LOW COST HOUSING IN THAILAND

by

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Submitted in Partial Fulfillment
of the Requirements for the
Degree of Master of Architecture

at the

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

July, 1967

Signature of Author

Certified by

Accepted by

Chairman, Departmental Committee on Thesis
Cambridge, Massachusetts
June 11, 1967

Dean Lawrence B. Anderson
School of Architecture and Planning
Massachusetts Institute of Technology
Cambridge, Massachusetts

Dear Dean Anderson:

In partial fulfillment of the requirements for the degree of Master of Architecture, I hereby submit this thesis entitled "LOW COST HOUSING IN THAILAND"

Respectfully,

Suthanyah Vichitransod
This thesis illustrates the Redevelopment of a slum area in Bangkok, Thailand. The main concern has been the incremental development of the site together with the preparation and implementation of a housing strategy.

The aim is to explore the "EFFECTIVE NEED" of the local situation such as local needs and material resources. Shelter and health, cultural behavior, security, location, incomes and budgets will be considered.

A system of "ON-SITE - PREFABRICATION" for low cost proto-type dwelling units was developed, realizing that this approach may only be possible far into the future, if at all.
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<td></td>
</tr>
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ACKNOWLEDGEMENTS

I am grateful to the following people for their invaluable advice and assistance during the development of this thesis:

Professor Horacio Caminos, Thesis Supervisor.
Professor Waclaw Zalewski.
Professor John Turner.
Mr. John G. Borrego.
Mr. Arlo Braun.
INTRODUCTION

Thailand, with an area of 518,000 square kilometers, is one of the South East Asian countries. It is situated in the Indochinese Peninsula. On the North it is bounded by China and Laos, on the West by Burma, on the South by Malaysia and on the East by Cambodia and Vietnam. Total population, according to a 1963 estimate, is roughly 29 million and increasing at a high rate of about 3% per annum. The population density for the entire country is about 56 persons per square kilometer.

BANGKOK

The site of the community unit is in Bangkok, the capital of Thailand. It is a curious amalgam of ancient pomp and ceremony contrasting with an extremely active program of modernization. Completely rural type slums and busy city streets are located side by side. Bangkok is a bustling metropolis; yet, in the midst of its up-to-date hotels and multi-storied office blocks are temples and places of fairy tale magnificence. It is the center of commerce, industry, communication and education. There are about 9,000 industrial establishments, a big railway station, a well equipped Port, the biggest International Air Port in South East Asia and five Universities. The population is 2 million and growing steadily since the end of World War II.
THE HOUSING PROBLEMS IN BANGKOK

With large natural population increases and a surge of migration from rural lands to Bangkok, -- the center of work and a source of cheap food --, many slums of squatters have resulted in the city's core. The problems are typical in most South American, Asian and African countries. These slums line the back alleys of the commercial buildings on rental land. Most of the shelters are built of cheap and flammable wood. Generally the squatters are workers with low incomes, however there are many people who are unemployed.

By overcrowding, they have no lot division, no children's playground. Children run along narrow wooden passages. (see photo) Private individuals own the squatter occupied land but rarely receive rental incomes from squatters, so they wish to get rid of them. However, as in most squatter situations, this is very difficult and takes a long time and a lot of money. Consequently, no one of authority takes care of such places. Slum areas not only exist in Bangkok's center but also along the streets of suburbs where land is still cheap and not too far from the city center or industrial areas. The absence of a system for removing the excrement from living areas continually exposes the healthy to the contaminated waste of the ill and disease carrier.

---

No figures
TO alleviate slum conditions and accommodate population increases and in migration, a public housing program in Thailand was conceived as early as 1942 when the government proposed to reorganize sub-standard habitations and build low cost housing for rent or hire-purchased by the low income section of urban population. An act was passed in the same year setting a committee under the chairmanship of the Minister of the Interior incharge of the housing project. Wartime conditions, however, made it impossible to carry out the plan and the work was only resumed in 1949, by which time the shortage had become evidently more acute, especially in the city of Bangkok whose population had already doubled itself and had continued to grow steadily since the end of World War II.

The Department of Public Welfare has been put incharge of the housing program since 1949, and in 1953 a Government Bank for Housing Promotion was founded to supplement the work. The Ministry of the Interior and the Municipal Authorities also helped to take care of slums clearence and general planning of the relocation of displaced occupants.

1 Thailand Official Yearbook, 1964
Three principle programs have been designed to aid the people in need of adequate housing:

1. Provision of mortgage-loans for construction or renovation of buildings.
2. Provision of houses complete with land on a long term hire-purchase basis.
3. Provision of houses for rent especially for people of the low income groups.

