THE UNIVERSITY OF NAIROBI
DEPARTMENT OF ARCHITECTURE & BUILDING SCIENCE
SCHOOL OF THE BUILT ENVIRONMENT

TROPICAL MODERN ARCHITECTURE
CLIMATE RESPONSIVE MODERN ARCHITECTURE IN EAST AFRICA BETWEEN 1940 AND 1980

A project report presented to the Department of Architecture & Building Science in partial fulfillment of the requirements for the degree of Master of Architecture, Environmental design.
University of Nairobi 2015/2016.

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DECLARATION

This project report is my original work and to the best of my knowledge, has not been presented for the award of a degree in any other institution.

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This project report is submitted in partial fulfillment of the examination requirements for the award of the Master of Architecture degree, Department of Architecture and Building Science, University of Nairobi

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May God in His wisdom grant you all, His unfailing blessings many-fold.
DEDICATION

To my Mother and Father, who have taught me to
“Be present in all things and thankful for all things
And most of all,
to thank God for life and all that's in it. “
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ABSTRACT

Between the years 1940 and 1980, tropical modern architecture defined the character of climate responsive design in the Tropics but after 1980, the emphasis on climate responsive design significantly declined. Today, climate responsive design is an issue of utmost importance but architects are experiencing a conflict in giving it expression in the contemporary architectural trends defined by the Intentional Style’s glass buildings adopted in developing countries since the 1980’s. Literature reviewed brings out the origin and spread of tropical modern architecture and portrays the critical architects and networks that facilitated the spread of tropical modern architecture in different areas within the tropics except East Africa. To understand the development of tropical modern architecture in East Africa, this study establishes the networks between architects in Europe and those who practiced in East Africa in order to understand the genesis of tropical modern architecture in East Africa and the key characteristics of climate responsive design required to ensure a building is climate responsive. From the analysis of the architects backgrounds, networks and architecture, the thesis is able to recommend a way forward in spurring interest in climate responsive design while embracing contemporary trends of architecture.
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INTRODUCTION

1.0 Background
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1.7 Organization of Study
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1.0 BACKGROUND

If one examines the East African cities today, most of the climate responsive buildings were
built between 1950’s and mid 1980’s. It was also during this period that most African states
attained independence. During this period, colonial cities and former colonial cities became
sites of experimentation in modern urban forms, ideologies and practices. This was mostly
because concurrently, around the world, architecture and urban planning were part of the ‘age
of improvement’ - the modern movement. This can be seen in architecture in East Africa;
from the works of modernist architects such as Ernst May (fig. 1.2), Richard Hughes, Amyas
Connell, in West Africa; from the works of modernist architects such as Oluwole Olumuyiwa,
Olivier Clement Cacoub, Jane Drew and Maxwell Fry (fig. 1.3), in India; from the works of
modernist architects such as Minnette De Silva, Geoffrey Bawa, Balkrishna Doshi, Le
Corbusier and Louis Khan and Brazil to name a few.

However, before modern architecture took root in the tropics, there was a language we can
safely describe as tropical colonial architecture. The link between the tropics and colonialism
(explained more in chapter two of this study) is made because the regions within the tropics
were predominantly colonised by European nations. The architectural progression of colonial
architecture to tropical architecture seen within the colonies gave way to the development of
tropical modern architecture.

Fig. 1.1: Modern architecture in East Africa—Cathedral of St. John the
Baptist in Eldoret, Kenya by Richard Hurley and Associates
Source: http://www.rha.ie/eldoret.html

Fig. 1.2: Oceanic Hotel, Mombasa built in 1952 by Architect Ernest May
Source: afriperspectives.com

Fig. 1.3: University of Ibadan, Nigeria by Jane Drew and Maxwell Fry, completed in 1955
In the case of East Africa, for example, a clear evolution from early temporary settlements to neo-classical architecture and eventually to neo-classical climate responsive architecture can be seen. Initially, the settlers in British East Africa favoured the ‘rondovale hut’ adapted from the Boers who had settled in South Africa (fig. 1.4). Its rammed earth floors, thick earth walls and heavily thatched roofs ensured cool temperatures during the day and retained warmth to insulate internal spaces. Nostalgia may have set in and resulted in the evolution of their building structures that resembled the English cottage. Some of the elements of the native hut were however maintained. The fusion of the two resulted in larger buildings, with larger living spaces whose exteriors were characterized by white washed walls, brick chimney flues piercing through the thatch roof and verandas. The walls were still built in wattle and earth but the floors were now timber boarded. The developed typology was extremely comfortable because of the addition of the veranda which shaded the window openings from direct sun and provided cool external outdoor space (fig. 1.5). (Katua 1989).

By 1910, more permanent structures had replaced the earth walled and thatch roofed buildings completely especially in the design of administrative buildings such as Ministry of Natives Affairs building in Nairobi by Architect C. Rand Ovary (1913) and Kipande House (Fig 1.6). Smooth faced stone blocks on one side, lined with earth on the rough edged interior façade were used for the external wall. The heavily thatched roofs, verandas and dark polished floors were retained in some buildings. The stone external finish was more durable and resistant to destruction by termites and rain. The earth lined interior façade of the walls ensured thermal comfort. Quarry stone was used as the main building material and clay tiles roofed most structures. The size of the structures was massive and required that the walls be large enough to carry the buildings weight. The thick walls and clay roofing tiles acted as a perfect thermal filter against the hot sun. Window openings were created in every room to allow cross ventilation and optimum lighting. Where windows were not located within a balcony, sun shades were added. Walkways were covered and shaded external seating spaces surrounded by a lot of tree cover were provided. Narrow plan spaces with high ceilings further enhanced the comfort of the buildings. This can be seen in the design of Kenya Railways Building (fig. 1.7), the Judiciary building, State House in Nairobi and Mombasa and Nairobi High School aka Prince of Wales School.

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Fig 1.4: Early settler hut; ‘rondovale hut’
Source: Katua (1989)

Fig. 1.5: Buildings with Shaded Verandas on Tom Mboya Street
Source: [http://www.oldeastafricapostcards.com](http://www.oldeastafricapostcards.com)
Due to the difference in temperature between the temperate regions the colonialist came from and the tropics, colonialists redesigned their architectural styles to suit the hot tropics. The colonial architecture built to suit the tropics was a result of experimentation and extensive research on appropriate construction and planning.

The idea to rethink the architectural design and planning approach was driven by critical health, hygiene and sanitation issues which seemed to be resolved through architecture and urban planning. Tropical architecture, medicine, hygiene and sanitation were inseparable concepts while trying to resolve sanitary and hygiene issues. The settlers developed a rudimentary somewhat informal manual for architecture within colonial East Africa. From the research gathered, George Atkinson at the British Royal Service initiated a series of building notes were renamed ‘Overseas Building Notes’ (Home 2013).

The manual advised on site and material selection and general design elements that would increase thermal comfort, offer protection from rain and help in keeping mosquitoes at bay. Fertile soils were recommended for gardening and farming, encouraging landscaping and tree cover to create comfortable microclimates. Locations with views those were neither too close nor too far allowed for the site to be open enough to allow free air movement but ensuring that the site was not too exposed that strong gusty winds swept across the site. Due to heavy rainfall, well drained site and settlement in areas with soils that could not get water logged were recommended. On the design of buildings it was advised that buildings be raised off the ground, to allow cool air to penetrate on all sides of the buildings cooling it even from below. It was also recommended that materials be sourced as close to the site of the building as possible.

According to Home (2013), the overseas manual and other research on tropical hygiene and medicine were used to guide architectural design in European colonies which in the topic of tropical modern architecture would refer to British West Indies, British West Africa and British East Africa.
1.1 PROBLEM STATEMENT

Independence seemed to breathe new life and zeal into former colonies of European powers. With decolonization, emerged an architecture borne from the modern movement. It was a welcome change from the expressive colonial forms of the British Empire because its forms lacked bits and pieces of historical reminiscence defining the colonial period. In Nairobi, this can be seen in the design of Hyslop Building (1960), Gandhi Memorial Library (1962), IPS Buildings and ICEA building (1982) among others (fig. 1-8). Its most definitive characteristic was that it had adapted a new form suited appropriately to the social, economic and climatic conditions in the tropics.

The modern movement in Africa sought to break from tradition and create new symbolic forms that reflected the contemporary realities. In East Africa, the ‘reality’ was the dawn of a new era; one of self-rule. The desire to break free from the past and start a new was apparent. Architects who contributed to the ‘rebuilding’ of the new colonies had developed principles that could be used to design climate responsive buildings in the tropics. Armed with the new architectural language developed during the modern movement and these principles, architecture in the east African cities was something of a marvel – receptive to the natives, free from the colonial nuances and best of all, suitable for tropical architecture.

Unfortunately after the 1980’s, many cities adopted the glass clad high-rise buildings associated with the International style/movement; a contrast illustrated in fig. 1-9. These buildings had originally been developed for the temperate climates where heat retention in the cold season is crucial and lower temperatures are experienced. The use of glass clad facades on buildings has since become dominant and principles that make buildings more climate responsive have been replaced by the use of energy intensive methods of making the building comfortable.

This thesis looks at the architecture of climate responsive buildings in East Africa during the era of independence. It seeks to understand its beginning, development and the cause of its decline in the 1980’s. It is from this understanding that the thesis aims to spur interest in design of climate responsive buildings today.
1.2 OBJECTIVES

1. To find out the key pioneers and protagonists in the establishment of tropical modern architecture;
2. To establish the characteristics of tropical modern architecture that made it stand out as climate responsive;
3. To establish the origin, spread and development of tropical modern architecture and to investigate why the drive towards tropical modern architecture diminished approximately 25 years after the East African countries attained independence;

1.3 RESEARCH QUESTIONS

1. Who were the key pioneers and protagonists in the establishment of tropical modern architecture?
2. What were the characteristics of tropical modern architecture that made it stand out as climate responsive?
3. What was the origin, spread and development of tropical modern architecture and why did the drive towards tropical modern architecture diminish approximately 25 years after the East African countries attained independence?

1.4 RESEARCH JUSTIFICATION

This research seeks to understand what brought about the unprecedented drive towards climate responsive architecture around the post independence years of British colonial Africa and why 25 years later, this drive vanished. In doing so, the research will attempt to find out how designers today can spur interest in climate responsive architecture which can increase energy efficiency and create more comfortable and sustainable living and working environments within our cities.

1.5 SIGNIFICANCE OF STUDY

This research will be of interest to historians, academics and different professionals who seek to understand the initial drive towards climate responsive architecture. It contributes to the body of knowledge on the history of architecture and environmental design. The study also adds to the documentation of tropical modern architecture in East Africa which in relation to other tropical regions like Brazil, India and West Africa is scarcely documented. It highlights the development of tropical modern architecture in different parts of the world and how that impacted its development in East Africa.
1.6 SCOPE AND LIMITATIONS

This research scope is limited to the study of modern architecture within the tropics. This is because areas within the tropic of Capricorn and the tropic of Cancer experience higher temperatures throughout the year than those beyond those limits. Buildings within the tropics are therefore faced with the challenge of keeping heat out and also limiting the high intensity of light from the sun specifically between early morning and late afternoon, which is when temperatures are predominantly high. A study of tropical modern architecture around the world will reveal the development of strategies and design principles various architects used to make buildings more climate responsive.

The research scope will also be limited to tropical modern architecture built between the 1940’s and 1980’s because that is the period when many of the modern climate responsive buildings in Africa were built. After 1980, the architectural language seems to change and the international style is adopted for buildings within African cities resulting in architecture that is not suitable for tropical climates but merely imitations and transplants of architecture in developed countries whose temperate climates benefit from materials such as glass which is the main façade material for architecture built in the International style.

The study will focus on the development and decline of tropical modern architecture in East Africa but will also examine, in passing, tropical modern architecture in other parts of the world namely: West Africa, Southern Asia, West Indies and the Brazil. To understand the driving force behind the development of tropical architecture, the study will investigate and analyse the architects who pioneered in developing tropical architecture, their influences and their works. The interaction between various architects who designed modern buildings in the tropics and a study of the development of their work around the world may give insight on how architects today can collaborate and develop architecture which is responsive to tropical climate and responds to current social, national and international issues that we face today.

The limitations during the study are time constraints, monetary constraints and inaccessibility into certain buildings and architects who designed between 1940 and 1980. The limitations affect the study outcome in that more in depth studies of architecture and architects selected for analysis was limited. The documentation of tropical modern architecture especially in East Africa is fairly limited and as such access to some information was limited.
1.7 ORGANIZATION OF STUDY

This thesis has five chapters. In chapter one, the study gives a brief background of the architectural language that preceded tropical modern architecture. The tropics were primarily under European rule and as such the architecture had classical and neoclassical semblances. The case of British East Africa is used as a case study to demonstrate the link between colonisation and tropical which is used to explain the development and spread of tropical modern architecture. Chapter one is also used to explain the problem statement which challenges the notion of the adoption of the international style—glazed facades which are not climate responsive. It is for this reason that the study attempts to follow the development of tropical modern architecture and its decline with an aim of understanding and illustrating the process of adapting a ‘foreign’ architectural language to the local climate and social conditions.

Chapter two attempts to establish the beginning of tropical modern architecture, its pioneers and protagonists and its development in other tropical regions. It establishes the link between the modern movement and tropical architecture and how the two develop tropical modern architecture. It establishes the protagonists and pioneers of the tropical modern movement to be linked to Le Corbusier, CIAM and other modern movement groups, the institutionalization of tropical architecture in institutions with strong leaning to modern architecture such as the AA School. Chapter two also analyses different aspects of the tropical modern movement such as the link between colonialism and the tropics, the variations in its development in different tropical regions that were not colonised by the British such as Brazil and its regionalization in terms of climate and culture in areas with strong defined regional identity like India and Sri Lanka. Chapter two also establishes the links and networks between protagonists which inform the study of architects and architecture in East Africa in chapter four.

Chapter three discusses the process and tools used to collect data in the field. The field of study is East Africa. Chapter three outlines the selected case studies and gives justification for the selection of each case study. It shows the sources relied on to collect data and the methods used and how the data different forms of data collected are analysed.

In chapter four, all the data collected from the selected case studies is analysed and explained. Selected buildings and architects are selected to understand the tropical modern movement in East Africa. The analysis of the architecture brings out the adaptation of modern architecture to climatic, regional and cultural context. The study of the architects brings out their background, their influences with regard to the modern movement, their design philosophy and their contribution to the tropical modern movement in East Africa. Chapter four summarises the data found in the field work and demonstrates the development of tropical modern architecture in East Africa i.e. its evolution, impact and extent.
Chapter five outlines the findings from chapter one, two, three and four of this study. It summarises the development of tropical modern architecture; its beginning, development, evolution and spread in the tropics. It outlines the answers to the research questions by summarizing how the thesis met the research objectives. Chapter five also gives recommendations with regard to the problem statement which discusses the challenges faced by architecture today by advising on solutions to adopt ‘foreign’ architecture and adapt it to local conditions

1.8 DEFINITION OF TERMS

i. British East Africa/ East African protectorate – territories formerly under British control in eastern Africa i.e. Kenya, Uganda, and Zanzibar and Tanganyika now known as Tanzania (2016 Encyclopædia Britannica, Inc.).

ii. British West Africa— Assortment of widely separated territories in western Africa that were administered by Great Britain during the colonial period i.e. Sierra Leone, the Gambia, Nigeria (with the British Cameroons), and the Gold Coast including Gold Coast crown colony, the Asante empire, the Northern Territories, and British Togoland (2016 Encyclopædia Britannica, Inc.).

iii. British West Indies — Diversified group of Caribbean islands, including Anguilla, British Virgin Islands, Cayman Islands, Monserrat, and the Turks and Caicos (2016 worldatlas.com).

iv. Modern Architecture—an invention of the late 19th and 20th centuries, conceived in reaction to the supposed chaos and ecclectism of various earlier 19th century revivals of historical forms. The architecture would be based on new means of construction with forms purged of paraphernalia of historical reminiscence and give a sense of human betterment.

v. Modern movement— a revolution in social purpose and architectural forms that attempted to reconcile industrialism, society and nature (Curtis 1996)

vi. Regionalist modernism— modern architecture that borrowed from vernacular architecture by adapting the modern principles to the cultural ones with an aim of promoting social transformation (Curtis 1996)

vii. Tropics — refers to regions located within the Tropic of Cancer and the Tropic of Cancer.

viii. Tropical architecture - Architecture adapted to tropical climate (Lefaivre & Tzonis 2001)

ix. Tropical modern architecture— Modern architecture adapted to tropical climate that arose after the second world war, prompted by post colonialism and globalization.
CHAPTER TWO
LITERATURE REVIEW

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   2.3.1 Le Corbusier
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2.4 The development of Tropical Modern Architecture in the Tropics
   2.4.1 West Africa: A Study of Tropical Modern Architecture in Nigeria and Ghana
   2.4.2 Southern America: A Study of Tropical Modern Architecture in Brazil
   2.4.3 Southern Asia: A study of Tropical modern Architecture in India and Sri Lanka
2.1 MODERN ARCHITECTURE IN THE TROPICS.

Modern architecture had its concepts based on various aspects; among them progress and the industrial revolution. It aimed at creating an architectural language not influenced by the past but generated entirely as a genuine expression of the present. The industrial revolution brought with it new methods, allowed for new solutions to be found and suggested new forms. New economic structures and centres of power brought about by the revolution spurred interest in the search for alternative social and urban structures since modernism was also founded on the belief of a just and rational society.

Among the earliest people to push forward the notion of modern architecture was Eugene Viollet Le Duc, a French theorist in the early eighteenth century. It was his belief that a new architectural language could be generated completely isolated from precedent styles and have a form appropriate to the new social, economic and technical conditions. The questions that arose were how the architecture would look and from where its forms be derived.

Curtis (1996) posits that in the 1890’s and the first decade of the 20th century, a language for modern architecture was defined but it was not as ‘pure’ or non-mimetic of the past as Viollet Le Duc had envisioned. However in the 1920’s, modernists like Le Cobusier and Mies Van de Rohe had formulated a language that seemed to proffer new symbolic forms recognized as modern architecture by infusing a greater degree of abstraction to both tradition and nature. The budding of the modern movement found its expression in the works of Walter Gropius (who advocated for cooperation and team work), Jacobus. J. P. Oud (who pushed for standardization) and in the writings and works of Le Corbusier (who pushed for embracing technological advancements).

By 1928, the number and influence of modern architects had grown significantly and they came together to form Congrès International d’Architecture Moderne (CIAM) also known as The International Congresses of Modern Architecture and later in 1933, The Modern Architectural Research Group (MARS Group), Groupe d’Architectes Modernes Marocains or Modern Moroccan Architects’ Group (GAMMA Group), Team X among other modern architecture groups. Lathouri (1999) states that the gathering of modern architects was initially aimed at the development of a document that would confront the realities of the changing world. Most critical to this study are CIAM and the MARS Group which had members who played a key role in the tropical modern movement by using the group as a networking platform for ideas on developing tropical modern architecture.
The 1940’s and 1950’s marked the period that modern forms had an appreciable impact on architecture in most of the developing countries (fig. 2-4, fig. 2-5). However according to Curtis (1996), the architecture developed was a degraded version of modern design that seemed to lack the depth and meaning that modern architecture was associated with in other parts of the world. He attributes this disparity to rapid economic development, colonization and brainwashing of post colonial elites who held western ideas as progressive resulting in the poor application of the principles of modernism.

The rapid economic development Curtis (1996) refers to, resulted in modern or minimalist buildings being designed to accommodate unprecedented functions, technology and urban circumstances within developing countries. Japan, Latin America, the Far and Middle East and most of Africa experienced difficulties adjusting to industrialization in the mid 20th century. Unlike other western countries that had decades to evolve, most developing countries had barely enough time to understand the changes that came with industrialization and adjust to them appropriately. Another problem that arose from the rapid economic development was that the design process was made shorter and many problems the design was intended to solve were unfortunately overlooked since the required specialization from different professionals had been removed from the design process.

According to Curtis (1996), Colonialism affected the quality of modern architecture in that it used modernism to serve as a symbol of foreign economic or political control. Colonization in many cities within the tropics reoriented urbanization, urban forms and functions to meet its needs making colonial cities during the interwar period sites of experimentation where modern urban forms, ideologies and practices were used to reorganise cities (Myers 2011). The result was an urgent and apparent need for minimalist design which defined the architecture between the 1940’s to the 1970’s (Demissie 2012). Here modern architecture is seen to be vital in projecting prototypes for mass housing and even cities serving a social purpose to alleviate the suffering and in turn quell increased rebellion.

The post colonial elites described by Curtis (1996) as brainwashed affected the quality of modern architecture by accepting ‘skin deep modernity’. In their view, liberation was the ability to enjoy similar consumer freedoms as the West there by dissociating themselves from their traditions and recent colonial past. In Brazil for example, modernist architect Lucio Costa noted that only ‘new money’, wanted pseudo-authenticity where by modern elements of architecture were hidden or suppressed instead of being expresses with the clarity that had come to be associated with modern architecture (Williams 2009).
Despite the challenges highlighted above, the idea of modernism was well received in developing countries and architects started looking for solutions to improving its quality by adjusting modern forms to the changing social conditions rather than using the solutions developed for the West. Another allure to modern architects to practice in developing countries was the unlimited freedom they got while working in developing countries. Sharp (2008) demonstrates this through the biography of Amyas Connell. When Amyas designed High and Over (fig. 2.6), it received a lot of resistance because it was so different from the norm. With his move to East Africa in 1947, Amyas worked on several projects such as the AG Chambers, Parliament of Kenya and Norwich Union in Nairobi, where he experimented with form as he desired.

Once modern architects started to work in the tropics, the concept of modernism being universal and adaptable to any region started to be challenged and ‘regionalist modernism’ was developed. Amyas Connell’s biography by Sharp (2008) describes how Connell’s experimentation in the tropics made him re-examine the concepts of modernism specifically Le Corbusier’s brise soleil and ornamentation. This two issues on climate and cultural expression through ornament were the issues regionalist modernism attempted to resolve.

Initially, regionalist modernism was seen to resemble the peasant vernaculars, which were viewed as backward and it was therefore rejected. However modern architects found that by unearthing the fundamental lessons in vernacular architecture and merging them with the already developed modern principles, an acceptable and high quality form of architecture emerged.

An example would be the works of Louis Kahn (fig. 2.7) and Le Corbusier in India where modern architecture was being used mainly as an instrument of social transformation. The two modern architects, for example, developed a convincing synthesis of practical, aesthetic and symbolic principles described as key values of harmonious forms of any architecture by Curtis (1996). The regionalist modernism concepts developed by Kahn and Corbusier were further enhanced by several Indian architects who had a richer understanding of indigenous principles which they integrated with modernist concepts. The expression of regionalist modernism can be seen in the works of Achyut Kanvinde, Balkrishna Doshi, Charles Correa and Raj Rewal to name a few. Modern architecture started to evolve not only to suit the social conditions of the regions it was located but also to suit the economic, environmental and climatic conditions.
Lefaivre and Tzonis (2001) describe tropical architecture as architecture adapted to tropical climate. Tropical climates offer a challenge to designers in terms of heat control and cooling which are crucial in ensuring comfortable internal environments. Within the tropic of Capricorn and Cancer, six distinct climate groups can be found. They include warm humid equatorial climates, hot dry desert climate, hot dry maritime desert climate, composite or monsoon climate, tropical upland climate and warm humid island climate.

i. Warm humid equatorial climate is experienced in regions between 15° North and 15° South of the Equator such as East African Coast, Lagos, Colombo, Malaysia, Thailand, Vietnam, Indonesia, Singapore, Northern Australia. It is characterised by seasons with very little variations. During the day air temperature ranges lie between 27°C to 32°C while at night temperatures range between 21°C to 27°C. The relative humidity experienced is consistently high averaging about 75% all year round. Despite the partly scattered cloud cover the solar radiation is very strong. The climate requires the architect to design for heat control and air movement that allows cooling and removal of humid air (fig. 2-8).

ii. Hot dry desert climate: Regions 15° North to 30° North and South of the equator such as Phoenix and Arizona, Sahara, Kalahari, Middle East (UAE, Saudi Arabia, Iran Iraq) Bagdad generally experience hot dry desert climate which is mainly characterized by two main seasons; hot season and a cooler season. Temperatures range between 27°C to 32°C during the day while night time temperatures lie between 17°C to 22°C. Due to the high temperatures caused by the high solar radiation with strong direct sun, humidity is low ranging between 10% and 55%. Wind is hot and local and frequently results in dust and sand storms. Precipitation within this regions is between 50 mm p.a to 150 mm p.a. Architecture in desert climates has the primary role of keeping heat out and promoting cooling and therefore thick walls and few windows are most effective (fig. 2-9).

iii. Hot dry maritime desert climates are found in areas where the sea adjoins a large land mass for example Kuwait, Afghanistan, Karachi. Like hot dry desert climate regions, they also lie between 15° North to 30° North and South of the equator. Temperatures during the day mostly range at 38°C while night time temperatures are as low as 10°C–8°C. The diurnal range lies between 9°C and 12°C. Due to high evaporation of the sea due to high temperatures and solar radiation, humidity is high ranging between 50% and 90%. The unequal heating and cooling of the land during the day and the inverse happening at night, winds are local, coastal land and sea breezes.

