtyard of Burkina Institute of Technology (2020)

3.6.6. Startup Lions Campus / Francis Kéré

Figure 3.6.6.1 Exterior Photo of Startup Lions Campus (Abdel, 2021)

This campus project is located in Kenya and was designed by Kéré Architecture. The campus and office buildings respond to the beautiful site it is built upon. Ventilation towers rise from the buildings and offer a natural ventilation system, allowing the warm air to rise and fresh air to be allowed in at the ground levels. The buildings use local quarry stone to lower the cost and improve the sustainability of the project. Kéré explains that collaboration with the local community aided the design decisions that needed to be made. This was heavily based on the local experience (Abdel, 2021).

This project was selected to study because of its location and the design emphasis on using local labor and materials, which are attributed to the project's overall sustainability.

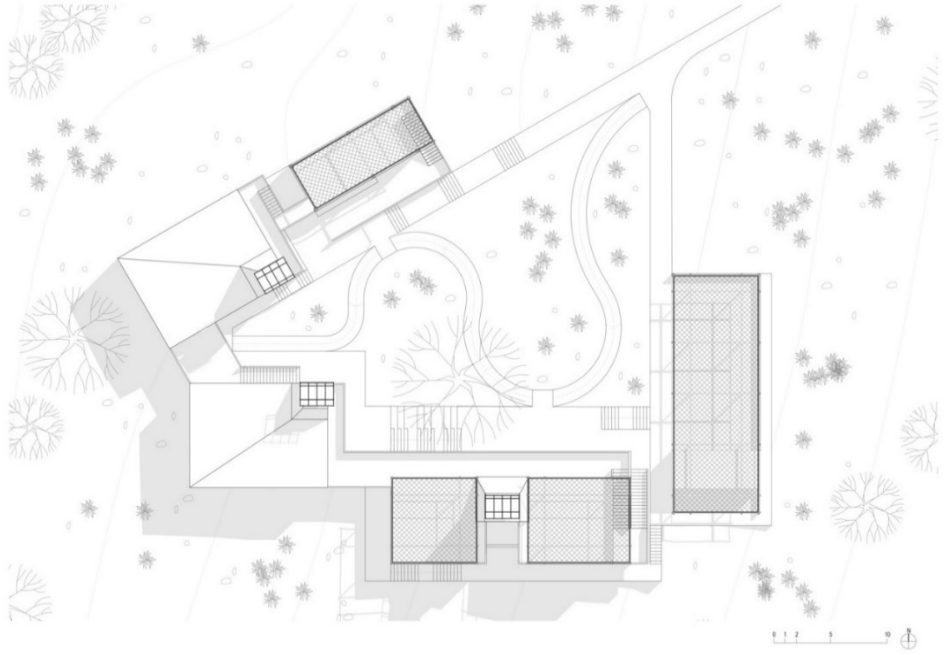

Figure 3.6.6.2 Site Plan of Startup Lions Campus (Abdel, 2021)

Figure 3.6.6.3 Exterior Photo of Startup Lions Campus Courtyard (Abdel, 2021)

3.6.7. Eco Moyo Education Centre / Arkitekter Uten Grenser + Architectopia + Jan Kazimierz Godzimirski

Figure 3.6.7.1 Exterior Photo of Eco Moyo Education Centre Courtyard (Caballero, 2020)

The Kindergarten by Architectopia, Arkitekter Uten Grenser, and Jan Kazimierz Godzimirski is located in Kenya. This is a small-scale project only consisting of two classrooms and spectacular views. The project is comprised of a concrete base, a wood structure, and a metal roof. The brush-looking walls are made from local palm leaves and protect the interior from heavy rainfall. The roofs intentionally slope and serve as a water funnel to collect rain during the rainy season.

This project is a great case study for the thesis proposal because it not only is located in the same country, and uses local materials and labor, but it also accommodates two hundred

students with free school. This project was also studied for inspiration with transitions between buildings as well as materiality choice.