One of the three housing projects in Bangkok, started in 1963, is in an area owned by the government at Din Dang Road, Tambol Sam Sean Nai, Phya Thai District. This project aimed at completing 79 flat houses of 5,000 units for accommodating 30,000 persons for low income families in 1967. In the project area there will be a primary and secondary schools, a health center operated by Municipality, two privately owned markets, a recreation area and two youth centers. Three bus lines are operated through this project area.

The other two housing projects about the same scale will be at Tung Mha Mek, Yannawa District and at Clong Jun, Bangapi District.
Loans for housing welfare projects may be obtained from two main sources, i.e., the Department of Public Welfare and the Housing Bank.

The Housing Bank was established in 1953 under the act of B.E. 2469 (1953). The Bank is under the general supervision and control of the Minister of Finance. Its management is vested with a Board of Directors composing of seven members, three of which are responsible for day-to-day work of the Bank. The Bank received an initial capital of twenty million Bahts (1 million) from the government. Its fund have been supplemented by advances and loans totalling 75 million Bahts (3.75 millions) from the Ministry of Finance and the Government Saving Bank.

The business activities of the Bank are confined to:— selling houses and land on an installment payment; making and renovating houses or for redeeming mortgages on houses and land; making loan on mortgages of property; and accepting fixed deposits of more than two years. (The actual amount of deposits is very small.)

1. 1$ = 20 Bahts.
So far the Bank has provided 450 houses to homeless families under long term installment basis and granted more than 300 loans amounting to 19.4 million Baht ( $ 0.97 million ) for Housing Project.

CONCLUSION

The housing problems in Bangkok will be more and more acute if there is no control of new slums. More details will be discussed in the following chapter.

The selected strategy will be the provision of rowhouses with land on a long term hire - purchase basis and the provision of walk - up apartments for rent for people of the low income groups.

The fiscal policy under which I will be developing this proposal will have the following procedure:
1. Finance by the Housing Bank of Thailand and probably American Banks and Insurance companies.
2. Developer will buy land and sell individuals plots with the house built on it and rent apartments and commercial space.
3. The housing project will be built by a group of Thai contractors.
4. A Thai Bank will be the mortgage guarantor.

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SUMMARY OF THE LOW INCOME SETTLEMENT

General Slum Growth Problems

Slum growth is presently uncontrolled because:

1. The migration of people from rural areas to urban centers is so large; that the supply of housing cannot accommodate them.

2. The government cannot meet the demand for housing since they are financially limited.

3. When squatters are allowed to stay, others take the message that it is all right to move in. Community facilities are inadequately provided in new settlement areas. The subdivision of lots is not controlled.

Problems with Government and Developer Built Residential Areas

Government built:

1. The government builds high-rise apartments for rent to low-income groups but this is far from adequate.

2. They also build detached houses, complete with land, on a long term hire-purchase basis for middle-income groups. However the spent on such developments seems mis-directed.

Developer built:

1. Developers often buy unused land located far away from the center; also they often put only minimum roads and, possibly, one water source for an entire project.

2. They sell lots of about 5x20 meters which are then usually
subdivided further by the occupant into four or five more lots. This practice is beyond the government's control since the projects are often outside administrative boundaries or they simply have not the finances to enforce the regulations over housing and material standards.

3. As the Municipal Boundary expands, the government finds it very difficult to extend roads and services through these projects.

4. These areas burn easily because of the density and the combustable materials used to make the housing. It is probable that these fires are sometimes intended.

5. The government may try to buy the land but because it is settled, it is very expensive.

6. The people do not want to move because they can sell for more money to other people than what they can get from the government; they then move to other underdeveloped land, farther out, and repeat the same process.
PROPOSED GOVERNMENT POLICIES

To cope with the problems of housing low-income people, the government should develop policies at the project scale with the following content:

1. They should expand the Municipality's jurisdiction well beyond the foreseeable development to maintain control over all the future development which may effect Bangkok. This would allow the power of review over all proposed land subdivision and they could therefore require certain standards for community services, facilities, housing, materials, etc..

2. The government would then be able to initiate land subdivision as well as review private development in the fringe areas.

PROPOSED GOVERNMENT ACTION

A proposed alternative for government action may be the following:

1. The government takes a piece of land, plans and develops the essential community facilities which may only mean road and water. At the same time they can develop standards which will not allow subdividing of land into smaller pieces that leads to the extreme densities which presently exist in slums.

