Affordable Housing: Enugu - Nigeria

Urban Human Settlement: A design project that deals with the issue of housing problems in Enugu

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Thesis Winter 1987
College of Architecture & Planning
Ball State University

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AFFORDABLE HOUSING: ENUGU - NIGERIA
A THESIS [Design Project] SUBMITTED TO THE
COLLEGE OF ARCHITECTURE AND PLANNING IN
PARTIAL FULFILLMENT OF THE REQUIREMENTS
for the degree
BACHELOR OF ARCHITECTURE
by
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COMMITTEE APPROVAL:

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ACKNOWLEDGEMENTS

I wish to express my sincere gratitude to my major thesis advisors, Professor Dan C. Woodfin and Professor Uwe Koehler for their interest, time, guidance, and patience throughout this study. I also thank them for their encouragement and interest in the study.

I would also like to extend my deep appreciation to my parents, MR. and MRS. C. N. EJINAKA, for their financial and moral support and for giving me the opportunity to further my education.

GOD BLESS YOU ALL.
THESIS ABSTRACT

Thesis: Affordable Housing in Enugu - Nigeria

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Degree: Bachelor of Architecture

College: Ball State University

Date: February 27, 1987

Pages: Sixty-three (63)

Affordable housing is a housing project which serves as a recommendation to the government of Nigeria and as an alternative to the present approach of solving Nigeria's massive urban housing problem. It is the opinion of this thesis that these types of housing should be located close to the workplace of the inhabitants since this will reduce the time and cost of commuting to work but, just as important, it will encourage cooperation within the community itself. As a result of the latter probability, house clusters were adopted as the most appropriate approach to achieve this goal.

It is also the opinion of this thesis that while the government supplies the necessary infrastructure at the site, the people who will be moving into this project should be given the freedom to be involved in both the design and construction phases that are within the traditional rural building vernacular of Nigeria. This thesis suggests that the proposed site be leased to the new inhabitants with eventual rights of ownership.

Since the identification of a boundary by the use of a wall is a strong element of design definition, as well as security in Nigeria, each project is approached through a major gateway which then leads to a cluster gateway and, eventually, to the individual home.

Efforts are made to minimize the amount of concrete surfaces on site, since concrete will add to the amount of heat radiated in the site. Instead, trees like coconut, palm, and mangoes, together with grass, should be utilized to provide the principal building elements.

This design recommends the use of concrete blocks with a brick curtain wall to provide a natural appearance. Fencing should be of bamboo while the windows and doors are louvered. The roof is of corrugated aluminum sheets or asbestos cement sheets to reflect heat away from the building, and each house has a total of 1280 square feet of ground, of which 952, 1042, 1742, and 2084 square feet are the actual houses for one-, two-, three- and four-bedrooms respectively, the last two designs having second floors. At $20.00 per square foot, the one- and two-bedroom homes would cost $19,040 and $20,840 respectively.
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INTRODUCTION

Affordable housing is a housing design project which serves as a recommendation to the Government of Nigeria and as an alternative to the present approach to solving Nigeria's massive urban housing problems. The deplorable urban housing conditions in Nigerian cities have long been a major concern to both the federal and state governments which led the government, in 1980, as proposed in its National Plan, to provide 200,000 new housing units in each state. Both the federal and state governments have consistently failed to meet their targets.

Because of bureaucratic bottlenecks, very long delays occur in importing such building materials as cement, asbestos, and roofing materials. The whole program was probably badly conceived, for the actual benefit of the urban housing scheme would have been much greater if, instead of directly undertaking housing construction itself, the government had left individuals to develop their plots after the basic amenities such as roads, water, sewage, and electricity had been provided.

Individuals with assured incomes could then build houses more economically that would conform with the standards set by the government, especially if helped by government sponsored and organized housing loan schemes. This approach would be much cheaper, faster, and more socially acceptable than the present scheme in which the government builds the houses and allocates them to the people.

One major reason why housing construction is slow and expensive in Nigeria is the excessive dependence on imported building materials and inadequate use of the locally abundant building materials. These consist of both soft and hard timber which can be treated, and local clay, to make good quality bricks and cement. Urban housing problems in Nigeria could be considerably reduced if building materials were massively and cheaply produced.

The location for the proposed housing scheme is in Enugu - capital of Anambra State in Nigeria (see Figure 1). Enugu has a population of more than 500,000. The city's main base is coal mining, commercial and mostly government establishments, with three universities.

The site for this project is located in the northern part of the city between Onitsha Road on the west and Works Road on the east. This site is in close proximity to Enugu market, the hospitals, work places, and two elementary schools. It also has good access to major transportation nodes along Onitsha Road, Works Road, Iva Road, and Cemetery Road.
Geographical Location of Enugu in Nigeria

THESIS STATEMENT

The rapid growth of population in Nigeria has caused massive immigration from the rural areas to the cities in search of employment, amenities, and opportunities and attractions that are available there. As a result, the housing problem, which is already acute in Nigeria, has been intensified. There is strong evidence to believe that there is a serious urban housing problem, partly caused by the size of Nigeria's major urban areas, which has imposed high costs and poor environmental conditions on large segments of the population.

Poor housing conditions are associated with lower incomes. In 1975, about 75 percent of the population were unable to afford decent housing because of their income level and, to a great extent, because of the high cost of rent. This sizeable portion of the population frequently lives under extremely crowded conditions and in very low quality environments. The problem, then, is one of improving standards and increasing benefits to the nation by influencing the types of housing produced. The provision of adequate housing for the urban population is considered by this study to be a starting point for efforts to improve the quality of life and meet the basic needs of Nigeria's urban households.

This study is of the opinion that housing production must be increased if this problem is to be solved. But the question is, what is the best way to do this? While lack of data makes accurate estimation difficult, it is estimated that between 300,000-500,000 new dwelling units must be produced annually in Nigeria's major urban centers to meet the demand for housing.

The assumption and practice in Nigeria is that if the problem of housing in urban areas is to be solved, prefabrication and mass produced housing, as evidenced in most low income housing schemes, is the revolutionary technology to be applied because the technique can accomplish the following:
1) Quick in application;
2) Can be mass produced;
3) Speedy and economical;
4) Minimizes waste in materials;
5) Better in quality;
6) Reduces costs;
7) Quicker turnover.