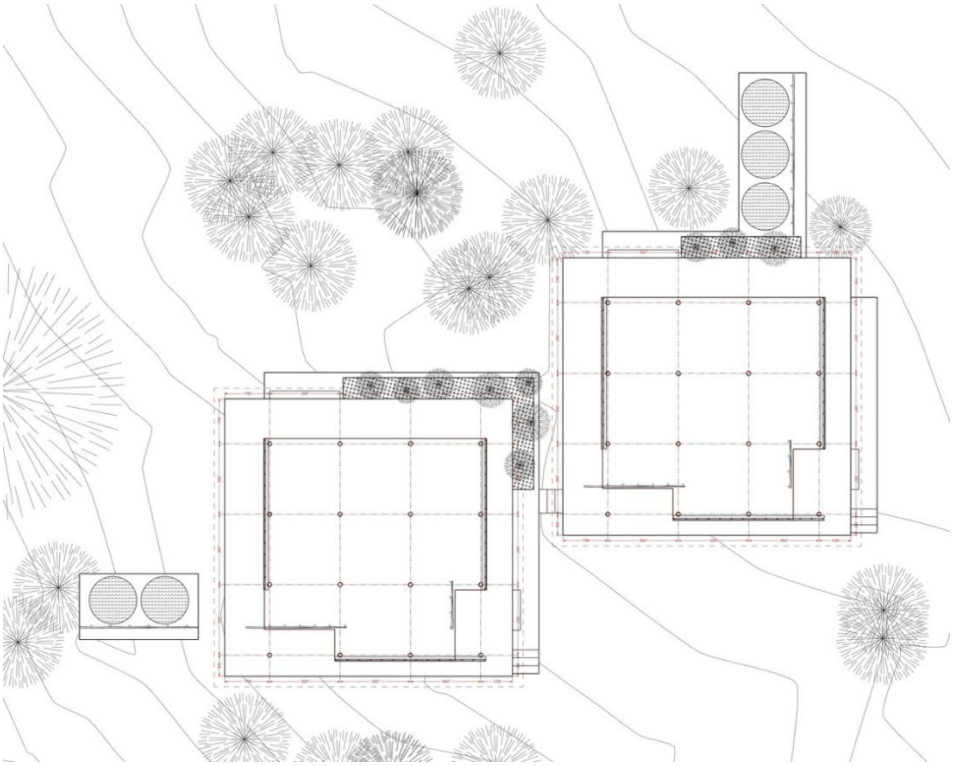

Figure 3.6.6.2 Floor Plan of Eco Mayo Educational Centre (Caballero, 2020)

Figure 3.6.6.3 Construction of Eco Mayo Educational Centre (Caballero, 2020)

3.7. Detailed Space Program

The spaces that are required for this program are as follows: eight classrooms, four teacher offices, indoor/outdoor gathering spaces, a kitchen, boy/girl bathrooms, and a soccer field (Muyia, 1995). To accommodate forty students per classroom, the dimensions per classroom will be 25 ft. by 30 ft. equaling 750 sq. ft. per classroom, and with eight classrooms at 750 sq. ft. each, that equals 6,000 sq. ft. of classroom space. Teacher offices should be 15 ft. by 15 ft. or 225 sq. ft., with four offices that equals 900 sq. ft. for teacher offices. The kitchen should also be 15 ft. by 15 ft., or 225 sq. ft. Bathrooms will be communal and can be used by both boys and girls. With anywhere from 280 to 400 students attending this public school, one bathroom per twenty students is required. With that ratio in mind, there should be fifteen bathrooms minimum to accommodate 320 students. At 3 ft. by 5 ft. per bathroom, or 15 sq. ft., and fifteen bathrooms that is 225 sq. ft. of bathroom space. Lastly, the soccer field dimensions should be 200 ft. by 300 ft. or 60,000 sq. ft., per the Burkina Institute of Technology case study by Francis Kéré above (Burkina Institute of Technology, 2020).

4. RESULTS + CONCLUSIONS

4.1. Final Project Description

Kibera Public School is a public school in Kibera Slum, near Nairobi, which seeks to empower Kenya through the use of local materials and labor. The school consists of eight classrooms, four offices for teachers, two sets of restrooms, and a soccer field which the buildings encircle. The school buildings utilize a rammed earth construction process which is a sustainable approach and utilizes the local materials of Kenya.

Figure 4.1 Exterior View of Kibera Public School

4.2. Project Objective

To reiterate, the project objective of Kibera Public School, it is to empower Kenya through the use of local materials and labor by providing a comfortable and safe learning environment for its students. This objective can be broken into four subsections: comfortability, affordability, sustainability, and community involvement.