2. The government may then sell the lots for the lowest possible cost. This process may allow them to better control the extent and organization of urban development in Bangkok at a minimum cost. When increased density is a goal, high rise
buildings can be built by the government and rented.

PROPOSED PRIVATE DEVELOPER ACTION

(Under Government controls)

1. The developer buys a piece of land and with the approval of the Municipality, subdivides into lots with minimum services such as access streets and water taps. They also should allocate land for future Community facilities; such as schools and clinics (preferrably placed at the center of the site).

2. The developer may build rowhouses on smaller lots -- say 3.5m.x16.5m. -- and sell them with land. Later shops could be built on the reserved commercial space, possibly near the main access street.

With better facilities, the developer can sell more lots at a higher cost. The people would also have more choices from which they could select the standard of living which best fits their needs and resources.
THE PROGRAM

Having described the Existing Housing Situation and illustrated various possible solution, the following is a design for the incremental development of a site within a critical slum area. The project is designed for housing 2,500 low-income families in the Din Dang District, Bangkok, Thailand. It will also involve a system of "ON-SITE-PREFABRICATION" which may reduce construction costs and time and also provide the possibility for individuals to expand their dwelling units freely in the future. The steps of the design approach were:

1. To select a site.
2. To study the local situation -- the existing boundary conditions; the people, their behavior, incomes, housing budgets, social needs, material resources, etc..
3. To design a suitable lay-out which provides the basic need of life, adequate community facilities, and public utilities.
4. To propose stages of development with minimum demolition and to provide facilities to all the people according to their financial resources.
5. To study the customary sizes of dwelling units and their functional requirements and to propose appropriate sizes according to the different income groups.
6. To make a survey of the local construction systems and study and propose an "ON-SITE-PREFABRICATION" system.
THE SITE

The site, with an area of 175,000 square meters, is in a suburban area at Din Dang road, Tambol Sam Sean Nai, PhyaThai District, Bangkok. It is a flat piece of land, located about 5 or 6 kilometers from the main business center and 1 or 2 kilometers from small business areas. On the North, it is bounded by the Din Dang Government Housing Project; on the East, by a main road and a residential area; on the West, by a paddy field; and on the South, by a canal which connects to the Chao Praya River. Small motor boats are another type of communication. The site was formerly a paddy field but is now a typical slum, crowded with squatters along the main road and periphery streets by the canal which still leaves the central part of the site open.

THE PEOPLE

The area has around 20,000 families living both within and around the site. About 13,000 of the families are service and production workers and laborers. The other 7,000 families are self employed or do clerical and sales work. Respectively, their monthly incomes vary from 692-1,083 Bahts ($34.6-$50.4) and 1,083-1,686 Bahts ($50.4-$84.3). An average of 46-49.1% of this income is spent on food and beverages, and 11.5-15.7% is spent for housing and furnishings. (These figures are shown in Tables I, II, VI)
There are about 800 squatters of different income levels around the periphery roads cutting through the paddy field from the main street. There are no community facilities and public utilities like water mains, sewers or power lines. It is evident that, even when the nearby Government Housing Project for 5,000 low income families is finished, there still will be a need for more housing in the area.

THE PEOPLE'S DOMESTIC LIVES

Most of the people are friendly. Eighty percent are Buddhist. Some go to the temple, 500 meters away, on Sunday and Monk day. Others spend their time after working at home. The main transportation is by public bus. Very few people have motorcycles; none have cars. In the evening, men often speak and chat in the coffee shops nearby. Women gossip when they go to the market about 1.5 kilometers away from the site. Some take buses to another bigger market in the downtown area.

Almost no families have refrigerators, so they buy fresh food and beverages everyday. The most common food is rice, fresh pork, beef, sea food, poultry, eggs, green vegetables, chillies and garlics. The popular fruits are bananas, oranges and coconuts. Lard is the most popular item among fat and oil since most of the dishes are prepared by frying. This is one of the main reasons why kitchens are preferred to be located outdoors or
placed where they can have direct ventilation; frying causes a lot of smoke and also has a very strong smell.