One thing the authorities fail to understand is that housing is more than a structure intended to provide shelter. Housing encompasses all the ancillary services and community facilities which are necessary to human well being.

It is, then, the intention of this study to show that Nigeria's urban housing problem cannot be satisfactorily solved by the continuing production of low income housing based on mass production and prefabricated processes. In addition, this study tends to show that the above assumption can be better realized by a process other than the existing one, which is essentially nothing but the repetition of boxes. This process, which takes into consideration the social, economic and climatic character of Nigeria, is a much better process, capable of producing much better and much cheaper houses that are deeply rooted in the
psychological and social nature of the environment, as opposed to mass production and prefabrication. Also important is the fact that this process recognizes that each occupant of each dwelling unit is unique and yet a part of society which requires interaction with others. Above all, this process makes it possible for anyone to afford housing because of its lower cost.

The hypothesis for this thesis is: Low cost housing in Nigeria can be produced more quickly, cheaply, with a better product, and more responsively to the user, environment, and culture by the use of the principles of pattern language as a process for housing production, than it can be by the process of prefabrication and mass production.

Pattern language is a way of doing. It provides a language for building and planning. Pattern language describes the detailed patterns for towns and neighborhoods, houses, gardens, and rooms. The patterns describe problems which occur over and over again in the environment, and then describes the role of the solution to the problem in such a way that this solution can be used a million times over without ever doing it the same way twice.

Low cost housing, whether in Nigeria or elsewhere in the world, should not be planned in such a manner that its inadequacies serve as a constant reminder to its inhabitants that their lives are hard, but rather it allows hope, growth, and education by being a true haven and an asset. These goals can be achieved through pattern language,
The major problem that this architectural thesis will address is how to plan, design, and build low cost housing that is cheaper and flexible enough to reflect the characteristics and life styles of the inhabitants, as opposed to using prefabrication and mass produced processes, to solve the serious housing problem in Nigeria.

To solve this problem, the writer of the study thinks that modern materials and technology should be blended with natural materials, technology, and construction techniques when considering the design of low income housing projects in Nigeria. High cost construction materials and those which require the extensive use of energy and equipment for installation should only be used to extend the limitations of native materials and techniques. They should not be used to simulate the architecture and life styles of modern Western civilization. One approach which is environmentally and economically feasible in one environment and culture will not necessarily be so in another culture.

Organizational Data:
- Government provides the land and required amenities for owners and sets up housing loan boards. The home owner obtains a loan and builds to his taste and pays back the loan to the government through the loan board or directly to the government.
ENVIROMENTAL SETTING

Enugu, latitude 6°20' north, longitude 7°52' east, lies within the humid forest zone of Nigeria. Owing to the prevalent system of moving cultivation, in which bush is cleared by fire, virtually not much virgin forest remains around Enugu. The crops grown by farmers in the region include cassava, oil palm produce, koala, yams, maize, rice, oranges, bananas, peppers, and various vegetables for the home market.

Temperatures in Enugu vary from an average daily maximum of 92.1°F in February and March to an average daily minimum of 83°F to 89.3°F in December. Relative humidity is high all year round, ranging from an average daily maximum of 93 percent at 6:00 a.m. in October to an average daily minimum of 46 percent at 12:00 noon in February. The mean annual rainfall is 71.5 inches and most rain falls between March and October.

For most of the year, the prevailing winds blow from the southwest but, in the Harmattan season - December to February - as the tropical continental air mass moves south, they blow from the north and create a dry season.

A Brief History of Enugu as an Urban Settlement:

Enugu is a modern city which is new to Nigeria. It was founded in direct response to the administrative and economic initiatives of the colonial administration. Enugu, with a population of 143,000 in 1963, is the administrative capital of the East Central State and owes its origin and early growth to coal mining. It is still affectionately known as a 'coal city'. Prior to the beginning of mining in the area, the only settlement on this site was the small Nike village of Ogui (see Figure 5). When mining staff quarters were added to the mining camps in 1915, the settlement was given the name of Enugu which means 'hilltop'. In actual fact, the new settlement is located on the plains at the foot of an escarpment. It is one of the new towns of tropical Africa which have arisen as a result of contact with Europe. During the last twenty years its growth has been very rapid. Today, Enugu is not only an administrative and mining town, but is also an industrial and educational center.

The growth of its residential districts reflects the functional growth of the city. Coal Camp is one of the oldest planned residential areas and was built for miners. China Town was started in 1923 as a special residential area for African railway workers. Mining brought the development of commercial activities and Ogui Town grew up to service migrants who were attracted by the new opportunities offered by the town. The European settlement was built on the far northern side of the railway, separated from the African townships by a neutral zone. This latter was done to provide an excellent site for the Enugu sports stadium.

Since the end of the Second World War, the city's growth has resulted from its position as
the seat of the regional administration. There is now more employment through administration than the colliery, formerly the main employer of labor. The newer residential areas of Asata, Uwani, and Ogui-Nike have grown up to provide accommodation for these workers.

The Independence layout consists of grandiose buildings which are reserved for ministers of state. This is the latest development in residential districts and contains an ultra-modern hotel - the Presidential Hotel. However, industrial development at Enugu is still in its infancy. This is largely because of the dominance of Port Harcourt, Aba, and Onitsha in this area. The coal industry is declining, as is the pottery industry at Efulu. The latter is due to the development of a larger pottery establishment at Umuahia by the government. It should be noted that there is a large furniture factory and a steel rolling mill at Emene.
HOUSING TYPES:

Nigerian traditional houses may be regarded as the physical expression of their owner's social standing, constructed well within the constraints imposed by the building materials obtainable, the type of climate against which the houses afford protection and, finally, the financial resources available. Nigeria is composed of different ethnic groups, each with their own different customs, ecological environments, and degrees of prosperity. As a result, there are as many traditional house types as there are groups and environments. The intention of this thesis is to limit itself to the type of Nigerian traditional houses which exist in Enugu, which is the focus of the design.