2.1 TROPICAL MODERN ARCHITECTURE.

Lefaivre and Tzonis (2001) describe tropical architecture as architecture adapted to tropical climate. Tropical climates offer a challenge to designers in terms of heat control and cooling which are crucial in ensuring comfortable internal environments. Within the tropic of Capricorn and Cancer, six distinct climate groups can be found. They include warm humid equatorial climates, hot dry desert climate, hot dry maritime desert climate, composite or monsoon climate, tropical upland climate and warm humid island climate.

i. Warm humid equatorial climate is experienced in regions between 15° North and 15° South of the Equator such as East African Coast, Lagos, Colombo, Malaysia, Thailand, Vietnam, Indonesia, Singapore, Northern Australia. It is characterised by seasons with very little variations. During the day air temperature ranges lie between 27°C to 32°C while at night temperatures range between 21°C to 27°C. The relative humidity experienced is consistently high averaging about 75% all year round. Despite the partly scattered cloud cover the solar radiation is very strong. The climate requires the architect to design for heat control and air movement that allows cooling and removal of humid air (fig. 2-8).

ii. Hot dry desert climate: Regions 15° North to 30° North and South of the equator such as Phoenix and Arizona, Sahara, Kalahari, Middle East (UAE, Saudi Arabia, Iran Iraq) Bagdad generally experience hot dry desert climate which is mainly characterized by two main seasons; hot season and a cooler season. Temperatures range between 27°C to 32°C during the day while night time temperatures lie between 17°C to 22°C. Due to the high temperatures caused by the high solar radiation with strong direct sun, humidity is low ranging between 10% and 55%. Wind is hot and local and frequently results in dust and sand storms. Precipitation within this regions is between 50 mm p.a to 150 mm p.a. Architecture in desert climates has the primary role of keeping heat out and promoting cooling and therefore thick walls and few windows are most effective (fig. 2-9).

iii. Hot dry maritime desert climates are found in areas where the sea adjoins a large land mass for example Kuwait, Afghanistan, Karachi. Like hot dry desert climate regions, they also lie between 15° North to 30° North and South of the equator. Temperatures during the day mostly range at 38°C while night time temperatures are as low as 10°C–8°C. The diurnal range lies between 9°C and 12°C. Due to high evaporation of the sea due to high temperatures and solar radiation, humidity is high ranging between 50% and 90%. The unequal heating and cooling of the land during the day and the inverse happening at night, winds are local, coastal land and sea breezes.
4. Composite climates, also referred to as monsoonal climates are experienced in areas close to the tropic of Cancer and Capricorn lying at 23.5° North and 23.5° South such as New Delhi, India, Kano, Mandalay, Lahore, Asuncion. Two seasons are experienced where a hot dry season is experienced for two thirds of the year while the rest of the year has a warm humid season. During the hot dry season, temperatures during the day lie between 32°C and 43°C. At night, the temperature range is 21°C to 27°C. During the warm humid season, day temperatures lie between 27°C to 32°C while at night they fall between 24°C and 27°C. In the wet season, humidity 55% to 95%. Composite climate regions generally have strong solar radiation and strong, steady winds all year round. The wettest month has a precipitation level of between 200 mm and 250 mm. The design recommendation for such climates according to Hopper (1996) is protection from intense heat, humidity, and flooding (fig. 2-9).

5. Experienced closest to the equator, tropical upland climate, is generally characterized by minimal seasonal variations. In areas with altitudes of about 1,800 meters above sea level, air temperatures during the day fall between 24°C and 30°C while at night, fall to about 10°C to 13°C and as low as 4°C in some areas resulting in a very high diurnal range. The relative humidity within tropical upland climate regions is 45%-99%. Direct strong solar radiation and variable moderate winds are also experienced.

6. Warm humid island climate: Islands within the equatorial belt and in the trade wind zones such as the Caribbean Islands, Barbados, Indonesia, Burma, Philippines and the Pacific Islands experience warm humid island climate. In these areas seasonal variations are almost negligible. Air temperatures fall between 29°C to 32°C during the day while at night temperatures experienced are between 18°C and 24°C, resulting in a diurnal range of about 8°C. The humidity levels experienced are between 55% and 100%. Occasional cloud cover causes diffuse radiation but mostly strong direct solar radiation is experienced. Predominant winds in islands within the equatorial belt are from the east and North East and are generally steady. However, tropical islands found within the hurricane belt can experience winds with velocity’s of 45 m/s to 70 m/s.

The tropics are therefore generally hot areas which require that designers add measures which regulate heat gain within buildings.

Besides climate, Lefaivre and Tzonis (2001), also describe the other similarities of tropical architecture as being associated with two challenges that arose after the second world war namely, post colonialism and globalization. In this research emphasis is made on the first challenge on post colonialism because it is the dominant unifying factor of the areas of study in different continents within the tropics, without exception.
Tropical architecture emerged shortly after the second world war whereby colonial architecture, as described in chapter one of this study, was enhanced to respond to the high temperatures within the tropics and redesigned to suit local climatic conditions (as illustrated in chapter one of this study).

Bawejja (2008), describes the origin of tropical architecture as being based on tropical medicine. She describes manuals developed by medical practitioners within the colonies as the basis from which architectural principles for designing in the tropics were developed. The focus of the manuals was on physiological well being given the difference of in climatic conditions between the temperate climatic areas the Europeans were used to and the tropics in the areas they colonised and settled in. The content of the manuals covered issues on the relationship between health and climate, building sanitation, appropriate building technology, effective ventilation techniques, lighting and control of tropical disease spread; which affected urban planning and zoning. Towards the 1930’s, research on architectural design in the tropics started to be looked at as an individual entity and not as a subsidiary concept of medical manuals.

The origin of tropical architecture is however not a simple one to trace and its beginning or decline does not have clear cut dates. Like all other precedent styles in history, tropical architecture has a complex history but several theories have been posited by a few protagonists of beginning of tropical architecture. Oduku (2006) suggests that the origin of tropical architecture had its birth in British West Africa i.e. Ghana, Nigeria, Sierra Leone and Gambia. She adds that it was initiated by a few architects working for the British government in the 1940’s such as Maxwell Fry and Jane Drew (fig. 2-11, fig. 2-12). Although there is a degree of truth in her statement, it is important to note that the concept of tropical modern architecture had already started being developed in other parts of the world such as the West Indies from as early as the 18th Century according to Jackson (2013).

The earliest recorded development of modern architecture suitable for hot climates is the work of Le Corbusier in a residential house in Carthage, Tunisia in 1928. According to Yannas et al (1991), Le Corbusier while working in Tunisia encountered a challenge that reoriented the way he approached modern architecture. The project was for client Lucien Baizeau, a building materials merchant who, aware of the hot climate in North Africa, rejected four of Le Corbusier proposals which did not respond to the climate in Carthage. It was with the forth rejection that the client suggested that Le Corbusier use deep porches on three facades of the building to shade the facades. There after, Le Corbusier developed a language based on modernist architecture principles that included sun shading devices within his façade that varied with the climate and context within which he built. It is here that the concept of tropical modern architecture was developed.
Tropical architecture was thereafter characterised by facades covered with sun shading devices, use of local technology and adaptation to the regional architecture. This was then adopted all over the world by architects building in the tropics.

Authorship on tropical modern architecture by renown authors such as Iain Jackson, Vandana Baweja, Hannah La Roux reveal the notable areas where tropical modern architecture was dominant around the world. This study looks at the reasons why it spread, its protagonists and evolution in the tropics.

It is their networks and affiliations that Kohte (2009) attributes to the spread and impact of tropical modern architecture. Architects such as Le Corbusier (Algiers, Tunisia, Brazil, India), Josep Lluis Sert (Peru), Konstantinos Doxiadis (Iran and Pakistan), Ernst May (Tanzania, Kenya and Uganda), Bruno Taut (Japan), Otto Koenigsberger (India) among others are used to describe the spread of tropical modern architecture.

It is from this understanding that the study begins to bring out the links and networks that lead to its development to East Africa.
2.2 THE ORIGIN AND SPREAD OF TROPICAL MODERN ARCHITECTURE

Motivated by different circumstances, several prominent modern architects from Europe found themselves within the tropics. For modernist architects such as Koenigsberger, Ernst May and Bruno Taut, for example, it was the war during the Nazi period that made them leave home and find exile in Africa and Asia. Others like George Candilis, Shadrach Woods (fig. 2-16), Michael Ecochard (fig. 2-17), Maxwell Fry, Jane Drew, among others were working in colonies planning urban areas, carrying out ethnological studies and designing architecture for the colonial administration.

Besides colonization and war, Kohte (2009) correlates the origin and spread of tropical architecture with three other key factors:

i. Modern architecture and architects

ii. CIAM and the MARS Group

iii. Architectural Association Department of Tropical Studies

Similar to Kohte (2009), this study investigates the development of the tropical modern movement by categorizing the pioneers and protagonists into three categories namely:

i. Modernist architects and architecture specifically Le Corbusier: His contribution to the tropical movement is investigated through his architecture in the tropics, development of brise soleil, publications like L’esprit Noveau and the Athens Chater, establishment of CIAM and networks with other architects. This study posits that Le Corbusier is the key link between modernism and tropical modern architecture.

ii. CIAM and MARS Group: both groups among others served as networking platforms for tropical modern architects and bring out the architects known to be responsible for the tropical modern movements spread in the tropics. This study uses the history of CIAM and MARS group to bring out more protagonists of tropical modern architecture, those they worked with and those who influenced them.

iii. Architectural Association Department of Tropical Studies: This study looks at the institutionalization of tropical architecture and uses the AA School as a case study of the impact courses on tropical design had on the tropical modern movement. The AA School was the first school to start a course devoted entirely to the study of tropical architecture and that contributed some of the most renowned architects who furthered the environmental design agenda.
2.2.1 LE CORBUSIER

This study posits Le Corbusier’s contribution to the modern architecture movement as the key contribution that led to the start, development and spread of tropical modern architecture. This is based on his contribution to the beginning and development of tropical modern architecture through the development of the brise-soleil and through the modern architects who he influenced to design climate responsive architecture within the tropics such as CIAM members, readers of L’esprit Noveau and architects such as Amyas Connell.

Born Charles Edouard Jenerret Gris in La Chaux de Fonds on October 6th, 1887, Le Corbusier developed an interest in art and architecture under the tutelage of one of his teacher in Chaux de Fonds called Charles L’Epplattenier. In 1904, L’Epplattenier offered to train Le Corbusier to become an architect rather than becoming an engraver, which is what he had earlier been apprenticing to become. According to Curtis (1996), it was L’Epplattenier (an avid follower of John Ruskin) who stressed the beauty of simple geometric forms to Le Corbusier and taught him to look beyond appearances to the true nature of natural and architectural forms (Boesiger & Stonorov 1974).

Shortly after training under L’Epplattenier, Le Corbusier decided to travel and on arrival in Paris, Eugene Samuel Grasset, a decorative artist and publisher considered to be among the pioneers of Art Noveau, drew Le Corbusier's attention to Architect Auguste Perret.

Auguste Perret’s architecture was strongly influenced by the works of Viollet le Duc and Anatole de Baudot, a French architect credited as the pioneer of reinforced concrete construction (fig. 2.18). Like Anatole, Perret was among the few architects who embraced the use of reinforced concrete, a material not widely accepted before the late 1920’s. He believed that reinforced concrete would revolutionize architecture. Le Corbusier describes Perret as holding a very strong, very definite place in the history of modern architecture which is very evident in Perret’s architecture which bore great semblance to international style architecture.

From as early as 1903, Perret had designed an apartment building; 25 Rue Franklin in reinforced concrete, a garage; 51 Rue de Ponthieu and later, the Church of Notre Dame in 1922 (fig. 2.19) which was one of his most celebrated works. It was while working for Auguste and his brother, Gustave Perret at Perret Frères’, that Le Corbusier started to appreciate concrete and the revolutionary forms it could create which, according to Le Corbusier, was the most profound lesson he learned from Perret Frères.
The same year Le Corbusier met Auguste Perret, he also had the opportunity to interact with Tony Garnier (Boesiger & Stonorov 1974). Garnier, who was one of the most influential architects to modern architects in the 1920’s especially with his work on the modern city— ‘The Industrial City’, envisioned a new architecture that arose from a critical response to the arising social conditions. Besides inspiring Le Corbusier to continue to search for a ‘new architecture’, Garnier may have also been a great influence on Le Corbusier’s urban planning concepts on projects such as Ville Radieuse (Radiant City) (fig. 2-20).

Later, between 1910 and 1911, Le Corbusier worked under Peter Behrens, who had also employed Walter Gropius in 1910 and Ludwig Mies van de Rohe from 1908 to 1911. According to Curtis (1996), it was such interactions with pioneers of modern architecture such as Tony Garnier, Auguste Perret and Peter Behrens that seemed to drive Le Corbusier’s quest for the ideal form.

In 1922, along with his cousin Pierre Jeanneret, Le Corbusier started a firm in Paris and engaged in numerous projects which helped him develop his infamous ‘five points of a new architecture’ which can be illustrated by Villa Savoy built in 1931 (fig. 2-21) among other works:

i. The pilotis,

ii. the free plan (achieved through the load-bearing columns),

iii. the free façade

iv. the continuous windows

v. the roof garden

Le Corbusier had developed a language for modern architecture and his ideal form (Boesiger & Stonorov 1990). The developed principles formed the basis of modern architecture. However, an issue arose when those principles were applied directly to architecture outside Europe and America there by unravelling the notion of the universality of modern architecture. Le Corbusier realised that the glass planes which had now become vital elements to modern architecture, allowed too much heat to penetrate into buildings causing discomfort in hot climates. Therefore, in 1928, Le Corbusier started to investigate ways of cutting off direct sun while continuing to use the large windows which cut the façade along its entire length.
While working on a project in Carthage in Tunis, Tunisia for his client, Lucien Baizeau, a building materials merchant Le Corbusier proposed a modern building. Aware of the hot climate in North Africa, Lucien rejected four of Le Corbusier’s proposals which did not respond to the climate in Carthage. According to Mackenzie (1993) it was with the forth rejection that the client suggested that Le Corbusier use deep porches on three facades of the building to shade the windows (fig. 2-22). To ensure cross ventilation, open plan spaces were used throughout the entire house (fig. 2-23). Since the house was by the sea, breezes could be harnessed from the west facade which was the one facing the sea (fig. 2-24).

To cut off the sun’s heat two layers were created on the facade. The outer facade on the west and south facades was defined by columns between the floor slab and ceiling slab. This layer was porous to allow cool breezes and natural light to reach the inner facade. The inner wall was lined with ribbon windows to allow in light and because of the deep porches created, the sun’s heat did not reach the glass.
Le Corbusier realised that to continue to use glass in the intensity and way it was used in modern architecture, it required to be shaded from the sun. Boesiger and Stonorov (1974) posit that it was with the project in Carthage that he started to develop the one of the biggest contributions to tropical modern architecture—the brise soleil.

After 1928, Le Corbusier started applying different variations of sun shading elements to different projects; experimenting with different arrangements especially in Algiers and Barcelona. According to Boesiger and Stonorov (1974), in 1933 Le Corbusier found a sun shading arrangement that seemed to work in the design of Maison Locative in Alger (fig. 2-25 & fig. 2-26). The sun shades were placed on the South and west facades (fig. 2-27).

Using the combined studies in Barcelona and Algiers, Le Corbusier improved on the sun shading features and in 1935 he was consulted in Brazil to advice on the design of the Ministry of Education and Public Health building in Rio de Janeiro.
According to Zheleznova (2015), the building was designed in 1935 by a team comprised of Lucio Costa, Alfonso Eduardo Reidy, Ernani Jorge Machando Moreira and Roberto Burle Marx. The Ministry of Education and Public Health building was oriented facing North (fig. 2-28). It used adjustable horizontal sun shades and vertical sunshades located on the building’s west facing façade (fig. 2-29). Shortly after, two other skyscrapers were built using vertical sun shades on their west facade such as one by the Roberto Brothers and the other by Reidy Moreira Architects.

Le Corbusier’s influence was growing fast. The brise soleil was the contribution that revolutionised tropical architecture. A renown letter to Le Corbusier from British architect, Clive Entwistle written in 1946, documented by Mackenzie (1993), illustrates Le Corbusier’s contribution to the tropical modern movement. It says:

‘I take this opportunity on behalf of young people here to thank you for your latest gift to architecture: the brise-soleil, a splendid element, the key to infinite combinations. Now architecture is ready to take its place in life. You have given it a skeleton (independent structure), its vital organs (the communal services of a building), a fresh shining skin (the piloti). And now you have given it magnificent clothes adaptable to all climates! You must be a little proud!’

Architect Entwistle’s view on the value of the brise soleil was clearly shared by other modernist architects and the brise soleil concept was adopted by several modernist architects and disseminated through various channels like modern architecture forums such as CIAM and MARS Group.

Fig.2.28 : Sun shading devices on the Ministry of Public Health Building in Rio
Source: www.fondationlecorbusier
2.2.2 CIAM AND MARS GROUP

By 1920, Le Corbusier had already started to open minds in the society to modernist architecture and influence other architects with his contemporary review magazine L'esprit nouveau which he wrote with Derme Ozenfant. In 1928, in an effort to increase networks among modern architects and influence the architectural direction, Le Corbusier together with 28 other architects founded Congrès International d'Architecture Moderne (CIAM) also known as The International Congresses of Modern Architecture.

Gunay (1988) postulates that several important events occurring between 1922 and 1927 led to the formation of CIAM, namely: the Düsseldorf Congress of Progressive Architects in 1922, the International Competition for the Chicago Tribune, The International Competition for the League of Nations in 1927 and The Stuttgart Exhibition organized by the German Werkbund also in 1927. In the Stuttgart Exhibition, for example, Modernist architects namely Mies Van de Rohe, Walter Gropius, Peter Behrens, Hans Poelzig, Bruno Taut, Jacobus Oud and Le Corbusier, presented modernist approaches to their town planning concepts which were rejected by traditionalists Gunay (1988) adds that Le Corbusier considered the International Competition for the League of Nations one of the most vital steps in the formation of CIAM. For Le Corbusier, the CIAM was to be an upheaval against conservative academies.

In 1928 representatives of the Modern Movement from all over the world, met in La Sarraz in Switzerland to form CIAM. A few notable members include: Le Corbusier (Swiss), Sigfried Gideon (Bohemian), Karl Moser (Swiss), Pierre Jeanneret (Swiss), Ernst May (German), Gerrit Rietveld (Dutch). Other prominent architects who joined CIAM later were Walter Gropius, Alvar Aalto, Minette de Silva and Josep Lluis Sert.
There were eleven (11) CIAM meetings between 1928 and 1956; when CIAM was dissolved. Through their meetings, exhibitions and publications, modern architecture spread widely. An example would be in the planning of Brasilia, the capital of Brazil, by Lucio Costa in 1960 (fig. 2-30). The scheme was designed based on the urban planning principles of CIAM (Wilson 2007). CIAM acted as a networking platform for tropical modern architects because it is through this interactions that the idea of tropical architecture was spread.

In Britain, CIAM had a subsidiary known as the Modern Architecture ReSearch Group (MARS Group). The MARS Group was founded in 1933 with a view to have British Modernist architects having spokespersons in CIAM meetings who could represent them. The MARS group was founded by Maxwell Fry and Francis Reginald Stevens Yorke. Other notable members include

i. Jane Drew (an AA School trained Architect, tropical modernist architect and author on tropical architecture—discussed in detail in Chapter two, part 2.3.3 of this study)
ii. members from Tecton Group (where tropical modernist architect Anthony Chitty worked between 1932 and 1936—Chitty is discussed in detail in Chapter four, part 4.2.2)
iii. Architect Amyas Connell (tropical modernist architect in UK and East Africa—Connell is discussed in detail in Chapter four, part 4.3.2)
iv. Ove Arup

MARS group was dissolved in 1956.

CIAM’s reach as an avenue that pushed the modernist agenda resulted in formation of its British subsidiary called the MARS group and another subsidiary in Morocco called Groupe d’Architectes Modernes Marocains (GAMMA group). The GAMMA group consisted of several notable architects such as Michel Écochard, Georges Candilis and Shadrach Woods. Although CIAM, MARS Group and GAMMA Group’s agendas were primarily urban, their role as a networking platform contributes significantly to the tropical modern movement as evidenced by the presence of some of the most renowned contributors of the tropical modern movement within the groups.
One of the greatest contributions towards tropical modern architecture is its institutionalization in schools such as the AA School and several others there after such as the Kwame Nkrumah University Technical School in Ghana. Other tropical modernist architects also develop sensitivity to climate issues while studying in the University of Liverpool such as Maxwell Fry (fig. 2-31) and Robert Gardner Medwin and Sir J. J School in India namely Achyut Kanvinde, Balkrishna Doshi (fig. 2-32) and Minnette de Silva.

However, it is the Department of Tropical Studies at the AA School that was the most influential in developing programs on tropical architecture because of its curriculum that was fully dedicated to design in the tropics.

The AA School was founded in 1847 in London and is one of the oldest architectural schools in UK. It offered courses on environmental design but none of their programs had lessons on how to design in the tropics. With a growing number of students from the commonwealth and colonies, there emerged a need to go beyond teaching environmental design but to start teaching the students how to design specifically for the tropics (Wakely 1958).

Adedokun Adeyemi, a fourth year student at the Manchester school of Architecture from Nigeria approached Otto Koenigsberger, then a research fellow at the London School of Hygiene and Tropical Medicine (fig. 2-32), with a request to help him mount a short course on designing and building in the tropics (Wakely 1958). As grounding for the course, a conference on tropical architecture was organised and held in March 1953 at the University college London.

The main objective of the conference was to drum up support for the training course and also gain input from professionals who had worked in the tropics on the main areas that would need to covered by the course. Several academics, reputed professionals in Tropical Architecture and government advisers formed the organising committee for the conference and fifteen papers were presented at the conference.
The debate at the 1953 London Conference covered issues on building technology and climatic design. For instance British architects, George Anthony Atkinson, Sir William Holford and Arthur M. Foyle presented papers debating the use and extent of use of local materials from the tropics vis a vie imported materials and their impact on climate, geography, socio-cultural patterns, availability of materials and economy. Koenigsberger and Artkinson’s papers touched on climate issues and the need to develop climate responsive architecture for the tropics. The fifteen papers presented during the entire conference laid the basis for the development of the curriculum for the proposed school of tropical architecture.

At the end of the conference five main responsibilities were placed upon the organising committee:

i. To foster the establishment of improved educational facilities for students and architects interested in working in the tropics and to establish of permanent centres for both postgraduate and undergraduate studies in Tropical Architecture.

ii. To encourage the use of local materials and building technology in designing and building contemporary architecture within the tropics.

iii. To publishing information on Tropical Architecture and Planning

iv. To establish regional research and information centres with information specific to that region

v. To organise more conferences and forums that could push the agenda of educating architects on tropical architecture

The objectives set out by the committee were met. To improve education facilities for students and architects, the School of Tropical Studies at the AA School was founded. In 1963, the AA department of Tropical Studies launched a new course on Educational Building that led to the establishment of Regional School Building Centres in Colombo, Khartoum and Mexico.

That same year, the AA Department of Tropical studies (AA DTS) collaborated with the Kwame Nkrumah University of Science and Technology (KNUST) in Ghana to develop its Faculty of Architecture, Planning and Building Technology (fig. 2-34).
In 1966 the AA DTS launched the Tropical Advisory Service (TAS) whose role was to advise architects and the government on climate responsive building design for the tropics. TAS promoted the use of appropriate technology for the tropics and also served as a knowledge resource for architects which was a major goal set by the 1953 London Conference. TAS, which in 1970 evolved to Training and Advisory Service led to Otto Koenigsberger’s book; Manual of Tropical Housing and Building. Several significant publications were also made by architects in the AA School working in the Tropics such as Tropical Architecture in the Dry and Humid Zones written by Maxwell Fry; published in 1964.

After the conference, Koenigsberger commenced negotiations with three schools in London about the course and in 1954, the Department of Tropical Studies was established at the AA School by Maxwell Fry, Jane Drew and James Cubitt. Oduku (2005) posits that it was the preferred institution for tropical studies for three reasons:

i. Its location in London—The AA School is located in central London at Bedford Square. This meant that the interaction between students and reputable modern and tropical architects could be easily facilitated. Several MARS Group and CIAM architects and tropical architecture modern architects worked within London and an interactive learning program between students and architects was possible. The Department of Tropical Architecture infused research and consultancy with the undergraduate and postgraduate teaching.

ii. The AA School had several international networks —With several reputed alumnae and tutors such as Jane Drew, James Cubitt, Leo De Syllas and Fello Atkinson, the AA School already had a human resource it could tap into. Jane Drew and James Cubitt were former students of the AA and already had a lot of experience working in the tropics. Maxwell Fry’s work in the tropics already had him speaking regularly at the AA.

Fry and Drew were also very conversant in merging local building technology into the contemporary buildings they designed, which was one of the areas of training emphasised on at the conference on Tropical Architecture. In addition Fry and Drew had worked extensively in colonial West Africa in Ghana and Nigeria and in India with Pierre Jeanerette and Le Corbusier in 1951. The couple had also published books on design in the tropics such as ‘Village Housing in the Tropics’ in 1947 and ‘How to Plan your Village’ in 1953 (fig. 2-33).
iii. The AA School had a close working relationship with the School of Tropical Medicine and Hygiene — Osten (2014) points out that the relationship between tropical medicine and architecture was inextricable since the concept of hygiene and sanitation in planning of settlement of colonies was primarily mitigated through architectural approaches. As elucidated in chapter one of this study, the School of Tropical Medicine created the background for training in Tropical Architecture. Otto Koenigsberger being from the School of Tropical Medicine and Hygiene and the developer of the course on Tropical Architecture further enhanced this bond where tropical medicine facilitated the evolution of tropical design.

In 1954, The Department of Tropical Architecture was established by the AA School under the directorship of architect Maxwell Fry. The department offered a six month course which culminated in the award of an AA Certificate in Tropical Architecture (Wakley and Levy, 2014). Koenigsberger designed the graduate level course in Tropical Architecture for the Department of Tropical Studies at the AA School. According to Wakely (1983) Its main emphasis was on the role of architects in the tropics and how to design and build appropriately in different climates using locally available materials. Having already had a lot of experience working in the tropics i.e. Cairo in 1930 and India from 1939 to the 1950’s, the developed curriculum based lessons on colonial planning and housing studies on architecture. Regional studies done in the West Indies, India and West Africa also influenced the curriculum content.