HOUSEHOLD EXPENDITURE SURVEY

In 1962 the National Statistical Office conducted a Household Expenditure Survey in the Bangkok Municipal area as well as in the rest of the country. The data derived from the survey has given a better understanding of the patterns of expenditures, amounts of goods and services consumed, and other economic and social data, especially those of low-income groups. The following tables show some fact about incomes and housing expenditure of the population.
### TABLE I  TYPICAL MONTHLY INCOME

<table>
<thead>
<tr>
<th>Type</th>
<th>Monthly income/person</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bahts</td>
</tr>
<tr>
<td>Domestic service workers</td>
<td>436</td>
</tr>
<tr>
<td>* Unskilled laborers</td>
<td>692</td>
</tr>
<tr>
<td>* Other service workers</td>
<td>1,050</td>
</tr>
<tr>
<td>* Craftsman &amp; production workers</td>
<td>1,083</td>
</tr>
<tr>
<td>* Clerical &amp; sales</td>
<td>1,620</td>
</tr>
<tr>
<td>* Self employed</td>
<td>1,686</td>
</tr>
<tr>
<td>Professional, technical &amp; managerial</td>
<td>3,206</td>
</tr>
</tbody>
</table>

### TABLE II  FAMILY ANNUAL INCOME CLASS

<table>
<thead>
<tr>
<th>Family annual income class</th>
<th>Percentage of all families</th>
<th>Average size (people)</th>
<th>Average earners</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bahts</td>
<td>Dollars</td>
<td></td>
</tr>
<tr>
<td>A under 6,000</td>
<td>under 300</td>
<td></td>
<td>19.8</td>
</tr>
<tr>
<td>* B 6,000-11,999</td>
<td>300-599</td>
<td></td>
<td>31.8</td>
</tr>
<tr>
<td>* C 12,000-23,999</td>
<td>600-1,199</td>
<td></td>
<td>27.7</td>
</tr>
<tr>
<td>* D 24,000-35,999</td>
<td>1,200-1,799</td>
<td></td>
<td>9.5</td>
</tr>
<tr>
<td>* E 36,000-59,999</td>
<td>1,800-2,999</td>
<td></td>
<td>5.9</td>
</tr>
<tr>
<td>F 60,000-up</td>
<td>3,000 &amp; up</td>
<td></td>
<td>5.3</td>
</tr>
</tbody>
</table>

* The studied income groups

1 Household Expenditure Survey 1962, National Statistical Office, Bangkok Thailand.
### TABLE III  TENURE OF HOUSEHOLD

<table>
<thead>
<tr>
<th>Income class</th>
<th>Owner of house &amp; land</th>
<th>Owner of house but rent land</th>
<th>Renter of house &amp; rent land</th>
<th>Renter of room &amp; rooms</th>
<th>Receives rent free</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>7.0</td>
<td>12.2</td>
<td>11.7</td>
<td>15.2</td>
<td>49.7</td>
</tr>
<tr>
<td>B *</td>
<td>19.6</td>
<td>34.2</td>
<td>33.7</td>
<td>33.1</td>
<td>34.6</td>
</tr>
<tr>
<td>C *</td>
<td>25.5</td>
<td>35.1</td>
<td>32.9</td>
<td>34.6</td>
<td>10.9</td>
</tr>
<tr>
<td>D *</td>
<td>17.3</td>
<td>9.8</td>
<td>9.8</td>
<td>8.8</td>
<td>3.6</td>
</tr>
<tr>
<td>E *</td>
<td>12.3</td>
<td>4.1</td>
<td>8.2</td>
<td>5.4</td>
<td>0.9</td>
</tr>
<tr>
<td>F</td>
<td>18.3</td>
<td>4.6</td>
<td>3.6</td>
<td>3.0</td>
<td>0.3</td>
</tr>
<tr>
<td>Total</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
<td>100.0</td>
</tr>
</tbody>
</table>

### TABLE IV  AVERAGE RENT AND SIZE (DETACHED HOUSE)

<table>
<thead>
<tr>
<th>Income class</th>
<th>Average rent</th>
<th>Average floor area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Baht</td>
<td>Dollars</td>
</tr>
<tr>
<td>A</td>
<td>61</td>
<td>3.05</td>
</tr>
<tr>
<td>B *</td>
<td>83</td>
<td>4.15</td>
</tr>
<tr>
<td>C *</td>
<td>228</td>
<td>11.4</td>
</tr>
<tr>
<td>D *</td>
<td>323</td>
<td>16.15</td>
</tr>
<tr>
<td>E *</td>
<td>520</td>
<td>26.0</td>
</tr>
</tbody>
</table>

* The studied income groups

Household expenditure survey 1962
TABLE V Average rent and size of rowhouses

<table>
<thead>
<tr>
<th>Income class</th>
<th>Average rent</th>
<th>Average floor area (m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bahts</td>
<td>Dollars</td>
</tr>
<tr>
<td>A</td>
<td>43</td>
<td>2.15</td>
</tr>
<tr>
<td>* B</td>
<td>59</td>
<td>2.95</td>
</tr>
<tr>
<td>* C</td>
<td>59</td>
<td>2.95</td>
</tr>
<tr>
<td>* D</td>
<td>54</td>
<td>2.7</td>
</tr>
<tr>
<td>* E</td>
<td>65</td>
<td>3.25</td>
</tr>
</tbody>
</table>