In Nigeria, the structural plan of each traditional house type reflects the given group's social organizations and customs and, in the same way, a house position in relation to its neighbors is intimately related to the shape, form, and organization of the largest settlement of which it forms a part. The traditional materials of these houses are also determined by the local environment. These differences in building materials, customs, habits and beliefs do not affect certain features which are common among the various Nigerian traditional house types.

There are four major differences which determine the form of Nigerian housing, as follows:

1) local custom and tradition; 2) the need for security and privacy; 3) the skill and types of building materials available in the community; 4) the structure of family and kinship and the ever-changing requirements of Nigerian families with each new generation for domestic space, and buildings.

Certain features are generally common with Nigerian traditional house types, as follows:

1) Generally, large walled compounds with the house located inside. This house is divided into smaller houses or rooms, a feature very common in southern Nigeria, as shown in Figure 6;

2) Multi-family houses or, to be more precise, a compound which is usually occupied by more than one household, especially since the people are relatives;

3) Courtyards are important common features in traditional Nigerian homes. The courtyard verandah, usually with a deep overhang of the roofs, helps to create a mood of subdued lighting and a relaxed atmosphere for living, chatting, and lounging;

4) A reception hall for guests or visitors.

The principal building materials used in traditional Nigerian homes include mud, wood, straw, palm fronds, and raffia mattings. Straws and mats made from raffia palm leaves are commonly used for roofing in the south and in some parts of the non-Muslim north.

In the southern parts of Igboland, for example, mud is used for walls and plastered over a wooden framework for added strength. In other parts of
Igboland, the lateritic soil is used because it is more cohesive and can stand on its own, unsupported. Wooden poles are usually used for roofs and covered with raffia palm leaves for thatching.

It is very rare for Nigerians to migrate within the rural areas and, in consequence, almost all traditional rural housing is owner-occupied, the same house being used by so many generations within one family that the emotional attachment to it borders on the religious.

**Figure 4**

**IGBO TRADITIONAL COMPOUND**

**HOUSE (COMPOND) STRUCTURE - EXPLANATION OF DIAGRAMS**

1. House or rooms for the head of the household (la, nimbura, tugura)
2. House or room for receiving visitors and for general relaxation (la, tugura)
3. Isolated houses or rooms for the wives or for the family's married male children and their wives
4. Shrine (oda, dünshia)
5. Granary, barn
6. Rooms for strangers and guests and for the family's male children over 12 years of age. Some of the rooms are also used by servants of the house.
7. Plain inner hall - designed to make the house deeper and to ensure greater privacy. This hall is sometimes used to store livestock, firewood and farm implements
8. Family burial ground if there is no public cemetery in the community
9. Outer courtyard (mbara obi, agbala, cikin gida)
10. Inner courtyard (cikin gida)
11. Wall marking limit of access to a male stranger
2) Urban:

In Nigerian urban housing types, there are considerable spatial variations in existence. These are different from the traditional housing types found in the countryside. This is partly due to the restrictions imposed by an urban setting. This is common with Nigerian cities which still retain the 'enclave' concept of colonial urbanism, the structural quality of which features government reservation areas alongside the rest (see Figure 7). The GRA enclaves, as well as the modern housing estates for high income groups, exhibit the quality of space and layout common to the better parts of many Nigerian cities. This type of spacious housing for a single, high-income household in such enclaves is very often rented at a subsidized price from an official's employer. This contrasts very sharply with the majority of housing found in the balance of the urban space (comprising the wing half of Figure 5).

Most of the structures are found in the built-up space outside the GRA and there are especially designed areas consisting of low-income group housing, with very poor ventilation and hardly any open space.
Figure 6

1. Householder's Rooms
2. Rooms for Wives and Children
3. Rooms for Grown up Sons
4. Stores and other offices

OWNER-OCUPIER HOUSING UNIT - TRADITIONAL

Figure 7

1 - 13. Housing Units
B. Bathing Enclosure
K. Kitchen

ROOMING HOUSES IN LOW-INCOME AREAS
SITE SELECTION

Housing is more than a simple shelter. As was stated at the United Nations Interregional Seminar on the Social Aspects of Housing in 1975: "Housing encompasses all the ancillary services and community facilities which are necessary to human well-being."

This study recognizes that housing is a complex product, providing a combination of services that are usual to development in both welfare and economic terms. While the first and most basic service is the shelter offered by the dwelling space, the structure provides, in conjunction with the services of land and utilities, a variety of environmental services. Water supply, sewage, solid waste disposal, energy use, and so forth. Further, there is a range of locational services available from housing resulting from the spatial links between the house and the relevant economic activities, such as access to work places, to health facilities, educational facilities, recreational facilities, and the market place. The site for this project was based on these primary considerations.

The site was also chosen for such secondary reasons as proximity to churches, parks, and the existence of natural facilities such as trees, and also for the fact that there is room for future expansion.
Site Description and View:

This affordable housing is to be located near the Secretariat area. It is bounded by Egerton Avenue on the west, Emole Street on the northeast, and residential buildings on the south and southwest. The site is easily accessible by automobiles and public bus systems. In addition, since the Secretariat buildings are located close to the site, it makes it easier for the residents to go to work without many problems associated with transportation.

The site is approximately 245,700 square feet of land. It is flat and rectangular in shape. At present it is vacant and without any structure.
City Circulation and Noise:

The development of the Secretariat (government offices) has created a traffic loop around the area. The major streets that border this site are: Egerton, Mary Avenue and Emole Street. These existing streets promote both rapid and slow movement through and around the site, starting from the market place through Garden Avenue, Kingsway Road, and Onitsha Road.

Due to the nature of activities that exist around the site, there is also a strong pedestrian movement around it. Most pedestrians make their journey to work (government and private workplaces) to the market place. As the diagram indicates, Egerton through Emole and Mary Avenue have more cars passing through them than do the lower part of Emole Street and the other streets around the site.
Sun and Wind Directions:

The sun rises in the east and sets in the west. The average daily temperature ranges from about 78° to 80°.

The wind blows from the southwest during the rainy season. This wind comes from the Atlantic while, during the 'harmattan' season, the wind blows from the northeast. This northeast wind comes from the inland and it brings the dry season.
Land Use:

The areas around the site are primarily designated business and residential areas. There are residential buildings as well as commercial buildings and government offices. This area of Enugu is where the Secretariat is located (government office buildings). These buildings are either one-to four-story high buildings. Most of them were built by the British using colonial designs, although there are a few more recent designs in the area. These old buildings can qualify as historical buildings.