4.2.1. Comfortability

Kibera Public School provides a comfortable environment for the students through the use of local materials. Additionally, the school uses many windows in the classroom spaces to fill each room with ample natural light and ventilation to decrease an unpleasant odor.

4.2.2. Affordability

Kibera Public School addresses affordability due to its use of local materials and labor. With local materials, the cost of transportation will be reduced as well as the buying of imported materials. Additionally, the construction costs will be reduced significantly by using the local community in the design.

4.2.3. Sustainability

Kibera Public School meets the objective of sustainability due to its use of local materials, which reduces the amount of transportation and thus the emission of fuel. Additionally, using clay in rammed earth walls, the building creates natural heating and cooling effects by cooling the interior when it is hot outside and warming the interior when it is cool outside.

4.2.4. Community involvement

The final objective that Kibera Public School addresses is the use of the community in construction. The community is an imperative part of the completion of this project. Involving the community in this project will give them a sense of ownership and say in the final design of the project as well as teach them the skills to construct a building so that they can use their knowledge gained from the project for future employment.

4.3. Project Design and Documentation

The following images will document the final design of Kibera Public School through design development plans, renderings, and photos of the final physical model.

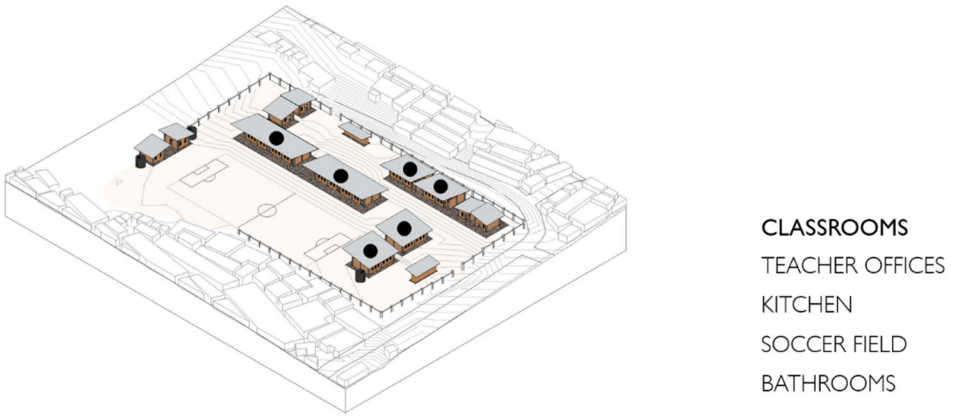

Figure 4.3.1 Isometric Site Plan- Highlighting Classrooms

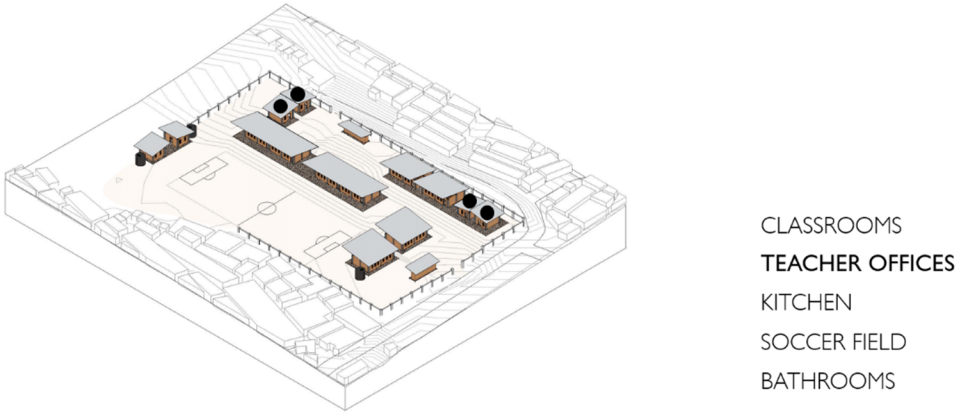

Figure 4.3.2 Isometric Site Plan- Highlighting Teacher Offices

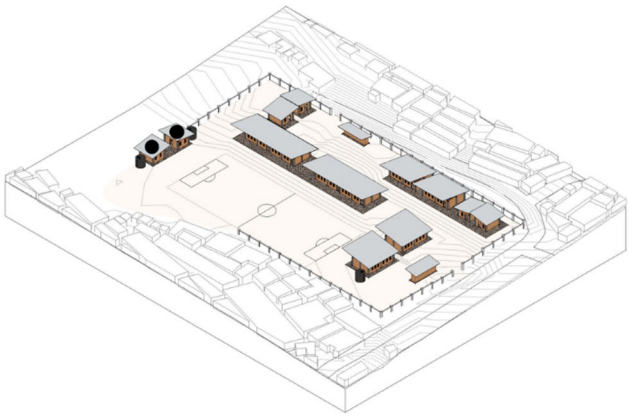

Figure 4.3.3 Isometric Site Plan- Highlighting Kitchen

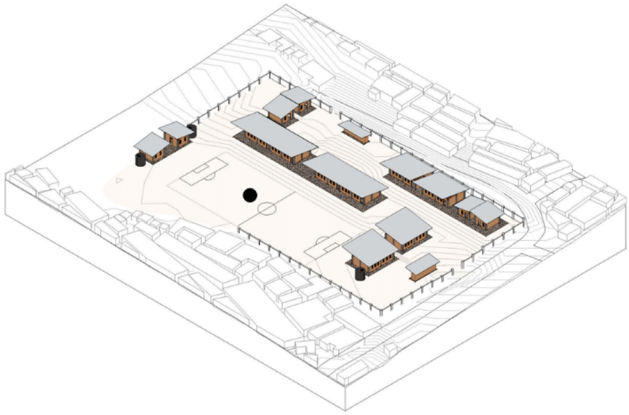

Figure 4.3.4 Isometric Site Plan- Highlighting Soccer Field

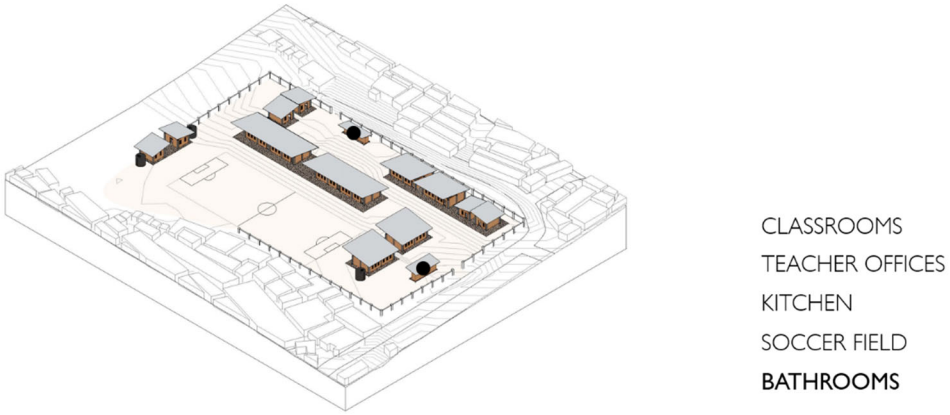