TABLE VI Housing expenditure

<table>
<thead>
<tr>
<th>Average monthly income</th>
<th>Percentage spent on housing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bahts</td>
<td>Dollars</td>
</tr>
<tr>
<td>Under 500</td>
<td>under 25</td>
</tr>
<tr>
<td>* 500-1,000</td>
<td>25 - 50</td>
</tr>
<tr>
<td>* 1,000-2,000</td>
<td>50 - 100</td>
</tr>
<tr>
<td>2,000-3,000</td>
<td>100 - 150</td>
</tr>
</tbody>
</table>

* The studied income groups.

Household expenditure survey 1962, National Statistical Office, Office of the Prime Minister, Bangkok, Thailand.
PROBABLE STAGES OF DEVELOPMENT

This housing project (2,500 families), requires very careful planning of the stages of development. The whole project may be accomplished in a short period of time, -- say, 2-3 years, or, in a long period of ten or more years. This time period depends on the developer's financial potential and on the existing housing problems. As already explained, the squatters are presently crowded along the periphery streets, the main road and along the canal. This is simply because people want to be near to the sources of communication. The space in the middle of the site is of rather low density and non-constructed land. This provides the possibility for beginning the first stage of development by moving out the few families from the center of the site.

FIRST STAGE (which may take up to 2 years)

In order to control the growth of the development, the major street, water mains, sewers and power lines connected to the main road will be constructed first. This will facilitate the simultaneous construction of ten five-story walk-up rental apartments along the street. The first stage will give an opportunity for the squatters who live along the periphery streets to move into the apartments, thereby providing the possibility for clearing the vacant space. (see diagram 1)
SECOND STAGE (which may take up to 5 years)

Two minor streets will replace the cleared space to serve the next 400 units of two-story rowhouses; then ten more five-story walk-up apartments will be constructed along the main street. A kindergarten and a school will be started. Also during this stage the squatters who live around the site are allowed to move in. (see diagram 2)

THIRD STAGE (which may take up to 10 years)

Another two minor roads and ten more five-story walk-up apartments along with 300 units of two-story rowhouses and more community facilities will be constructed. (see diagram 3)

FOURTH STAGE (which may take up to 10 or more years)

This will be a stage of continued construction of walk-up apartments and rowhouses along the major and minor streets. Also the scheme of community facilities and public utilities should be fulfilled. It is noted that the development may stop after the third stage or proceed into this stage and continue to grow towards the paddy field in the East. It is also possible that another housing development adjacent to this site may start its first stage since it is obvious that a great number of low income people really want to own decent houses. (see diagram 4)
STANDARDS OF ACCOMMODATIONS

To provide for healthful living and comforts, particular attention should be given to the environment and climate.

A. Climate

Thailand is a tropical country; the weather is hot and humid. It has three main seasons; a hot season with an average temperature 80-97 °F, a rainy season with 70-80 °F degree temperatures. In such a climate, cross ventilation in dwellings is most essential to maintain indoor temperatures near those that prevail outdoors. The prevailing wind comes mainly from the South and Southwest. Doors and windows are preferred to be in the North and the South sides. Canopies are also required to protect heat and rain. Heating system is not needed here. Open space enclosed by a wall at the back of the house is a desirable amenity, for in tropical countries, many activities -- including home industries -- take place outside the dwelling units.

B. Customary Activities

Private courtyards, for back-door life, are very desirable. Cooking, dining, laundry and relaxing, are preferred to be done privately here. The frontyard of the house is used for formal gathering among less familiar friends and guests. It is sometimes used for a home-industry area such as making paper bags, sewing, home furnishing, etc.
DWELLING UNIT TYPES

In order to make a decision on the sizes of the new dwelling units, the existing units, relative to family structure, is studied as follows:

<table>
<thead>
<tr>
<th>Existing family sizes (persons)</th>
<th>Existing floor areas (sq.m.) per person</th>
<th>Existing floor areas (sq. m.) per family</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>11.5</td>
<td>23</td>
</tr>
<tr>
<td>3</td>
<td>11.3</td>
<td>34</td>
</tr>
<tr>
<td>4</td>
<td>12.2</td>
<td>49</td>
</tr>
<tr>
<td>5</td>
<td>12.2</td>
<td>61</td>
</tr>
<tr>
<td>7</td>
<td>13.2</td>
<td>93</td>
</tr>
</tbody>
</table>

The average floor area is 12 square meters per person. The proposed floor areas are 31.50, 50.75 and 63 square meters for 2, 3-4, 4-5 persons respectively.