The residential buildings are mostly large, four-bedroom houses with large compounds around them. These houses were also built during the colonial days by Europeans and are still in good condition. At present, high income government officials reside in them.
Assumptions:
One of the problems encountered by this thesis is the lack of adequate sources of information on Nigerian housing, architecture, and statistics. As a result, this thesis made the following assumptions:

Assumption about the City of Enugu:
Enugu is one of the fastest growing cities in Nigeria and, as a result, there are changes. The nickname of the city is Coal City because it was founded on coal mining. The characteristics of Enugu are tree groups in places where there are no houses. Often they are cut down during construction.

The primary center of Enugu is the market place surrounded by other commercial activities. Most banks and financial houses are located around this area. In some areas, housing and commercial activities are integrated. While stores front the streets, residents live behind the stores.

Goals for the Spaces:
The major objective of the spaces is to enhance the quality of life in the environment. It creates an outside environment which encourages learning, promotes interaction and a sense of belonging. It is also the intention of this thesis, through its design, to enhance the quality of the interior spaces of the houses through the use of natural lighting, views, natural ventilation, and an atmosphere of a sense of belonging.

This design also intends to use trees to promote ventilation and provide shade for the houses. The design will also try to relate interior to exterior spaces.

Users of the Housing Project:
The major users of this project will be low-income government workers with a fixed minimum salary. These could be men or women in government services. These workers would have families who reside with them. Thus, the users will include the following:

1) Husband and wife;
2) Children in elementary schools;
3) Children in secondary schools;
4) Children in the universities;
5) Visiting grandfathers and grandmothers;
6) Cousins, aunts, and uncles;
7) Friends from the village;
8) Visitors from the workplace;
9) Townsfolk who, once in a while, hold meetings;
10) The mailman;
11) Children from other neighborhoods who are friends of the occupant’s children.
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**Note:** For each station the data given are:

1. Mean monthly rainfall in inches.
2. Mean daily maximum temperatures (*F*).
3. Mean daily minimum temperatures (*F*).
4. Mean relative humidity at 6 a.m. (%).
5. Mean relative humidity at 12 noon (%).

CASE STUDIES:

Case Study Number 1: Architect: Barack Hirschmar

City of Capetown Low Cost Housing

In the City of Capetown, blacks and non-whites are racially segregated in the Cape Flats. Housing built in the 1950s became nasty, cheap slums planned with a social infrastructure which never came into being. In the last ten years, major pressure to upgrade colored housing has led to many thousands of houses being built. This has entailed a degree of experimentation and revision to improve standards and the essentials of sound infrastructure.

The competition for this housing was part of the improvement program and the scheme shown in Figures 11 and 12 won principally because it provides neighborhood units with a sense of identity. This has been simply achieved by providing an entry signalled by columns, and the houses are staggered in a picturesque layout which is more desirable than relentless serial production which only ensures that the traffic slows down. The houses are based on European bungalow models which correspond with the increasingly middle-class expectations in Capetown. The technology is very straightforward: concrete blocks, standard joinery, and asbestos cement roofing.

This housing has been very popular. Its successful demonstration led to its design ideas being included as parameters for developers building thousands of units at a time.

Analysis of the Design:

This housing scheme won a nationwide competition for low cost housing. The brief called for 165 three- and four-bedroom houses with two play lots and a play park on a five-acre site. Provision was also made for a university school and a church, although their design was not part of the architect's brief. This area had to function as an entity, yet it was not to be an isolated enclave.

The layout responds to the planning framework of the surrounding suburb, particularly for pedestrian and vehicular movement. It is a simple grid, consisting of four major local roads, 10 m. wide. These interconnect with east and west movement routes. The configuration of the four major roads promote direct and rapid entry from the site, and discourages lateral traffic movement and eliminates all through traffic.

The central play park is an extension of the open space system running north-south through Westridge. Play lots for younger children are in traffic-free zones. There was also a need for children's play areas closer to the dwellings so, recognizing the existing situation of small children preferring to play close to home in areas inevitably used by traffic also, (vehicular access for each house was required), trafficable play courts were designed with clear priority given to pedestrians and playing children. The brick-paved surface of these play courts is different to the roads, with the kerb at court entrances clearly defining the change in environment and ensuring slow movement of traffic. Court entrances are also marked by simple gate posts. The play courts read as extensions to the individual front gardens.
rather than being anonymous realms for 'others' to maintain.

The houses are concrete block, single-story detached dwellings, allowing sight of the play areas. Each has a traditional front stoop (stoop), and a garden on the private side to ensure outdoor privacy. Spaces between frontages are carefully scaled in terms of the building heights. Each house has a car port and a large external storeroom.

The houses are staggered on the site to achieve variety. Walls are in different colors; each play court has a different gateway; the brick paving patterns vary. House orientation in terms of sun and prevailing winds was carefully considered.
Case Study Number 2: Architects: San Lan Chan, Kuala-Lumpur, Malaysia

The competition program called for a human settlement plan that would foster strong social ties and community interaction, as well as a degree of self-sufficiency for people who would get about mainly on foot. In response, the architect devised a cluster design which he believed best served this form of circulation. He suggested that a sense of security and community can be developed by grouping families together who have depended upon each other in the past or who are engaged in similar activities. In order to discover these familial and friendship linkages, it was proposed that a survey of the Tondo inhabitants be taken.

The Town Plan:

Chan proposed a pedestrian-oriented development throughout the new town of Dagat-Dagatan, with service roads acting primarily as access routes to important hubs within the site. These roads are intended mainly for use by ambulances, fire engines, and garbage trucks. Provisions for parking are made around the periphery of the barangays adjacent to the proposed minor vehicular roads, and within the cul-de-sacs of the service roads (see Figure 13). The major pedestrian routes throughout the development link the various zone centers, community centers, and the town center, as well as the public open spaces and the river banks.

