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PUBLIC SECTOR INVESTMENT IN THE DIRECT DEVELOPMENT OF URBAN HOUSING IN SRI-LANKA (CEYLON)

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1973.

I hereby declare that :

(a) This thesis was composed by myself.

(b) The research is my own original work.

Michael E. Joachim

ABSTRACT OF THESIS

Title: Public sector investment in the direct development of urban housing in Sri-Lanka (Ceylon).

1. The purpose of this study is to analyse the role of public sector investment in housing in Ceylon, with the objective of achieving a solution to the housing problem.

Since there exists a distinct difference between the urban and rural areas, the study was narrowed down to the urban sector.
Housing in its entirety covers the residential environment, and hence the field of analysis was narrowed down to the net residential area, hereafter called the direct development of housing.

Thus the title of this thesis "Public sector investment in the direct development of urban housing in Ceylon."

2. This study sets out to answer three basic questions. They are - (1) should the public sector invest in the direct development of urban housing in Ceylon? (2) If the public sector is to invest in the direct development of urban housing in Ceylon, what should be its objectives? And (3) how can these objectives be achieved?

3. In order to answer the three questions posed the study was divided into four main parts.
Part I is divided into two chapters. Chapter 1 defines terminology as will be understood in this study. This chapter is of importance in understanding the subsequent chapters, and in clearing the ambiguity that may exist between the terms used in this study and in the field of pure economics. Chapter 2 is of vital importance, since it is on this chapter that the rest of the study is based.
In a mixed economy like Ceylon one is faced with the basic question - can the private sector achieve the level of investment both in monetary and physical terms to provide adequate housing for the population, or is it necessary for the public sector to step in. The answer follows logically that if the private sector cannot do it, then the public sector must step in. Hence the need to develop a method of analysis, which is referred to in Part II, Chapter 3.
The second part of Chapter 2 deals with the objectives of public sector investment. Three basic objectives were set out. They were - (1) to solve the housing problem: (2) to do so at minimum physical costs, and (3) to maximise economic growth via the investment.
The analysis in this chapter leads to the conclusions that the housing problem is one of two parts, a physical problem defined by a set of standards, and a social problem that arises due to the unsuitability of this particular set of standards. Hence solving the housing problem meant defining standards which were related to the social, economic and cultural values of the population. The second objective was thus achieved since the standards defined were the minimum required. However, the costs involved had to be reduced within the limits of technology. An analysis of the third objective showed that the maximisation of economic growth in Ceylon via investment in housing could be achieved by maximising the marginal rate of employment generation, and minimising the rate of foreign exchange consumption.
Using this detailed analysis it was thus possible to approach Parts II, III and IV of the study.

4. Part II is divided into two chapters. In Chapter 3 a method of analysis was developed, which explained variation in investment patterns by the public and private sectors, both in the urban and rural areas, with reference to national policy from the year 1967 onwards. Using these trends it was possible to predict future investment patterns, and thus conclude that public sector investment was absolutely necessary. The method of analysis developed should be of immense use for other developing countries, since it is comprehensive and includes the contribution of self help housing in achieving the national targets set out.
Chapter 4 uses the conclusions drawn in Chapter 3 as a basis on which a model for financing the direct development of housing both urban and rural is developed. The conclusion reached showed that by diverting private sector resources in the form of savings such as compulsory savings, and provident funds, the level of investment could be achieved, and even the backlog cleared.

5. Part III of the study is divided into two chapters. Chapter 5 deals with achieving the objective of maximising economic growth by maximising marginal employment generation, and minimising the marginal rate of foreign exchange consumption. The whole problem is analysed via a theoretical model, and is then applied to Ceylon.
The main conclusion showed that though aided self help housing may help in solving the housing problem, it can have detrimental effects on employment generation. In Ceylon this can be disastrous where unemployment is about 15% of the labour force. Hence self help housing should be used with great care and is most suitable for areas of high employment, and where the ratio of housing to income is high.
In Chapter 6 the analysis sets out to define a concept for solving the housing problem at minimum physical costs. A theoretical analysis based on the principles of costs and benefits showed that if a housing programme is based on social, economic and cultural characteristics of a population, this objective could be achieved.
The main conclusion was that the concept of "housing need" did not achieve a solution at minimum physical costs, and thus the concept of "housing demand" was proposed which formed the basis on which public sector investment should view the problem at the urban scale.

6. Part IV uses the concept of demand to achieve the objectives at the urban scale. In Chapter 7, which is theoretical in its approach, a detailed model for guiding public sector investment at the urban scale is developed. This model is applicable to all developing countries, with slight modifications, and describes for the first time a mathematically integrated approach of viewing the costs and benefits of housing to the consumer.
This model was calibrated using original data obtained by surveying approximately 1200 households in the city of Colombo, and collecting hitherto unpublished data regarding the housing construction industry in Ceylon.
Chapter 8 is devoted to developing standards. This is the first time any reasonable set of standards has been developed exclusively for Ceylon.
Chapter 9 is devoted to an analysis of the costs of housing and uses data obtained in Ceylon for developing models that can be used for evaluating the different types of housing, at different locations. A most startling revelation was that it is cheaper to house larger households than smaller ones, and that flats are absolutely out of the question for urban Ceylon, cost wise.

Chapter 10 analyses the ability of a household to pay for housing, and is used in conjunction with the conclusions of Chapter 9 to define residential belts, which become basic information for the preparation of an urban plan.

Deviations from the theoretical predictions explained therein are quite revealing.

Overall the purpose of Chapters 8, 9 and 10, are to test the validity of the theoretical model, and set the base for future research. Chapter 11 describes briefly how this model can be of practical use in guiding public sector investment.

7. In conclusion the simple thesis that evolves quite conclusively from this study is that 'The public sector must play a major role in the direct development of urban housing in Ceylon, and to achieve its objective it must define the parameters of a programme on the social, economic and cultural characteristics of its population, i. e. use the concept of housing demand."

   There are numerous sub theses that come out of this study, which it is hoped will be of use to the developing countries in general.

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In June 1970, on completing my diploma in planning and housing in developing countries, I was encouraged by Professor Otto Koenigsberger to continue my research towards a Ph.D. With his help the O.D.A. agreed to finance my studies, and I am thus most grateful to him, not only from this point of view, but also for the constant interest he has shown in my work, and the encouragement he has given me throughout.

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As in any study of this nature I have gone through difficult periods when I felt like "throwing it all up". My wife, Estelle, has been my backbone during these periods, and it is because of her that I was ultimately able to complete the work.

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Michael E. Joachim

To

The teeming masses of the third world

AN ARIEL VIEW OF PART OF THE CITY OF COLOMBO, INDICATING HOUSING CONDITIONS

KEY: A: NEW LOW COST HOUSING. B: NEW FLATS. C: EXISTIN LOW COST HOUSING. D: SLUMS. P.S: PUBLIC SECTOR

INTRODUCTION

1. General

Housing, like food and clothing, is one of man's basic needs. Until recently, investment in housing has been considered as a pure "social overhead". However, more recent economists have argued that investment in housing can also generate economic growth.

As defined in Chapter 1, modern use of the term housing encompasses the entire living environment. The living environment consists of two basic parts. They are the area which consists of the housing units, and the area which consists of all other facilities required to support the population living in the housing units. Hence, the definitions in Chapter 1 defining the above parts as "the direct development of housing", and "the indirect development of housing." These definitions then set the first limitation to this study, i.e. the study is devoted to an analysis of the direct development of housing.