CONSTRUCTION COST

The existing cost of masonry houses is approximately 700 Bahts or 35 dollars per square meter. By using "ON-SITE-PREFABRICATION" one can assume the costs to be reduced down to 25-30 dollars per square meter.
<table>
<thead>
<tr>
<th>Floor area (sq.m.)</th>
<th>Cost/sq.m.($)</th>
<th>Building cost ($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>31.50</td>
<td>30</td>
<td>945.00</td>
</tr>
<tr>
<td>50.75</td>
<td>30</td>
<td>1,522.50</td>
</tr>
<tr>
<td>63.00</td>
<td>30</td>
<td>1,890.00</td>
</tr>
</tbody>
</table>

Existing cost of land is 2.5 dollars per square meter. In the case of two-story houses, the cost of land per family will be 1.25 dollars per square meter; for five-story walk-up apartments the cost will be 0.5 dollar per square meter. If we provide open spaces for rowhouses at the front and back, the lot divisions will be 73.50 and 147 square meters.

Generally, the costs of public utilities and administration are about 10% of the cost of structure.

Generally, it is only possible for people with such small incomes to become the owner of a house by making a long term loan, say of 15 years. The interest is normally 6% per annum or about 40% of the construction cost. The maximum loan should not exceed a family's three-year income.
ROWHOUSES BUILT BY GENERAL CONTRACTORS

| Cost                  | Floor area per family |  |  
|-----------------------|-----------------------|---|---
|                       | 31.50 m  | 63 m  |  
| Structure             | 945         | 1,890 |   
| Land                  | 91.87       | 183.75|   
| Utilities             | 94.50       | 189.00|   
| Administration        | 94.50       | 189.00|   
| Total                 | 1,225.87    | 2,451.75|  
| Interest 40%          | 490.34      | 980.70|   
| Grand total           | 1,716.21    | 3,432.45|   
| Minimum salary/month  | 47.6 $      | 95.34 |   

WALK-UP APARTMENTS BUILT BY GENERAL CONTRACTORS

| Cost of (Dollars)     | Floor area per family |  |  
|-----------------------|-----------------------|---|---
|                       | 31.50 m  | 50.75 m | 63 m  |  
| Structure             | 945       | 1,522.50 | 1,890 |   
| Land                  | 15.75     | 25.37    | 31.5  |   
| Utilities             | 94.50     | 158.25   | 189.0 |   
| Administration        | 94.50     | 152.25   | 189.0 |   
| Total                 | 1,149.75  | 1,852.37 | 2,299.80|   
| Interest 40%          | 459.90    | 740.94   | 919.80|   
| Grand total           | 1,609.65  | 2,593.31 | 3,218.30|   
| Minimum salary        | 44.6      | 72.0     | 89.0  |   

- 29 -
OCCUPANT FAMILY CHARACTERISTICS

<table>
<thead>
<tr>
<th>Existing family monthly income($)</th>
<th>Percentage of families</th>
<th>Required monthly income($)</th>
</tr>
</thead>
<tbody>
<tr>
<td>34.60</td>
<td>45</td>
<td>44.60</td>
</tr>
<tr>
<td>50.25</td>
<td>35</td>
<td>47.60</td>
</tr>
<tr>
<td>50.41</td>
<td>35</td>
<td>72.00</td>
</tr>
<tr>
<td>81.00</td>
<td>20</td>
<td>89.00</td>
</tr>
<tr>
<td>84.30</td>
<td>20</td>
<td>95.34</td>
</tr>
</tbody>
</table>

CONCLUSIONS:

Percentages of the dwelling unit types in the project:
Here we can see that 55% of the people can afford to own at the least, the smallest unit of walk-up apartments and rowhouses; of these, 20% can afford to own larger units. The remaining 45% are not able to own anything, so, the walk-up apartments must be rented to them. For those who can not even afford rental units, planned squatter areas, not too far from the site, are provided.
THE PROPOSED DWELLING UNIT TYPES

The proposed dwelling unit types are:

1. One to three - story rowhouses;
   a. Unit A. Contains - one living bedroom
      two bedrooms
      a kitchen and dining space
      a toilet and shower
      Area $7 \times 9 = 63$ square meters.
      Lot division $7 \times 21 = 147$ square meters.
      This unit can be expanded vertically and rented in the future.
   b. Unit B. Contains the same facilities as unit A., but the occupant is not supposed to rent the upper floor.
      Area $(3.5 \times 9) \times 2 = 63$ square meters.
      Lot division $3.5 \times 21 = 73.50$ square meters.
   c. Unit C. Contains - one living bedroom
      one bedroom
      a kitchen and dining space
      a toilet and shower.