The Zone:

The zone plan shows a group of barangays clustered around the main town center. It also indicates the hierarchy of pedestrian networks: from the semi-private courtyards to the minor public paths, to the main pedestrian spine which link up to the principal spine of each barangay.

The architect explained that the main pedestrian spines connected the major activity centers within the site, and should also connect the hubs of future barangays. The main spine is, therefore, the major element of the proposed policy for future growth. It serves to unify, at the pedestrian level, not only elements within the site, but major centers between different communities. Since it is expected that, in a development the size of Dagat-Dagatan, different architects might design different barangays, the designer suggested that the main spine fulfills an important function by providing guidelines for future planning and designs.

The Barangay:

In the detailed site plan of the barangay (see Figure 13), the architect shows how the main pedestrian spine meanders across the entire barangay, hugging the river bank and occasionally punctuating the major activity centers. In the barangay, the community center is positioned near the junction where the main spine changes axis and where the visual character of the barangay changes from being tight, enclosed, and interior-like to being loose, open, and river-oriented.

Recreational and social activities are centered around the basketball courts. The compact grouping
of the houses around these basketball courts and courtyards, combined with their separation from vehicular traffic, helps to create a tranquil environment for both family and social life. The spaces at the junction of four housing clusters are designed to be slightly larger than the usual minor pedestrian routes so that they can be used as local children's play spaces. To the south of the site is the proposed major expressway C3. The designer proposed that a combined pedestrian and cycling path be located within the boundaries of the proposed road. It was also suggested that trees be planted on earth barriers along the entire length of the site bordering the road to screen the sight and sound of vehicular traffic.

The Dwelling Units:

The architect proposed a cluster arrangement of dwelling units surrounding a communal courtyard (see Figure 13), pointing out that the courtyard concept conforms to the accepted practice of ten families sharing a communal tap. The proposed courtyards vary in size to accommodate from ten to thirty families with a proportional number of taps allocated to conform to the number of facilities. The courtyards would also serve as private recreation spaces and as utility spaces with laundry areas and workshops housed in simple huts, and windmills for generating electricity. The courtyards are interconnected by minor pedestrian routes, 4 to 5 meters wide. The houses are designed so that their front entrances face these paths. These circulation areas should be well taken care of, since the inhabitants' houses face them. The houses are staggered for variety and identity.

For the individual dwelling unit, the architect selected a core housing concept and suggested it be supplied by the government. The core would consist of the initial sanitary services, the structural frame and roof (see Figure 14). The type, size, and number of stories required for each house would depend on a government survey of family size, needs, and available funds, thus reducing initial government expenditure.
Case Study Number 3: Architect: Ian Athfield, New Zealand

The main feature of this first-prize winning design is a clearly defined community (barangay) surrounded by a wall which contains community workplaces. The designer expressed his philosophy throughout the scheme. In the planning, he indicated he did not believe it is possible to solve the squatters' housing problems without simultaneously working toward improving their lives through the provision of job opportunities. Therefore, he proposed workplaces in the form of a linear building surrounding each barangay. The architect argued that the new workplaces, containing cottage, light, and non-polluting industries with community gardens on top, are essential if the community is to become self-sufficient. He believes that the home and workplace should be near each other. Indeed, the workplace is so important to the design that the architect proposed it as the first part of each community to be built. Upon completion of the working periphery, industry would be able to lease space and make jobs available to residents of the barangay.

The provision of the workplace periphery structure would mean a considerable increase in cost to the government. Although much of the labor to construct the peripheral structure would come from the people who would move into the community, the costs would be well in excess of those involved in the more common approach of providing sites and services while the government supplies the infrastructure. However, the judges of the competition felt that the benefits of the proposal well justified the additional expense. These benefits would manifest themselves both in the physical design of the barangay and in the economic and social benefits to the community.

The wall-like workplace peripheral structure serves several purposes: it provides a source of employment for the residents of the barangay; it contains a cooperative run by local residents to control the supply, manufacture and use of building materials; and it contains the community 'energy centers' which would direct the conservation of energy and act as training centers in alternative energy and recycling techniques. The architect explained that the workplace wall surrounding the barangay is intended to create a well-defined barrio. He added that: "Within the Philippines, the wall has been a strong element of security from the beginning of Spanish influence. Today, upper income groups surround a 'village' or a cluster of houses in a 'compound' with a wall for security." The periphery also serves an important symbolic function.

The Barangay: In addition to the main feature of the working periphery surrounding each barangay, the plan (see Figure 16), shows four puroks (subdivisions of the barangay), each with its own basketball court and sari-sari store as a center. Each purok has from 121 to 138 housing sites, totalling 484 in each particular barangay. Also shown are the energy centers within the workplace periphery, the church,
and the marketplace with its adjacent nursery school, elementary school, and health clinic. Automobiles are parked only in open lots outside the barangay or under terraces which abut the inside walls of the working periphery (see Figure 5). No cars are to be found inside the barangay. The architect believes this is necessary in order to protect the community. "Once you get cars into the community, they start destroying it." In the report accompanying the submission, the architect stated the premise upon which his entire design is based: "The barangay is the most strongly defined social unit or community group in Filipino society. It is the unit of individual identification and a logical upper limit for individual understanding within society." But the architect was concerned with more than just the barangay. He realized that his design is for a community which possesses a highly organized community spirit while still fostering individual development. He believed that, in any viable community, the social structure must enable the weakest member of the community to survive. Thus, while dealing with this very delicate and balanced social structure, the architect emphasized his conviction that the existing structure of the community must not be disturbed. He felt that all physical improvements which he proposed are only secondary to the most important issue - the preservation of the community and its spirit.

The Dwelling Unit:
The dwellings will be built on individual sites of roughly 55 square meters, in clusters of four dwelling units each (see Figure 17). The houses will be constructed by the residents themselves within the rural building tradition of the Phillipines. The four families share the privy and laundry, the compost pile, a community kitchen, refrigeration and food preparation area, the cold water tank, and the agricultural windmill. Each family will have a silong, or space below the first floor at ground level, and a silid, or living and sleeping space, on the first or second floor.

The plans and elevations of the houses (see Figure 18) show how these homes may appear after the family has built the basic structure and added its personal touches such as balconies, cultivated gardens, and interior furnishing. The house design also takes into account the fact that the squatters keep pigs and chickens for additional income, and it provides for the opportunity to continue with this tradition (see Figure 10).