The second limitation to this study is arrived at due to the vast differences that exist between urban and rural communities in most countries, especially the developing countries. Thus this study is basically an analysis of the direct development of urban housing, specially related to the problems of the developing countries. Since there exist differences within developing countries, though the basic approach may be similar, details of analysis will differ. Therefore, this study is limited to an analysis of investment in the direct development of urban housing in Ceylon.

The final limitation to the study was set due to the broad scope of the above mentioned analysis. Working in the public sector in Ceylon, in the field of housing, the final scope of the study was limited by the author to an analysis of :

> "Public sector investment in the direct development of urban housing in Ceylon."

2. Basis of the study

Accepting the fact that housing is necessary from a social point of view, there arose three basic questions with regard to public sector investment in the direct development of urban housing in Ceylon. They were:

(1) Should the public sector invest in the direct development of urban housing in Ceylon?

(2) If the public sector is to invest in the direct development of urban housing in Ceylon, what should be the objectives of this investment?

(3) How can these objectives be achieved?

Answering these questions thus formed the basis on which the whole study is based.

3. The study

Based on the three basic questions posed, the study was divided into four parts. They are:

Part I : Definitions

Part II : The need and resources for public sector investment in the direct development of urban housing in Ceylon.

Part III : Towards achieving the objectives of public sector investment in the direct development of urban housing in Ceylon. The national scale.

Part IV : A model and its calibration, for guiding public sector investment in the direct development of urban housing in Ceylon, at the urban scale.

Under the above headings, the main approach and findings of the study are described below.

4. Definitions

Under the title of definitions the first objective was to define clearly terminology as would be understood throughout the study. Thus

Chapter 1 gives definitions of all the relevant terminology. It is important that anyone who reads this thesis first acquaint himself or herself with the terminology defined, as it is referred to not only in the title but throughout this work.

The second chapter is one of the most important chapters, since it defines the conditions under which it becomes necessary for the public sector to invest in the direct development of housing in Ceylon, and goes on to define the objectives of public sector investment.

This chapter is theoretical in its approach, and though it has been related to Ceylon in particular, it is applicable to the developing countries in general.

Briefly, the conclusions reached in Chapter 2 indicated that:

(1) The public sector should invest in the direct development of urban housing if it can be shown that the private sector alone will not achieve the level of investment both in financial and physical terms, to meet the requirements of the population.

(2) If public sector investment was necessary, the objectives of the investment should be:

(a) to solve the housing problem.

(b) to achieve the solution at the minimum physical costs

(c) to maximise economic growth via the investment.

The definition of the conditions for public sector investment are quite clear. However, the general objectives of public sector investment stated above are vague and need detailed definition. This detailed definition led to detailed objectives given in Chapter 2.

Of interest to the well versed reader on the subject is the definition of solving the housing problem. The definition defines the housing problem as one of two components, the physical component based on a set of standards, and the social component that may result due to the unsuitability of the standards. Thus solving the housing problem meant providing a physical solution to standards that eliminate related social problems. As seen in Chapter 2, this meant housing standards - based on the social, economic, and cultural characteristics of the population. This idea reverses the present one where standards are hypothetical, and social problems are not considered.

The second objective of achieving the solution at the minimum physical costs was possible by using the minimum standards needed to eliminate the related social costs, and providing these standards. at minimum initial costs and subsidies. This therefore indicated the need for an analysis of the technical aspects of housing.

The broad objective of achieving economic growth via the investment was then considered, in order to set out detailed objectives. The analysis led to the conclusion that this broad objective could be achieved if marginal employment generation could be maximised, and marginal foreign exchange consumption minimised via investment in housing.

Hence, this part of the study led to the definition of a set of conditions for, and objectives of public sector investment, which could be used as a basis for analysing public sector investment in the direct development of urban housing in Ceylon.

5. The need and resources for public sector investment in the direct development of urban housing in Ceylon

In order to establish a case for public sector investment in the direct development of urban housing in Ceylon, from the definitions developed in Chapter 2 it was necessary to show that private sector investment will not be able to achieve the physical and financial targets of investment.

For this particular aspect of the study the rural sector could not be isolated, since a national investment programme must consider the entire housing problem of the country.

With this in view a target of total investment was established as seen in Chapter 3. This target was relative to the G. N. P. at current factor cost prices. This total target was then divided into urban and rural areas.

The next stage of the analysis entailed estimating the investment made over the years 1967-1971. For this estimation, published as well as unpublished original data was used. Using these investment patterns as a basis it was possible to analyse investment patterns by the public and private sectors and explain the fluctuations with reference to national policy existing at the time.

Using this as a basis the five year plan (1971-1976) was appraised, and it was seen that total levels of investment would actually fall rather than increase, due to an overestimation of private sector investment.

Overall it was possible to build models that would describe investment patterns, considering existing and proposed government policy.

The conclusion reached was that if the investment targets were to be achieved, then greater public sector investment was necessary, thus establishing a case for public sector investment in the direct development of urban housing in Ceylon.

The biggest set-back to public sector investment in Ceylon, and the developing countries in general, is the lack of resources both domestic and foreign.

Considering at this stage the domestic resources necessary, a vital question arose. From where can resources for public sector investment in the direct development of housing in Ceylon be derived? Here once again both the urban as well as the rural sectors had to be taken into consideration. In order to answer this question a model was developed considering the possible sources from which resources could be drawn, showing that it was possible to raise the necessary resources.

The model was based on the projected investment trends developed in Chapter 3. Using these trends it was possible to estimate what extra resources were required to meet the annual as well as backlog targets.

The model is presented in Chapter 4, and makes use of private savings and a cut in food subsidies as a means to financing housing. The conclusion reached showed that using the model the annual target could be reached by 1976, and the backlog cleared by 1986. It also had the advantage of gradually reducing food subsidies, thus aiding economic growth. This conclusion has also been supported by the I.L.O. report to the Ceylon Government, and is cited in Chapter 4.

The overall conclusion of this part of the study showed that to solve Ceylon's urban housing problem public sector investment was necessary both to achieve the physical solution and raise the necessary resources.

6. <u>Towards achieving the objectives of public sector investment in the direct development of urban housing in Ceylon.</u>
<u>The National scale.</u>

On establishing a case for public sector investment in the direct development of urban housing in Ceylon, it was necessary to develop policy for guiding this investment, so that the objectives defined in Chapter 2 could be achieved.

There were three main objectives to be achieved. They were:

(1) To solve the housing problem, which was seen to be equivalent to providing standards compatible with the social, economic and cultural factors of the population.

(2) Achieve the solution at minimum physical costs, within the limits of technology.

(3) Maximise the marginal rate of employment generation, and minimise the marginal rate of foreign exchange consumption, to ensure economic growth via the investment.

These objectives were considered at this stage, at the total urban or national scale.

In trying to maximise the marginal rate of employment generation and minimise the marginal rate of foreign exchange consumption, a theoretical model connecting investment in housing with employment generation and foreign exchange consumption was built. This model also took into consideration the self help factor in housing, and related employment in industry. The model was then analysed theoretically from which general policy was developed.

A significant conclusion from the theoretical analysis showed that on the one hand self help housing increases the total investment for a given public sector investment, but on the other hand reduces the marginal rate of employment generation, and increases the marginal rate of foreign exchange consumption. It thus appeared that self help housing must be used with caution and is more suitable for areas of low unemployment but a high ratio of cost of housing unit to annual income of household.