2. Five - story walk - up apartment
   a. Unit D. Contains - one living
      three bedrooms
      a kitchen and dining space
      a toilet and shower.
Area 7 X 9 = 63 square meters.

b. Unit E (two floors.) contains - one living bedroom
two bedrooms
a kitchen and dining space
a toilet and shower

Area (3.5 X 9) X 2 = 63 square meters.

c. Unit F. contains - One living bedroom
one bedroom
a kitchen and a dining space
a toilet and shower

Area 3.5 X 9 = 31.50 square meters.

d. Unit G contains - one living room
two bedrooms
a kitchen and dining space
a toilet and shower

Area (3.50 X 10) + (3.5 X 4.5) = 50.75 square meters.

BUILDING EXPRESSION

From the previous discussion the resultant design is a dwelling unit: of one and two stories with a three and a half meter wide lot module. The basic house dimensions are 3.5 meters X 9 meters with courtyards at the front and rear.
The front portion of the house is designed as a combination living-bedroom and the rear portion as a kitchen and dining room. The frontyard of the rowhouse gives the possibility of expanding vertically up to three stories by adding a staircase that stands free of the structure. It is suggested that for more usage of the space, a staircase should be shared by two families. The entrance of the upper floor is through the front balcony. The frontyard will have better maintenance if it is publicly owned. A part of the rear balcony is used for a toilet and shower. Vertical circulation for the walk-up apartments is by a public staircase which serves about eight units. Floor to floor height is 2.60 meters to provide better cross ventilation and air movement inside the house.

CONSTRUCTION PROCEDURE

1. Footings for the party wall will be laid at marked locations and a precast concrete wall will be placed. Scaffoldings will be used to keep the wall vertical.
2. Pipes for the ground floor bath and toilet, etc., will be laid in the concrete bed for protection and connection with bath and toilet fixtures.
3. The wall will be grouted by concrete up to 0.80 meter from the ground floor level to make them stable.
4. Precast concrete slab will be placed and join with the party wall, leaving out some reinforcements. Paper bags will be laid between the joints and then grouted the beams with concrete to make walls and slabs rigid. Vertical steel rods will be placed to hold the upper precast concrete walls.

5. The topping of 2 c.m. will be laid on the concrete slabs, in the case of roofing, the topping will be 4 c.m. and have slopes from the center to both ends to drain the water.

6. For the openings or corridors, some of the components of precast concrete walls will be left open. The precast concrete beams will be used to carry the precast concrete slabs. The column at the corridor will be replaced by two "L" shape components.

7. Extension walls and interior partitions will be built.

8. Manufactured wooden stair will then be placed.

MAINTENANCE

Any housing design would fail if there is no maintenance. The main problem is to keep the public utilities going. The people may have to select a board of administration who would hire skilled workers to keep the utilities in good shape. The next problem is cleanliness; individual dwellings, front and back yards, the community playground and its facilities, and garbage areas should be well cleaned. There may be some regulations and services needed to control this. It is for the benefit of the whole community as well as the individual.
After long consideration, it was decided that there should be only one access to the site in order to reduce the intersections along the main road. The existing street at the North of the site is then used for another access. The main street is located in the middle of the site to provide the possibility of linear future expansion which serves both sides. (see diagram)

High density dwellings, consisting of five-story walk-up apartments with shops underneath, are later located along both sides of the main street to reinforce one another and limit the majority of cars to this same main street. Low density dwellings of rowhouses with private courtyards back to back, achieves the maximum usage of land and saves on construction cost. Integration of different incomes groups is facilitated by the shops and greenspaces. The community center and elementary school are interconnected with the public play field and canal. For the best orientation, all the buildings are placed North-South.
SURVEY OF EXISTING SYSTEM OF CONSTRUCTION

Due to the lack of heavy duty cranes and modern electrical equipment, construction is generally done by local machinery and hand labor. Therefore the construction work is of long duration and becomes very expensive.

The construction materials commonly used in Bangkok are bamboo, coconut leaves, zinc plates, wood, bricks, cement, clay tiles, concrete blocks, steel reinforcing and glass. The use of concrete and reinforced concrete construction, though more expensive, is increasing since they are more durable and have the quality of fire-resistance.