Figure 4.3.5 Isometric Site Plan- Highlighting Bathrooms

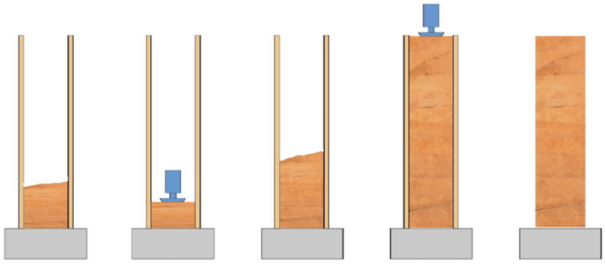

Figure 4.3.6 Step-By-Step of Rammed Earth Wall Construction

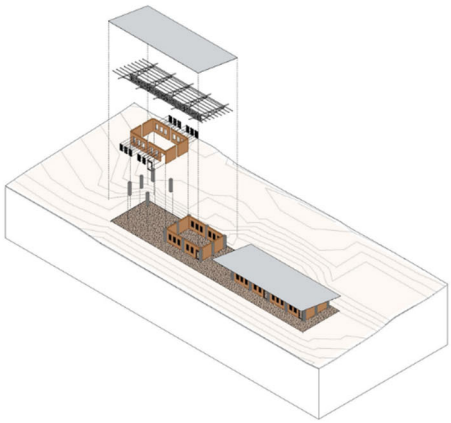

Figure 4.3.7 Axonometric Structural Diagram

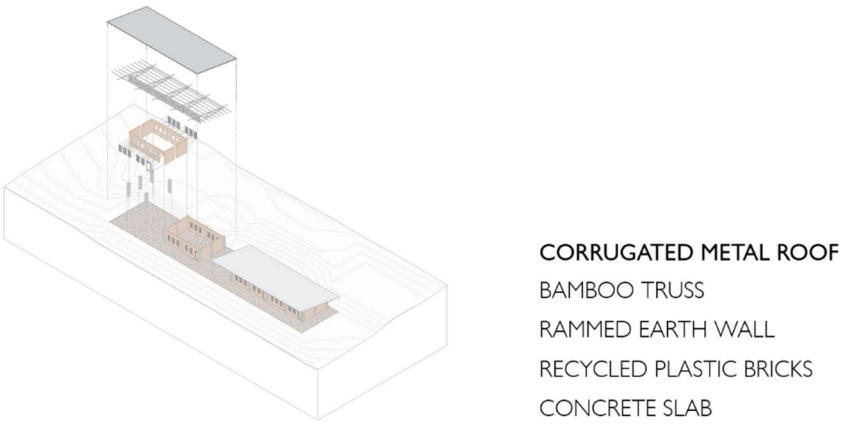

Figure 4.3.8 Axonometric Structural Diagram- Corrugated Metal Roof

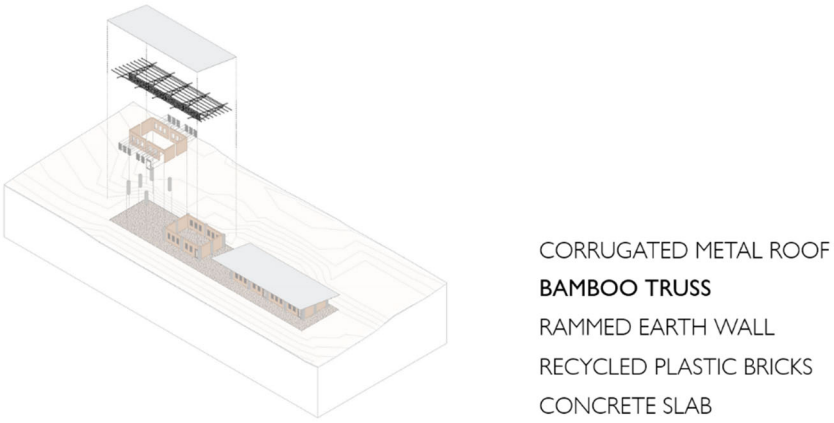

Figure 4.3.9 Axonometric Structural Diagram- Bamboo Truss

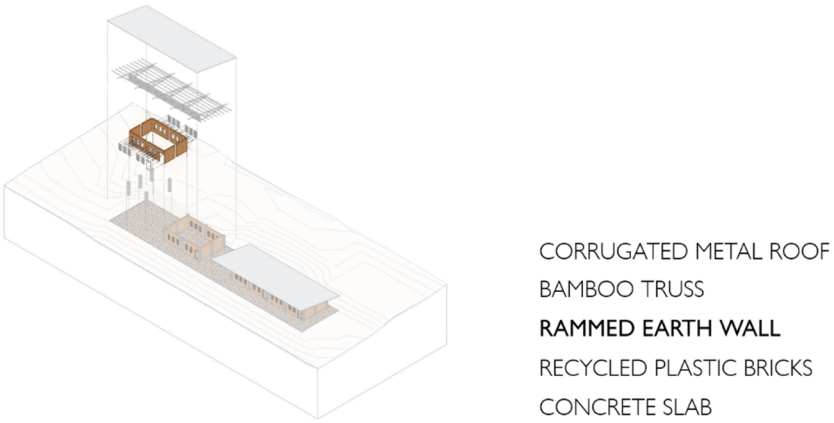

Figure 4.3.10 Axonometric Structural Diagram- Rammed Earth Wall

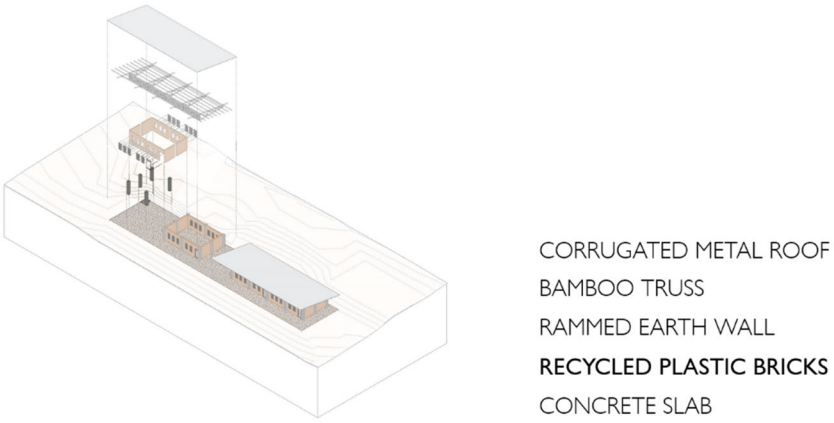

Figure 4.3.11 Axonometric Structural Diagram- Recycled Plastic Bricks

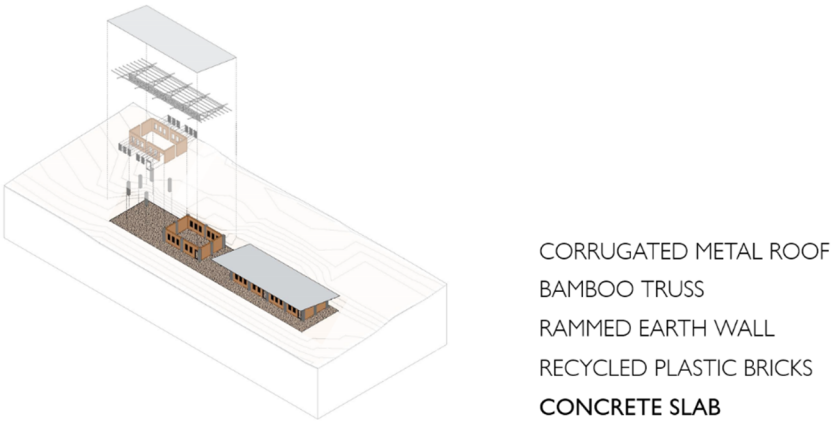

Figure 4.3.12 Axonometric Structural Diagram- Concrete Slab

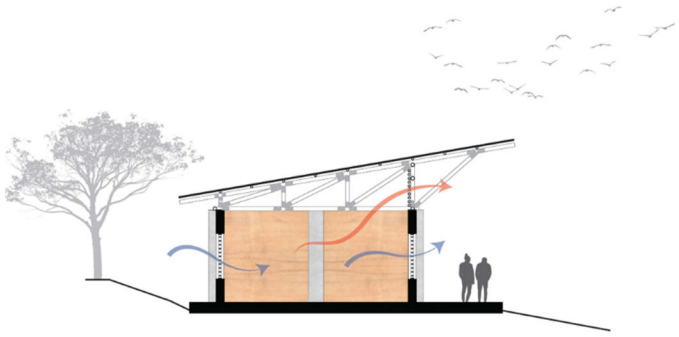

Figure 4.3.13 Diagram Showing Natural Ventilation

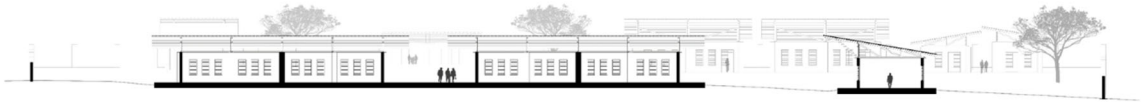

Figure 4.3.14 Image Showing Section Cut of Classrooms

Figure 4.3.15 Interior Rendering of Classroom

Figure 4.3.16 Exterior Rendering of Courtyard Space

4.4. Conclusions

While this project seeks to solve the lack of student attendance and the overarching problem of helping individuals rise out of poverty by offering a public school, I have just touched the tip of the iceberg, and there is still a lot of research yet to be done. Surveying community members and listening to what the community needs would be the starting place. Further research would consist of the longevity and limitations of rammed earth. Other local materials to Kenya that could be implemented affordably and sustainably. Further research into the redevelopment of slums and the effects that it has on the community. Different structural systems that could be used in Kenya. In conclusion, the results and conclusions from this project are only the beginning of solving the problem statement. Finally, I hope that this project starts the beginning of a discussion around this problem and that designers realize their role in helping those in poverty. We must lock arms and face this challenge head-on.

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