In applying the theoretical model to Ceylon this fact was confirmed, and also showed that in general the housing construction industry should be labour intensive, and use more local materials if it is to aid economic growth, and thus demand its fair share of national resources.

Chapter 5 of this study presentsthe theoretical model, its analysis, and use for developing broad policy for public sector investment in the direct development of urban housing in Ceylon. This particular model will, it is hoped, be of use to other developing countries as well.

The first two objectives, namely solving the housing problem, and doing so at minimum physical costs, were then considered. The main objective here was to develop a concept which when applied would achieve these two objectives.

One fact was known, and that was the existence of a relationship between standards and socio-economic factors that determine the population, if the urban population was considered to be of similar cultural background. The point that required analysis was to establish the relationship between the socio-economic factors and the elements that made up the physical costs. The physical costs are built up of the annual equivalent of recovering the initial costs, the annual maintenance costs, and the cost of subsidies.

In Chapter 6 the analysis was approached on a theoretical cost-benefit basis. Costs represented the real cost to the consumer which included the recovery of the initial cost, and annual maintenance cost of a housing unti to which a household aspired. This aspiration as seen in Chapter 6 is related to the household's socio-economic status. Social status was measured as equivalent to job classification of household head, and economic status to long run income of household. Thus costs are a function of socio-economic status.

Benefits on the other hand were represented by the household's ability to pay for housing. This again as seen in Chapter 6 was a function of the socio-economic status.

Hence, subsidies which are costs less benefits were also a function of socio-economic status.

Analysis of these basic relationships showed that if housing is based on the socio-economic factors of the population, a solution can be achieved at minimum physical costs.

Based on these findings the concept of housing need was appraised and rejected since it did not achieve any of the objectives stated.

Thus the concept of "housing demand" was proposed, and in its simplest form states that the parameters which determine a housing programme for an urban area or for that matter any area should be based on the social, economic, and cultural factors that define the population of the area.

Thus, at the end of this section it was possible to formulate broad policy for guiding public sector investment in the direct development of urban housing in Ceylon.

7. A model and its calibration, for guiding public sector investment in the direct development of urban housing in Ceylon.

The study up to this stage may appear to be highly theoretical in its approach. This was necessary to develop a basis on which a housing programme, for public sector investment, could be formulated.

The main object of this part of the study is to develop a model which could be used for formulating a housing programme at the urban scale.

Once again it is necessary to delve into a theoretical approach first, and then calibrate the theoretical model for practical use.

The theoretical model is based on a detailed analysis of costs and benefits as developed in Chapter 6. However, at this scale certain factors such as household size, location, tenure, form of house, etc. which were held constant are made variable.

It may appear that certain long held views have been dispelled in this model. This is understandable since most existing models have little or no theoretical background. On the other hand sophisticated models that exist are practically inapplicable to situations in the developing countries.

In order to calibrate the theoretical model developed, a large amount of data was required. The data was collected mainly from (1) a study of records of housing construction available at the department of National housing in Ceylon; (2) a special survey of approximately 1200 households (i.e. a 2% sample) of the city of Colombo. The data collected via this survey is completely original. This survey organised by the author is described in Appendix I together with the raw data obtained; (3) other available sources of data.

Calibration of the model is divided into three chapters. Chapter 8 deals with the determination of standards; Chapter 9 - a detailed analysis of costs. In Chapter 10 the ability of the household to pay for housing or benefits is analysed, leading to a definition of the housing threshold. This definition is then used to develop threshold maps for housing location.

It will be appreciated that the model is calibrated using only a 2% sample of Ceylon's largest city; hence, the results of the calibration will only confirm the basic assumptions of, and trends indicated in the thoretical model. The results may be indicative of the probable values that may be obtained in a larger survey. For practical use the model is theoretically valid, but must be calibrated using a larger sample.

Chapter 11 indicates how the model could be used in formulating policy, for a public sector programme for the direct development of urban housing in Ceylon.

8. Overall conclusions

The broad thesis that can be drawn from this study is as follows:

> "The public sector must play a major role in the direct development of urban housing in Ceylon, and the parameters for determining the programme must be based on the social, economic, and cultural characteristics of the population."

This may not be new, but the theoretical approach used to prove this thesis and the models developed therein for applying this thesis may be of use not only to Ceylon but to other developing countries interested in defining "non-politically" the role of their public sectors in the direct development of urban housing.

PART I. DEFINITIONS

CHAPTER 1. **Definitions of Terminology.**

CHAPTER 2. **A Definition of Conditions for, and Objectives of Public Sector Investment in the Direct Development of Urban Housing in Ceylon.**

CHAPTER I

DEFINITIONS OF TERMINOLOGY

1.0 Introduction

The purpose of this chapter is to define terminology as will be understood in this study.

1.1 The "development of urban housing"

In the broader sense of the word, the development of urban housing can be said to include:

(1) The provision and development of land for residential use.

(2) The building of dwelling units.

(3) The provision of support facilities, which comprise community, commercial, and recreational facilities.

The provision of light industrial concerns within the residential area has not been included in the definition, as it cannot be strictly classified as housing development. However, it must be noted that the provision of light industrial factories are necessary for generating employment within the residential area. It also follows that in redevelopment plans, any existing employment opportunities should be retained, so long as they are not of an obnoxious nature.

1.1.1 The "direct development of urban housing"

The direct development of urban housing refers to those functions related to the development of the net housing area, and comprise:

(1) The provision of land for the net residential area.

(2) The provision of infrastructure within the net residential area (i.e. vehicular and pedestrian access, potable water supply, sewage disposal, storm water drainage, and power).

(3) The provision of the dwelling units.

1.1.2 The "indirect development of urban housing"

The indirect development of urban housing refers to the provision of those facilities which are necessary to support the net residential area, and thus make up the gross residential area. It comprises of:

(1) The provision of land and infrastructure for the support facilities, to be provided.

(2) The provision of community facilities (i. e. schools, clinics, community centres, and administrative offices).

(3) Commercial facilities (i. e., shops, restaurants etc.)

(4) Recreational facilities (i. e. parks, playgrounds, and entertainment facilities).

As mentioned in 1.1. the provision of light industry is treated as separate from the residential area.

1.2 The public sector

The public sector is defined as the institutional and administrative organisation of government.

1.2.1 Public sector resources

Public sector resources consist of:

(1) Revenue from taxes.

(2) Direct revenue from profits.

(3) Foreign borrowings and aid.

It will be noticed that domestic borrowings have been excluded. This is because domestic borrowings are actually private resources being invested via the public sector. (see 1. 3.1).

1.3 The private sector

The private sector is defined as all individuals, and private institutions and organisations.

1.3.1 Private sector resources

Private sector resources can be classified into two main types:

(1) Capital for investment derived from wages, profits, and savings. Savings in Ceylon include cash deposits in banks and in hand, provident and pension fund contributions, life insurance policies, contributions to saving institutions, and contributions to the

compulsory[1] savings fund. These monies are utilised by the public sector via domestic borrowing. This is why domestic borrowing is not classified as a public sector resource in (1.2.1).

(2) The other form of private resource often not taken into account is the labour potential available, which could be used effectively for organised home building.

1.4 Public sector investment

"Public sector investment" is defined as the value of net capital formation, by the public sector as defined in (1.2) via the use of its own resources as defined in (1.2.1), and/or resources derived from the private sector as defined in (1.3.1) via domestic borrowing.