The greatest factors in the cost of reinforced concrete construction are formwork materials, labor and scaffolding. Precast construction begins to cut construction time and costs; it has the property of fire resistant and requires very low maintenance. In the future more and more constructional systems may be precast or prefabricated concrete. See appendix A for sketches of 3 different systems of construction and their sequence of erection in Thailand.
APPENDIX A

MATERIALS OF CONSTRUCTION

Local Materials
1. Cement
2. Asbestos cement board @ 1.20 x 2.40 M.
3. Asbestos cement corrugated roofings @ 0.90 X 1.20 M.
4. Asbestos cement shingles @ 0.30 x 0.30 M.
5. Concrete blocks @ 0.20 x 0.40 M.
6. Bricks - red
   - decorated
   - fire proof
7. Clay tiles @ 0.15 x 0.15 M.
8. Precast panels - floor slabs
   - wall
9. Precast columns and footings
10. Wood - Yang
    Teng, Dang and Teak wood
11. Plywood doors and partitions
12. Perforated wood
13. Rock
14. Marble
CONCRETE STRUCTURE
Imported Materials

1. Steel and rods
2. Aluminium
3. Metal windows and doors
4. Glass
5. Glassblocks
6. Bathroom accessories - glazed tiles
   - mosaic
   - sanitary equipments
7. Zinc
8. Foil insulation
9. Fiber glass
10. Ceramic tiles

SCHEDULE OF WOOD CONSTRUCTION PROCEDURE

1. Foundation - wood pillings 4" x 4.00 M. 6" x 6.00 M.
   8" x 8.00 M.
2. R.C. Footing and R.C. Column
3. 4" x 4", 6" x 6" or 8" x 8" wood column
4. 1½" x 8", 2" x 6" or 2" x 8" beam
5. 1½" x 6", 2" x 6"or 2" x 8" joist @ 0.50 M.
6. 4" or 6" and 3/4" thick flooring
7. 1½" x 8", 2" x 8" or 2" x 10" beam
8. 1½" x 6", 2" x 6" or 1½" x 8" rafter @ 1.25 M.
9. 1½" x 3" purlin @ 1.00 M.
WOOD STRUCTURE
CONCRETE & WOOD STRUCTURE
10. 0.60 x 1.20 M. corrugated asbestos roofing overlapping 0.20 M.

11. 1½" x 3" @ 0.50 M. vertical and horizontal members

12. 4" or 6" and ¾" thick, wall

13. Wood window, Teak or Teng wood panels @ 4", 3/4" thick

SCHEDULE OF CONCRETE AND WOOD CONSTRUCTION PROCEDURE

1. Foundation - wood pilings 6" x 6.00 M. or 8" x 8.00 M.
2. R.C. Footing
3. R.C. Column
4. R.C. Beam 0.15 x 0.30 M. or 0.20 x 0.40 M.
5. 1½" x 8" or 2" x 10" wood beam
6. 1½" x 6" or 2" x 6" or 1½" x 8" rafter @ 1.25 M.
7. 1½" x 3", 2" x 3" purlin @ 1.00 M.
8. 0.60 x 1.20 M. Corrugated asbestos roofing
9. 2" x 4" wood frame
10. 2" x 4" wood window, glass 3/16" thick
11. Glass louvres 3/4" thick
12. Ordinary red bricks 1½" x 4" x 8"
13. Plasterer both sides
14. R.C. Slab 0.10 M. thick
SCHEDULE OF CONCRETE CONSTRUCTION PROCEDURE

1. Foundation: wood pilings 6" x 6.00 M. or 8" x 8.00 M.
2. R. C. footing
3. R. C. column 6" x 6" or 8" x 8"
4. & 5. R. C. beam 0.15 x 0.30 M. or 0.20 x 0.40 M.
6. R. C. slab 0.10 M. with built up roofing
7. R. C. slab 0.10 M. thick
8. 2" x 4" wood frame
9. Concrete window sill
10. 2" x 4" wood window, glass 3/16" thick
11. Ordinary red bricks 1 1/2" x 4" x 8" plastered both sides
12. Decorated brick 2 1/2" x 4 1/2" x 9"

It is rather difficult to get good wood for construction now since people keep on cutting young trees. Sometimes construction work has to stop and wait for wood. In the future wood will become more expensive; concrete and precast concrete, though more expensive, will become more and more common.

Wood Construction cost 15-30$ per square meter
Concrete Construction cost 25-45$ per square meter
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SECTION

FLOOR SLAB SECTION

WALL SECTION

WALL-FLOOR JOINT

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