The Department of Tropical Studies’ curriculum comprised of five courses namely:

i. Climatology— The course required the students to acquire and interpret climatic data. The analysed data would then be used to inform design of architectural elements. Baweja (2008), describes a studio brief given in the first week of the term in 1962 which required the students to design sun shading devices that cut off the sun’s heat but allowed for day light and views. The brief gave the students information a building with a known latitude, a fixed orientation and defined window size. By plotting the sun’s path and using a rule of thumb, the students met the brief requirements by designing a shading device or louver system. However, a student from Kenya called O. J. Pereira gave a design solution of the sun shading devices that was different from the rule of thumb. Pereira used the buildings sections, plans and elevations to calculate the exact size of the sun shading device for the building.
Fig. 2.39: Maxwell Fry (1889 –1987) became the first director of the AA DTS
Source: www.open.edu

Fig. 2.40: Otto Koenigsberger (1908–1999) became the second director of the AA DTS
Source: http://www.telegraphindia.com

ii. Building Materials  
iii. Climate Responsive Design  
iv. Building Services  
v. Sanitation and Hygiene

According to Wakley and Levy (2014), in 1956, Maxwell Fry and Jane Drew became increasingly busy with their practice and student numbers began to dwindle therefore in 1957, Otto Koenigsberger was appointed director of the department. His appointment as director also a rise in student intake especially from newly independent countries of the Commonwealth.

The Tropical School changed its name to AA Department of tropical Studies (AA DTS) to reflect the departments increasing capacity to undertake serious theoretical and empirical research in building physics, social housing and planning policy. In 1965, the AA DTS extended the six month course to a nine month programme that allowed the students to do a dissertation leading to the award of an AA Diploma of Graduate studies. In time, the department became increasingly involved in urban studies and social political issues of development rather than building design and in 1968, the Department of tropical Studies changed its name to Department of Development and Tropical Studies (DDTS) to better reflect the variety of courses offered and the change in (Wakley and Levy, 2014).

In 1971 the DDTS was moved to the University College London, to the Faculty of Environmental Studies and became entirely absorbed into the academic structure of University College London. Otto Koenigsberger was appointed Professor of Development Planning.

The impact of the Department of Tropical Studies at the AA School between its foundation in 1954 and 1971 is key to this research. This is because both the students and teachers at the AA School during that period are some of the most renowned names in Tropical Architecture and contributed greatly to the development of environmental design in the tropics.
Notable Alumnae of the AA School who contributed to Tropical Modern Architecture Include:

i. Dorothy Hughes - 1926 to 1931 Practised in East Africa
ii. Jane Drew - 1929 to 1934 Practised in India and West Africa
iii. James Cubitt - 1940 Practised in West Africa
iv. Fello Atkinson - 1936 to 1947 Practised in West Africa
v. Minette De Silva - 1948 Practised in Sri Lanka
vi. Alan Vaughan Richards - joined in 1954 (Tropical School) Practiced in West Africa
vii. John Godwin - 1950 Practised in West Africa
viii. Gillian Hopwood - 1950 Practised in West Africa
ix. Raj Rewal - 1955 Practised in India
x. Geoffrey Bawa - 1957 Practised in India
xii. Mike Pearce - 1962 Practiced in Zimbabwe
xiii. Richard Huges - 1947 to 1953 Practiced in East Africa
xiv. Leo De Syllas
xv. Thomas Peatfield
xvi. Geoffrey Bodgener

Fig. 2.41: Fello Atkinson working at James Cubitt and Partners where he was a partner
Source: http://www.jamescubittandpartners.com

Fig. 2.42: Architects of the Architects Co. Partnership founded by 11 AA Alumnae—Standing from left to right: Anthony Cox, Peter Cocke, Michael Grice and Kenneth Capon; sitting, from left to right: Leo De Syllas, Michael Powers and Michael Cooke-Yarborough
Source: https://www.architecture.com
Other notable architects associated with the AA School and contributed to the Tropical Modern Movement include:

i. Dennis Sharp: Author on modern architecture and Architects. Sharp is an alumnae of the AA School.

ii. Manuel Herz: Author on modern architecture and Architects. Herz is an alumnae of the AA School.

iii. David Oakley: Studied at the AA School from 1948 to 1953. Oakley was an academician and consultant on Housing and Planning issues in developing countries. Oakley taught at the AA School in London, the New Delhi School of planning and Architecture, University of Nairobi (1967 and 1968) and University of Westminster. He was the founder of the Housing Research and Development Unit (HRDU) at the University of Nairobi’s Department of Architecture which focused on building technology. HRDU has since been renamed Housing and Building Research Institute (HABRI).

iv. Otto Koenigsberger: German émigré, author on tropical architecture and architect and Second director of the Department of Tropical Studies at the AA School. He practiced in India (Koenigsberger is discussed in detail in chapter two part 2.4.1)

v. Maxwell Fry: Architect and author on Tropical architecture who practiced extensively in West Africa and Chandigarh. He became the first director of Department of Tropical Studies at the AA School. He practiced in Chandigarh and West Africa (Maxwell Fry is discussed in detail in chapter two part 2.4.3)

vi. Anthony Chitty: Modernist architect and president of the AA School in 1951 to 1952 (Chitty is discussed in detail in chapter four part 4.2.2)

vii. O. J. Pereira: Studied Architecture at the AA School in 1962 and is credited with coming up with the calculation for dimensioning sun shading devices.
2.4 THE DEVELOPMENT OF TROPICAL MODERN ARCHITECTURE IN THE TROPICS

To understand the development of tropical modern architecture, this study looks at modern architecture on three continents in six regions located within the tropics i.e. Southern Asia; case of India and Sri Lanka, Southern America; case of Brazil and West Indies and West Africa; case of Nigeria and Ghana.

The study of tropical architecture in West Indies is used to illustrate link between colonial architecture and tropical architecture. In Western Africa, Ghana and Nigeria are used to reveal the influence of the protagonists and pioneers of tropical modern architecture. The study of tropical architecture in Brazil is used to reveal the impact and development of tropical modern architecture within the tropics. In Asia, the study of tropical architecture in India and Sri Lanka is used to demonstrate the evolution of modern architecture (fig. 2.45) to climate responsive regional modern architecture (fig. 2.46).
2.4.1 TROPICAL MODERN ARCHITECTURE IN WEST AFRICA: A STUDY OF NIGERIA AND GHANA; NETWORKS AND PIONEERS

Through the study of the tropical modern movement in West Africa, the networks between the colonies, CIAM architects, the MARS Group, the AA School and other notable Universities, are revealed. Ghana and Nigeria are used to explain the pronounced networks of the tropical modern movement throughout the tropics. The networks extend to the rest of Africa and parts of Asia. The contribution of British West Africa to the tropical modern movement is critical and impacted architecture in the rest of the tropics greatly.

Uduku (2005) posits that the beginning of tropical architecture in West Africa begins in the 1940's with the architects who were commissioned by the colonial government to develop better facilities; such as education centres for the natives, with the hope that that would quell rebellion. She also notes that it was during this period that three key events that, lead to the grounding of tropical architecture in West Africa, occurred. They include:

i. The height of the modernist movement through CIAM and MARS Group

ii. Architects/ students billeted to tropical regions as part of the Royal British Service for their national service

iii. The collaboration of influential institutions like the AA School and the School of Tropical Medicine and Hygiene

In 1947, CIAM IV was held in Bridgewater, England. Its main agenda that year was in the reconstruction of cities (Lathouri 1999). Its significance is however in the contribution of Joseph Luis Sert when he suggests that CIAM open up its meetings to areas beyond Europe since the extent of modern architecture had expanded exponentially (fig. 2.48). The meeting at Bridgewater was attended by Jane Drew, Maxwell Fry and Leo De Syllas who are all notable architects who influenced tropical modern architecture in West Africa and around the world.
Students billeted to the Royal British Service in the tropics in the 1930’s and 1940’s had modernist influences contributed to tropical modern architecture through their research and architectural work. In West Africa, one such architect is Maxwell Fry, whose name is synonymous with tropical modern architecture in West Africa. In 1945, Fry did his national service in Ghana and in 1946, he returned to work in Ghana with his wife Jane Drew. Both of them were members of MARS Group and changed the direction of tropical modern architecture through their publications on tropical architecture such as Village Housing in the Tropics in 1947, Chandigarh and Planning Development in India in 1955, Tropical Architecture in the Humid Zone in 1956 and Tropical Architecture in the Dry and Humid Zones in 1964.

The AA School Jane Drew’s alma mater played a key role to tropical modernism in West Africa in the 1950’s. As illustrated in chapter one of this study, tropical medicine and tropical architecture were inseparable aspects and were developed together. The link between the researchers in the tropics and institutions further facilitated the development of modern architects. As a result of the interaction between architects working in Africa and the AA School, several alumnae and architects interacted with students at the AA School and influenced a few to work in the tropics. Oduku (2005) gives the example of Maxwell Fry’s speaking engagements at the AA School which influences Leo De Syllas and James Cubitt to set up practices in West Africa.

Another significant contribution of the AA School to West African architecture is in the establishment of an offshoot of the AA School’s Tropical School at University of Kumasi in Ghana in 1963. The AA School’s teachers and alumnae worked as staff at the University of Kumasi. Notable staff include Patrick Wakely, Jerry Ingersol and Martin Evans.

The West African tropical movement has several key architects who contributed to its architecture and therefore this study uses their backgrounds and architecture to illustrate the networks of tropical modern architects. They include Maxwell Fry, Jane Drew (fig. 2-50), Leo De Syllas, James Cubitt, John Godwin and Gillian Hopwood, Kenneth Scott, Olumuyiwa Oluwole, Alan Vaughan Richards, John Owusu Addo (fig. 2-51) and A. Ifeanyi Ekwueme.
Architecture in West Africa between the 1940’s and 1960’s is a description of tropical modern architecture and several works show tropical modernisms evolution to regionalist modernism. This can be seen in the design of the University of Ibadan designed in 1951 by Architect Jane Drew and Maxwell Fry. The patterns which create ornamentation on the façade of buildings like the Tedder Hall Hostel (fig. 2-52) and Kenneth Dike Library (fig. 2-53) vary from the typical modern movement principles which are characterised by simplicity and lack of ornamentation on facades. In Nigeria, vernacular architecture is characterised by ornamentation on facades.

The couple deal with climate by using the lattice screens on facades and deep balconies to sun shade the buildings. Narrow plan layouts and courtyard arrangements are used to ensure natural ventilation and lighting.
Other architecture by Jane Drew and Maxwell Fry in West Africa includes Wesley Girls High School in Ghana, Cooperative Bank Offices and Shop in Lagos, British Petroleum Headquarters in Lagos, Opoku Ware Boys Secondary School in Kumasi, Abisadel College in Cape Coast, Ghana, Premeh College in Ghana, Mfantsipim School (1958) in Ghana (fig. 2-56) and National Museum in Accra. Iain (2014) characterises their architecture in West Africa as being defined by perforated concrete screens, rain water harvesting, window hoods and projecting eaves; elements aimed at controlling the temperature and air movement of the building, as well as conserving the limited resources available to them.

Besides climate responsive architecture, Fry and Drew had other considerable contributions to the tropical movement as a result of their interactions with other architects. Fry for instance had worked with Walter Gropius and this interaction had a strong influence in grounding Fry’s modernist principles. According to Jackson & Holland (2014), Fry considered his modernist principles a result of architects such as Bruno Taut, Gropius and Mies Van der Rohe.

However, the architecture in West Africa was not always influenced by social cultural factors. This can be seen in the architecture of Godwin and Hopwood. John Godwin and Gillian Hopwood were both AA School graduates and completed their studies in 1950. The couple emigrated to Lagos in 1954 and designed several climate responsive buildings (Godwin and Hopwood 2012). They include Allen and Hanbury House in Lagos, WAEC Building in Yaba, Lagos, Nestle Nigeria PLC Water Plant in Lagos, Faculty of Sciences building at the University of Lagos (fig. 2-57), Glaxosmith Headquarters building in Lagos, Boyle Street Residential building in Lagos, Bishop Court Building in Ikeja, Lagos, Chris Church Cathedral School in Lagos, Northern Police College in Nigeria and Niger House & CSS Bookshop among others. They still practice in Nigeria and run the firm Godwin Hopwood Kuye.

Another notable tropical modern architect in West Africa is Kenneth MacKenzie Scott. Kenneth Scott, the founder of Ghana Institute of Architects, is described as the architect who contributed the most to architecture in Accra in a tribute by Amoah in the Journal of the Ghana Institute of Architects. The Australian born architect moved to the United Kingdom in 1929 and in 1939, when the World War II broke out he enlisted in the British Army which seconded him to the Gold Coast Regiment of the Royal West Africa Frontier Force.
After the war, Kenneth returned to England and completed his architectural studies and returned to Ghana in 1949. He initially practiced architecture as a partner at James Cubitt Scott and Associates but left to practice on his own. His architectural contribution extended to Sierra Leone and Fiji but his most notable works in West Africa include: U.S.T. Schools of Pharmacy, Engineering and Classroom block, Faculty of Arts of the University of Cape Coast, Institute of Statistical, Social Economic Research at the University of Ghana, Department of Nursing at the University of Ghana, Lincoln Community School at Dzorwulu in Accra, Ashanti Gold Fields Hospital at Obuasi, the Surgical, Maternity, Paediatric, Tuberculosis and Isolation Units of the Korle-Bu Teaching Hospital, Kumasi Sports Stadium in Ghana, Tamale Air Force Barracks, British Council building in Accra (fig. 2-58), Unions Carbide factory at Tema, Kenneth Scott house in Accra (fig. 2-59) and the Ministry of Foreign affairs building.

James Cubitt, who Kenneth Scott had partnered with, also practiced tropical modern architecture extensively in West Africa, Malaysia, Sierra Leone, Libya and Burma. His most recognized work is in the design of Kwame Nkrumah University of Science and Technology (K.N.U. S. T) in Kumasi (fig. 2-60).

Besides European architects, Nigeria also had a number of local architects who had been trained in the West and had a significant contribution to tropical modernism. The notable ones are Olumuyiwa Oluwole and Alex Ifeanyi Ekwueme. Oluwole was born in Nigeria in 1929 and studied architecture at the University of Manchester from 1949 to 1954 (Aradeon 1998). He practiced at the Architects Co. Partnership (ACP) briefly before opening his own practice. Ekwueme, on the other hand, studied architecture at the University of Washington. After his studies he returned to Nigeria and was the first Nigerian to open his own architectural practice in Nigeria. Although Ekwueme later ventured into politics, he is the Chairman of the board of trustees of the Nigerian Institute of architects.


Leo De Syllas and Alan Vaughan Richards are among the architects whose contribution to tropical architecture is quite significant. Like Olumuyiwa Oluwole, De Syllas and Vaughan worked at the Architects Co. Partnership (ACP) The Architects Co. Partnership was founded in London in 1939 by eleven (11) AA School Alumnae, among them Leo De Syllas (Uduku and Le Roux 2013). The founders who were greatly influenced by Tecton Group and Berthold Lubetkin, practiced climate responsive design with highly modernist forms. Leo De Syllas set up ACP in the 1950’s and the firms work is covered intensively in publications such as Jane Drew and Maxwell Fry’s ‘Tropical Architecture in the Dry and Humid Tropics’ published in 1964. A few notable projects of the ACP include: Ansar-Ud-Deen School in Lagos, private house in Kano and the Department of Marketing Exports in Ibadan (fig. 2-62).
2.4.2 TROPICAL MODERN ARCHITECTURE IN SOUTHERN ASIA:

A STUDY OF INDIA AND SRI LANKA; REGIONALIST MODERNISM

India and Sri Lanka are culture rich countries which were both under colonial rule. Therefore like other countries discussed in this study such as Nigeria, Ghana and the West Indies, the influences on modern architecture had a strong colonial link in that European influences such as European architects and academic institutions, prompted the modern movements development in India and Sri Lanka as well. Examples of tropical modern architecture in Southern Asia includes the works of Le Corbusier (fig. 2.64 & fig. 2.65), Jane Drew and Maxwell Fry, Louis Khan (fig. 2.63) and Otto Koenigsberger to name a few.

Ashraf (1998) credits Jawaharlal Nehru, the first prime minister of India after its independence, with formerly ushering in modernism in India by urging his country men to embrace modernism. In 1950 Nehru demonstrated his commitment to his vision on modernism by inviting tropical modern architects Jane Drew and Maxwell Fry to design the new capital of Punjab, Chandigarh. They invited Le Corbusier to work on the project.
Le Corbusier’s approach in India is an experimentation of form especially in the issue of thermal control and playful variation of the brise soleil. The variation in design of the solar control devices indicates a sensitivity to climate but hardly does Le Corbusier’s architecture respond to the culture. The same is also seen in Louis Khan’s architecture which is very minimalist unlike Indian architecture which has a lot of ornamentation as seen in the design of the Salk Institute. According to Ashraf (1998) it was Le Corbusier’s work in India and Louis Khan’s work in Bangladesh that were most impressionable and led to modern architecture taking root in South Asia. Other notable modern architects in Southern Asia include Joseph Allen Stein, Habib Rehman, Jeet Malhotra and Laurie Baker (Ashraf 1998).

However, in the context of regionalism, some of the most notable modern architects working in Southern Asia include Balkrishna Vithaldas Doshi, Achyut Kanvinde, Minette de Silva, Raj Rewal, Geoffrey Bawa and Charles Correa.

The unifying factor of all the above named architects is that they are local architects who redefined modernism by regionalizing it. However they each had different but intertwined influences such as similar academic backgrounds and similar influences in climate responsive design such interactions with Le Corbusier, Jane Drew, Maxwell Fry. Most of them are also cited in this study with regard to participation in CIAM, their affiliation with the AA School, interactions with each other or regionalization of modern architecture e.g. Balkrishna Doshi.

Balkrishna Doshi was born in Poona in 1927 and studied in Bombay at the Sir J.J. School of Art before moving to Paris. There he worked for Le Corbusier from 1951 to 1954 and then again in India where he supervised Le Corbusier’s projects in Ahmedabad and Chandigarh (Sharp 1991). In 1956 Doshi established his own practice in Vastu-Shilpa practicing regionalist modernism.

Through his practice Doshi worked on several notable projects associated with regionalism namely: Aranya Community Housing in Indore, India (fig. 2-66), Sangath (1980) in Ahmedabad (fig. 2-67), Centre for Environment and Planning Technology (1972) in Ahmedabad, Indian Institute of Management (1974) in Bangalore. Doshi also founded the School of Architecture and Planning in Ahmedabad and in 1962 he founded the Vastu-Shilpa Foundation for Environmental Design.
Minnette de Silva who practiced in Sri Lanka is an ideal example of role of the networks formed in the development of the tropical modern movement. Having worked for Otto Koenigsberger, studied at the AA School, become a member of CIAM (fig. 2.68), Minnette played an influential role in the development of the modernism in Sri Lanka. Lefaivre (2003) posits that Minnette de Silva's architecture is the earliest example of critical regional architecture and credits her with coinining the term ‘modern regional architecture’.

Minnette de Silva was born in 1918 in Sri Lanka. Like Balkrishna Doshi, Minnette studied architecture at the Sir J. J. School in Bombay and shortly after worked for Otto Koenigsberger in his office in Bangalore (Lefavrire 2003). Otto Koenigsberger was already an environmentally conscious architect and may have influenced Minnette de Silva’s thoughts on climate responsive design. Thereafter she left Bombay for the AA School and returned to Sri Lanka in 1949 and interacted with Otto Koenigsberger, Jane Drew and Maxwell Fry and other members of CIAM which she became a member of in 1947.

Since her influences in architecture were primarily tropical modern architects, De Silva was sensitive to climatic issues but felt that the architecture needed to go beyond modernism by breaking from the past and go beyond tropical design. Influenced by her family, who bore strong anti colonial views and the need to protect their culture, Minnette started to develop her tropical modern architecture to reflect Sinhalese culture. For example, she maintained the use of verandahs and a space that linked the outdoor area with the indoor spaces which were typical of Asian vernacular architecture.

One of her first houses was the Karunaratne House in Kandy in 1950 (fig. 2.69), which she used to experiment her ideas on regionalism by designing using modern materials, incorporating local handicrafts and timber lattices. Subsequent projects show an integration of modern and regional planning principles, forms and ornamentation. A few notable projects include: The Daswani Houses (1952) in Kandy, Pieris House I and II (1952) in Colombo, C.H. Fernando House (1954) in Wellawatte, Asoka Amarasinghe House I (1954) in Colombo, Aluwihare Sports Pavilion Police Park (1955) in Kandy, Watapulu Housing Scheme (1958) in Kandy, Senanayake Flats (1957) in Colombo, Nadesan Villa (1961) in Kandy and the Kandy Arts Centre.
Like Minnette de Silva, Geoffry Bawa was a regional modern architect who practiced in Sri Lanka and studied architecture at the AA School graduating in 1954. Unlike Minnette, Bawa initially studied law but started learning architecture in 1951 as an apprentice of H. H. Reid of Edwards, Reid and Begg, a firm in Colombo. After his studies at the AA School, Bawa returned to Sri Lanka in 1957 and according to Lefavaire (2003), started to model his modern architectural ‘tastes’ to regionalism; inspired by the work of Minnette de Silva. A few notable projects by Geoffrey Bawa include: Kanangara House (1959) in Colombo, The A.S.H. de Silva House (1959) in Galle, State Mortgage Bank (1978) in Colombo, Panama Hotel (1977) in Panama, University of Ruhuna (1988) in Matara, Serendib Hotel (1970) in Bentota (fig. 2-70).

Ashraf (1998) states that modernism in Southern Asia was principally dictated by climate. He describes the regionalist modernism in southern Asia as being expressed with consciousness and caution not to mimic vernacular architecture but rather to express modernism based entirely on the needs the project demands. The architecture therefore ends up resembling modern forms but bearing the expression of its local context. Ashraf demonstrates this notion through the description of the work of Achyut Kanvinde who he describes as having ‘consciously distanced himself from symbolism of any kind’ especially those of religious significance. This study notes that the same conclusion can be drawn from the work of Raj Rewal.

Kanvinde’s influences are similar to those of Minnette de Silva and Balkrishna Doshi in that he too studied architecture at J. J. School of Arts in Mumbai. Later he went to Harvard where he worked with Walter Gropius who undoubtedly influenced Kanvinde’s thoughts on modernism. A few of his notable projects include: Physical Research Laboratory in Ahmedabad, Ahmedabad Textiles Industries Research Association, Council of Scientific and Industrial Research, Harivallabdas House in Ahemdabad, Gandhi Krishi Vigyan Kendra in Bangalore (1965), IIT Kanpur Campus (1966), Doodhsagar Dairy, Mehsana aka National Dairy Development Board (1973), Institute of Rural Management in Anand (1979) and Nehru Science Center in Mumbai (1985).
2.4.3 TROPICAL MODERN ARCHITECTURE IN SOUTH AMERICA: A STUDY OF BRAZIL; ‘DEVELOPMENT IN ISOLATION’

Williams (2009) describes Brazil as the international exemplar of modern development between 1930 and 1960. He goes as far as to describe it as the most modern country in the world by virtue of the extent to which it embraced modern architecture. Key to this study is the integration of *brise soleil* into modern architecture in Brazil, a phenomenon that piqued international interest specifically because of the design of two buildings namely the Ministry of Education and Health building in Rio de Janeiro (Ministerio de Educacao e Saude, or MES) and Associacao Brasileira da Imprensa (ABI) (Williams 2009).

The MES was designed in 1936 by Lucio Costa, Carlos Leao, Jorge Moreira, Oscar Niemeyer, Affonso Reidy and Ernani Vasconcelos. The Associacao Brasileira da Imprensa was designed by Marcelo and Milton Roberto and completed in 1936.
Upon its completion the MES was published in several documents such as Brazil Builds in 1943 by Phillip Goodwin, the New York Times on 13th January 1943 and L'Architecture d’aujourd’hui in 1947, to name a few. Most publications emphasized the ingenuity of the sun shading devices and publicized the building as the ‘most advanced architectural structure in the world’ according to the New York Times and a building that was functional and able to meet the modern needs of the modern office.

However, this was not the view held across the board. As mentioned in chapter 2.0.1 of this study, Curtis (1996) described modern architecture in the developing countries between the 1940’s and 1950’s as a ‘degraded version of modern design’. To describe modern architecture in Sao Paulo, Max Bill, a Bauhaus trained architect, described the buildings as jungle growth that did not meet the client needs and buildings functions (Williams 2009). He added that the forms of the buildings also failed to construe the principles of modern design appropriately resulting in variations in design of elements such as the pilotis which he described as varied in size and shape without any structural justification and arranged haphazardly. Max Bill’s observation, though harsh, may bear some truth and may even have been the process modern architecture had to undergo in Brazil to evolve into regional modernism or critical modernism suited to Brazil’s context.

This study uses the aforementioned buildings and architects to illustrate the development of tropical modern architecture in Brazil, its development, spread and decline. Based on Williams (2009), there were several key factors that relate to the development and spread of tropical movement, namely:

i. Existing precedence of Tropical Architecture in Brazil

As illustrated in the introduction in chapter one of this study, architecture in Brazil had elements that responded to the climate in Brazil such as sun shades for control of heat gain and emphasis on cross ventilation to ensure cooling. The same elements and other cultural elements such as the azulejos—blue Portuguese style tiles (fig. 2.76) - were later applied to modern architecture localizing the style which may have increased its adoption and spread specifically in Rio de Janeiro, Sao Paulo and Brasilia.
ii. The political, economic, cultural and historical context of Brazil in the 1930’s
As early as 1922, modernism had been introduced in Brazil. According to Williams (2009), on February 1922, Emilio di Cavalcanti, a painter and Mario de Andrade, a poet organized an art festival dubbed Semana de Arte Moderna meaning Modern Art Week. It was held in Sao Paulo’s Municipal Theatre. This gave a footing for modern architecture. Williams (2009) notes that the initial starting point for modern architecture can be traced to 1927 in the design of a residential house by Architect Gregori Warchavchic (fig. 2.77), a Russian émigré. The house integrated into the modern building, local materials and techniques. By 1930, modern architecture was the preferred architectural style.