1.4.1 Public sector investment in the direct development of urban housing (C_{UD})

Public sector investment in the direct development of urban housing is defined as that part of public sector resources (defined in 1.2.1), and/or that part of private sector resources (defined in 1.3.1) derived via domestic borrowing, invested via the public sector (defined in 1.2) for the direct development of urban housing (defined in 1.1.1).

1.4.2 Public sector investment in the indirect development of urban housing (C_{UI})

Public sector investment in the indirect development of urban housing is defined as that part of public sector resources (defined in 1.2.1), and/or that part of private sector resources (defined in 1.3.1), derived via domestic borrowing, invested via the public sector (defined in 1.2) for the indirect development of urban housing (defined in 1.1.2).

1.4.3 Total public sector investment in the development of urban housing (C_{UT})

Total public sector investment in the development of urban housing is defined as that part of public sector resources (defined in 1.2.1) and/or

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[1] Legislation was passed in 1970 whereby income tax payers had to contribute to a state compulsory savings fund.

that part of private sector resources (defined in 1. 3. 1), derived via domestic borrowing, invested via the public sector (defined in 1. 2) for the development of urban housing (defined in 1. 1). Therefore it follows that:

$$C_{UT} = C_{UD} + C_{UI} \quad \ldots\ldots\ldots\ldots\ldots \quad (1\text{-}1)$$

1.5 Private sector investment

"Private sector investment" is defined as the value of net capital formation, by the private sector as defined in (1. 3), via its own resources as defined in (1. 3. 1).

1.5.1 Private sector investment in the direct development of urban housing (P_{UD})

Private sector investment in the direct development of urban housing is defined as investment by the private sector as defined in (1. 3), of that part of its own resources as defined in (1. 3. 1), in the direct development of urban housing as defined in (1. 1. 1).

1.5.2 Private sector investment in the indirect development of urban housing (P_{UI})

Private sector investment in the indirect development of urban housing is defined as investment by the private sector as defined in (1. 3), of that part of its own resources as defined in (1. 3. 1), in the indirect development of urban housing as defined in (1. 1. 2).

1.5.3 Total private sector investment in the development of urban housing (P_{UT})

Total private sector investment in the development of urban housing is defined as investment by the private sector as defined in (1. 3) of that part of its own resources as defined in (1. 3. 1) in the development of urban housing as defined in (1. 1). Therefore it follows that:

$$P_{UT} = P_{UD} + P_{UI} \quad \ldots\ldots\ldots\ldots\ldots \quad (1\text{-}2).$$

1.6 Total investment in the development of urban housing (U_T)

The total investment in the development of urban housing is defined as the sum of the total public sector investment in urban housing defined in (1.4.3) and the total private sector investment in the development of urban housing as defined in (1.5.3). Therefore it follows that:

$$U_T = C_{UT} + P_{UT} \quad \ldots\ldots\ldots\ldots \quad (1\text{-}3).$$

$$\text{i.e.} \quad U_T = C_{UD} + C_{UI} + P_{UD} + P_{UI}$$

If we write $U_D = C_{UD} + P_{UD}$ i.e., the total investment in the direct development of urban housing, and $U_I = C_{UI} + P_{UI}$, i.e. the total investment in the indirect development of urban housing - then $U_T = U_D + U_I$.

1.7 Notation for application of definitions to rural housing

The definitions of terminology given for various aspects of urban housing may be used to define similar aspects of rural housing. The notation, however, will incorporate the letter R in place of the letter U.

Thus $R_T = R_D + R_I$

CHAPTER 2

A Definition of Conditions for and Objectives of Public Sector Investment in the Direct Development of Urban Housing in Ceylon.

2.0 Introduction

The basic assumption from which this study begins is that, "shelter", like food and clothing, is a basic human need. It thus follows that one of the goals of government should be to ensure that its population is provided with adequate shelter. The term shelter used here refers to those functions contained within the definition of "the direct development of urban housing", (section 1.1.1) applied both in the urban and rural context. Hence, the role of government is to ensure that the level, and type of investment, in the direct development of housing is equal to that necessary for the provision of adequate shelter for its entire population.

Ceylon like most countries has a mixed economy, i.e. a mixture of private and public enterprise. This raises certain basic issues. These issues can be posed as questions, as follows.

(1) Is public sector investment necessary to achieve the level and type of investment required, and if so how much is required?

(2) If public sector investment is necessary, what should be the objectives which guide it, and how can they be achieved?

The purpose, therefore, of this chapter is to identify the general conditions under which public sector investment may be necessary, and define the objectives which should guide this investment when referring in particular where relevant to urban housing in Ceylon. The conditions defined thus form the basis on which a systematic analysis of investment in the direct development of housing in Ceylon is carried out, and presented in Chapters 3 and 4, with particular reference to investment in the direct development of urban housing.

Chapters 5, 6, 7 and 8 are devoted to analysing public sector investment, with a view to achieving the objectives to be set out for "public sector investment in the direct development of urban housing in Ceylon".

2.1 Conditions for public sector investment in the direct development of housing

In trying to answer the basic question whether public sector investment is necessary, it becomes necessary to consider the alternative to public sector investment, and define the conditions for the selection of one of the systems of investment, thereby including in the definition the conditions for public sector investment.

2.1.1 Systems of investment

There are three systems under which investment in the direct development of housing can take place. They are:

(1) Pure private sector investment.

(2) A mixture of private and public sector investment, and

(3) Pure public sector investment.

Within a capitalist economy the direct development of housing has been mainly achieved via private sector investment, while in a socialist economy investment has been mainly via the public sector. However, in a mixed economy it becomes necessary to define the role of the private and public sectors.

The role to be played by each of the sectors in the direct development of housing will differ from country to country and also between the urban and rural areas of a country. This is obvious since the definition of the roles will depend on overall economic and related policy in addition to the availability of resources and income distribution.

2.1.2 Selection of a system of investment

In purely capitalist and socialist economies there is no doubt about the selection of a system. Whether the system works is an entirely different question.

Fortunately Ceylon, which has a mixed economy, can be treated as a general case, wherein varying the proportion of investment can vary the system from one of purely private sector investment to one of purely public sector investment. Hence, the basis of selection of a system should be to determine the optimum proportions of investment subject to national policy, such that the following objectives are achieved.

The objectives to be achieved are:

(1) The total level of investment achieved is equal to that necessary for the provision of adequate shelter. This explains why the proportions will differ from country to country and also between the urban and rural areas of a country.

(2) Objective (1) measures investment in monetary terms. It is not sufficient to achieve the desired level in monetary terms only, but the investment measured in physical terms must also equal the desired level.

It thus follows that the conditions for public sector investment in a particular area of a particular country, in this case the direct development of urban housing in Ceylon, depend on achieving the desired level of investment both in monetary and physical terms, subject to existing overall national policy. An analysis of investment patterns under different policy conditions is thus necessary to answer the question, and determines the level of public sector investment necessary. The objective of the analysis is to achieve the desired level of investment. Chapter 3 of this study is thus devoted to analysing investment patterns in the direct development of housing in Ceylon, with special reference to the urban areas, while Chapter 4 uses the conclusions of Chapter 3 to develop a model for generating the resources necessary for achieving the desired level of investment.

2.2 Broad objectives of public sector investment in the direct development of housing in Ceylon

On establishing the need for and level of public sector investment necessary in the direct development of housing in a specific area of a specific country, it follows that the next step is to define the objectives of the investment. Once again it will be appreciated that the objectives may vary for different countries and areas within countries. However, generalising for the developing countries, and Ceylon in particular, the objectives can be broadly stated as follows:

(1) To solve the housing problem.