Construction:
As illustrated by the typical construction details (see Figure 19), the coconut palm is utilized to provide the principal building elements. It is in abundant supply in the Phillipines and will continue to be so in the foreseeable future. The timber can be used in its natural state, if dried and preserved. Its byproducts include charcoal, chip-based cement blocks, particle board, insulation fiber cement board, furniture, and joinery. The architect recommends that the house be built of timber frame for resistance to earthquakes, a type of construction which is within the craft skills of the Tondo foreshore squatter.
Roofs and walls should be panels of plaster made with coconut sawdust, sand, and cement over expanded metal mesh. These panels are fire resistant and provide good insulation against the Manila heat. The material lends itself to additional alterations without skilled techniques. The use of coconut fiber cement insulation in party walls for sound insulation has also been recommended. The architect strongly urged that the materials be limited to the coconut palm and its byproducts to give a visual unity to the barangay. He pointed out that by consistently using these materials, the residents would become skilled in their use.

Each family is to receive financial assistance in building the initial structure. Before building, the family members will discuss their personal problems and needs with the design team and receive advice on boundary situations and building techniques. The architect felt that it is at this level that the majority of the work of the design team will take place.

Community Technology:
Workplaces and households will combine to supply community energy centers for individuals in alternative energy and recycling techniques. Such energy centers are to be looked after by a caretaker. Each community of 500 families would have several small energy centers which contain toilets, showers, a communal laundry, a solar heating element, and a waste disposal plant with a compost unit from which methane gas would be extracted.
Pattern of Energy Utilization in Hot-Humid Climates

For buildings located in the hot-humid climates, the principal problem is in the cooling of the building for thermal comfort. "Although the temperature which is experienced in this region rarely exceeds 32°C, the presence of high vapor pressure will create more discomfort than in the hot-dry climate at equal temperatures. It is, therefore, essential that adequate air movement and high rates of air changes are provided in these buildings at human occupancy levels during hot weather. If buildings in this area are poorly designed and constructed, they will require high energy input to achieve acceptable comfort standards."

Generally speaking, the principal areas of energy consumption in hot-humid climates fall within the following: 1) space cooling; 2) cooking; 3) refrigeration; 4) TV, ironing and lighting, 5) hot water. It is difficult to provide a general estimate of the magnitude of energy consumption for each of the areas listed. However, it will be useful to note that in most urban areas of hot-humid climates, where buildings are usually crowded and lack adequate ventilation, air conditioners or mechanical fans are used for achieving acceptable conditions. From an analysis carried out in a high density area of Lagos, it was found that the annual mean net energy consumption from selected buildings was 60 GJ. For those with four fans in each building, the annual mean net energy consumption for this system was only about 6 GJ. This value is relatively low when compared with air conditioned buildings. It should be noted, however, that most of the air conditioned buildings maintained a more acceptable environment comfort than those with fans. This is usually because cooling load requirements in these buildings depend on the heat gains into them.
No Page 30
Function:
The major function of this project is to provide housing for poor people and their families. The majority of these people are low-income government workers who barely make ends meet.

Interior Flexibility:
It is the object of this design thesis to provide a flexible floor and wall system which allows easy rearrangement to the taste of the occupants.

Interior Circulation:
The major interior circulation should occur within the hallway. This hall should not be more than ten percent of the total floor area of each type of unit, which ranges from one to four bedroom units. In the three- and four-bedroom types, space should be provided. Alcoves and closets will be along the hallways.

Building Core:
The only mechanical equipment needed for these houses will be plumbing pipes that will run in between the hollow core walls of masonry and brick facing. There will be hallways with alcoves, closets, and storage spaces.

Economic Efficiency:
The importance of the life-cycle cost of the houses should be stressed more than the initial cost.

Energy Efficiency:
Significant use of energy conserving features in the initial design is one of the most important considerations of this project. The emphasis on natural ventilation dictates the building shapes, orientation, types of windows used, and also types of materials used.

Security:
The need for security has led the design into using cluster housing with a common entrance which has a gateway. This makes it possible to identify whoever comes into the cluster. Each housing unit will have a well-defined front and back yard.

Code Requirements:
The site will have a major access road for fire trucks but, since the incidence of fire should be very low, this design will integrate a pedestrian spine with five truck accesses. This will reduce the amount of land that otherwise would have to be allocated to services. The houses will conform with other city requirements, both for energy conservation and ventilation.

Design Considerations for Energy Conservation:
In hot-humid climates, it is feasible to design buildings for minimum energy consumption. They could be achieved by judicious control of the thermal heat gains and losses. Some of the major areas for energy conscious designs in this geographic belt are as follows: 1) ventilation, 2) orientation, 3) shape, 4) insulation, and 5) shading.
Several early traditional buildings in hot-humid climates integrated these factors. For example, in Nigeria, several buildings in the rural areas still maintain traditional methods. For a typical vernacular building in the rain forest, shading is provided by the trees and the local thatch used for roofing is a good insulator against the intense solar radiation. Ventilation is usually adequate for thermal comfort because there is sufficient circulation of air around the entire building as it is suspended on stilts which are about 1-2 meters from the ground.

Although it has been possible to achieve comfort levels in traditional buildings, it is often difficult to do this in modern buildings. Because the present trend in hot-humid countries is toward modern Western or European type buildings, it is essential that most of the energy design factors listed previously are integrated in the basic building concepts.

Ventilation:

Ventilation, which is basically the supply of outside air, is useful in buildings for three main purposes. First, it is essential for the control of the concentration of carbon dioxide in an occupied room. It is also useful for the control of odors in buildings. Natural ventilation is needed for the maintenance of adequate thermal environment. Although ventilation may be required most of the time in most areas, it is only needed for thermal comfort when the external climate is harsh.

"In hot-humid climates, it is essential to have high air flow rates in rooms for human thermal comfort. This rate will be influenced by the existing relative humidity and the dry bulb temperature of the environment inside the building." 2

Although natural ventilation could be made available in buildings for thermal comfort, there may be occasions when the external temperatures may be high enough to require the use of mechanical ventilation. This should be taken into account in the design of the buildings. However, buildings should be designed for minimum utilization of mechanical ventilation or cooling systems.