Modernism in Brazil between 1930 and 1960 coincided with political stability and economic stability. The government was pro modernism and supported the development of the capital in modernist style. This was primarily aimed at opening up the interior of Brazil for development. One of the most significant actions by the government that allowed for the development of modern architecture was the creation of Sociedade do Patrimonio Historico e Artístico Nacional, or Society of National Historical and Artistic Heritage (SPHAN) in 1937 initiated by the then minister of Culture, Gustavo Capanema. It was a government agency with members like Lucio Costa and Carlos Leão (both architects of the MES) whose duty was to identify and preserve historical monuments and guide the construction of symbolic national architecture. It controlled the relationship between modern buildings and historical sites. Brazil’s modernism was clearly consciously intended to preserve the past, a fact that may have lead to regionalization of modern architecture. Williams (2009) illustrates the involvement of SPHAN in the design of Oscar Neimeyer’s Grande Hotel at Ouro Preto in 1940.

iii. International networks with modern architects especially Le Corbusier
Le Corbusier’s interaction with architects in Brazil stared with his first visit to Rio in 1929. Williams (2009) sites this visit as a crucial factor in initiating an interaction between European and Brazil on modern architecture. In June 1936 the MES design team invited Le Corbusier to contribute to its design and he spent four weeks on the project, interacting very closely with Oscar Niemeyer who acted as his translator. Unfortunately his impact in Brazil was limited due to language barrier especially when he gave talks and also through his magazine L’espirit Noveau. His impact on Oscar Niemeyer’s architecture is however quite significant.
2.5 SUMMARY OF LITERATURE REVIEWED

Modern architecture was defined as a break from the past and an expression of the present and therefore modernists embraced new forms, materials and technology. It was defined by its minimalist approach which was expressed through use of simple forms, lack of ornamentation, orthogonal forms and open plan layouts which defined its functionalism. Modern architecture positioned itself as a universal language that was suitable for any context and it started to trickle into the tropics. Its budding within developing countries in the tropics marked the beginning of the tropical modern architecture.

The initial attempts at designing modern buildings in the tropics revealed a shortcoming of modern architecture as a universal language because the buildings were not adapted to the climate. However in the late 1920’s, Le Corbusier found a solution to this shortcoming through his design of solar control devices or brise soleil that could be incorporated to the facades of modern architecture. Thereafter he developed a system of horizontal and vertical planes attached to the external facades of the buildings that could be used to shade windows from direct sun.

Thus modern architecture in the tropics was transformed into a unique language characterised by the brise soleil. It is this innovation that this study finds to be the cornerstone of tropical modern architecture and the use of the brise soleil or sun shading devices by other modern architects working in different regions within the tropics bears witness to this. This study found that the knowledge gathered from experiences gathered by architects like Corbusier and others working in the tropics was disseminated through the networks they shared. The analysis of the networks brings out the key pioneers of tropical modern architecture around the world.

The literature reviewed brought out different aspects of tropical modern architecture such as the networks created (using case studies of tropical modern architecture in West Africa), the transformation of tropical modern architecture to regionalist modernism (using case studies of Southern Asia) and the different ways tropical modern architecture developed in the tropics (using case studies from Brazil).

From the analysis of tropical modern architecture in Nigeria and Ghana, the study found that tropical modern architecture advanced significantly due to the links and networks formed between its pioneers. Their backgrounds and architecture reveal the influence the networks had on their approach to designing in the tropics. On the issue of regionalism, this study found that regionalist modernism was not exclusively seen in India and Sri Lanka, which undoubtedly have strong cultural identity. Architects practicing in Brazil and West Africa also attempted to reflect culture in their designs. For instance to conserve cultural identity, the Brazilian government created the Society of National Historical and Artistic Heritage (SPHAN) in 1937 which was responsible for guiding construction of modern architecture to preserve historical identity. From the investigation carried out on tropical modern architecture in Brazil, the author found that unlike West Africa, East Africa and Southern Asia, tropical modern architects in Brazil did not have as many networks with other modern architects and modernist groups. Minimal interaction with the pioneers of tropical modern architects in Europe and modernist groups lead to the development of modern architecture through experimentation using limited information.
CHAPTER THREE
RESEARCH METHODS

3.0 Introduction
3.1 Research Strategy
3.2 Sampling Design
3.3 Research Tools
3.4 Data Collection Methods
3.5 Data Processing and Analysis
3.0 INTRODUCTION

As defined in chapter one in the scope and limitations, this research focuses on architecture built by modern architects within East Africa between the 1940’s and late 1980’s (fig. 3.1). This chapter outlines the process used to meet the objectives listed in Chapter one of the study which are:

1. To find out the key protagonists in the establishment of tropical modern architecture;
2. To establish the characteristics of tropical modern architecture that made it stand out as climate responsive;
3. To establish the origin, spread and development of tropical modern architecture and to investigate why the drive towards tropical modern architecture diminished approximately 25 years after the East African countries attained independence;

This research is qualitative because the issues to be studied will be looked at in their natural setting and the impact of their context on them will be analysed. The grounded theory approach is used for this study because it allows the data collected to develop the theory giving the resultant conclusions more validity. The grounded theory is also selected for this study because it allows the information collected to offer insight, enhances understanding and provide practical recommendations on issues brought out in the problem statement (Groat and Wang 2002).

3.1 RESEARCH STRATEGY

To meet the research objectives, the research strategy used is the case study method. The case study research strategy has been selected for this study because case studies have been found to be compelling and convincing in deriving a reliable theory and can be generalized to form a theory (Groat and Wang 2002). Case studies selected from East Africa give insights into how tropical modern architects responded to climate while maintaining the language of modern architecture.
The case study method has five core strengths that are crucial to meeting the objectives of this study.

i. Case study strategy is able to focus on the selected case within its context thereby bringing out its interaction with its environment rather than looking at it in isolation of the crucial elements that are part and parcel of it. The study uses selected buildings and architects relevant to the study to meet the objectives. By studying the buildings, environmental factors that influenced their design and the architects who designed them, the study is able to draw a more conclusive deduction on the history of the tropical modern movement in East Africa.

ii. The case study method is also vital in explaining casual links. The selected buildings and architects in the study explain the impact of climate and culture on form and the architects response to climate. The underlying factors that developed the architects interest in climate responsive design and modern architecture can also be explained.

iii. Case studies incorporate multiple sources of evidence and therefore an examination of all issues is possible regardless of their different methods of providing data. A few methods utilized in the study include examination of buildings from available published and unpublished data available such as maps and drawings of the buildings, interviews with architects on their architecture and other relevant people who are in a position to give insight on either the buildings or architects and observation and physical examination of the buildings character and performance within their contexts.

iv. Case studies can be generalized to form a theory. The selected case studies are able to give reliable theory on the tropical modern movement, its key players, its development, its impact and decline. The theory developed can be analysed to give an indication on how climate responsive architecture can be emphasised today, given momentum and developed such that it does not decline after the key protagonists have 'left the scene'.

v. Case studies have been found to be compelling and convincing and therefore the study employs the strategy to derive a reliable theory.
3.2 SAMPLING DESIGN

An extensive number of tropical modern buildings were put up between 1940 and 1980 and therefore the need to use sampling to select the case studies that the author felt would be most responsive and save on cost and time as recommended by Taylor et al (2006). The sampling frame is defined by the outlined timeline of this study i.e. 1940 to 1980, the location of the case study and the typology of the case study. Simple random sampling is used to select the case studies from each typology of interest in this study.

The sampling frame is defined by typologies discussed by Udo Kulterman in his book New Architecture in Africa (1969). The selection of Kuterman’s criteria to select case studies for this study is based on the fact that Kulterman (1969) was the first book that discussed modern architecture in Africa (Lagae 2010). It has since prompted other documentation on modern architecture in books and papers from renown authors such as Ola Uduku, Hannah Le Roux and Manuel Herz to name a few.

Kulterman’s criteria is also able to capture the similarities and differences in architecture in different regions by different architects within different periods. Using a similar criteria, this study gives a richer understanding of the tropical modern architecture approaches in East Africa between the 1940’s and 1980’s.

In addition, the criteria of analysis used by Kulterman brings out the architects and architecture in Africa that influenced or were influenced by the modern movement. It is the aim of this study to bring out the different architects who practised in East Africa and their contribution to the tropical modern movement. This benefits the study in that different approaches by different architects can be appreciated and analysed to create a better understanding as to how the architects the tropical modern movement developed in East Africa.

Kulterman uses 12 typologies of buildings to generate a theory and generalize the findings such that they are applicable through out Africa. This study attempts to do the same by studying a broad selection of typologies, through out different towns and built during different times. The criteria makes the findings more reliable. Kulterman (1969) analyses the buildings he discusses in 12 categories namely:

- Education buildings
- Government buildings (fig. 3.4)
- Commercial buildings
- Social and Cultural buildings (fig. 3.5)
- Religious buildings
- Hotels and restaurants buildings
- Hospitals buildings
- Stadiums buildings
- Market halls buildings
- Exhibitions buildings
- Transportation buildings
- Housing buildings
Of the twelve (12) categories in Kulterman (1969), this research selected the first five (5) categories as listed here below. The buildings studied under each category are outlined in Table 3.1 and Table 3.2.

i. Education buildings
ii. Government buildings
iii. Commercial buildings
iv. Social and cultural buildings
v. Religious buildings

The selection of the above listed categories is based on the fact that the five categories cover some of the most impactful buildings that the author felt would sufficiently bring out the climate responsive attitude of architects in East Africa between 1940 and the 1980’s. This study acknowledges that the other seven typologies used by Kulterman would also bring out an understanding of tropical modern architecture but they will not be included in this study. Examples include:

vi. Hospitals buildings such as Aga Khan Memorial Hospital in Nairobi by Richard Hughes, Kenyatta National Hospital in Nairobi by Cobb & Scammel, Aga Khan Hospital in Tanzania by Ernst May, Aga Khan Maternity Hospital in Kisumu by Ernst May

vii. Hotels and restaurants buildings such as Watamu Beach Hotel in Malindi by Richard Hughes, Club House for Goan businessmen by Anthony Almeida (fig 3-6), Golden Beach Hotel in Diani by Dorothy Hughes, Oceanic Hotel in Mombasa (demolished) by Ernst May

viii. Stadiums buildings such as Lugogo Stadgium in Kampala by Peatfield and Bodgener, Uganda Sports Union Headquaters in Kampala by Peatfield and Bodgener

ix. Market halls buildings such as Kariakoo Market in Dar es Salaam (fig. 3-7)

x. Exhibitions buildings such as the German Pavillion for the Nairobi agricultural exhibition in Nairobi by Theodore Raschkow

xi. Transportation buildings such as the Nakuru Railway Station (architect unknown)

xii. Housing buildings such as Delamere flats in Nairobi by Ernst May, Richard Hughes' home and studio in Nairobi
In addition to Kulterman’s criteria, the sampling criteria for the case studies also required that the building contain the following characteristics:

I. Designed by a modernist architect
   i. member of CIAM or MARS Group (fig. 3-8)
   ii. an architect who worked for or with a modern architect
   iii. an architect who taught or trained at the AA Schools Department of Tropical Studies
   iv. an architect whose work reflects an awareness of climate responsive design and modern architecture (fig. 3-9)

II. Buildings whose design falls within the period between 1940 to the late 1980’s, the sampling criteria for the case studies also limits the selection of the study to climate responsive buildings.

III. Building has the characteristics of a climate responsive modern architecture building.
The criteria used to select climate responsive buildings is based on 9 principles published in The Architect Magazine issue 2 September 2013–March 2014 written by Architect Musau Kimeu, an environmental design specialist in East Africa. The principles are based on prevention of heat gain and provision of cooling and are listed as follows:
   i. Buildings orientation is such that the long axis is along the East-West axis.
   ii. Buildings that are narrow in plan
   iii. Sun-shade all glazed areas
   iv. Use natural ventilation to provide cooling
   v. Locate building services on the East and West facing facades.
   vi. Have minimal window openings.
   vii. Use external finishes that are smooth and light coloured to reduce solar heat absorption
   viii. Use high thermal mass on walls
   ix. Place window openings on the North and South facing walls
<table>
<thead>
<tr>
<th>Table 3.1: Case studies from the five categories selected for this study.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>I. EDUCATION BUILDINGS</strong></td>
</tr>
<tr>
<td>i. Mahatma Gandhi Memorial Library, University of Nairobi</td>
</tr>
<tr>
<td>ii. New Mitchel Hall, CCE Complex, Makerere University</td>
</tr>
<tr>
<td>iii. Kenya Science Campus Hostels, University of Nairobi</td>
</tr>
<tr>
<td>iv. Hall of Residence 6, 7 &amp; 8, University of Nairobi</td>
</tr>
<tr>
<td>v. Main Library Building, Makerere University, Kampala</td>
</tr>
<tr>
<td>vi. Hyslop Building, University of Nairobi</td>
</tr>
<tr>
<td>vii. Aga Khan Girls High School, Kisumu</td>
</tr>
<tr>
<td>viii. St Joseph Convent School aka Forodhani, Dar es Salaam</td>
</tr>
<tr>
<td><strong>II. GOVERNMENT BUILDINGS</strong></td>
</tr>
<tr>
<td>iv. Kenyatta International Conference Centre</td>
</tr>
<tr>
<td><strong>III. COMMERCIAL BUILDINGS</strong></td>
</tr>
<tr>
<td>i. Kenwood House, Nairobi</td>
</tr>
<tr>
<td>ii. ICEA Building, Nairobi</td>
</tr>
<tr>
<td>iii. Norwich Union, Nairobi</td>
</tr>
<tr>
<td>iv. Rehani House, Nairobi</td>
</tr>
<tr>
<td><strong>IV. SOCIAL AND CULTURAL BUILDINGS</strong></td>
</tr>
<tr>
<td>i. Uganda National Theatre, Kampala</td>
</tr>
<tr>
<td>ii. Kenya National Theatre</td>
</tr>
<tr>
<td>iii. Kilimanjaro Native Cooperative Union Cultural Centre, Moshi</td>
</tr>
</tbody>
</table>

**Buildings and architect selected for further analysis:**

- **Building:** Mahatma Gandhi Memorial Library at the University of Nairobi (1962)
  **Architect:** Architect Hening and Chitty
- **Building:** Parliament of Kenya (1954 and 1963)
  **Architect:** Architect Amyas Connell
- **Building:** Norwich Union (1959)
  **Architect:** Architect Amyas Connell
- **Building:** K.N.C.U Cultural Centre (1949)
  **Architect:** Architect Ernst May
<table>
<thead>
<tr>
<th>Table 3.1: Case studies from the five categories (cont’d):</th>
</tr>
</thead>
<tbody>
<tr>
<td>V. RELIGIOUS BUILDINGS</td>
</tr>
<tr>
<td>i. Joint Christian Chapel at University of Dar es Salaam</td>
</tr>
<tr>
<td>ii. Christian Leadership Centre, University of Nairobi</td>
</tr>
<tr>
<td>iii. Holy Family Basilica, Nairobi</td>
</tr>
<tr>
<td>iv. Krapf Rebman Memorial Church, Kilifi</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ARCHITECT</th>
<th>YEAR</th>
<th>BUILDING NAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Anthony Almeida</td>
<td>1975</td>
<td>Krapf Rebman Memorial Church (1960)</td>
</tr>
<tr>
<td>Dorothy Hughes</td>
<td>1962</td>
<td></td>
</tr>
<tr>
<td>Richard Hughes</td>
<td>1960</td>
<td></td>
</tr>
</tbody>
</table>

From each building category, one building will be selected for a more in depth study based on ten environmental design principles stated in Musau (2014). The in depth study looks at the architect who designed the building and the climate responsive strategies in the building to gain an understanding as to how tropical modern architecture was developed, the reason for its decline and an recommendation as to how interest can be spurred in climate responsive architecture today.

Fig 3.10: Selected case studies for further analysis

<table>
<thead>
<tr>
<th>Table 3.2: List of selected case studies for further analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>TYPOLOGY</td>
</tr>
<tr>
<td>EDUCATION BUILDINGS</td>
</tr>
<tr>
<td>GOVERNMENT BUILDINGS</td>
</tr>
<tr>
<td>COMMERCIAL BUILDINGS</td>
</tr>
<tr>
<td>SOCIAL CULTURAL BUILDINGS</td>
</tr>
<tr>
<td>RELIGIOUS BUILDINGS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ARCHITECT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hening and Chitty</td>
</tr>
<tr>
<td>Amyas Connell</td>
</tr>
<tr>
<td>Amyas Connell</td>
</tr>
<tr>
<td>Ernst May</td>
</tr>
<tr>
<td>Richard Hughes</td>
</tr>
</tbody>
</table>
3.4 DATA COLLECTION METHOD
To meet the research objectives and collect the required data the research will utilize structured observation for the case studies. Structured observation is effective in providing systematic descriptions of behaviour and is useful in testing hypotheses which in this study is the climate responsiveness of tropical modern architecture in East Africa.

3.4.1 OBSERVATION
According to Taylor et al (2006), structured observation requires standardization of conditions of observation and therefore the author uses checklists to observe and record the presence or absence of a specific behaviour or condition. The author uses a static checklist derived from the 9 principles outlined in the sampling criteria in part 3.2. Observation is used to collect the observable physical elements of the case studies such as:

i. The built form of the building — this includes the buildings' form and buildings’ orientation in relation to the sun path. This informs the study on the architects sensitivity to heat control in the building.

ii. The Facade design — Analysis of the window size, orientation and detail informs the study on the architects sensitivity to heat gain with regard to how many openings are provided, the size of the openings, the location / orientation of the openings and the treatment of the openings with regard to natural day lighting.

iii. Solar control strategies — Sun shading elements incorporated in the design will inform the study on the architects sensitivity to heat control and control of glare.

iv. Ventilation strategies— Fenestrations created to allow ventilation and their location in the building will inform the study on the designers sensitivity to heat control and provision of cooling in his/her design.

The observed data is then recorded using the data collection tools listed below:

i. Photographs
ii. Sketches and analytical notes
iii. Measured drawings

Fig. 3.11: Kenwood House (1937) by Architect Ernst May showing the building form, façade design, solar control devices and ventilation strategy used
Source: Quiring (2011)
3.4.2 INTERVIEWS
The research objectives require that the lives of architects and their impact on architecture in the tropics, are studied. The research thus uses standardised, open ended interviews to acquire the data on two main issues namely:

I. Selected architect’s academic and architectural background:

The background study helps gain an understanding of the architects personal background such as:

i. Academic background and architectural influences

ii. Networks they are affiliated with (especially those discussed in the literature review)

iii. The architect’s (selected as a case study) architectural impact and influence towards the development and spread of climate responsive architecture.

II. Selected architect’s notable works in East Africa between the 1940’s and 1980’s:

The study of the architects notable works throughout East Africa informs the study on the architect’s pattern and evolution (if any) of climate responsive design. An understanding of the architect’s consistency and development of tropical design skills aims to give an understanding of the architect’s need to design climate responsive architecture regardless of the location and typology of the building. The interviews will be conducted on:

i. Architects who designed the building’s selected for study in the sampling design in section 3.2 of this study: The architect’s will provide primary data on their academic and architectural background and the building design strategies of buildings selected as case studies in the study.

ii. Architects affiliated with the architects selected as case studies in section 3.2 of this study: Architects who worked for or with the architects selected as case studies give secondary data on academic and architectural background, the architects selected as case studies and building design strategies of case studies of buildings selected.

iii. Professionals and personal acquaintances affiliated with architects selected as case studies.
3.4 DATA PROCESSING AND ANALYSIS

Each building’s design is studied and analysed based on four principles established as key principles of tropical modern designs in the literature review, namely the building form, facade design, solar control strategies and ventilation strategies. This approach gives an indication of the key architects and architectural language of tropical modern architects and strategies in East Africa between 1940 and 1980.

From each building category, one building will be selected for a more in depth study based on ten environmental design principles stated in Kimeu (2014). The in depth study looks at the architect who designed the building and the climate responsive strategies in the building to gain an understanding as to how tropical modern architecture was developed, the reason for its decline and a recommendation as to how interest can be spurred in climate responsive architecture today.

The description of the 9 points used for analysis are:

i. Buildings orientation is such that the long axis is along the East-West axis: The long axis should run along the East West axis to ensure that the longer façade is protected from direct sun from the East and West. (fig. 3-13)

ii. Buildings should be narrow in plan: A narrow plan allows for natural lighting and cross ventilation

iii. Sun-shade all glazed areas: All glazed areas of the building should be protected from direct heat from the sun to prevent excessive heat gain.

iv. Use natural ventilation to provide cooling: For energy efficiency, natural ventilation should be ensured using operable windows and louvered openings along external facades.

v. Locate building services on the East and West facing facades: The services areas are non habitable spaces like circulation cores and washrooms. This spaces can act like heat buffer spaces on the East and West façade which receive direct sun in the morning and afternoon.

vi. Have minimal window openings: Fewer window openings reduce the glazed areas that allow heat in and therefore limit heat gain.

vii. External finishes that are smooth and light coloured reduce surface area for sun heat absorption and reflect heat from the sun reducing the buildings heat gain.

viii. High thermal mass on walls and roof reduce the amount of heat that penetrates the buildings shell

ix. Location of window openings on the North and South facing walls controls heat gain by protecting the windows from direct East and West sun.
CHAPTER FOUR
DATA COLLECTION AND ANALYSIS

4.0 Introduction: Tropical Modern Architecture in East Africa

4.1 Climatic Zones of East Africa and their Impact on Human Comfort

4.2 Climate Responsive Modern Architecture: Education Buildings in East Africa; 1940—1980
   4.2.1 Case Study: Gandhi Memorial Library by Hening and Chitty; 1960
   4.2.2. Hening and Chitty Architects: Life and Other Work

4.3 Climate Responsive Modern Architecture: Government Buildings in East Africa; 1940—1980
   4.3.1 Case Study: Parliament Buildings by Architect Amyas Connell; 1952
   4.3.2 Architect Amyas Connell: Life and other Work

4.4 Modern Climate Responsive Commercial Buildings in East Africa; 1940—1980
   4.4.1 Case Study: Norwich Union by Architect Amyas Connell; 1959

4.5 Climate Responsive Modern Architecture: Social Cultural Buildings in East Africa; 1940—1980
   4.5.1 Case Study: Kilimanjaro native Cooperative Union by Architect Ernst May
   4.5.2 Architect Ernst May: Life and Other Works

4.6 Climate Responsive Modern Architecture: Religious Buildings in East Africa; 1940—1980
   4.6.1 Case Study: Joint Christian Chapel by Architect Richard Hughes; 1975
   4.6.2 Architect Richard Hughes: Life and Other Work

4.7 Development of Tropical Modern Architecture in East Africa; 1940—1980
   4.7.1 Notable Pioneers of Tropical Modern Architecture in East Africa Between 1940 and 1980
4.0 INTRODUCTION: TROPICAL MODERN ARCHITECTURE IN EAST AFRICA

This chapter discusses the data collected and the analysis of the data as explained in the research methodology section of the research. It begins by analyzing the climate in each of the climatic zones of the towns where the case studies are found within East Africa. The analysis of the climatic zones explains the key climate issues experienced within the selected towns and how they affect human comfort within the building.

This chapter goes on to examine five typologies of buildings in East Africa namely: education buildings, government buildings, commercial buildings, social cultural buildings and religious buildings. From each typology the differences and similarities in approach to climate responsive design is brought out. Chapter four also summarises the notable architects in East Africa and illustrates their life, academic background and career back ground. It also attempts to list the architects’ other notable works.

4.1 CLIMATIC ZONES OF EAST AFRICA AND IMPACT OF HUMAN COMFORT

East Africa falls within the tropic of Cancer and Capricorn with the Equator cutting across Uganda and Kenya. Temperatures are generally moderate except in the hot and humid coastal belt where temperatures can reach 25°C Celsius and as drop as low as 15°C Celsius. However, geographical features influence the microclimate of an area and therefore an understanding of the different climates is necessary for each town where a case study is located ie. Nairobi, Kisumu, Mombasa and Kilifi in Kenya, Moshi, Tanga, Dar es Salaam in Tanzania and Kampala in Uganda. There are six (6) climatic zones in East Africa illustrated by Hopper (1975) namely:

i. Coast Zone (Koppen climate: Tropical Savanna Climate)
ii. Semi Desert Zone (Koppen climate: Warm Semi-arid Climate)
iii. Savannah Zone (Koppen climate: Tropical Savanna Climate)
iv. Lake Zone (Koppen climate: Equatorial Monsoon Climate)
v. Highlands Zone (Koppen climate: Humid Subtropical Climate)
vi. Upper highland zones (Koppen climate: Humid Subtropical Climate)
Of the six zones, four zones are significant to this study since selected case studies fall within these zones. The four zones include the Coastal Zone which is characterized by warm humid climate, the Lake Zone, which experiences hot humid climate, highland zone, characterized by wet and dry climate and the Upper highland zone, which is characterized by montane or wet climate. The description of the four zones (Coastal Zone, Lake Zone, Highland zone, Upper highland zone) where the case studies fall are as follows:

i. Coast zone - Kilifi and Mombasa in the Kenyan Coast and Tanga the northernly seaport city in Tanzania and Dar es Salaam near Tanzania’s shoreline, are the case study areas in the coastal climatic zone. The climate in this areas is warm humid climate which is characterized by high temperatures (annual mean maximum of about 29°C – 30.5°C and annual mean minimum of 22.5°C to 24.5°C) and high humidity (approximately 65%-75% at 1500hrs).