(2) To achieve a solution within the permitted level of investment, especially due to the fact that there is a tremendous shortage of resources. The objective may thus be restated as achieving the solution at minimum physical costs.

(3) Toeensure that the investment generates maximum economic growth.

The three basic objectives can now be analysed in greater depth with a view to clarifying their meaning, and identifying the detailed objectives to be achieved when referring to the direct development of urban housing in Ceylon.

2.3 Solving the housing problem

To solve a problem one must define a problem, hence the analysis starts by defining the term "housing problem", which then leads to a definition of solving the housing problem. This definition of solving the housing problem is then used to identify the objectives, which must be achieved by the public sector in investing in the direct development of urban housing in Ceylon.

2.3.1 A definition of the term "housing problem"

In referring to a "housing problem" current usage of the word tends to refer to a quantitative and qualitative shortage of housing units. However, more recently a more vague meaning has been applied, which refers to an unsatisfactory living environment. Obviously, the first was too narrow but objective, while the second tends to be broader, but subjective. In view of this let us try to define the "housing problem" so that it is as broad as the second definition and as objective as the first. In Chapter 1 (section 1.1) the phrase "development of urban housing" was defined. This definition included the development of the land, the provision of the dwelling units, and the provision of the support facilities. This then covers the residential environment. Therefore, broadly the housing problem can now be defined as:

(1) Insufficient housing units to meet the requirements of a specific population, based on some specific standards.;

and/or

(2) Insufficient support facilities to serve the population housed, based on some specific standards.

It will be observed that the problem has been defined as a physical one, in relation to some set of standards. This problem can now be expressed in economic terms, by relating it to the cost of providing the dwelling units and the related support facilities, to the specified standards.

An important point comes up at this stage, and that is the social problems related to the shortage of dwelling units and related support facilities. These social problems result in future social costs. Thus in economic terms these future social costs can be expressed as their present value.

We can now write the following:

Housing problem = physical problem based on some set of standards + social problems created as a result of the unsuitability of the defined standards.

In simple terms this identity means that a definition of the housing problems defines the shortages of dwelling units and related support facilities based on some specified standards, and that if these standards do not eliminate the social problems related to housing, these problems must be included, as part of the housing problem.

This identity expressed in terms of cost then becomes:

Cost of solving housing problem $\equiv$ Cost of physical solution to achieve a defined set of standards + Present value of social costs related to social problems not eliminated by use of the defined set of standards - see diagram (2-1), total cost line.

2.3.2 A definition of solving the housing problem

From the definition of the "housing problem" in (3.1) it appears that solving the housing problem is the provision of dwelling units and support facilities in quantity and quality defined by a set of standards that eliminate any social problems related to unsatisfactory housing. Thus the real solution lies in solving the social problems using the physical solution to achieve this end. This approach therefore reverses the current approach whereby the major objective is to solve the physical problem, with the hope that the social problems may be eliminated. Hence ideally solving the housing problem means that the standards for the physical development should be based on the elimination of related social problems.

2.3.3 Application of the definition to the direct development of urban housing in Ceylon

The general definition of solving the housing problem can now be applied to a specific area of housing, i.e. the direct development in the urban areas as defined in (1.1.1). This covers the provision of land for the dwelling units, the provision of infrastructure for these units, and the provision of the dwelling units.

Hence, the direct development of urban housing must adhere to a set of standards which eliminate social problems related to the aspects of development within the definition. However, standards for the indirect development may be related to standards for direct development, and therefore such relationships should be taken into account if they exist.

It is thus possible to state that the first objective of public sector investment in the direct development of urban housing must be to achieve the physical development to standards which eliminate related social costs, due regard being paid to the relationship between direct and indirect development.

2.3.3.1 Social problems related to the direct development of urban housing in Ceylon

The term "social problems" in its wider sense covers any occurrence that upsets the social wellbeing of a community or individual of a community. Social problems are numerous and spring from various causes. Social costs are the costs involved in solving the social problems of a society. Hence elimination of social costs means eliminating the cause of the social problems.

Social problems in relation to the direct development of urban housing are of two types. They are:

(1) Social problems that present themselves in a physical form, and can be said to originate from any one of the aspects of the direct development of urban housing. An example would be the spread of disease due to the pollution of the water supply. This type of problem is thus termed "Socio-physical" and is defined as a social problem that presents itself in a physical form, and can be traced to an inadequacy in the standards used for the direct development of urban housing.

(2) Social problems that present themselves in mental form, that may or may not lead to a complexity of physical forms. An example would be the effect of insufficient space and privacy on family life. This may lead to numerous problems that present themselves in a complexity of physical forms. This type of problem is termed "socio-mental", and cannot be eradicated by treating the physical form that may arise, but must be eradicated by eliminating the root cause that creates the mental attitude, which is responsible for the physical form. In other words, "socio-mental" problems are defined as problems that emanate due to the mental dissatisfcation of a oommunity or individual of a community as a result of inadequacy of the standards used for the direct development of urban housing.

2.3.3.1.1 Socio-physical problems and the direct development of urban housing

From the definition in section 2.3.3.1, "socio-physical problems are direct physical problems affecting the population as a result of inadequate standards, which result in social costs.

Basically the physical problems that result in social costs are related to the physical health of the population housed. Thus socio-physical problems can be regarded as problems that affect the physical health of the population, that can be traced to inadequate housing standards.

In applying this form of definition, one of the major factors to be considered is the climatic conditions of the area to which the definition is being applied. This is necessary since countries situated in the tropics need to keep the housing unit cool, and is generally directly open to the atmosphere for ventilation, while those in temperate areas need to keep the housing unit warm, and thus closed to prevent a loss of heat.

The following discussion will treat countries situated in the tropics, and will refer to Ceylon in particular.

Socio-physical problems related to the direct development of urban housing in the tropics, and to Ceylon in particular, arise due to two major reasons. They are:

(1) Non-availability of a supply of potable water,

and

(2) Non-availability of a system for sewage and waste water disposal.

It will be noted that overcrowding has not been considered as a factor affecting the physical health of a population due to the fact that climatic conditions necessitate ventilation, which in most forms of housing is provided by windows open to the atmosphere. In other cases overcrowding is overcome by the fact that people sleep in the open areas surrounding the house.[1] However, it must also be noted the tropics has monsoon rains which last for about three months of the year. During this period there will be an obvious overcrowding, and the possibility of a health hazard. However, in comparison to the temperate climates where the climate is cool the whole year round, and sleeping out in the open is virtually impossible, the health hazard of overcrowding in the tropics is virtually negligible.

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[1] During the survey described in Appendix I it was found that in certain cases an occupancy rate of 15 persons/habitable room was recorded. The fact that the majority slept outside the house was confirmed by enquiring where they slept.

Table (2-1)

Urban Water Supply[1]. Ceylon (1969-70).

Source/ Purpose	Drinking %	Cooking %	Bathing %
Pipe Borne	59.4	58.7	41.4
Well	40.6	41.3	49.6
Tank	-	-	2.1
River/ Stream	-	-	6.9

Table (2-2)

Urban Sewage Disposal[2]. Ceylon (1969-1970).

Type of Toilet	Flush	Bucket	Water Seal	Cess Pit	None
Percentage	20.6	27.6	24.8	13.0	14.0

1, 2. Socio-Economic Survey of Ceylon, 1969-70. Tables 50 and 52, respectively. Department of Census and Statistics, October, 1971.