Some of the architectural features which influence air movement are: 1) size and location of openings; 2) internal arrangement of the rooms; 3) details of projections on the facade; 4) types of louvers, sashes and pelmets. The location and size of openings in a room will influence its air change rate and the mode of air circulation in a building is affected by the internal arrangement of partitions and other forms of obstructions.

Orientation:

The amount of heat gains and the magnitude of aeromotive forces in a building are influenced by its orientation. It is important to give adequate consideration to this factor in the design stage of a proposed building. If the orientation of a building is poor, it will be extremely difficult to keep the building cool without spending large sums of money. A common belief holds that
buildings should be oriented perpendicular to the prevailing wind for the maximum advantage of the wind, but this does not hold true in most cases. A building may be oriented at any suitable angle from 0-30 degrees without the loss of the available natural wind. The position and flow characteristics of all openings in the building will influence the air flow and ventilation rate of rooms. This aspect should be considered in the initial planning of the building orientation.

The building should also be planned in such a way that direct solar radiation is avoided wherever possible. For instance, living rooms are mostly used during the day and should be oriented toward the shade, usually provided by a tree.

Shape:

The functional performance of a building can be influenced by its shape. Ratios of length to width and height of a building will affect the magnitude of its exposure to solar radiation. It is possible to achieve an optimum design shape which is capable of admitting the minimum amount of solar heat. It may not be entirely possible to obtain this shape due to the constraints of the site and orientation. A detailed analysis of the site, orientation, and suggested shapes will produce a suitable solution for minimum heat gains in the building.

Insulation:

Thermal insulation is very important in hot-humid climates due to the fact that heat gains through the roofs and walls can be reduced by the adoption of various design concepts.

Heat insulation of roofs can be handled in the following ways: 1) by the application of heating insulating materials to either the external or internal surfaces of the envelope walls. Because of the heavy rainfalls, it is usually necessary to apply waterproofing materials to all external insulating components; 2) it is possible to reduce heat gains through the roofs if shiny or reflective materials are applied externally.

For an integrated heat control, it is essential to consider the insulation of all exposed walls in conjunction with roof insulation. Thermal performance of walls which are exposed to solar radiation can be improved by the following: 1) the attainment of a thermal mass achieved by the increase of wall thickness; 2) lightweight materials which are suitable insulators may be used for the external walls; 3) use of cavity wall construction would also assist in heat insulation; 4) exposed sides of the walls can be painted with light color paint. If adequate measures are taken, good insulation in hot-humid countries could become a meaningful national energy conservation strategy.

Shading:

It is essential to control heat entry into the living spaces. The weakest area for such entry is through the window openings. The concept and principles for thermal heat control used for walls and roofs could be very difficult to achieve in the
in the case of window openings. Windows usually have thin materials, such as glass or timber. Solar heat gains through these openings could be controlled mainly by the use of shading devices. Such shading devices have been used in the past without proper consideration of their effectiveness, due either to inexperience on the part of the designer or ignorance of tropical building design methodology. There are several methods which could be adopted to determine effective shading devices for windows. The designer should have an idea of the year-round performance of the proposed shading device. The most appropriate solution is the use of solar charts and shadow angle protractors.

Although shading devices are usually considered as an addition to the designed building, it is possible to integrate this system in the main design. There is a great difference between modern design methods and traditional ones and, in terms of energy conservation, traditional buildings will perform better than modern structures. Nevertheless, many people prefer the modern buildings and, as they require large amounts of energy for cooling, they constitute a major area of a nation's energy consumption.

Building Materials Used for Nigerian Traditional and Modern Construction:

In Nigeria, as in many other tropical countries, various types of building materials and techniques of construction have evolved through the interplay of two factors. First are the traditional techniques which are the result of experience passed down from generation to generation. Second, there are the results of the architectural developments which took place during the last century, triggered by the Industrial Revolution in Europe. Very often these two methods can be found side by side in commercial, industrial, and housing projects in Nigeria.

The general performance of some common tropical building materials, both traditional and new, is the object of this section of the thesis. The durability of these materials is affected by the local weathering agents. The most common causes leading to deterioration of these materials in the tropics are moisture, solar radiation, fungus growth, and termites. Some of the major building materials include:

Bamboo:

This material is commonly used, not only in Nigeria but throughout the humid tropics, for house construction since it is widely available in tropical countries. Unless well selected, stored, and protected from damp and termites, bamboo has a short 'life'.

"Recently research has been carried out both in the USA and India to use bamboo to reinforce concrete. Even a partial substitution of bamboo for steel can lead to substantial savings and increase rural employment."4

Bamboo is noted in Nigeria as having the following properties: 1) Low degree of elasticity; 2) Low concrete adhesion; 3) A limited range of
practicable diameters and lengths; 4) A wide range of variability of moisture content.

Palm Frond Stems:

In Nigeria, palm fronds occur in varying forms and densities. They are not uncommonly used as food and to produce mats, boats, and houses. The trunks can be used for the construction of the basic framework of a house or as roof beams. Palm frond stems are ideal materials in the tropics where high temperatures and humidity make air movement very vital.

The stem of a palm frond can be used for constructional purposes such as curtain walls, screens, and as a base for plastering. Since palm fronds are highly susceptible to termites, the timber framework and the palm frond stems are usually replaced every four to five years. With the use of anti-termite chemicals, the life span could be increased to fifteen years.

Earth and Mud Bricks:

"Thanks to the low cost, the most common material of rural construction in the tropics is earth or mud." Earth and mud bricks possess extraordinary properties and qualities. This material has dictated both the construction and the design of dwellings in various regions of the tropics, including Nigeria, for many centuries. Mud walls are often built straight on the bed level of excavations which may vary from 15-30 m. below ground level.