Due to the coastal regions are at a lower altitude, high temperatures are experienced and humidity can be as high as 65% to 75% due to the high evaporation rate of the ocean and proximity of the town to the coast. The climate is basically influenced by the seasonal winds known as the monsoon winds. These seasonal winds affect the coastal areas of East Africa i.e. the N.E & S.E monsoons tend to bring in heavy rainfall. The rainfall is high and ranges between 1000mm and 1800mm.

The discomfort due the combination of high temperatures of up to 30°C and humidity of over 70% is characteristic of warm humid climates. Due to the low diurnal range of about 5°C to 8°C, the night does not offer much relief from the high daytime temperatures. To attain a comfortable internal environment, air movement should be increased and heat gain limited.

ii. Lake Zone— Kisumu City in Kenya and Kampala, Uganda’s capital city, are the areas within the Lake Zone that case studies of tropical modern architecture are selected. Their climate is characterized by high temperatures of about 25°C and 27°C and high humidity of about 50% to 60%. Because of the high altitude above sea level, which falls between 1130 meters and 1250 meters, the lake zone in East Africa is characterized by lower temperatures (than other lake zones within the tropics) which average 17°C. Heavy rainfall of about 1500mm and a short dry spell are experienced especially in January and June. Although the humidity and day time temperatures result in high humidity, the breezes from the lake create some relief. With a diurnal range of 12.3%, nights are cooler than days improving human comfort levels.

iii. Highland Zone – The highland zone is found within an altitude of 1250 meters and 2000 meters. Nairobi, Kenya’s Capital city, from which several case studies of tropical modern architecture are selected, falls within the tropical highland zone at an altitude of 1,795 metres above sea level. Its tropical highland climate is exceptionally agreeable. Although air temperatures only rarely exceed comfort limits (fall between 29°C maximum) temperatures can get as low as 8°C. Solar radiation can cause overheating within buildings and necessitate ventilation where air movement is critical.

iv. Upper highland zone—this zone refers to areas with an altitude above sea level of at least 2000 metres. Moshi town is found at 890 meters above sea level but because it is found along the slopes of Mount Kilimanjaro, it experiences wet and dry climate.
4.2 CLIMATE RESPONSIVE MODERN ARCHITECTURE: EDUCATION BUILDINGS IN EAST AFRICA; 1940–1980

Education buildings in East Africa are possibly the most effective case studies in demonstrating the transition from tropical colonial architecture to modern architecture. As has been illustrated in chapter two of this study, independence played a key role in architectural development of modern architecture in former colonies within the tropics.

Although there were numerous education facilities within East Africa before independence, most of the better designed buildings had been designed for the Europeans and borrowed heavily from classical and neo-classical architecture. Such schools include Prince of Wales School now known as Nairobi School designed by Architect Herbert Baker (fig. 4.2) and The Main Administration block for Makerere University, normally called the Main Building opened in 1922 in Uganda (fig. 4.3). Tanzania’s pre-independence architecture has significant German and British influences that integrated Swahili designs.

Education buildings in East Africa after independence depict the adoption of modern architecture and its application was climate responsive. This can be seen in the design of University of Nairobi Mahatma Gandhi Bookshop by Henning and Chitty (1962), New Mitchel Hall at Makerere University by Norman and Dawbarn (1962), University of Nairobi Kenya Science building by Graham McCullough (1965), University of Nairobi Hostels—Hall 6, 7 and 8, Makerere University Main Library Building by Norman and Dawbarn (1959), Hyslop Building by Graham McCullough (1960).

Tropical modern architecture can also be seen in several secondary and primary schools in East Africa. A few discussed in this study include: Aga Khan Girls High School in Kisumu by Ernst May (1949–1951) and Forodhani Primary School also known as St. Joseph Convent School in Dar es Salaam by Anthony Almeida (1955).

After independence Kenya, Uganda and Tanzania gave priority to development of education and this saw numerous education buildings being built after 1960. Significant to this study are higher education buildings because of the role they played in East Africa in the sixties in the architecture of the colleges that formed the University of East Africa.
Education buildings were characterized by simple modern forms and sun shading devices while in other cases, the modern architecture was infused with indigenous forms and symbols. This served to localize the architecture, give identity that differed from colonial architecture and symbolic elements added were functional and used to prevent heat gain into the buildings. An example can be seen in the design of the University of Nairobi Library designed by Robert Henning and Anthony Chitty in 1962.

The façade consists of two vertical layers connected to each other by two horizontal members; one over the covered walkway and shorter spanning slabs at the level of the second floor slab. Along with the horizontal planes, the outermost layer of the building serves as a sun shading element for the inner layer which is mostly glazed (fig. 4.6). However it is its aesthetic and symbolic function that the outer façade has that makes the building stand out as the ‘face’ of the University of Nairobi. The pattern is an abstraction of the giraffe which is one of the animals in the University of Nairobi logo used to communicate to the staff and students at the university, to aim high (fig. 4.5).

The west facing façade has its windows extruded from the wall and oriented towards the north. The unique design of orienting windows away from the direct sun’s heat is one seen replicated in several East African campuses to add character to the building form. Such buildings include New Mitchel Hall, Kenya Science Students’ Halls of residence and University of Nairobi’s Hall 6,7 and 8 to name a few.
The New Mitchel Hall is a students hostel which forms part of the Continuing Education Complex. Hall is one of the nine (9) students’ halls of residence in Makerere University. The Old Mitchell hall, was built in 1922 and named after Philip Mitchell, the governor of Uganda Protectorate. In the 1960’s Architects Norman and Dawbarn designed the New Mitchell Hall, opened in 1963. While the Old Mitchell Hall bears classical architecture elements, the new Mitchell Hall is a modern building, with a generally rectangular form. The external walls form a serrated outline because the section of the wall with window openings is extruded to orient the façade away from the East and West.

The entire CCE complex is organized around two courtyards and each block is raised off the ground level by rectangular columns/pilotis (fig. 4-7). The buildings have long narrow spanning layouts and windows with louvered permanent vents along each façade. As the blocks change orientation so does the direction of the window openings along the extruded façade (fig. 4-8). To ensure cooling and ventilation, Norman & Dawbarn provided operable windows along the entire length of each façade. Each window is designed with permanent louvered openings located at the top of the window (fig. 4-9).
Similar in design to Mitchell hall, is the University of Nairobi, Kenya Science Campus Halls of residence along Ngong road in Nairobi. The halls were designed by Graham McCullough in 1965. The Kenya Science hostels are organized in four rows parallel to each other and have a rectangular layout and cubic form (fig. 4.10). The length of each hostel lies along the North–South axis and therefore to control heat gain, the architect orients the windows against the East and West cutting off most of the sun's heat. On the facades that face the north and south the architect has no window openings (fig. 4.11).

Within University of Nairobi, in the Main Campus of the University located within the Central Business District, students’ halls of residence; Hall 6, 7 and 8 are also designed in a similar way. Like Mitchell Hall and Kenya Science Halls of Residence, Hall 6, 7 and 8 are generally rectangular in plan. The hostels are organised along an axis that is oriented slightly off the North–South axis (fig. 4.12). The ventilation and cooling within the halls is provided for by louvered openings created using concrete and timber lattice screens which also serve to ensure daylight reaches the circulation spaces.
In the Main Library Building in Makerere university built by Norman & Dawbarn in 1959, a concrete lattice system is used to shade the inner glazed facade of the library and is located along the length of the balcony. The library has its long façade receiving direct contact from the East and West in the morning and afternoon sun. The screening along the length of the wall acts as a sun shade element as well as giving the building character (fig. 4-14).

The concrete lattice and inner glazed façade are separated by a balcony or walkway. The design allows a lot of natural light to enter the library while shading the windows from direct sun thereby preventing excessive heat gain. As for ventilation and cooling the building has large operable windows which ensure cross ventilation.

A similar layering system is used in University of Nairobi main Campus Hyslop Building designed by Architect Graham McCullough in 1960. This building is raised on pilotis allowing for passage of cool air below the building. It has a generally cubic form and rectangular layout whose length is oriented slightly off the East - West axis.

Along the length of the building is a concrete external wall with white washed interconnected rings that form an egg crate shading system. The inner layer of the wall of the Hyslop building is a fully glazed façade with operable windows. The shorter external walls of the Hyslop Building are generally north and south facing facades with no openings to prevent excessive heat gain from morning and afternoon sun since they are partially East and West facing. To give character to the shorter facades, Architect McCullough uses ornately designed relief forms on the concrete and pieces of metal organized along the wall in interesting patterns (fig. 4-15).

Cooling and ventilation in Hyslop Building is controlled using operable windows located along either side of the long façade.
Higher education buildings are however not the only expression of climate responsive modern architecture in East Africa. In 1949 Architect Ernest May was commissioned by Aga Khan III to design Aga Khan Girls’ High School in Kisumu completed in 1951.

Architect May put up a three story cubic building raised on columns/pilotis on the ground level. The other two floors have six class rooms on each level. Perpendicular to the classroom block is another narrow plan cubic block that houses the administrative offices (fig. 4-16).

The classroom block is oriented along the East—West axis a concrete lattice screen is used to control heat gain and promote ventilation and cooling which are all crucial design issues to be considered especially in the hot and humid Kisumu climate (fig. 4-17). Beyond the layer of the concrete screen is a walkway while the other length of the classrooms is shaded using vertical and horizontal concrete panels (fig. 4-18).

Within the same compound as the Aga khan school for girls is the Aga Khan Maternity building also done by Ernst May between 1949 and 1951. Like the school, the hospital is raised on pilotis and to control heat gain the hospital also has the same orientation as the classroom block.
A different approach to heat control and cooling in expression of tropical modern architecture is seen in Tanzania in the design of Forodani School designed by architect Anthony Almeida. The school was completed in 1955 and was initially called St. Joseph Convent School and belonged to the catholic church. It is located approximately 80 metres from the shoreline of the Indian Ocean. The building therefore benefits from the Ocean breezes (fig. 4.21).

Due the high temperatures and humidity in Dar es Salaam, Architect Almeida designed the buildings as narrow plan structures arranged around a courtyard. On each façade within the courtyard Almeida used a different strategy to respond to air movement and sun shading. The entry foyer of the building is a concourse raised on pilotis (fig. 4.19). On the front façade of the entrance block which is oriented to the North, horizontal sun shading fins are used. On the inner side of the courtyard, the same block faces south and is lined with louvers on white washed walls. The louvers capture the ocean breezes cooling the internal spaces (fig. 4.20).

On the blocks the East and West, architect Almeida uses deep balconies and few, high level windows. The concrete lattice within the courtyard which gives the space more character encloses the stairwell and ensures cross ventilation.

Fig. 4.19: View of internal courtyard of Forodhani Primary School, Dar es Salaam designed by Architect Anthony Almeida; 1955
Source: https://www.facebook.com

Fig. 4.20: View of South Facing façade within the internal courtyard of Forodhani Primary School, Dar es Salaam
Source: http://www.akilipix.com

Fig. 4.21: Location plan of Forodhani Primary School, Dar es Salaam
Source: Author (derived from Google maps)
ANALYSIS OF EDUCATION BUILDINGS

**BUILDING ORIENTATION (SUN MOVEMENT)**

<table>
<thead>
<tr>
<th>Name</th>
<th>University</th>
<th>Architect</th>
<th>Year Built</th>
<th>Location</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kenya Science Hostels</td>
<td>University of Nairobi</td>
<td>Graham McCullough</td>
<td>1965</td>
<td>Nairobi</td>
<td>Hot humid Climate</td>
</tr>
<tr>
<td>Hall 6 and 7</td>
<td>University of Nairobi</td>
<td>Daglish Marshall</td>
<td>1967</td>
<td>Nairobi</td>
<td>Upland Tropical Climate</td>
</tr>
</tbody>
</table>

**BUILDING CHARACTER**

- The building is a four story, deep plan building with interior that is defined by a double volume space that facilitates ventilation and cooling.
- The main facade of the building defines the building character with the abstraction of the grilles to form the sun shading elements and structural support for the characteristic undulating roof.
- South West facade experiences the highest insulation levels and also the most glazed.
- The halls are four story, narrow plan buildings with a circulation core along the length of the building's centerline.
- Each facade's openings are oriented differently depending on the orientation of the building in relation to the sun.
- Kenya Science halls of residence are three story, narrow plan buildings with a circulation core along the length of the building's centerline.
- Each facade's glazing openings are oriented away from the East and West facade to prevent heat gain creating a four Now design along the length of each block.
- The sun shading strategy used defines the building's character.
- It is a four story, narrow plan hostel with windows and glazing along North and South facing external walls that facilitates ventilation and cooling.
- The spatial arrangement of the rooms protects the spaces from excessive heat gain and defines the building character.
- All glazing windows are oriented due North or South protecting the internal spaces from excessive heat gain.

**REMANSTATION OF HEAT GAIN - SOLAR CONTROL STRATEGIES**

- Use of operable windows
- Use of smooth light colored finishes
- Use of permanent louvered vents
- Use of double volume spaces that increase air volume
- Use of high thermal mass
- Use of permanent louvered vents
- Use of smooth light colored finishes
- Sun shading along glazed facades orientation of glazed facades away from East and West axis
- Use of high thermal mass
- Minimal window openings on the East and West facing facades.
- Use of smooth light colored finishes
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**VENTILATION STRATEGIES**

- Use of operable windows
- Use of permanent louvered vents
- Use of smooth light colored finishes
- Use of operable windows
- Use of permanent louvered vents
- Use of smooth light colored finishes
- Use of operable windows
ANALYSIS OF EDUCATION BUILDINGS (cont’d)

**Name:** Mlima Library, Makerere University
**Architect:** Norman & Dawbarn Architects
**Year Built:** 1952
**Location:** Kampala, Uganda
**Climate:** Hot Humid Climate

**Building Character:**
- The library has its main area running slightly off the North-South axis. Therefore the longer facades of the main library building are exposed to hot East and West sun.
- The architect prevents heat gain by layering the glazed facade using a concrete lattice screen and louvers on the South and North facades.

**Building Orientation (Sun Movement):**
- The two story building has a deep plan orthogonal to the major facades.
- Its front facade is defined by the concrete lattice along the balcony and external glazed facades.

**PREVENTION OF HEAT GAIN - SOLAR CONTROL STRATEGIES**

1. Use of operable windows
2. Use of permanent louvred vents
3. Sun shading along glazed facades
4. Layering - Concrete lattice screen intuffnt of glazed external wall
5. Louvers along glazed facade
6. Use of high thermal mass
7. Minimal window openings on the East and West facing facades
8. Use of smooth light colored finishes

**SOLAR CONTROL**

1. Sun shading along glazed facades
2. Layering - Concrete lattice screen intuffnt of glazed external wall
3. Use of operable windows
4. Use of permanent louvred vents

**PROVISION OF COOLING - VENTILATION STRATEGIES**

1. Use of operable windows
2. Use of permanent louvred vents
3. Sun shading along glazed facades
4. Layering - Concrete lattice screen intuffnt of glazed external wall
5. Vertical sun shades along the East facing facades
6. Use of high thermal mass
7. Minimal window openings on the East and West facing facades
8. Use of smooth light colored finishes

**PROVISION OF COOLING - VENTILATION STRATEGIES**

1. Use of operable windows
2. Use of permanent louvred vents
3. Sun shading along glazed facades
4. Layering - Concrete lattice screen intuffnt of glazed external wall
5. Vertical sun shades along the East facing facades
6. Use of high thermal mass
7. Minimal window openings on the East and West facing facades
8. Use of smooth light colored finishes

**Future Strategies:**
- The use of smooth light colored finishes is encouraged to reflect more sunlight and reduce heat gain.
- Operable windows can be used to control airflow and manage ventilation effectively.
- Vertical sun shades can be installed along the east and west-facing facades to provide shading and reduce heat gain.
- Use of high thermal mass materials can help in managing internal temperatures by storing heat.
- Minimal window openings on the east and west-facing facades can also help in reducing heat gain from direct sunlight.

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4.4.1 Source Fig. sun from the East determined by the Great Court
The longer facade of the library is oriented slightly off the East West axis.

4.4.2 Sun path over Mahatma Gandhi Library

4.4.3 Each facade employs different solar control strategies

South WEST FACADE
Along the south west facing facade, the roof overhanging the glazed facade from direct sun. Between the horizontal plane of the roof and the vertical walkway canopy, four horizontal slats actuated to the vertical column, sun shade the lower part of the glazed area. The vertical walkway canopy is also orientated to sun shade the glazed area.

North WEST FACADE

North EAST FACADE
The doors in the roof of the library shade the windows and timber louvres located on fifth floor. Along the facade the lower windows are not sun shaded probably because it is a non-habitable space.

4.4.4 Solar control devices
The library employs different strategies to protect the glazed areas from receiving direct sun. They include:

I. Brise Soleil
II. Orientation of windows away from direct rays.
III. Small Narrow Windows

4.4.5 Each facade employs different solar control strategies

North WEST FACADE

Part section of the North East facade and orientation of office windows from direct Eastern sun. Source: Author.

4.4.6 North West facing facade of Gandhi Memorial Library

South West facing facade of Gandhi Memorial Library

North East facade of Gandhi Memorial Library

Shading

North West

North East

Fig. 4.32 North East facing facade of Gandhi Memorial Library
Source: Author's archive.

Fig. 4.31 North West facing facade of Gandhi Memorial Library
Source: Author's archive.

Fig. 4.28 Section showing North East facing facade of Gandhi Memorial Library
Source: Author's archive.

Fig. 4.27 South East facing facade of Gandhi Memorial Library showing the sun shading strategies
Source: Author's archive.

Fig. 4.26 Section showing South East facing facade of Gandhi Memorial Library
Source: Author's archive.

Fig. 4.25 Looking north west over Mahatma Gandhi Memorial Library
Source: Author.

Fig. 4.24 Plan of Gandhi Memorial Library, overall view, showing the deep plan layout
Source: Author.

Fig. 4.23 Section through Gandhi Memorial Library South West facing facade, showing the sun shading strategies
Source: Author.

Fig. 4.22 Plan of Gandhi Memorial Library, overall plan, showing the deep plan layout
Source: Author.

Fig. 4.21 The covered walkway canopy also serves to sun shade the glazed part of the wall from direct sun.

4.4.7 Solar control strategies

I. Brise Soleil
II. Orientation of windows away from direct rays.
III. Small Narrow Windows

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The doors in the roof of the library shade the windows and timber louvres located on fifth floor. Along the facade the lower windows are not sun shaded probably because it is a non-habitable space.
4.1 Location of non habitable spaces along the East and West: 

North East facade

The non habitable spaces include the circulation core, the washrooms and the stair run. The washrooms, stair cores and circulation core are located along the South East facing facade and the North West facing facade. The stair core exits from the North East facing facade. The location of each of these spaces is ideal since they are located for the habitable spaces it connects them to the East and West facing facades which increases heat loss from the West.

Stair location in the facade.

4.2. HENNING AND CHITTY ARCHITECTS

4.2.1 Academic and career background, network and design philosophy

Gordon Chitty is a partnership formed in 1953 by Architect Robert Henning and Anthony Merick Chitty. Chitty worked at Tecton Group Practice and later at the University of Zambia by Anthony Chitty, University of Lusaka in Zambia, designed in partnership with Anthony Chitty in 1968, was a member of the Governing Council from 1955 and 1962. Chitty was a member of the Secretary of State for Education and Science and Technology, and a member of the Governing Council of the University of Nairobi.

4.2.2 Henning and Chitty Architects

4.2.3 Mahatma Gandhi Memorial Library

4.2.4 Consideration to Tropical Modern Architecture

Although their projects in Africa include Malama Gandhi memorial library (now known as University of Nairobi Bookshop) at the University of Nairobi, Kasaratu, Darlington between 1930 and 1937.

4.3.1 History and Academic and career background, network and design philosophy

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4.3.2 Contributions to Tropical Modern Architecture

Although their projects in Africa include Malama Gandhi memorial library (now known as University of Nairobi Bookshop) at the University of Nairobi, Kasaratu, Darlington between 1930 and 1937.

4.3.3 Notable projects in Africa includes

University of Lusaka in Zambia, designed in 1965 to 1966 by Anthony Chitty and Julian Turner.

4.3.4 Partnership

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4.3.5 Consideration to Tropical Modern Architecture

Although their projects in Africa include Malama Gandhi memorial library (now known as University of Nairobi Bookshop) at the University of Nairobi, Kasaratu, Darlington between 1930 and 1937.
4.2 CLIMATE RESPONSIVE MODERN ARCHITECTURE:

GOVERNMENT BUILDINGS IN EAST AFRICA BETWEEN 1940—1980

Government buildings in newly independent countries in Africa are sometimes adoptions of buildings used during colonization such as the Kenyan Statehouse by Sir Herbert Baker. However, in some cases the newly independent states commissioned new structures to house their administrative, legislative and judicial buildings. Those buildings borrowed heavily from modern architecture and sometimes included indigenous symbolic elements in form of decorative features and functional features to localize the designs. Examples include the Attorney General Chambers in Nairobi by Amyas Connel (fig. 4-36), the Kenyan parliament buildings also in Nairobi by Amyas Connell (fig. 4-37), the Parliament of Uganda in Kampala by Peatfield & Bodgener (fig. 4-38) and the iconic Kenyatta International Conference Centre by Karl Henrik Nostvick.

Other government buildings were designed in simpler modernist forms and got their character from the array of vertical and horizontal sunshades. Such buildings include the the Ministry of Public Works Building in Upperhill, Office of the President and Jogoo House ‘B’ by Daglish Marshall.
Ministry of Public Works Building located in Upper hill near Nairobi’s Central Business District is one of the several government buildings that has a simple tropical modern form. It has a cubic form, a narrow plan rectangular layout and is oriented with its longer façade running along the East—West Axis. Its windows are placed on its North and South façade and are shaded using vertical and horizontal sun shading devices (fig. 4-39). Along the East and West façade the building has fewer windows. Its plan is such that the building receives natural light from the length of the façade and natural ventilation from the operable windows. Services are located along the East and West facades which generally receive the most direct heat from the hot morning and afternoon sun, and therefore act as heat buffers. Its shape and form is similar to that of the Office of the President (fig. 4.40 and fig. 4.41).

Jogoo House ‘B’, designed by Dagliesh Marshall houses the Ministry of Education, Science and Technology and is located on Kimathi Street a few meters from the office of the president. Like the Ministry of Public Works Building, Jogoo House is a narrow plan building with a cubic form and rectangular layout. It is generally oriented with its long axis due East and West. The character of its façade and form is characterized by an array of vertical and horizontal sunshades (fig. 4.42); much like the Office of the President in Nairobi, Ministry of Education Building in Brazil discussed in chapter two of this study.
In 1951 Architect Amyas Douglas Connell was commissioned by the British colonial government to design the Kenyan parliament building (fig. 4.43). According to an article published by the Standard (2013) Amyas Connell had been requested to design a replica of the Palace of Westminster (Parliament Buildings of the United Kingdom) built by the 19th Century Architect, Sir Charles Barry. Amyas Connell designed the form of Kenyan parliament with some semblance to the Palace of Westminster but without the gothic elements by adding the scaled down clock tower which is similar to that of the Palace of Westminster (fig. 4.43 and fig. 4.44). Working with Architect Thornley Dyer, the first wing of the parliament buildings was completed in 1954 and consisted of the main ceremonial entrance, the clock tower, the library, the speakers walk and the curvilinear members lounge that overlooks the garden.

The second part of the design of the Parliament building was the Assembly chamber which was completed in 1963. It consisted of the dining, the private dining, a private bar, the speaker’s walk and hall and the debating chamber. Besides the clock tower, the chamber’s form is one of the stronger defining features of the Parliament. Its ‘Corbusian’ form, sweeping curved roof and the aesthetic relief forms on its main façade, make it iconic and symbolic newly independent Kenya (fig. 4.45).
Like the parliament of Kenya buildings, the Ugandan Parliament is just as unique because its modern design was chosen not by the newly independent leaders but by the British Protectorate of Uganda under Governor Andrew Cohen. The Ugandan parliament was completed in 1958 and two years later Uganda gained independence (fig. 4.46).

In 1956, British Commonwealth Association mounted an architectural competition for the design of the New Parliament for the then Protectorate of Uganda and an international jury selected the design by Peatfield and Bodgener, UK architects. The firms heads were Thomas Peatfield and Geoffrey Bodgener both of whom are alumnæ of the AA School. Of the two only Geoffrey Bodgener remained in Uganda after they established an office in Uganda while supervising the construction of the Ugandan Parliament.

The Ugandan parliament is a modern building with none of the classical architectural elements that most colonial buildings in East Africa were designed with. The Building has three wings; the North wing, East Wing and the South wing which forms the main entrance to Parliament Building. The main entrance building is has a south facing façade which is defined by relief artwork on the wall and a mid section inset into the façade that frames the Ugandan logo hung at its centre. A tall orthogonal water tank is located between the main entrance building and three other interconnected buildings. To link the two sections two parallel bridges, on either side of the water tank tower, are used.

Due to the spatial arrangement of each wing or block of buildings comprising the parliament buildings, the architects heavily sun shade each façade and the design of the sun shading gives character to the buildings. The narrow slits along the length of the main entrance building create interest on its east and west façade (fig. 4.47). An intricate honey comb screen is used to screen the side of the tower and add aesthetic value to its character. The other three blocks that seem to frame the main entrance building, have vertical and horizontal sun shading devices that define their character.
Kenyatta International Conference Centre (KICC) in Nairobi is Kenya’s most iconic building, a symbol of independence and an expression of regional modernism (fig. 4.48). It was designed by Architect Karl Henrick Nostvik while working as an intern in the Ministry of Public Works headed by Architect David Mutiso, the first Kenyan born architect. Karl had left his job in Oslo and come to work in Nairobi on an assignment funded by the Norwegian Agency for development.