Referring to Ceylon in particular, tables (2-1) and (2-2) describe the availability of a potable water supply, and sewage disposal system within the urban areas of Ceylon. It will be noted that only 59.4% of the population have purified water for drinking, and 14.0% have no form of toilet facilities at all. This has resulted in the rapid spread of communicable diseases[1], and a large expenditure of approximately 7% of current and capital expenditure on health facilities.[2]

A survey (Appendix I) revealed that in the city of Colombo the occupancy rate varied from 1 to 15 persons per habitable room, averaging around 3.

The problems mentioned above occur mainly within the lowest income groups who live in old tenements and in improvised structures, which constitute about 30% of urban housing in Ceylon.

2.3.3.1.2 <u>Elimination of "socio-physical problems" related to the direct development of urban housing</u>

From the discussion (section 2.3.3.1.1) it follows that in order to eliminate the "socio-physical" component of the social costs, the root cause of the "socio-physical" problems must be eliminated. Thus for countries situated in the tropics and for Ceylon in particular the direct development of urban housing must ensure that

(1) Housing is provided with a supply of potable water.

(2) Housing is provided with a system for sewage and waste water disposal.

What of the question of overcrowding? As mentioned earlier the detrimental effects of overcrowding are much less in the tropics than in countries situated in temperate climates. Hence occupancy rates can be more realistically determined by referring to their relationship to "socio-mental" problems as will be seen in section 2.3.3.1.3.

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[1] Report of the planning committee on Education, Health, Housing and Manpower - page 46, para. 25. Government Press, Ceylon. May 1967

[2] Table 36. Report of the Central Bank of Ceylon for 1971.

To support this view, the study of "Housing and Tuberculosis in a mass radiographic survey"[1], dispelled the long held view that high densities were the cause of infection, and showed that it could be more related to socio-economic status.

Further, the work done by Van Huyck[2] shows that as per capita G.N.P. decreases, occupancy rate increases, and they are related hyperbolically. However, it is evident from his graph that the obvious effects of climate have been neglected, wherein Italy and Mexico had a similar per capita G.N.P.'s but their occupancy rates were 1.3 and 2.8 respectively. A similar disparity existed between the U.K. and Israel.

This thus proves that occupancy rate is more realistically determined by referring to a basis of socio-economic satisfaction, and that climatic conditions are equally important.

2.3.3.1.3 "Socio-mental" problems and the direct development of urban housing

"Socio-mental" problems as defined in section 2.3.3.1 are problems that arise due to the standards used for the physical development being unacceptable, and thus resulting in a dissatisfied population.

Unlike "socio-physical" problems, "socio-mental" problems cannot be definitely identified with particular aspects of the direct development of housing, since the problems arise from a complex combination of reasons[3]. However, since "socio-mental"

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[1] G.E.Brett and B. Benjamin: "Housing and Tuberculosis in a mass radiographic survey". British Journal of preventative and social medicine, XI (1957) 7-9.

[2] Van Huyck, A.P. "The housing threshold for lowest income groups; the case of India". Graph 2, page 86.

[3] In support of this, quoting from the article "Social functions of the urban slum" by Marc. Fried and Joan Level, in Urban Planning and Social Policy, edited by B.J. Fireden and R.Morris (Basic Books Inc. New York 1968) "There is little doubt that poor housing and higher rates of social pathology are associated with slum residence, but whether they are functions of residential location or socio-economic status remain an open question. Many efforts to implicate the slum as the cause of social pathology have failed; even in the sphere of physical health there is evidence to suggest that socio-economic status is more critical than slum residence."

problems are associated with dissatisfaction, it follows that an increase in dissatisfaction should lead to an increase in "socio-mental" problems.

It thus follows that the elimination of related "socio-mental" problems depends on providing housing to such standards as satisfy the population to be housed.

2.3.3.1.4 Elimination of "socio-mental" problems

Since the elimination of "socio-mental" problems related to the direct development of urban housing depends on formulating standards that satisfy the population to be housed, it follows that standards should be based on the basic factors that contribute towards satisfaction.

As suggested earlier there is evidence to show that social pathology or "socio-mental" problems are the result of socio-economic status, rather than the direct result of the physical condition of housing. However, where standards do not satisfy the socioeconomic status, it tends to aggravate the situation by increased dissatisfaction. Hence satisfying the socio-economic status is one of the basic objectives that must be achieved when developing standards.

A factor neglected in most studies has been the cultural factor. Two households of identical socio-economic status may have very different patterns of family life as a result of different ethnic origins. Hence ethnic origin; and thus culture is the second criteria on which standards must be based.

It thus follows that basic factors to be considered in the formulation of standards are:

(1) Social status

(2) Economic status; and

(3) Cultural background or ethnic origin.

In order to use these basic factors in determining standards it is necessary to determine the variables that determine social status, economic status, and cultural background.

(1) Social status (S)

In relation to housing social status can be identified broadly with job classification of the head of household. This form of social stratification has been shown to reflect the attitudes of people toward housing on a satisfactory basis.[1, 2.] This type of classification is particularly true in urban Ceylon where the population can be classified socially in respect to their attitude towards housing in the following groups:

(1) Blue collar workers
(2) White collar non-professional workers; and
(3) Professional workers.

(Proof of this is given in Chapter 8, using the data obtained from a survey described in Appendix I.)

(2) Economic status (E)

Economic status can be described by the normal or long run household income. (Chapter 6 and 8).

(3) Cultural background (C)

Cultural background can be related to ethnic origin. However, in the broader context it can also be considered as urban, and rural for a particular country. This broad definition is more practical in its application, especially for a country like Ceylon where the majority of the population stems from two basic ethnic groups, which are culturally similar. (Chapter 8)

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1 Rain-water, Lee. "Fear and the house-as-havenn in the lower class"; page 85 - Urban Planning and Social Policy.

2 Anthony, Judith (1970). Urban systems: data on household income and socio-economic group. Land use and built form studies. Working Paper No. 37. University of Cambridge, School of Architecture.

Thus the elimination of "socio-mental" problems related to the direct development of urban housing in Ceylon can be achieved by basing standards on:

(1) The classification of households in terms of the job of the head of the household, i. e. the social group.

(2) The normal or long run income of the household; and

(3) The ethnic origin of the household. In this particular case this factor may be considered to be common to all urban households in Ceylon, and may not be of significance.

A population will be composed of different social groups and different income groups. It thus follows that if standards are to be based on satisfying the various groups, it will not be possible to do so with one set of standards. Hence an extension to the original thesis states that one set of standards is insufficient for the elimination of the related "socio-mental" problem, but what is needed is a range of standards satisfying the various socio-economic groups in a community.

2.3.4 Detailed objectives for solving the housing problem via public sector investment in the direct development of urban housing in Ceylon

From the foregoing discussion in sections 2.3 to 2.3.3, it follows that if the basic objective of solving the housing problem is to be achieved, standards should be based on the elimination of related social costs. It was also seen that to eliminate related social costs standards should be based on satisfying the socio-economic values of a population in addition to provision of basic facilities such as potable water, and sewage and waste water disposal.

Therefore if public sector investment in the direct development of urban housing is to achieve the basic objective of solving the housing problem it must be guided by policy objectives which state that:

(1) Every housing development must be supplied with some form of potable water supply and sewage and waste water disposal.

(2) The detailed standards of development must be based on satisfying the social and economic values of the population, which results in the need for a range of standards, rather than one set of standards.