Flat mud roofs are usually constructed by planting wooden joists at suitable intervals covered by planks or bamboos. Twigs and leaves are then superimposed and topped off by mud which is then tamped, screened, and plastered. Floors are generally made up by dressing and leveling the ground surface, compacting and then smoothing it. Because mud has less strength than most other construction materials, mud walls are built of greater thicknesses. Since the mud walls are thick and possess low thermal conductivity, rooms built of mud are much cooler in hot climates than those built with other materials. Mud walls heat up to a lesser extent during the day and deter the flow of heat so that temperatures are above those prevailing outside. Thus mud bricks have a beneficial effect in hot, dry climates which experience a wide fluctuation between day and night temperatures. Mud bricks, either in their traditional form or upgraded and stabilized, are a material of great potential for domestic as well as public buildings in Nigeria.

Bricks and Clay Bricks:

Bricks are widely used as building materials in Nigeria. Their strength and durability vary in different regions. However, faced with competition from concrete block manufacturers, the manufacture and use of bricks has declined over the years. Although bricks have a low load bearing capacity, perforated bricks are good thermal insulators. Of two walls of the same weight built with one using concrete and one using perforated bricks, the advantage appears to be with the brick wall.

Concrete and Concrete Blocks:

Despite the occasional shortages of cement,
concrete and other cement products are being used increasingly for construction purposes in Nigeria. One of the commonest of the concrete products is the sandcrete block, usually made from a relatively dry mixture of cement and fine aggregate, such as sand, mixed in a hand tamping machine. In order to reduce weight and save material, the blocks are made with core. Wherever cement is cheap and sand readily available, sandcrete blocks are likely to remain the popular wall building materials.

Timber and Plywood:

Timber is in abundant supply in Nigeria. The characteristics of timber found in Nigeria vary greatly from one region to the next. This material should be selected with utmost care, keeping in mind what functions it is expected to perform. Preventative measures have to be taken against deterioration. In Nigeria, plywood is mostly used for indoor construction because it splits and warps if subjected to rain followed by exposure to the hot sun.

Natural stone is also used in housing construction where it is available. When available, both walls and the roof can be built with stone slabs, thus bringing a very good and bold regional characteristic to architecture.
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<td>1-bedrm. unit</td>
<td>80 sf</td>
<td>Working, food storage and preservation. Utensil storage, laundry, child care and eating</td>
<td>Family use</td>
<td>Prox. to dining and living rooms. Good ventilation. Good light. Accessibility to the outside.</td>
</tr>
<tr>
<td>2-bedrm. unit</td>
<td>80 sf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-bedrm. unit</td>
<td>80 sf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-bedrm. unit</td>
<td>80 sf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathroom:</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-bedrm. unit</td>
<td>60 sf</td>
<td>Hand, face and head washing, bathing, grooming, elimination, infant care</td>
<td>Family and guests</td>
<td>Good arrangement of facilities. Good illumination and ventilation. Good sound control. Moisture-resistant finish. Increased counter op, children's convenience, mirrors. Access to other rooms. Wide door, 2'6&quot;.</td>
</tr>
<tr>
<td>2-bedrm. unit</td>
<td>60 sf</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-bedrm. unit</td>
<td>60 sf</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

-37-
<table>
<thead>
<tr>
<th>Closets:</th>
<th>12 sf. ea.</th>
<th>Clothing storage and box storage</th>
<th>Family and guests</th>
<th>Convenience. Preservation. Door open full width. Ventilation between two bedrooms</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-bedrm. unit</td>
<td>36 (3)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-bedrm. unit</td>
<td>48 (4)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-bedrm. unit</td>
<td>60 (5)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-bedrm. unit</td>
<td>72 (6)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-bedrm. unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-bedrm. unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-bedrm. unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-bedrm. unit</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bedroom Area:</td>
<td>120 sf.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1-bedroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-bedroom (120 + 80)</td>
<td>200 sf.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3-bedroom (120 + 160)</td>
<td>280 sf.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4-bedroom (120 + 240)</td>
<td>360 sf.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Obi or outer courtyard</td>
<td></td>
<td></td>
<td></td>
<td>South facing, outdoors. Sunny, spacious, and private.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### SUMMARY OF UNITS

<table>
<thead>
<tr>
<th>Number of Units</th>
<th>Area per Unit</th>
<th>Total Area per Type of Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>(0) 1-bed unit</td>
<td>952 sf.</td>
<td>0 on site</td>
</tr>
<tr>
<td>+ 25¢ for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) internal circ.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) front yard or Obi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(5) 2-bed units</td>
<td>1042 sf.</td>
<td>5210 sf.</td>
</tr>
<tr>
<td>+ 25% for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) internal circ.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) front yard or Obi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(10) 3-bed units</td>
<td>1742 sf.</td>
<td>17420 sf.</td>
</tr>
<tr>
<td>+ 25% for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) internal circ.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) front yard or Obi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2 floors)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(25) 4-bed units</td>
<td>2084 sf.</td>
<td>52100 sf.</td>
</tr>
<tr>
<td>+ 25% for:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(a) internal circ.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(b) front yard or Obi</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(c) garden</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(2 floors)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total Area:</strong></td>
<td><strong>74730 sf.</strong></td>
<td></td>
</tr>
</tbody>
</table>
### 45° Matrix

- **Outer Courtyard**
- **Living Room**
- **Dining Room**
- **Kitchen**
- **Bathroom**
- **Bedroom**

- Very important
- Desirable
- Not crucial

---

### 90° Matrix

<table>
<thead>
<tr>
<th></th>
<th>Outer C. Yard</th>
<th>Living Rm</th>
<th>Dining Rm</th>
<th>Kitchen</th>
<th>Bathroom</th>
<th>Bedroom</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Courtyard</td>
<td><strong>●</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Living Room</td>
<td></td>
<td><strong>●</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dining Room</td>
<td></td>
<td></td>
<td><strong>●</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kitchen</td>
<td></td>
<td></td>
<td></td>
<td><strong>●</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bathroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>●</strong></td>
<td></td>
</tr>
<tr>
<td>Bedroom</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>●</strong></td>
</tr>
</tbody>
</table>
Figure 19 - Space Relationships
Figure 20 - Space Relationships
SCHEMATIC DESIGN
FINAL DESIGN
FIGURE 28

SECTION A-A

ELEVATION

1ST FLOOR 3,4 BED

3 BED FLOOR PLAN
REFERENCES


4. Ibid.

BIBLIOGRAPHY