In 1967, Kenya’s first president approached the ministry of public works to design a building to house Kenya African National Union (KANU), the country’s only political party. However in 1973 the World Bank decided to host its Global Meeting in Kenya at the KICC and Nostvik had to adjust his design so it could host an event of such a magnitude. Its design was developed from the concept of a fully blossomed flower for the tower and a bud for the auditorium.

The outcome was an expansive L-shaped podium and a 32 story, sixteen sided polygon tower defined by its horizontal sunshades that hung above each window all round the tower (fig. 4.49). The plinth / podium of KICC is shaded using cantilevering slabs and balconies and characterized by several floor to ceiling windows (fig. 4-50). The ‘bud’ shaped auditorium receives natural light from openings on the roof of the opening.
**ANALYSIS OF GOVERNMENT BUILDINGS**

<table>
<thead>
<tr>
<th>Name</th>
<th>Architecture</th>
<th>Year Built</th>
<th>Location</th>
<th>Climate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Parliament of Kenya</td>
<td>Amyas Connell</td>
<td>1965</td>
<td>Nairobi, Kenya</td>
<td>Upland Tropical Climate</td>
</tr>
<tr>
<td>Kenyatta International</td>
<td>Daglish Marshall</td>
<td>1965</td>
<td>Nairobi, Kenya</td>
<td>Warm Humid Climate</td>
</tr>
<tr>
<td>Parliament of Uganda</td>
<td>Peatfield &amp; Busheger</td>
<td>1956</td>
<td>Kampala, Uganda</td>
<td>Warm-Humid Climate</td>
</tr>
<tr>
<td>Kenya International</td>
<td>Karl Henrik</td>
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</tbody>
</table>

**PREVENTION OF HEAT GAIN - SOLAR CONTROL STRATEGIES**

- Sun shading along glazed facades
- Long extended canopies
- Vertical and horizontal Brise Soliel
- Lancers along glazed facade
- Shaded walkways/hallways that layer the spaces along the west facades
- Use of high thermal mass
- Minimal window openings on the East and West facing facades
- Smooth light-colored finishes
- Use of operable windows
- Use of permanent louvered vents
- Narrow plan layout influences cross ventilation

**BUILDING CHARACTER**

- Two-story cubic forms form the parliament building complex. The main debating chamber has the external walls raised on pilasters. The solidity of the facade with small narrow vertical openings define parliament character.
- The structures that form KICC are deep-plan and have their service cores within the building core. The abstraction of the flower and bud forming the tower and amathipture define the building character.
- Three flanking blocks are shaded using deep hallways along sunshades.
- The long facades run along the North, East, South and West directions.
- The architect arranges each length of the facade with lower and horizontal and vertical sunshades. The West-facing facade are shaded using deep hallways along walkways and sunshades.
- The architect shades the main entrance using deep hallways along the North-South axis.
- The structure that form KICC are deep-plan and have their service cores within the building core. The abstraction of the flower and bud forming the tower and amathipture define the building character.
- The covered walkways, internal courtyards and horizontal and vertical sunshades protect the blocks from heat gain.
- The facade is defined by the arrangement of the blocks around a courtyard, the tall block tower and sun-shading elements.
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5. Building depth: Narrow plan with no double banking in habitable spaces.

West facing walls are double banked to buffer heat gain using brise soleil and changing rooms like the kitchen stores. Connell located concrete louvers and Colonnaded walkways hallways and passages between 23 Metres and 8 Metres in height along each long facade. The building can be described as a narrow plan since habitable spaces have no double banking and therefore those that are relatively deep are still well planned - good cross ventilation.

Every room has access to natural light and ventilation with some of the spaces receiving two adjacent facades and cross ventilation.

The arrangement of the blocks around a courtyard facilitates good functioning of the narrow plan spaces i.e., efficient ventilation and lighting. Every room has access to natural light and ventilation with some of the spaces receiving two adjacent facades and cross ventilation.

The North and South facades are lined with horizontal and vertical sun shading devices. In areas where more lighting is required to light deeper spaces such as the debating chamber entrances, Connell uses a concrete lattice screen to shade and provide lighting to the hall's front along the South facade.

The two facades are not affected by the sun heat and therefore the main features used to limit heat gain.

6. Solar control devices

The orientation of the parliament buildings is such that the main area of the building faces the East West facades. Each facade is lined with sun shading systems in form of brise soleil, continuous layered canopies and saloon windows and balconies. When the glazing and opening are large, he shades using extended roof canopies as seen from the entrance of the council chamber. Along the rest of the East facing facade, Connell uses an array of vertical and horizontal shading devices.

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The two facades are not affected by the sun heat and therefore the main features used to limit heat gain.

6. Solar control devices

The orientation of the parliament buildings is such that the main area of the building faces the East West facades. Each facade is lined with sun shading systems in form of brise soleil, continuous layered canopies and saloon windows and balconies. When the glazing and opening are large, he shades using extended roof canopies as seen from the entrance of the council chamber. Along the rest of the East facing facade, Connell uses an array of vertical and horizontal shading devices.

The North and South facade are lined with horizontal and vertical sun shading devices. In areas where more lighting is required to light deeper spaces such as the debating chamber entrances, Connell uses a concrete lattice screen to shade and provide lighting to the hall's front along the South facade.

The two facades are not affected by the sun heat and therefore the main features used to limit heat gain.
4.2.1 Case Study: Parliament of Kenya by Amyas Douglas

**Connell** uses solar control devices to limit heat gain into the building. The parliament buildings are oriented such that the primary axis of the complex runs along the length of the two major roads, Parliament Road and Uhuru Highway. Connell used solar control devices to limit heat gain into the building.

Along the North and South facades since they do not face any main road. Therefore Connell tried to limit the number of openings on the windows is high along the length of parliament structures along the two major roads that abound it. Because of the orientation of the primary axis of Parliament along the two major roads that abound it, the number of glazed openings are fewer significantly reduces the heat gain into the building since the number of glazed openings are fewer.

**Use of Light Colored Finishes**

The color of parliament buildings is a light brown finish on smooth textured plaster. The building facade therefore reflects heat protecting the spaces from excessive heat gain.

**Use of High Thermal Mass**

The thickness of the external walls of Parliament of Kenya Buildings is 0.2 meters. The mass lag for 0.2 meter walls is six (6) hours and therefore the buildings are protected from heat gain for six hours in a day. The color of parliament buildings is a light brown finish on smooth natural plaster. The building facade therefore reflects heat protecting the spaces from excessive heat gains.

**Non-Habitable Spaces**

The non-habitable space are located along the West facing facades to act as heat buffer spaces that control heat gain.
4.4.2 AMYAS DOUGLAS CONNELL

I. History: Academic and career background, networks and design philosophy

Amyas Connell was born in New Zealand on 23rd June 1901 to an artist father and he too was supposed to train to become an artist but was instead apprend to architect Stanley W. Fearn in Wellington from 1919 to 1924. According to Sharp (2008), Fearn had interests in the aesthetic use of building materials and rejected brutalism; aspects that may have rubbed off on Amyas Connell.

While studying under Fearn, Connell participated in several student competitions held by the New Zealand Institute of Architects (NZIA), where he met Basil Ward, whom he would later partner with to form the firm Connell, Ward and Lucas. Since the NZIA exams were not enough to allow either Connell or Lucas to be registered with RIBA, the two had to study in England where Connell joined the Bartlett School of Architecture taking evening classes. During the day, he worked as an architectural draughtsman at Messrs William and Edward Hunt’s office.

In 1927, Connell won the Rome Scholarship and enrolled at the British School in Rome. Sharp (2008), while interviewing Basil Ward, found that the two architects were exposed to Modern Architecture during trips they went on together. Their Modernist influences were from the works they visited by Auguste Perrette, Tony Garnier, Bruno Taut, Mies Van Der Rohe, Walter Gropius, J. J. P. Oud and Pavillon de L’Esprit Noveau’, an exhibition they attended together held from April to October of 1925.

Impressed by Connell’s work, the director of the British School at Rome asked Connell to design a house for him and Connell designed the High and Over House. After a lot of rejection and hostility to such a foreign design, the house was approved by the council and built. This is the design Connell is most known for around the world because of its contribution to modern architecture.

In 1930, Amyas Connell, Basil Ward and Colin Lucas formed the practice Connell, Ward and Lucas. Colin Lucas had studied at Trinity College in Cambridge in 1928 and favored Modernist Architecture. Each of them worked separately and designed over twenty private residences and other projects during their collaboration together. In 1939, the partnership came to an end.

Fig. 4.87: Houses in Kanga Village in Tanzania designed by Amyas Connell in 1947 for Bird & Co.; this project was Amyas Connell’s first project in East Africa after his arrival in 1947
Source: Sharp (2008)

Fig. 4.88: Manager’s House for African mercantile Co. Ltd in Tanga by Amyas Connell in 1950; design reflects his modernist influence before he starts to adapt his designs to East African Climate through shading.
Source: Sharp (2008)
Connell worked for the British Army and the Ministry of Works and Building briefly and in 1947, he moved to Tanzania. The move had been prompted by the Chairman of Tanganyika Sisal Growers Association, Ernie Hitchcock, who had been looking for an architect. Connell worked in Tanzania until early 1950, when he moved to Nairobi on invitation by Thornley Dyer, the British Government architect then. Dyer wanted Connell to work with him on the Legislative Assembly Building; now Parliament of Kenya Building. In 1963 Connell and Graham McCullough, opened TRIAD Architects. Unfortunately, in the 1970’s Connell fell ill and had to return to London. He worked on a few projects in TRIAD’s Westminster office with his sons James and Graham until he died in 1980.

Having developed his knowledge on architecture in East Africa for over 30 years, Connell stated to understand his architecture and discovered that some of the things he had idolized Le Corbusier for, were not as straight forward as he though they were before moving to East Africa. Sharp (2008) notes three evolutions in Connell’s design namely:

i. Brise soleil: Connell found that the Le Corbusier’s brise soleil were not as effective in the tropics as patterned screens he had seen on Indian and Persian architecture. Connell’s adoption of the screens is seen on his architecture from 1960 especially in the design of the AG Chambers (fig. 4-89).

ii. Climate responsive architecture: With the publication of Maxwell Fry and Jane Drew’s book on designing for the tropics, Connell adopts those lessons and his architecture starts to display a higher regard for climate responsive design.

iii. Ornamentation: In following Le Corbusier’s model for modern architecture which had little to no ornamentation, Connell’s designs are initially ‘very corbusian’ as seen in the design of High and Over and the Aga Khan Memorial Hospital. As he develops his architecture in East Africa, Connell returns to Frean’s ideas of architecture and is quoted by Sharp (2008) in a message to a intern of his saying how bland and dull brutalism is. In the letter he ponders how much greater le Corbusier’s work would have been if only he would have better understood ornamentation and its place in Modern architecture.

iv. Regional modern architecture: As Connell evolves his architectural style, he starts to appreciate and apply regional design to his architecture.

Fig. 4.89: Façade treatment on AG Chambers showing sun shading, ornamentation, and borrowing of Indian and Persian motifs
Source: Author's archive
II. Contribution to Tropical Modern Architecture:

According to Sharp (2008), Connell had considerable influence over the younger generation of local architects in Nairobi especially students who were familiar with his work in England and had studied at the AA School and the University of Westminster.

Documentation of his work while he was the Chairman of East African Architects Association was also very high and no doubt impactful on local architecture and architects in training.

III. Notable projects in Africa include:

i. Sisal farm and village in Kanga near Tanga, Tanzania (fig. 4-87)

ii. Novelty Talkies cinema in Tanga, Tanzania

iii. Manager's House in Tanga for African Mercantile Co. Ltd in Tanga in 1950 (fig. 4-88)


v. Old Nation Centre in Nairobi Kenya

vi. Aga Khan Platinum Jubilee Hospital in Nairobi, Kenya; 1956 –1962 (fig. 4-90)

vii. Town House Building in Nairobi, Kenya

viii. Norwich Union Building in Nairobi, Kenya in 1959

ix. Crown law Offices (now Attorney General Chambers) in Nairobi, Kenya in 1960 (fig. 4-91)

x. Harambee House in Nairobi, Kenya
4.4 CLIMATE RESPONSIVE MODERN ARCHITECTURE: COMMERCIAL BUILDINGS IN EAST AFRICA BETWEEN 1940–1980

A study of commercial buildings in East Africa reveals a variety of responses to tropical climate in East Africa and architects who contributed to architecture in East Africa. Commercial buildings tend to demand economical use of space, resource efficiency to increase value of the investment and facades and building forms that attract stakeholders, tenants or clients to invest. After independence attracting foreign and local investment was crucial and the stability that followed after independence provided a platform where commerce thrived. Unlike government and educational buildings which sought to express the status of the country through cultural and regional forms, most commercial buildings sought to demonstrate the countries ability to embrace commerce at a global scale and so they had very strong modern forms.

Those selected for this study are a few notable examples of the commercial buildings that embraced modern architecture while maintaining the need for climate responsive design. Such buildings in Kenya include: Kenwood House by Ernst May in 1937 (fig. 4.66), Norwich Union by Amyas Connell in 1959 (fig. 4.65), ICEA Building by Richard Hughes in 1982 (fig. 4.67) and Rehani House by Mutiso Menezes International (fig. 4.68).

Fig. 4.65: Norwich Union, Nairobi by Architect Amyas Connell; 1959
Source: Author’s archive

Fig. 4.66: South West facing façade of Kenwood House, Nairobi by Ernst May 1937
Source: www.flickr.com

Fig. 4.67: ICEA Building in Nairobi (1982) by Richard Hughes
Source: structurae.net

Fig. 4.68: Rehani House in Nairobi by Mutiso Menezes International
Source: http://www.mmiarch.com
Kenwood Wood House has a very definitive form because of the way Architect May chose to control heat gain especially on the South west facing façade. May oriented the windows on the West façade due South creating an undulating outline on the layout of each floor (fig. 4.69). Using an extended horizontal plane that follows the profile of the building layout, May sunshades the openings on the East and South façade and on the west facing façade as well as orienting them to the south. The building layout is influenced by the street and therefore the longer facades are oriented off the North-south axis. Kenwood House is relatively deep plan and therefore to bring light into its core, Ernst May used an atrium light well. All spaces have access to natural lighting and natural ventilation from the exterior wall of the building. The circulation core is located within the top lit atrium and therefore does not require artificial lighting during the day. Along the stair well is a wall lined with glass blocks that light and ventilate the stair well.

A similar approach to control heat gain by orienting façade openings along East – West is seen in Richard Hughes’ design of ICEA building in Nairobi. The plinth of ICEA building is set on the site along the street orientation i.e. offset off the North-South axis by approximately 30° (fig. 4.70). To maximise on space, respect plot ratios and respond to the climatic aspect of Nairobi, Architect Hughes orients the tower diagonally across the plinth such that it lies with its length along the East–West axis.

Fig. 4.69: Kenwood House, Nairobi by architect Ernst May 1937
Source: www.flickr.com

Fig. 4.70: ICEA Building, Nairobi by Architect Richard Hughes 1981
Source: www.skyscrappercity.com

Fig. 4.71: Orientation of Kenwood House; West facing façade undulated to orient openings to the South
Source: Author

Fig. 4.72: Orientation of ICEA Building; tower designed to run along the East–West axis
Source: Author
Norwich Union designed by Architect Amyas Connell in 1959. It’s cubic form is characterised by an interplay of cubes extruded beyond the façade and vertical and horizontal sun shades brought out by the colourful red and blue hues on the external wall. The East and West façade do not have any openings and the stairwells are located along those facades to act as heat buffers (fig. 4.73).

The west facing façade is adorned with a mosaic of blue and white tiles while the East façade has a curvilinear wall that defines the buildings form and encases the curved staircase. Operable windows are used through out the entire building in the circulation areas, services and commercial spaces to ventilate and allow cooling.

Rehani house in Nairobi was designed by Architect David Mutiso of Mutiso Menezes International. The building has a four storey podium and a nine storey tower (fig. 4.74). The building is oriented with its tower along the East–West axis. Along the tower’s east and west façade, the architect uses only narrow slits as openings. The North and South façades along the tower are recessed in balconies to shade the glazed openings along the offices. On the podium the layout of the floors is open plan to facilitate sufficient air movement and lighting (fig. 4.75). A louvered screen along the West facing façade of the podium is used to screen the building from hot afternoon sun. To protect the South facing façade of the podium from direct sun, the façade has deep recessed windows.
ANALYSIS OF COMMERCIAL BUILDINGS

**PREVENTION OF HEAT GAIN - SOLAR CONTROL STRATEGIES**

**PROVIDING OF COOLING - VENTILATION STRATEGIES**

**NAME**  
Kennetwood House  
Norwich Union

**ARCHITECT**  
Ernst May  
Amyas Connell

**YEAR BUILT**  
1937  
1959

**LOCATION**  
Nairobi, Kenya  
Nairobi, Kenya

**CLIMATE**  
Upland Tropical Climate  
Upland Tropical Climate

### BUILDING ORIENTATION (SUN MOVEMENT)

- **North**  
- **West**  
- **South**  
- **East**

### BUILDING CHARACTER

- **Building 1**
  - **Building axis** runs along the North-West and South-East axis.
  - The long facades primarily face the North-East and South-West orientation.
  - **Two architects** contribute to the South-West facade: most heavily using horizontal shades and orienting the roof towards the South.

- **Building 2**
  - **Building axis** runs along the East-West axis.
  - The length of the building therefore receives minimal direct sun from the East and West.
  - The **architect** maximizes the facade by orienting the length of the ICEA building along the East-West axis. The building's tower is characterized by the tower which has a layout that balances the natural lighting and ventilation.

- **Building 3**
  - **Building axis** runs slightly off the East-West axis.
  - The length of the building therefore faces the North-West and South-East facade reducing the surface area of the building.
  - **The architect** maximizes the facade by orienting the length of the Norwich Union tower.

### STRATEGIES

- **Facades**
  - Sun shading along glazed facades
  - Long extended canopies

- **Horizontal and vertical brise-soleil**
  - Use of permanent louvred vents

- **Podium**
  - Location of building services along West-facing facade

- **Walkways**
  - Shaded walkways/hallways that layer the spaces along the podium.

- **Use of high thermal mass**
  - Use of operable windows

- **Location of building services along West-facing facade**
  - Smooth external finishes

### BUILDING ORIENTATION (SUN MOVEMENT)

- **Jan**
  - **60°**
- **Feb**
  - **60°**
- **Mar**
  - **60°**
- **Apr**
  - **120°**
- **May**
  - **120°**
- **Jun**
  - **120°**
- **Jul**
  - **120°**
- **Aug**
  - **120°**
- **Sep**
  - **120°**
- **Oct**
  - **0°**
- **Nov**
  - **0°**
- **Dec**
  - **0°**

### BUILDING CHARACTER

- **Four-story, deep-plan building.**
  - The horizontal shades and undulating south-facing facade defines the building character.

- **The South-West facade experiences the highest insolation levels and is also the most glazed.**
  - **The architect** sunshades the South-West facade, most heavily using horizontal shades and orienting the roof towards the South.

- **The length of the tower is the sun shading strategy used to control heat gain.**

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- **Jun**
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- **Oct**
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  - **120°**
- **Jul**
  - **120°**
- **Aug**
  - **120°**
- **Sep**
  - **120°**
- **Oct**
  - **0°**
- **Nov**
  - **0°**
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  - **120°**
- **Jun**
  - **120°**
- **Jul**
  - **120°**
- **Aug**
  - **120°**
- **Sep**
  - **120°**
- **Oct**
  - **0°**
- **Nov**
  - **0°**
- **Dec**
  - **0°**

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  - **The architect** sunshades the South-West facade, most heavily using horizontal shades and orienting the roof towards the South.

- **The length of the tower is the sun shading strategy used to control heat gain.**
Building ANALYSIS IN RELATION TO HEAT CONTROL AND COOLING

1. Building orientation The architect organises the building such that in length rare parallel to the railway line and is therefore oriented along the East-West axis approximately. The general orientation of Norwich Union at 27° off the East-West axis. The tower is oriented such that the facade remains protected from direct sun from the East and West.

2. Width of building The width of the tower is oriented such that the facade remains protected from direct sun from the East and West.

3. Orientation and positioning of windows The area of glazed areas on the Norwich Union Building is relatively high. The coverage of the glazed areas on Norwich Union is 28%. The central location of the corridor does not promote sufficient and direct light spreads. Light entering the offices is horizontally shaded. Air movement is more difficult, natural light is directed to light the corridor and inhibits cross ventilation. To counter this the architect uses sun shading and the minimization of glazed area.

4. Location of non-habitable spaces The North and South facing facades are both characterised by horizontal and vertical sunshades in front of each facade. However, the motion of the facade that lights the corridor is glazed with no sun shades.

On the North facade a concrete lattice is located along the curvilinear wall on the East and West facades but do not have sun shades. Windows located along the East facade are naturally lit by the windows on the South and North facades but do not have sun shades. The facade along the West facade are sun shaded by a concrete lattice above the door to protect it from rain. Increased heat gain through the glass is thus avoided.

To counter this the architect uses sun shading and the minimization of glazed area.

Air movement is more difficult, natural light is directed to light the corridor and inhibits cross ventilation. To counter this the architect uses sun shading and the minimization of glazed area.

South facing facade of Norwich Union

Solar control devices

Location of window openings

The West facade has no openings. On the East facing facade, the only opening is a door along the corridor wall on the 7th floor. A small window is located above the door to protect it from rain. This measure protects the building from the hot East and West sun.

Location of non-habitable spaces along the East and West

All services are lift lobby, stair walls and washrooms are located along the east and west facades. The window located along the East facade are naturally lit by the windows on the South and North facades. The door to the lift lobby are naturally lit. The facade along the West facade are sun shaded by a concrete lattice to protect the building from the hot East and West suns.

Location of high thermal mass

The wall thickness of the solid parts of the internal walls is 12.2 mm. The wall is made from reinforced concrete which has a modulating factor of 0.8 which is sufficient for Nairobi since Nairobi receives intense sun from 0900 hours to 1700 hours.

In use of light colored finishes

The East facing facade. Amyas Connell uses a light colored smooth finish. The West facade, has light colored plaster finish on the facade of the smaller external cube, while the larger cube is lined with light colored tile in a pattern. Amyas Connell has used characteristic colourful pattern of tiles along the walls of the North and South facades. Sensitivity to the East and West facades reduces heat instead of being absorbed.

Building DESCRIPTION

The general orientation of Norwich Union at 27° off the East-West axis. The central location of the corridor does not promote sufficient and direct light spreads. Light entering the offices is horizontally shaded. Air movement is more difficult, natural light is directed to light the corridor and inhibits cross ventilation. To counter this the architect uses sun shading and the minimization of glazed area.
Social cultural buildings sampled for discussion in this study are social buildings however their promotion of cultural aspects of the area they are located is mostly in their function and not necessarily expressed in their form. In Tanzania a few examples include Kilimanjaro Native Cooperative Union Cultural Centre in Moshi by Ernst May in 1956, Young Women's Christian Association (YWCA) in Tanzania by Charles Alfred 'Peter' Bransgrove in 1969 (fig.4-92), Uganda National Theatre by Peatfield & Bodgener and Kenya National Theatre designed by Dorothy Hughes.

Young Women's Christian Association (YWCA) in Tanzania was designed by Charles Alfred 'Peter' Bransgrove in 1969 along the shores of the Indian Ocean. It has two storeys above the ground level which is characterized by columns which give the feeling of the porosity of modern buildings which have pilotis. The entire building is a composition of three white washed cubes arranged perpendicular to each other. Its form is characterized by the sun shading devices located along each façade (fig.4-93). To respond to the high temperatures and humidity, Architect Bransgrove designed the building such that no glazed façade was exposed to direct sun. The concrete lattice screen used on the East facing façade prevents heat gain by cutting off direct sun from heating the wall and creating privacy to the balcony which is used to access the rooms (fig.4-94).
Adjacent to the Ugandan parliament is the Uganda National Theatre built in 1956 by Peatfield & Bodgener (fig. 4.96). It was designed to promote Ugandan expressive art but its design does not proffer Ugandan culture. Its form is defined by its curvilinear front façade screened with a concrete lattice which sun shades the building’s south west facing façade (fig. 4.97). The ground level has pilotis that raise the two levels above the ground. Its design is relatively deep plan to accommodate the needs of a large gathering space.

In 1960, Dorothy Hughes, an AA trained architect designed the Kenya National Theatre (fig. 4.99). Like the Ugandan Theatre the National theatre in Nairobi did not bear a strong cultural identity to Kenya and rather served as a European theatre designed for Europeans. To control heat gain, Dorothy Hughes used high thermal mass and minimal openings.
In 1949 a cooperative Union of Chagga Coffee Farmers commissioned Architect Ernst May to design a cultural centre in Moshi City in Tanzania. The centre was to function as a multifunctional cultural and commercial centre for all races.

The building designed consists of three blocks arranged around a courtyard linked to each other by stair wells encased in cubic blocks (fig.4-100). Initially Ernst May designed the centre such that it would include manufacturing and warehouse facilities, however these were never built. The central and eastern blocks house the retail shops on the ground level and offices and a library on the floor above. The central block has additional floors above the first floor which house the hostels. The more public spaces are located within the third block which houses the restaurant, a museum, an auditorium and meeting rooms.

The orientation of the building specifically the central block is such that the longer façade faces the North; away from direct sun and also facing the scenic Mount Kilimanjaro. Vertical and horizontal sunshades are lined along each façade to prevent heat gain through the glazed areas (fig. 4-101). Along the stairwells perforated screens are used to block the space from direct sun while ensuring there is continuous air movement.
**ANALYSIS OF SOCIAL CULTURAL BUILDINGS**

**BUILDING ORIENTATION (SUN MOVEMENT)**

<table>
<thead>
<tr>
<th>Climate</th>
<th>Location</th>
<th>Year Built</th>
<th>Architect Name</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tanzania</td>
<td>Moshi</td>
<td>1969</td>
<td>Ernst May</td>
</tr>
<tr>
<td>Uganda</td>
<td>Kampala, Uganda</td>
<td>2016</td>
<td></td>
</tr>
<tr>
<td>Kenya</td>
<td>Nairobi</td>
<td>1969</td>
<td></td>
</tr>
<tr>
<td>Tanzania</td>
<td></td>
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</tr>
</tbody>
</table>

**BUILDING CHARACTER**

- YWCA is a three story building comprising of four main blocks arranged around a central courtyard. The architect minimizes the number of glazed areas and openings limiting solar heat gain. The long facade is therefore exposed to minimal Eastern and Western sun. Natural ventilation is provided using operable windows and to control heat gain, few openings are used.