2.4 Achieving the solution at minimum physical costs

The second objective of public sector investment as stated in section 2.2 was that the solution to the problem should be achieved at minimum physical costs.

In this section physical costs related to the direct development of urban housing are defined in detail. This definition leads to an identification of the detailed objectives that must be achieved if the broad objective is to be achieved.

2.4.1 Physical costs related to the direct development of urban housing

Physical costs related to the direct development of urban housing are of two types, viz.

(1) The initial costs of development

(2) The future costs of maintenance and subsidies.

Hence the costs will be defined under the above broad headings, which leads to identifying the relationship between these two basic forms.

2.4.1.1 Initial costs of the direct development of urban housing

The initial costs related to the direct development of urban housing arise from four basic sources. They are:

(1) The cost of land per housing unit.

(2) The cost of infrastructure development per housing unit;

(3) The cost of a housing unit; and

(4) The total quantity of housing to be built.

It will be seen that each of these costs is related to the standards used, and in certain cases to the indirect development of urban housing.

Theoretically if a policy of acquiring land by means of using government bonds is implemented, and a policy of owner occupation and rent purchase is implemented, the public sector will not have to meet the initial costs of land or make allowance for maintenance costs. However, if these two costs are not minimised the cost of housing to the consumer will rise, resulting in a need for greater subsidies. Since subsidies itself are to be minimised, it is necessary to consider the minimisation of the total cost, on the theoretical assumption that all costs are being met by the public sector.

2.4.1.1.1 The cost of land per housing unit

One of the basic factors that determine urban land costs is its location in relation to the city centre. Land costs tend to decrease with distance from the city centre![1] It thus appears that in order to minimise the cost, housing should be situated as far from the city centre as possible. However, an important point that arises is the cost and time of travel, which will be dealt with in Chapter 7.

Irrespective of the location factor, the most important factor that affects the land cost per housing unit is the density of development in units/acre. It is quite clear that higher densities will reduce the cost of land per dwelling unit. However, as we will see later on, indiscriminate increase in densities can create social problems, thus not achieving the primary objective of eliminating the social costs. It thus appears that there must exist an optimum density of development, and that this should be determined by considering the density level that satisfies the population, as concluded in section 2.3.

As mentioned earlier the net development of housing cannot be considered in isolation. Land is one of the factors affected by this criteria. Support facilities are required to provide a

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[1] Richardson, H.W. (1971). Urban economics page 50, Penguin books, England.

satisfactory living environment, these require land, and thus it is not the net density but the overall gross density that should be maximised if the cost is to be minimised.

2.4.1.1.2 The cost of infrastructure development

It has been shown that the cost of urban infrastructure development decreases as densities increase.[1,2.] This again suggests that high densities will minimise the cost of the direct development of urban housing. However, here again we must consider the effect of high density on social costs, and the obvious fact that high densities result in high rise building. This leads to the consideration of the cost of high rise building, and also the social costs of living in flats.

2.4.1.1.3 The cost of the housing unit

The initial cost of the housing unit depends on three basic factors. They are:

(1) Standards

(2) Overall size; and

(3) Form of building.

In relation to these basic factors, Dr P. A. Stone has shown that the cost of a unit tends to increase with an increase in standards. This can be applied as a general conclusion to any form of housing construction. Hence in the case of the developing countries, and Ceylon in particular, one is drawn back to the definition of the physical housing problems, which, when western European standards are applied to it, define the problem as a colossal one. As we saw in section 2.3, certain minimum standards are necessary to eliminate the socio-physical problems. But what standards should

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[1] Stone, P.A. (1970). Urban development in Britain, standards, costs, and resources 1964-2004. Cambridge University Press.

[2] This aspect is analysed in detail in Chapter 7.

be adopted if the socio-mental problems are to be eliminated? Obviously the standards adopted should again be related to the level of satisfaction of the population to be housed. As explained in section 2.3, satisfaction depends on the social, economic, and cultural values of the population. These vary widely within a particular urban area, which thus suggested that one particular set of standards is not a suitable solution, but that what was needed was a range of standards between some minimum and maximum. This enables the use of the fact that if standards can be varied so can the initial cost, enabling not only the satisfaction of the social and cultural values, but also the economic ability of the household to pay for the house.

The second factor that affects the cost of the housing unit is its overall size. As Dr. Stone has shown, the cost/unit area tends to decrease with increase in size, which results in the fact that the cost of housing/capita reduces with increase in household size.[1] This is based on the fact that the space requirement per household is directly proportional to the size of the household. This suggests that for Ceylon minimisation of the initial cost should follow two basic policies. They are:

(1) Encouragement of the concept of the extended family, which is socially and culturally and economically an accepted norm. (See also Chapters 6, 7, 8 and 9.) This would result in a reduction in the cost of housing/capita, and a reduction in the overall number of housing units required, for a particular population.

(2) The space standards to be adopted should be based once again on the level of satisfaction of the population, as concluded in section 2.3, having the economic advantage of reducing the initial cost of housing (see Chapters 7 and 8.)

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[1] P.A. Stone. Urban development in Britain, Standards, Costs and Resources, 1964-2004, page 148.

The third factor is the form of building. As Dr. Stone has shown there appears to be an increase in the cost with an increase in the number of floors.[1] Hence high rise building tends to increase not only the initial physical costs, but also social costs as shown from Pearl Jephcott's study.[2]

In the developing countries there are three other basic forms to be considered. They are:

(1) The provision of a complete house.

(2) The provision of a core house for completion on a self-help basis; and

(3) The provision of a serviced block of land for the construction of a self-help house.

Each of these forms progressively reduces the initial expenditure, since there is a progressive increase in the use of self-help labour, working on the assumption that the material content remains the same.

This thus suggests that form is an important consideration in controlling the initial cost of housing, to the consumer.

2.4.1.1.4 The total quantity of housing

The quantity of housing required for a specific population can be defined by two variables. They are (1) the number of housing units, and (2) occupancy rate in persons/habitable room.

For a specific population the number of housing units is equal to the number of households. The number of households depends on the standard used for defining the size of a household which requires a separate dwelling. It therefore follows that if a specified standard of space is used per capita the size of the unit will be proportional to the size of the household.

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[1] P. A. Stone. Urban development in Britain. Standards, costs and resources, 1964-2004, page 148.

[2] Jephcott, Pearl. (1971). Homes in high flats. Oliver & Boyd, Edinburgh.

The number of habitable rooms in the housing unit will be inversely proportional to the occupancy rate for a specific household unit.

Hence, the cost of a housing unit will be directly proportional to the size of the household if the rate for construction per unit area is constant for all sizes of housing unit. But this is not so, as shown by Dr P. A. Stone. He has shown that the cost/unit area decreases with the size of the unit[1], therefore the cost of housing per capita will decrease with an increase in household size. Further, if the same unit is divided into a greater number of rooms the cost tends to rise due to an increase in the area of walling required. Therefore it follows that the cost of housing for a specified population reduces with an increase in household size and reduces with an increase in occupancy rate. (This is true if all the houses are otherwise equal in all respects.)

This thus suggests that for the minimisation of initial costs the standard of household size and occupancy rate should be made as large as possible. However, this cannot be based on purely arbitrary thinking, but must be related to the social problems related to the standards selected. (Section 2. 3.)

It also follows that the minimisation of the total quantity of housing will result in cutting down to a further minimum the overall costs of land, and land development.