- LPJ building is the theatre seating area oriented primarily along the South axis. The long facade is therefore exposed to Eastern and Western sun. The theatre is a deep plan building mainly because of the volume required for the auditorium seating. Natural ventilation is provided using operable windows and to control heat gain, few openings are used.

- Kenya National theatre is a deep plan building mainly because of the volume required for the auditorium seating. Natural ventilation is provided using operable windows and to control heat gain, few openings are used.

**REBATEMENT OF HEAT GAIN - SOLAR CONTROL PROVIDING COOLING - VENTILATION STRATEGIES**

- The centre comprises three narrow plan blocks and the fourth is the auditorium which is a deep plan space. The courtyard arrangement serves to improve natural lighting and ventilation. The sun shades elements define the buildings character.

- Use of permanent louvered vents

- Use of high thermal mass

- Minimal window openings on the East and West facing facades

- Smooth light colored finishes

- Use of operable windows

- Sun shading along glazed facades

- Sun shading along glazed facades

- Location of building services along West facade

- Use of high thermal mass

- Location of operable windows on East and West facade

- Use of high thermal mass

- Minimal window openings on East and West facade

- Smooth light colored finishes

- Use of operable windows

- Extended canopies

- Use of permanent louvered vents

- Layering - Concrete lattice screen shading external glazed facade and walllite

- Use of high thermal mass

- Minimal window openings on the East and West facing facades

- Smooth light colored finishes

- Use of operable windows

- Sun shading along glazed facades

- Sun shading along glazed facades

- Location of building services along West facade

- Use of high thermal mass

- Minimal window openings on East and West facade

- Smooth light colored finishes

- Use of operable windows

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- Extended canopies

- Use of high thermal mass

- Minimal window openings on East and West facade

- Smooth light colored finishes

- Use of operable windows
The buildings are oriented such that they run along Old Moshi Road which is approximately cutting off the North axis.

The cultural center uses sun shading devices and covers to shade interior spaces. The design of sun shades used by Ernst May in the center vary depending on the orientation of the facade. Ernst May shades the East and West facing facades more strongly than the North and South facing facades. The West facing windows are lined with horizontal shading devices that are hung off the window at an angle. The amount of sun cut off is set for a longer period of time during the day. Covers are also used along the sterilation area to shade the building from direct heat.

The design of sun shades is influenced by the orientation of the facade and the amount of light that needs to be cut off.

Kulterman (2011) showed that the West facing windows are lined with horizontal shading devices that are hung off the window at an angle. The amount of sun cut off is set for a longer period of time during the day. Covers are also used along the sterilation area to shade the building from direct heat.

The cultural center uses sun shading devices and covers to shade interior spaces. The design of sun shades used by Ernst May in the center vary depending on the orientation of the facade. Ernst May shades the East and West facing facades more strongly than the North and South facing facades. The West facing windows are lined with horizontal shading devices that are hung off the window at an angle. The amount of sun cut off is set for a longer period of time during the day. Covers are also used along the sterilation area to shade the building from direct heat.

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The white washed walls of the cultural center reflect heat off the wall to the interior of the cultural center from heat gain for at least six hours. The thickness of the walls is 350 mm. The cultural center has openings with glazing facing North. Use of light colored finishes, sun shades and the North orientation of the openings use of High Thermal Mass Location of non habitable spaces along the East and West facade and in the auditorium along the South East facade. The orienentation of the openings is along the South East facade. Non habitable spaces are located to the terminnation of the blocks. The non habitable spaces are used as buffer spaces to the terminnation of the blocks. The Schlottmann Villa-1937.

3.4.2 DR. ERNST MAY

I. History, Academic and career background, networks and Design philosophy

He was born in Frankfurt 20th July 1886. He studied in Darmstadt and subsequently left Frankfurt to study architecture at University College, London in 1907. However, he was called back to Germany do his military service and it was his experience here that he got influenced by architects who worked in the desert to bring about a renaissance in architecture. At the end of his service he studied architecture at the Technische Hochschule in Munich under notable architect like Theodor Fischer. In 1925 in Frankfurt he posited Dr. Ernst May returned to London and worked under Architek and Urban Planners Sir Cecil Rainsorn and instructed with reknowned German architect Sir Erwin Heimann while working on the Garden City project.

In 1913, May completed his studies in Munich and after practicing in several firms became an architect in Frankfurt in 1913 until 1929. At that time Met listed several of his colleagues to work with him among them Walter Gropius. Opus 120(27) notes that by 1926, May had constructed about 56,500 square meter of housing. His contribution to modern architecture is also seen in his membership of CIAM where he was the Vice President and organized CIAM II in Frankfurt in 1929. After a failed project in USSR in 1935, May was killed in a plane crash in 1935. His contribution to modern architecture is seen clearly in projects such as Aga Khan Maternity Clinic in Kisumu, Elverston Residence in Gilgil, Hoffmann House in Kampala, and Young Men’s Christian Association Shauri Moyo Flats in Nairobi.

II. Contribution to Tropical Modern Architecture

In the early 1930s Ernst May founded the Deutscher Wohnungsbau (German Housing Society) and the Deutscher Werkbund, an organization that brought together architects, artists and craftspeople. May was a founding member of the Werkbund and played a key role in organizing CIAM (Congress Internationaux d’Architecture Moderne), an international organization of architects that focused on modern architecture. May’s work was characterized by his emphasis on simplicity, functionality, and mass production. He believed in using standardized components and modular construction techniques to achieve efficient and affordable housing solutions.

In the early 1930s, May began to develop his ideas for what he called “mass-production architecture.” He envisioned a system of prefabricated building components that could be quickly and easily assembled on site. This approach was intended to reduce costs and improve the quality of construction. May’s designs were characterized by simple, rectangular shapes and the use of light, airy materials such as concrete and glass. His work was influenced by the ideas of the Bauhaus, a German art and design school, and by the modernist architecture of Frank Lloyd Wright.

In the late 1930s, May returned to London and worked under the famous architect Sir Erwin Heimann. During this time, May continued to develop his ideas for mass-production architecture. He designed several housing projects in London, including the Drury Lane Housing Project and the Day’s Hotel. May also taught at the London School of Architecture and Design, where he lectured on modern architecture.

May’s work was widely influential, and his ideas were adopted by architects around the world. He continued to lecture and write about modern architecture until his death in 1937. His legacy is remembered as a pioneer of modern architecture and a leader in the development of mass-production housing.
Sampled buildings in this study that explore the variety/diversity of ways modernism was expressed in religious buildings include: St. Thomas Church initially known as Krapf Rebman Memorial Church (1960) in Kilifi, Christian Leadership Centre also known as Ufungamano (1974), Joint Christian Chapel at the University of Dar es Salaam (1975) by Architect Almeida and Holy Family Basilica (1962) in Nairobi by Architect Dorothy Hughes.

Anthony Almeida’s inclusion of sun shading devices in the design of the Joint Christian Chapel and its apparent modern design make it a tropical modern building (fig.4.116 & fig.4.119). The form may have been influenced by the fact that the chapel was intended to be able to accommodate multiple Christian denominations. The Greek cross layout used for its design allows that one of the four arms can be closed off to allow a smaller meeting to be held as the larger partitioned area is being used. The interior space is an expansive double volume space which improves air movement.

Fig. 4.116: Joint Christian Chapel at the University of Dar es Salaam (1975) by Architect Almeida
Source: www.akilipix.com

Fig. 4.117: Interior of Joint Christian Chapel at the University of Dar es Salaam (1975) by Architect Almeida
Source: www.akilipix.com

Fig. 4.118: Interior of Joint Christian Chapel showing the space between the roof and wall used to ventilate the chapel. Source: www.akilipix.com

Fig. 4.119: Vertical fins
Source: www.akilipix.com
The external walls are lined with vertical fins and narrow window openings between each pair of fins. The windows used have colored glass which add to the aura of the church relating the modern building with ‘traditional’ models of churches.

At the University of Nairobi, Richard Hughes designed the Christian Leadership Centre now known as Ufungamano (fig. 4-120). The building form is cubic with undulating walls which Richard Hughes uses to orient the windows away from direct sun and also influence the acoustics within the Ufungamano auditorium. The structure is also clad in brick which is locally sourced, has good thermal control properties and is excellent for noise control.

The layout of Ufungamano is such that its length runs along the North South axis and therefore in the architect had to control heat gain from the East and West. Like he did with the Halls of residence, which are located very close to the hall, Hughes offset the part of thee façade with window openings such that they face South.

A more conventional plan of a religious building is the Holy Family Basilica in Nairobi by AA trained modern architect Dorothy Hughes. The building has a transept layout with a 31 metre tall bell tower. The roof is constructed using a grid of intersecting beams which carry the concrete slab while giving the interior a similar finish to that of the the Joint Christian Church by Almeida and other catholic churches around the world such as Sainte-Chapelle in Paris, France.

Being within Nairobi CBD, the churches orientation is affected by the orientation of streets. Its orientation has its longer façade running slightly off the East-West axis. The volume of the internal space allows for cooling and promotes temperature control since the warm air rises and gets expelled through the high level vents (fig. 4-121). Like Almeida, Dorothy uses the colored glass to create the ambience associated with churches when the glass transmits light into the church. Along the windows, in the interior space of the church, Dorothy uses light shelves to reflect light even deeper into the church.

![Fig. 4.120: Ufungamano (1973) by Richard Hughes showing orientation of the windows away from direct sun](source:artmatters.info)

![Fig. 4.121: Interior of Holy Family Basilica (1960) by Dorothy Hughes showing volume of the internal space and impact of high level natural lighting](source:architecture.com)
The design of Krapf Rebman Memorial Church in Kilifi by Richard Hughes also has a very unconventional look compared to the other transept shaped church design and its layout has a semblance to Ron Champ by Le Corbusier (fig. 4.122). The church is located approximately 100 meters from the Indian Ocean. Its layout is generally a rectangular plan abound by two curvilinear walls on the East and West façade with a bell towering over the single story structure (fig. 4.123). The curvilinear walls have a high thermal mass and were designed using locally sourced coral which is essential in allowing humid air to move out of the building.

The openings are located on the north east and south west facing facades and are shaded by an extended roof eave. The church has no glazed openings and instead utilizes timber louvered vents on the doors and concrete lattices along the walls to screen views and allow cross ventilation (fig. 4.124). The church borrows from local design in the design of the roof where a gap is left between the wall and roof that allows for cross ventilation and promotes air movement.

Fig. 4.122: Krapf Rebman Church in Kilifi (1960) by Richard Hughes (with extension)
Source: St. Thomas ACK, Kilifi Ministries

Fig. 4.123: Orientation and layout of Krapf Rebman Church in Kilifi built in 1960 by Richard Hughes
Source: Kultermann (1969)

Fig. 4.124: South facing façade of the of Krapf Rebman Church lined with timber louver doors for ventilation
Source: St. Thomas ACK, Kilifi Ministries
ANALYSIS OF RELIGIOUS BUILDINGS

<table>
<thead>
<tr>
<th>Climate</th>
<th>Location</th>
<th>Year Built</th>
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- The church has four arms arranged perpendicularly to each other oriented off the cardinal axis by approximately 45°.
- The architect maximizes each facade using vertical sun shades and uses small narrow openings.

- The church is deep plan because of the volume required to seat a large gathering and therefore ventilation and heat control is provided using extensive louvred openings on the walls and a roof opening created between the roof and the roof.
- The character of the church is created by the array of vertical sun shades along the facade and white washed walls reminiscent of modernist architecture.

- Ufungamano has its main axis running along the North-East to South-West axis.
- The length of each block is therefore exposed to East and West sun.
- The architect protects the building from heat gain by orienting the glazed parts of the facade towards the North face.

- Krapf Rebam Memorial Church has its main axis running along the East-West axis.
- The architect further protects the church from heat gain by using narrow openings along the length of the building.

- The church has its main axis running along the North-East to South-West axis.
- The church has its main axis running along the East-West axis.
- The church has its main axis running along the East-West axis.

- The church in Kilifi is narrow plan and therefore allows for cross ventilation.
- Ventilation and heat control is provided using timber louvres along the length of the building.
- The character of the church is defined by the thick curvilinear coral walls and distinctive verticality created by the water tower.

- The character of the church is created by the water tower.
- The church is deep plan because of the volume required to seat a large gathering.
- Ventilation and heat control is provided using small operable window openings on the walls.
- The volume of the church also limits internal discomfort since the air volume in the church can not be all heated.

- The church in Dar es Salaam is narrow plan layout allowing cross ventilation.
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Building analysis in relation to heat control and cooling:

1. Building orientation in relation to sun movement:
The church is orientated with its length slightly off the North-South axis. This orientation was chosen to take advantage of cross ventilation and to minimize excessive heat gain from the sun.

2. Provision of natural ventilation:
   - Louvers and concrete lattice screens are used for solar control devices.
   - The church has no windows in the bell tower and clock tower, which is located along the North East facing facade.
   - The church has no glass and has few openings on the North East and South West facing facades.
   - The Chapel has no windows.
   - Architect Hughes used several strategies to control heat gain. These include:
     - Louvers and concrete lattice screens.
     - High thermal mass walls.
     - The thickness of the walls ranges from 200 mm to 550 mm, which may be the most impactful since the church has glass walls on all shaded using louvers.
     - Other openings include louvers along the North West and South East facing facades.

3. Location of window openings:
   - The Chapel has no windows. Instead, Architect Hughes used (4) double doors with timber louvres to light and ventilate the church. Other openings include louvers along the North East and South West facing facades. These increase air movement and promote cooling.

4. Location of habitable spaces along the East and West:
   - The church has no non-habitable spaces located within it. The tower water cum clock tower is located along the North East facing facade. It buffers the church from hot East Sun - which may be the most impactful since the church has church services in the morning hours.
   - Use of high thermal mass:
     - The church walls are made from coral stone which is ideal for controlling humidity in humid environments.
     - The church walls are thick, with a range from 200 mm to 550 mm thick, which may be the most impactful since the church has glass walls on all shaded using louvers.
     - The church walls are thick and reflect heat. The high thermal mass prevents excessive heat gain from the East and West sun.

5. Use of light colored finishes:
   - The facade of the church is light coloured. The external walls which are made from coral stone have been given a light finish. However, the rough textures increase the surface area for heat desorption. Since the walls are thick, the time lag and reflective color reduces heat gain into the building.

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4.6.2 HENRY RICHARD HUGHES

I. History: Academic and career background, networks and design philosophy

Richard Hughes was born in London on 4th July 1926 and moved to Kenya with his family in 1937. He studied in Kenya and South Africa and from 1944 to 1946, Hughes was a Corporal in the Kenya Regiment attached to Royal Engineers. Thereafter, he returned to London to study architecture at the AA School between 1947 and 1953. It is important to note that it was during this period that discussions on tropical architecture and hygiene were being emphasized on and no doubt impacted on Hughes career. On completion of his studies at the AA School, Hughes moved to USA to work for Henry J. Ludorf in Hartford. Hughes returned to Kenya and from 1955 to 1957, he worked at Blackburn and Norburn in Nairobi. In 1957, Hughes opened Richard Hughes and Partners which run until 1986. During that period, Hughes had a brief partnership with Architect Brian Arthur Smith in 1976 but it ended by 1978.

II. Contribution to Tropical Modern Architecture:

Hughes contributed to books on architecture and articles published in East Africa such as Build Kenya Magazine, Architecture Review Magazine, Architects Journal, New Common Wealth and Habitat Handbook (1982). A notable article published by Hughes is ‘The Logic of Geometry’ published in Build Kenya Magazine. In it, the logic behind the design of ICEA can be seen as he postulates that geometry can be used to influence critical factors such as orientation of buildings in relation to the sun’s movement.

In 1978, Hughes was a consultant for United Nations Environmental Programs on Human Settlements and at the United Nations Centre for Human Settlements in 1979 where he was consulted on building materials and construction technologies in developing countries. Having already worked intensively with local materials such as brick in the design of Ufungamano House at the University of Nairobi in 1974 and with coral in 1960 at the Krapf Rebman Memorial church in Kilifi, among other projects, Hughes contribution was quite significant.

Hughes also participated in several exhibitions that served as idea sharing platforms on architecture in the tropics. They include an exhibition in 1953 at the Overseas League and Imperial Institution.
III. Notable projects in Africa include:

i. Chapel at Alliance Girls High School in Nairobi; 1958-1959
ii. Krapf Rebman memorial Church (now St. Thomas ACK Church) in Kilifi; 1960
iii. Chapel at Alliance High School in Nairobi; 1962–1972
iv. Carey Francis Memorial Lecture Theatre at Alliance High School in Kikuyu
v. Young Men's Christian Association (YMCA) Chapel in Nairobi; 1962
vi. Watamu Beach Hotel in Malindi, Kenya; 1966
vii. Telecomm House in Kampala, Uganda; 1970
ix. Christian Leadership Centre (now Ufungamano Building) in University of Nairobi, Kenya; 1974
x. Student Halls of Residence—Hall 9 & Hall 13 in the University of Nairobi, Kenya
xi. Mombasa Air Terminal in Mombasa, Kenya (Designed along with Gollins, Melvin, Ward and Partners); 1977
xii. ICEA Building in Nairobi, Kenya; 1981
xiii. Development House Phase I and Phase II (1980) in Nairobi, Kenya
xiv. Bank of Oman, Khartoum, Sudan in 1982
xv. Bank of Oman in Nairobi, Kenya; 1981
xvi. Embassy of Japan, Nairobi, Kenya; 1981
xvii. Sumitomo Corporation in Nairobi, Kenya; 1982
xviii. Kenya Commercial Bank in Lodwar, Kenya; 1984
xix. Staff Housing for Kenya Commercial Bank in Nairobi, Kenya; 1984
4.7 SUMMARY OF FINDINGS

The data collected and analysed illustrates that Tropical Modern Architecture in East Africa was prevalent between 1940 and 1980. The architecture seems to undergo and evolution in terms of improvement of thermal control strategies used. Architects practicing in East Africa before 1940, seem to go through an experimentation of thermal control strategies by adjusting the building's geometry and limiting the number of glazed areas. This is apparent in the works of Ernst May in Kenwood House in Nairobi (1937) and City House in Kampala (1938).

After 1940, experimentation with the Corbusian brise soleil is dominant and the variation in size and shape reveals an attempt at finding what amount of shading is sufficient in the tropics (fig. 4.140). The analysed case studies reveal that architects used overhangs, balconies and canopies to shade glazed facades.

The approach at controlling heat in the 1950’s and 1960’s is seen to evolve dramatically. As seen from the building analysis of different typologies, architects start to use concrete lattice screens and louvers to shade building. Amyas Connell while designing Parliament of Kenya Building in 1952, realizes that Le Corbusier's brise soleil are not entirely effective in cutting out the hot tropical sun. In the second phase of the Parliament Buildings, Amyas uses less windows and uses louvers more intensely. Architect Bransgrove, who started practicing in Dar es Salaam in 1947, uses the louvers and concrete lattice screens in front of glazed facades in several projects. Bransgrove believed the louvers to be the solution for heat control in the tropics and patents the a louvre block design in 1956.

The 1960’s change the way the Corbusian brise soleil are used because the calculations for the exact size of sun shade device needed is found by O. J. Perira at the AA School. Jane Drew and Maxwell fry also publish their book on tropical and therefor the buildings put up during this period are more resolved in terms of responsiveness to climatic issues.

Chapter four reveals notable architects and architecture in East Africa between 1940 and 1980 that contributed to the tropical modern architecture.
4.7.1 OTHER NOTABLE PIONEERS OF TROPICAL MODERN ARCHITECTURE IN EAST AFRICA BETWEEN 1940 AND 1980

Besides the architects discussed in detail in part 4.6 of this study, this study found that some of the other Tropical Modernist architects who contributed to the Tropical Modern Architecture in East Africa between 1940 and 1980 were:

i. Architect Dorothy Hughes (who opened the practice Hughes and Polkinghorne in Nairobi in 1933)

ii. Architect Charles A. P. Bransgrove (who opened his practice in Dar es Salaam in 1948)

iii. Architect Anthony Almeida (who opened his firm in Tanzania in 1950)

iv. Architects Thomas Peatfield and Geoffrey Bodgener (who opened a firm—Peatfield and Bodgener in Kampala around 1956)

v. Architect David Mutiso (who opened his firm Mutiso Menezes International in Nairobi in 1974)

vi. Norman and Dawban Architects (established a practice in Dar es Salaam in the 1960’s)

vii. Architect Graham McCullough (founder member of TRIAD architects in Nairobi in 1963)


ix. Architect Karl Henrik Nostvic (who worked in Kenya under the Ministry of Public Works from 1966 and later opened an architectural practice)
Eugenie Dorothy Hughes was born on 26th July 1910 and in 1913, her family moved to Eldoret Uasin Gishu County. In 1926, Dorothy went to study at the AA School until 1931 when she completed her studies. After working in Westminster briefly on the Luytens housing Project she came back to Kenya in 1933. Dorothy started practicing architecture in Kenya from as early as 1933 when she set up Hughes and Polkinghorne, an architectural practice in Nairobi, with Architect Dick Polkinghorne. Her architecture displays a leaning towards climate responsive architecture and strong modern forms. A few of her projects include:

i. Kenya National Theatre (1959)
ii. Holy Family Basilica in Nairobi (1960)
iii. Egerton College in Eldoret (1984)
iv. St Mary's School (fig. 4.141) in Nairobi
v. F1 aka Mad House in Nairobi (1960)
vi. Golden Beach Hotel (fig. 4.142) in Diani
vii. Nakuru War Memorial Hospital
viii. Rift Valley Sports Club
ix. Princess Elizabeth Hospital
x. Muragi House among others

Fig. 4.141: St. Mary’s School, Nairobi by Architect Dorothy Hughes
The school has four narrow plan blocks arranged around a courtyard and facilitate passive cooling, ventilation and has balconies that shade the walkways
Source: http://rochehealthcenter.weebly.com

Fig. 4.142: Golden Beach Hotel in Diani is built using coral to control humidity and has minimal glazing to limit heat gain.
Source: www.latisnetwork.com
Architect Charles Alfred Peter Bransgrove moved to Tanzania from England to work on the Tanganyika Groundnut Scheme as Chief architect in 1947. The move came ten years after Ernst May set up his firm in Nairobi and in the same year Amyas Connell moved to Tanzania. The Tanganyika Groundnut Scheme failed and in 1948, the Overseas Food Cooperation, which was the company overseeing the project, gave Bransgrove land in Dar es Salaam as payment for his services.

In 1948, Bransgrove settled in Dar es Salaam and opened the first independent architectural practice in Tanzania. Among his first employees were Architect Trigger Hastings of French and Hastings and H. L. Shah. Both Shah and Hastings have contributed greatly to architecture in East Africa since then. Another notable contribution to tropical modern architecture by Bransgrove is his patented louver block which was designed for use in the tropics. It was patented on 10th July 1956.

Notable projects by Bransgrove include:

i. Tanganyika Standard Offices in Dar es Salaam (built in 1952; now demolished)
ii. Barclays Bank DCO in Dar es Salaam (1957)
iii. Government European School; now known as Bunge Primary School in Dar es Salaam (1957)
iv. British Legion Offices and Hostel in Dar es Salaam (1957)
v. Pamba House in Dar es Salaam (1958)
vi. Libya St. Post Office in Dar es Salaam (1958)
vii. First Permanent Building Society in Dar es Salaam (1961)
viii. Luther House in Dar es Salaam (1963)
x. Young Women’s Christian Association (YWCA) in Dar es Salaam, among others.
In 1950, **Architect Anthony Almeida** became the first Tanzanian-born architect to open an architectural firm in Tanzania and has since contributed immeasurably to the Tropical Modern Movement using architecture, publications, exhibitions and inspiring young architects.

Anthony Almeida Bosco was born in Tanzania in 1921 and later moved to Bombay where he studies and practiced architecture until 1949, when he returned to Tanzania. In 1950 Architect Almeida opened his own practice in 1950. Almeida’s designs reflect his design philosophy which is based on climate responsive design. He emphasizes on incorporating passive design strategies to architecture.

Projects by Anthony Almeida include:

i. St Xavier School/ School for the Goan Community in Chang’ombe, Dar es Salaam (1954)
iii. Forodhani School aka St Joseph’s Catholic School in Dar es Salaam (1955–1958)
 v. Tanganyika African National Union regional Headquarters (TANU) in Tanga (1963)
vi. East African Community Regional Headquarters (EASCo) in Dar es Salaam (1965)
 vii. Central Library in Dar es Salaam (1968)
 viii. Joint Christian Chapel in Dar es Salaam (1975)
Architect Thomas Peatfield and Geoffrey Bodgener formed the partnership Peatfield and Bodgener in 1952 in London and later opened a practice in Uganda. The two architects graduated at the AA School in UK and both served in the Royal Air force during World War II.

Their contribution to the Tropical Modern Movement in East Africa is seen in the design of iconic works such as the Ugandan Parliament Building in Kampala, Uganda in 1956.

Other notable projects include but are not limited to:

i. Uganda National Theatre in Kampala (1956)
ii. Parliament of Uganda (1956)
iii. Makerere University buildings
iv. Uganda Management Institute
v. Uganda Commercial Bank (1969)
vi. Lugogo Sports Stadium
vii. Fisheries Institute in Entebbe
viii. Embassies in Uganda for Sweden, France, Norway, Iceland and Belgium
ix. Sleeping Sickness Centre
x. British High Commission
xi. Virus Research Institute
xii. Kasese Cobalt Company
xiii. British American Tobacco
xiv. Uganda Telecom Limited
xv. Ibero Coffee
xvi. LG Offices

Notable projects include:

i. International Life House in Nairobi
ii. International House in Dar es Salaam
iii. Kenindia House in Nairobi
iv. Bruce House in Nairobi (1971)
v. Jogoo House ‘B’ in Nairobi
vi. 680 Hotel in Nairobi (1972)
vii. Mombasa Intercontinental Hotel
viii. National Museums of Kenya
ix. Central Catering Unit for the University of Nairobi
x. Hostels and Dining in Chiromo Campus, University of Nairobi
xi. Hall 6, 7 and 8—Halls of Residence for University of Nairobi, Main Campus
xii. Alliance Françoise aka French Cultural Centre in Nairobi
xiii. Bomas of Kenya in Nairobi (1973)
xiv. Aberdare Country Club in Nyeri County
xv. International Livestock Research Institute (ILRI) in Kabete, Nairobi
xvi. Institute of Primate Research at Ololua Forest in Nairobi
xviii. Pan Afric Hotel in Nairobi
xix. Voi Safari Lodge
Architect Karl Henrik Nostvic was a Norwegian architect employed at the Kenya Ministry of Works under renowned Kenyan architect, David Mutiso. Architect Nostvic was among the first experts sent to Kenya by the Norwegian Government in 1965. He later moved to Kenya and opened a practice.

Notable projects include:

i. Kenyatta International Conference Centre (initially designed to house the Kenya African national Union headquarters) in Nairobi (1966–1973)


iii. Canteen and Workshop for police vehicles, Kiambu in Nairobi (1966)


v. Loreto Msongari, Upper Primary School building in Nairobi (1970)


vii. Kimathi Institute of Technology in Nyeri (1972)

viii. Science Building for University of Nairobi (1973)


Architects Henry Nigel Norman and Graham Richards Dawbarn established Norman and Dawbarn architects between 1933 and 1935. Norman was born in 1897 and served as a consulting civil engineer and Royal Air Force officer in the 1920’s. Graham was born in 1893 and studied at Cambridge University and completed his architectural studies in 1914. Graham also served in the Royal Flying Corps, which is probably where the two met. They established an office in Dar es Salaam, in the 1960's and embarked on the design of University of Dar es Salaam among other projects.

Notable projects include:

i. University of Dar es Salaam

ii. Main Library building for Makerere University in Kampala (1952)

Architect Graham McCullough is one of the founding members of TRIAD Architects founded in 1963 in Nairobi with Architect Amyas Connell. Graham McCullough is the founder of Architectural Association of Kenya (AAK), Professional Centre in Nairobi.

Notable projects include:

i. St. Andrews Church, Nairobi (1949)

ii. Kenya Science Teachers Training College (now Kenya Science Campus, University of Nairobi) in Nairobi (1965)

iii. Hyslop Building for University of Nairobi (1960)

iv. Education building for University of Nairobi (1968)
CHAPTER FIVE
CONCLUSIONS AND RECOMMENDATIONS

5.0 Introduction
5.1 Conclusions
5.2 Recommendations
5.0 INTRODUCTION

This research was carried out to explain tropical modern architecture and its impact on climate responsive design in East Africa. It achieves this by establishing the origin, spread and development of tropical modern architecture and what led to its eventual decline.

From the literature the author reviewed and data collected in the field, conclusions were made based on the objectives of this study which are:

i. To find out the key pioneers and protagonists in the establishment of tropical modern architecture;
ii. To establish the characteristics of tropical modern architecture that made it stand out as climate responsive;
iii. To establish the origin, spread and development of tropical modern architecture and to investigate why the drive towards tropical modern architecture diminished approximately 25 years after the East African countries attained independence;

From the research objectives set out, three main conclusions were made. They are:

i. Notable modern architects practicing in the tropics between 1940 and 1980 were responsible for the spread of tropical modern architecture in the tropics. This spread was facilitated by the networks they established which allowed them to collaborate and share information.

ii. Tropical modern buildings have similar climate responsive strategies aimed at providing cooling and preventing heat gain. The design elements and character of the buildings used to control heat gain and provide cooling, give the buildings their unique character that revealed their sensitivity to climate in the tropics.

iii. The origin, spread and development of tropical modern architecture can be attributed to the networks formed by the pioneers of tropical modernism that allowed them to develop climate responsive strategies and integrate them with modernist design principles. The significant role played by the AA School of Architecture, CIAM and MARS Group members and the development of the Le Corbusian Brise Soleil are found to be the cornerstones of the development of tropical modern architecture. The decline of tropical modern architecture was caused by the removal of the structures developed by the pioneers that initially gave the drive towards climate responsive design momentum and the failure of stakeholders of the construction industry to put in place structures that could ensure its continuity.
5.1 CONCLUSIONS

The key pioneers and protagonists in the establishment of tropical modern architecture in the tropics were modern architects practicing in the tropics between 1940 and 1980. Through the analysis of tropical modern architecture, modern architects and their networks in West Africa (using case studies in Nigeria and Ghana), Southern Asia (using case studies in India and Sri Lanka), South America (using case studies in Brazil) and East Africa (using case studies in Kenya, Uganda and Tanzania), the author found the key tropical modern architects who were the pioneers of tropical modern architecture.

The pioneers of tropical modern architecture in West Africa were Jane Drew, Maxwell Fry, Leo De Syllas, James Cubitt, John Godwin, Gillian Hopwood, Kenneth Scott, Olumuyiwa Oluwole, Alan Vaughan, Jose Addo and Ifeanyi Ekwueme. From the analysis of tropical modern architecture in Nigeria and Ghana, the study found that tropical modern architecture advanced significantly due to the links and networks formed between its pioneers. Their backgrounds and architecture reveal the influence the networks had on their approach to designing in the tropics.

The study finds that the pioneers of tropical modern architecture in India and Sri Lanka were Balkrishna Doshi, Achyut Kanvinde, Minnette de Silva, Raj Rewal, Geoffrey Bawa and Charles Correa. The study also found that local architects who designed modern architecture in India developed modern regional architecture with the aim to deal with India’s climate and cultural issues specific to the region. The architecture developed by these architects gave identity to tropical modern architecture in Southern Asia.

This study established that, just like India, the pioneers of tropical modern architecture in Brazil were mainly local architects. The notable pioneers of tropical modern architecture in Brazil include: Lucio Costa, Carlos Leao, Jorge Moriera, Oscar Niemeyer and Affonso Reidy. However, From the investigation carried out on tropical modern architecture in Brazil, the author found that unlike West Africa, East Africa and Southern Asia, tropical modern architects in Brazil did not have as many networks with other modern architects and modernist groups. Minimal interaction with the pioneers of tropical modern architects in Europe and modernist groups lead to the development of modern architecture through experimentation using limited information on tropical modern architectural trends.
The pioneers of tropical modern architecture in East Africa were Dorothy Hughes, Ernst May, Charles A. P. Bransgrove, Anthony Almeida, Thomas Peatfield, Geoffrey Bodgener, Henry Richard Hughes, David Mutiso, Henry N. Norman, Graham R. Dawbarn, Amyas Connell, Graham McCullough, Robert Marshall and Karl Henrik Nostvic. Analysis of their architecture and background revealed the significant role international networks had on the development and spread of tropical modern architecture.

<table>
<thead>
<tr>
<th>ARCHITECT</th>
<th>PRACTICE</th>
<th>YEAR OPENED</th>
</tr>
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<tbody>
<tr>
<td>Dorothy Hughes</td>
<td>opened the practice - Hughes and Polkinghorne in Nairobi</td>
<td>1933</td>
</tr>
<tr>
<td>Ernst May</td>
<td>opened the practice Ernst may and Partners in Nairobi</td>
<td>1937</td>
</tr>
<tr>
<td>Charles A. P. Bransgrove</td>
<td>opened his practice in Dar es Salaam</td>
<td>1948</td>
</tr>
<tr>
<td>Anthony Almeida</td>
<td>opened his firm in Tanzania</td>
<td>1950</td>
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<tr>
<td>Thomas Peatfield</td>
<td></td>
<td></td>
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<tr>
<td>Geoffrey Bodgener</td>
<td>opened the firm— Peatfield and Bodgener in Kampala</td>
<td>1950's</td>
</tr>
<tr>
<td>Henry Richard Hughes</td>
<td>opened Richard Hughes and Partners in Nairobi</td>
<td>1957</td>
</tr>
<tr>
<td>David Mutiso</td>
<td>opened the firm Mutiso Menezes International in Nairobi</td>
<td>1974</td>
</tr>
<tr>
<td>Henry N. Norman</td>
<td>established the practice Norman and Dawbarn in Dar es Salaam</td>
<td>1960's</td>
</tr>
<tr>
<td>Graham R. Dawbarn</td>
<td></td>
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</tr>
<tr>
<td>Amyas Connell</td>
<td>Opened the firm TRIAD Architects in Nairobi</td>
<td>1963</td>
</tr>
<tr>
<td>Graham McCullough</td>
<td>Opened the firm TRIAD Architects in Nairobi</td>
<td>1963</td>
</tr>
<tr>
<td>Robert Marshall</td>
<td>opened the firm Dalgliesh Marshall in Nairobi</td>
<td>1965</td>
</tr>
<tr>
<td>Karl Henrik Nostvic</td>
<td>worked in Kenya under the Ministry of Public Works from 1966 and later opened an architectural practice</td>
<td>N/A</td>
</tr>
</tbody>
</table>

Table 5.1: Table showing the pioneers of tropical modern architecture in East Africa and the date which they established architectural firms in East Africa
Source: author
Analysis of the architecture by the aforementioned pioneers of tropical modern architecture practicing in West Africa, Southern Asia, South America and East Africa revealed that their buildings are climate responsive. The analysis of their work illustrated in chapter four of this study, brings out similarities between their buildings which are generally characterized by passive heat control and cooling strategies.

It was noted that tropical modern buildings share the following characteristics that make them stand out as climate responsive:

i. The buildings are oriented with the long axis running along the East-West axis to ensure that the longer façades are protected from direct sun.

ii. They have narrow plan layouts to ensure sufficient natural lighting and cross ventilation

iii. The glazed areas of the building are protected from direct sun to prevent excessive heat gain into the building.

iv. The buildings have provisions for natural ventilation and cooling.

v. Fewer window openings are used on the facades of the buildings to reduce limit heat gain.

vi. They have smooth external finishes and light coloured external finishes which reflect heat from the sun reducing the buildings heat gain.

vii. The buildings have high thermal mass on walls and roof to reduce the amount of heat that penetrates the buildings shell.

viii. The window openings are located on the North and South facing walls to control heat gain by protecting the windows from direct East and West sun.
The third conclusion derived from the objectives shows that the origin, spread and development of tropical modern architecture in the tropics can be attributed to networks or links that facilitated the spread of knowledge and experiences the architects had on tropical modern architecture.

There were three main networks or links that facilitated the spread of knowledge and lessons on tropical modern architecture. They are:

I. Collaboration in projects with architects who designed climate responsive architecture. Modern architects had projects in the tropics which they worked on together and this led them to exchange lessons learnt on designing in the tropics, learn about different approaches used in climate responsive design and improve on their already acquired knowledge on designing in the tropics.

Several examples of such collaborations are described in this study. For example, Le Corbusier's involvement in the design of Ministry of Education and Health building also known as Ministerio de Educacao e Saude (MES) in Rio de Janeiro in Brazil in 1936. This study found that the involvement of Le Corbusier in the design on the MES led to the spread of the use of brise soleil or sun shades in Brazil. His involvement in designing the MES also led to Le Corbusier's close interaction with Oscar Niemeyer. Oscar is said to have learnt a lot from Le Corbusier and those lessons influenced his architectural direction thereafter.

In India, Architect Minnette de Silva worked for Otto Koenigsberger (the author of the book ‘Manual of Tropical Housing and Building’ written in 1975). Minnette’s decision to study at the AA School, comes shortly after Otto Koenigsberger returns to London and from this interaction, the study concludes that he may have influenced her to study architecture and also design climate responsive architecture.
Other examples include:

i. Ernst May working with Bruno Taut

ii. Leo de Syllas, Olumuyiwa Oluwole and Alan Vaughan working together at the firm Architects Co. Partnership in West Africa

iii. Robert Medwin with James Cubitt and Leo de Syllas in the West Indies

iv. Anthony Chitty’s collaboration with Jullian Elliot in Zambia

v. Jane Drew in collaboration with Maxwell Fry in West Africa and Chandigarh,

vi. Le Corbusier’s collaboration with Fry and Drew in Chandigarh and several other notable networks

II. Membership of modernist groups such as CIAM, MARS Group and GAMMA Group is also a unifying link shared by most of the modern architects studied in this study. The groups acted as networking platforms for the architects since they got to interact and share ideas.

III. Studying or being involved with students from institutions that emphasised climate responsive design such as the AA School in London. The AA School was the first school to start a course devoted entirely to the study of tropical architecture and that contributed some of the most renowned architects who furthered the environmental design agenda. Other schools found to have trained several architects who have contribute to tropical modern architecture includes: University of Liverpool in UK and the J. J. School in India.

Modern architecture had an appreciable impact in the tropics in the 1940’s and the 1950’s. On the development of tropical architecture, the study found five factors that gave momentum to its spread during 1940’s and 1950’s, namely:

i. Colonization:

The study found that in the 1940’s, uprising in colonized states were increasing significantly. To curb the rebellion, the British Government opted to improve the living conditions of natives by improving their housing and education facilities. Modern architects such as Maxwell Fry, Jane Drew and James Cubitt amongst others were commissioned to build schools and other social amenities.
Colonial cities were also convenient sites for experimentation with modern forms, ideologies and technology especially in the 1940's and 1950's. Architects experienced a freedom of design in the tropics and they received very little resistance compared to that experienced in Europe at the time. An example is seen in the work of Amyas Connell. His design of the High and Over House got a lot of resistance during approval for construction stage because it was too different from conventional architecture in Europe. When he arrived in East Africa, his designs were well received and he worked on very significant projects such as the National Parliament of Kenya building, Attorney General Chambers and the Aga Khan Jubilee Hospital all in Nairobi. A similar observation is deduced from the analysis of the works of other tropical modern architects.

European settlers also invested in various projects which required services of professional architects and therefore hired architects from England to work in the tropics. Examples of architects who ended up establishing practices after being hired to design buildings in the tropics include Charles Bransgrove and Amyas Connell. Bransgrove came from England in 1948 to work as the chief architect for the Tanganyika Groundnut Scheme; a project which was being carried out by the Overseas Food Cooperation. When the project ended he settled in Dar es Salaam and opened his practice in 1948. Amyas Connell on the other hand was invited to work in Tanzania by the Chairman of Tanganyika Sisal Growers Association and thereafter in Kenya by the then Chief Architect, Thornley Dyer. In 1963, Connell made his move permanent by opening the firm TRIAD Architects.

ii. The Royal British Service:

Architects and students of architecture were billeted to the British Army and posted to different areas in the tropics where the army required their services. After concluding their service, several modern architects returned to the tropics to practice architecture. A few examples include Maxwell Fry, Richard Hughes (Corporal in the Kenya Regiment attached to the Royal Engineers), Thomas Peatfield and Geoffrey Bodgener (both served in the Royal Air Force during WW II), Henry Norman and Graham Dawbarn (served as consulting engineers and Royal Air Force Officers).
iii. The Nazi Era:

Several pioneers of tropical architecture left their home countries because of war. The study found that the rise of Adolf Hitler to power in 1933 pushed several architects out of Germany. This resulted in the emigration of the architects to different parts of the world after 1930. Their networks and projects played a key role in the development and spread of tropical modern architecture.

Notable architects who left Germany because of the Nazi era include: Walter Gropius (moved to Britain in 1934 with the help of Maxwell Fry and worked with him), Otto Koenigsberger (moved to Cairo and later practiced in India), Ernst May (moved to Tanzania and practiced throughout East Africa) and Bruno Taut (fled to Switzerland and practiced in Japan).

iv. Facilitation by Government:

In the 1940's and 50's, tropical modern architecture in India and Brazil, was advocated for by senior political figures. The study found that in India, Jawaharlal Nehru, the first Prime Minister of India vehemently advocated for modernism and therefore in 1950, he invited Jane Drew and Maxwell Fry to prepare the Master Plan of Chandigarh, the Capital of Punjab (fig. 5.4).

In Brazil, the push for modernism was very vigorous and Brazil's government was pro modernism as seen in the intensity of modern architecture built in Brazil between 1930 and 1960. The Capital of Brazil, Brasilia was planned by modernist architect, Lucio Costa based on CIAM principles (fig. 5.5).
iv. Independence:

The study found that the regions where tropical modern architecture was most dominant were former British Colonies e.g. in Africa (Nigeria, Ghana, Kenya, Uganda, Tanzania, Zambia, Zimbabwe among others) and in Asia (India, Bangladesh, Sri Lanka) and the Caribbean countries. Outside the former, British countries is Brail, where tropical modern architecture was also dominant. The 1940's and 1950's mark the period that most colonies; specifically those in Africa start to rebel and fight for freedom. Areas such as India and Brazil had already received independence and they were developing their new capitals with tropical modern architecture.

In Africa, most countries attained independence from Britain between the mid 1950's and early 1980’s. It is during this period that the newly independent countries started to develop their countries and the preference of the newly independent African nations is similar to that of Brazil and India namely modern architecture. The study found that the absence of elements with colonial reminiscence made modern architecture common in most newly independent countries. The study also found that it represented progress and development and therefore modern architecture was preferred by governments and investors who wanted to portray an image of progress and increase in investment.

Fig 5.6: Map of the world showing the countries colonized by Britain and when they attained Independence
Source: en.wiki2.org

Author modified to highlight the tropic of Cancer and Capricorn to illustrate the colonies within the tropics.
However, the study found that the decline of tropical modern architecture in East Africa was not unique to East Africa only. The examination of tropical modern architecture indicates its decline throughout the tropics.

The study deduces that the reasons for its decline were as follows:

i. Dissolution of modern architecture forums and groups such as CIAM, which ended in 1959 and MARS Group which was dissolved in 1956. Such groups enabled networking and provided forums where ideas could be exchanged and developed. Therefore when these groups were dissolved, the development of tropical modern architecture also started to break down or decline.

ii. The closure of the AA School of Architecture, Department of Tropical Studies and its relocation to University College London and its eventual shift of focus from climate responsive design in the tropics to urban planning issues. The institutionalization of tropical architecture gave tropical modern architecture momentum because it increased the dissemination of knowledge on designing in the tropics and increased the number of climate responsive architects. The end of the course on designing in the tropics at the AA School reduced the emphasis on climate responsive design in the tropics.

iii. Lack of dedicated programs on climate responsive design in the tropics in local architectural institutions. There is no evidence of local schools of architecture designing courses or developing programmes that are entirely dedicated to designing in the tropics during the 1940's to 1980's. The lack of dedicated programmes on climate responsive design in the tropics waters down the significance of designing climate conscious buildings.

iv. Lack of structured apprenticeship or in-house training on the importance of climate responsive design in the leading practices in the tropics. There is very little evidence of apprentices or trainees of pioneer architects of tropical modern architecture in the tropics. Employees of the pioneer architects do not seem to come up as the next generation of climate responsive architects indicating that the in-house training on the importance of climate responsive design was very minimal and the pioneer modern architects who practiced tropical modern architecture were majorly responsible for its rise in the region and decline with their exit from the architectural scene.
v. Minimal dissemination of knowledge through published materials on climate responsive design by architects practicing in the tropics. With the exception of a few architects such as Jane Drew, Maxwell Fry and Otto Koenigsberger, there is minimal documentation on designing in the tropics. In East Africa for example, very few pioneer architects published or contributed articles to publications to educate and inform architects and students of architecture on their projects and climate responsive design.

vi. Very few local architects borrowed lessons from the pioneer architects on tropical modern climate responsive design. There is very little evidence of locally trained architects borrowing lessons or learning from the pioneer architects especially in East Africa. This contributed to the decline of tropical modern architecture since there seems to be no transfer of knowledge or ideas as was initially seen during the genesis of tropical modern architecture.

vii. Wind of change from climate responsive architecture to international style in architecture characterized by non climate responsive strategies. The 1980’s mark the increase of international style architecture which is borrowed from the West. Unlike the adoption of modern architecture, which underwent a transformation which made it suitable for the tropics, international style was imported to the tropics with no attempt to transform it to make it suitable for the tropics.

It is from these conclusions that the author makes recommendations that could address the problem defined in the problem statement which brings out the issue on the decline of climate responsive design in the contemporary architectural styles adapted after the 1980’s.
5.2 RECOMMENDATIONS

The adoption of any new architectural style within a region other than the one it was developed in, requires that the architectural language undergo a transformation that can make it suitable to the region’s climate. From the study of tropical modern architecture, the process of regionalizing a ‘foreign’ architectural language is brought out. This research was prompted by the fact that most of the climate responsive buildings in developing countries were built between 1940 and mid 1980’s. After 1980, climate responsive design declined because architects started to give more priority to the need to keep up with contemporary architectural trends (developed for temperate climates and unsuitable for tropical regions) rather than designing thermally comfortable buildings.

It is with this in mind that this research recommends the following strategies that can spur interest in climate responsive design:

a. Revival of groups and forums that increase collaboration and exchange of ideas on designing for the tropics. The aim of such groups would be to improve and increase research on climate responsive design.

From the analysis of the backgrounds of the key protagonists of tropical modern architecture in West Africa, Southern Asia, South America and East Africa, it is clear that networks between architects had a crucial role in the spread of some of the most climate responsive buildings in most developing countries. These architects collectively built up the body of knowledge on how to integrate modernist principles with climate responsive design principles and developing structures that were in sync with their modernist principles.
b. This study recommends that architects use the following passive and low energy intensive design strategies in their designs to prevent heat gain and provide cooling to their buildings:

i. The buildings are oriented with the long axis running along the East-West axis to ensure that the longer façades are protected from direct sun.

ii. They have narrow plan layouts to ensure sufficient natural lighting and cross ventilation.

iii. The glazed areas of the building are protected from direct sun to prevent excessive heat gain into the building.

iv. The buildings have provisions for natural ventilation and cooling.

v. Fewer window openings are used on the facades of the buildings to reduce limit heat gain.

vi. They have smooth external finishes and light coloured external finishes which reflect heat from the sun reducing the buildings heat gain.

vii. The buildings have high thermal mass on walls and roof to reduce the amount of heat that penetrates the buildings shell.

viii. The window openings are located on the North and South facing walls to control heat gain by protecting the windows from direct East and West sun.

The strategies above were found to be common among most of the climate responsive buildings analysed in this research. The pioneers of tropical modern architecture discussed in this research, had climate responsive design as one of the most important considerations in their architecture and therefore put up most of the thermally comfortable buildings in most cities within the tropics between 1940 and 1980.

The objective of any designer in the tropics should be to create thermally comfortable spaces for people to live and work in.
c. From the analysis of the origin and spread of tropical modern architecture, this study noted several factors that lead to its decline as outlines in the conclusions. It is with those factors in mind that the author recommends that following actions be taken to restore interest in climate responsive design and ensure its continuity:

i. Institutionalization of studies on tropical design.

A post graduate studies program on tropical design should be established in architectural schools within the tropics. This program should be entirely dedicated to training already established architects on designing in the tropics by increasing their sensitivity to climatic design.

ii. Collaboration of stakeholders such as academic institutions, architectural associations and leading consultants associated with the architectural profession to ensure structured apprenticeship programs and in-house training.

The training and apprenticeship should be guided by structures established by the stakeholders that are aimed at increasing knowledge on climate responsive design.

iii. Increased contribution through publications by architects on projects which are climate responsive.

This should go hand in hand with increasing research on innovation and lessons acquired during design of climate responsive architecture.

iv. Collaboration of local architects towards a common goal of increasing climate responsive designs.

This can be done by ensuring that already established firms involve the services of trained architects in environmental design. The collaboration would provide an opportunity for architects to learn from each other and develop greater sensitivity to issues on climate responsive design.

v. Re-emphasizing the need for climate responsive design.

Instead of merely following trends, all stakeholders of the construction industry should come together to device solutions to designing climate responsive buildings while retaining a global view of architectural trends that clients demand.
Areas of Further Research

This study focused on part of the history of environmental design by looking at the development of tropical modern design in the tropics between 1940 and 1980. Other areas of investigation on related research include but are not limited to:

i. The influence of pioneer architects of tropical modern architecture in East Africa

This research brought out 12 notable architects who practiced in East Africa between 1940 and 1980. Several of the architects discussed, played a great role in establishing architecture in east Africa and as such a documentation of their individual works and contributions would add greatly to the body of knowledge on development of sustainable design in East Africa.

ii. Transformation of climate responsive architecture in East Africa

A study on the evolution or transformation of pre-colonial and post colonial tropical architecture in East Africa would bring out patterns in dealing with climatic issues through the changing times and hopefully give an indication of how contemporary architecture can be influenced to give a ‘true’ regional expression of East Africa by responding to climate and socio-cultural issues faced today.

iii. An Analysis of the Architectural Design Curriculum in Schools of Architecture in East Africa and its impact on climate responsive design

As seen from this study, institutionalization of tropica design in 1954 had a significant global impact on climate responsive design. Understanding the curriculum in schools of architecture and establishing its strengths and shortcomings from an environmental design point of view, would give great insight as to how to resensitize architects to climate responsive design.

iv. Sustainable design strategies for East Africa—Manual for Sustainable Design in East Africa

An analysis and understanding of social, political, economic and climatic issues specific to each region in East Africa could create a manual of tropical design specific to East Africa. Besides bioclimatic design, the research would also study issues on energy efficiency, management of resources, renewable energy and the economics of sustainable design.
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