2. 4. 1. 2 <u>Future costs of the direct development of urban housing</u>

Future physical costs of the direct development of urban housing arise due to two reason. They are:

(1) The cost of maintenance of the house and related infrastructure.

(2) The cost of subsidies.

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[1] Stone, P. A Urban development in Britain. Standards, costs and resources. 1964-2004. page 148.

2.4.1.2.1 The cost of maintenance (M)

According to Dr. P.A. Stone[1] costs of maintenance are directly proportional to

(1) the initial cost

and (2) the age of the building.

Age is a factor that is inevitable. However, maintenance costs, since they are related to initial costs, can be minimised by minimising the initial costs.

2.4.1.2.2 The cost of subsidies (s)

Subsidies arise as a result of the cost of housing being beyond the household's ability to pay for it. There are two basic factors that determine a subsidy. They are:

(1) The proportion of income that a household can devote to housing, without economic hardship, and thus without the creation of socio-mental problems.

(2) The percentage the real rent of the house bears to household income.

If (2) above exceeds (1), the need for a subsidy arises. Hence, if subsidies are to be minimised there arises a need for minimising the percentage rent bears to household income. As household incomes increase this percentage will decrease, showing the well known fact that the upper income groups do not need a subsidy. It thus follows that if a minimum standard is to be maintained then there is an income level below which a subsidy must be paid.

The question that arises is, what is the minimum standard? Obviously if the primary objective is to be satisfied, the minimum standard is that which satisfies the lowest socio-economic group of the community.

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[1] Stone, P.A. Urban development in Britain. Standards, costs and resources. 1964-2004. page 154.

There are other factors which add to subsidy. They are:

(1) The interest rates charged; and

(2) The time over which the initial cost is amortised.

It is well known that an increase in interest rates results in an increase in rents and thus an increase in subsidies, while reduction in the time of recovery results in an increase in rents and thus an increase in subsidy. Hence, theoretically housing should charge the lowest interest rate possible, and recover the costs over the longest period possible. (The case of Ceylon will be dealt with in Chapter 9.)

2.4.2 Objectives for achieving the solution at minimum physical costs

The nature of physical costs related to the direct development of urban housing has been described in section 2.4.1. It is now possible to identify the detailed objectives that must be achieved if the major objective of solving the problem at minimum costs is to be achieved.

2.4.2.1 The relationship between standards and costs

As discussed earlier, the costs related to the direct development of urban housing are of two forms, viz.

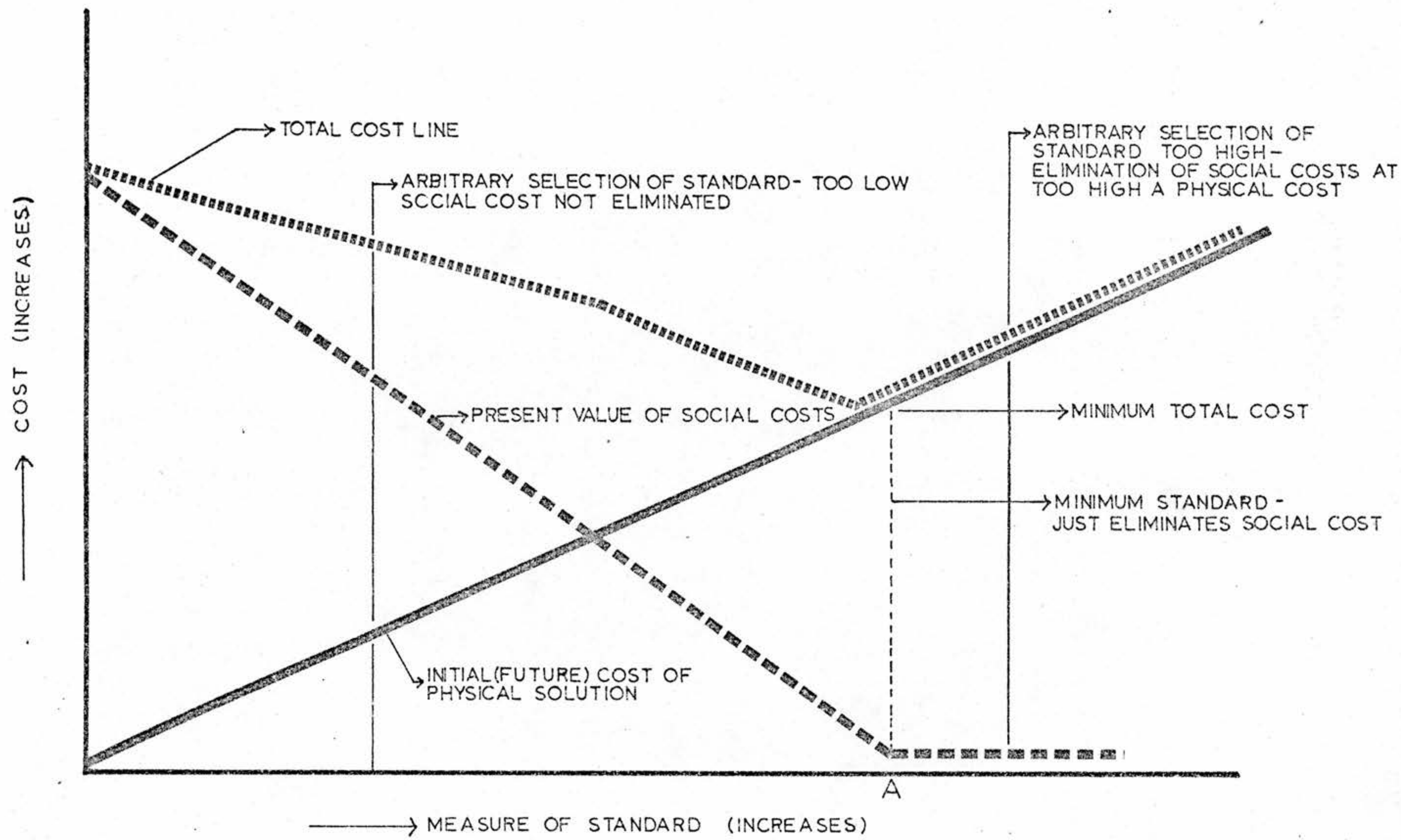
(1) The social costs that arise due to the unsuitability of standards.

(2) The physical costs which comprise (i) the initial costs of development and (ii) the future costs of maintenance and subsidies.

The discussion in section 2.3. led to the conclusion that unsuitable standards create socio-economic dissatisfaction and thus lead to social costs. Hence, if a graph of the present value of social costs vs. standards is plotted it will take the form shown in diagram (2-1), i.e. at zero standards the social costs will be a maximum reducing as standards increase, and ultimately vanish at the point where the standards are compatible with the

DIAG · 2-1

MINIMUM COST OF SOLVING THE HOUSING PROBLEM



socio-economic status. It follows that the point A on the graph where costs vanish will keep moving to the right as the graph is plotted for higher socio-economic groups.

Considering the case of the physical costs, and looking at first the initial costs and then the future costs, the following observations can be made.

(1) It will be observed that other than locational and technological considerations which include form, the cost of each item depends on the standards used in providing each item.
The cost of land per unit increases with a decrease in density (section 2.4.1.1.1)
The cost of infrastructure development decreases with an increase in density, and increases as the general standard is raised (section 2.4.1.1.2)
The cost of the housing unit increases as space standards are increased, and increases as the level of finishes is raised. (Section 2.4.1.1.3)
The total number of housing units increase as the standard of defining household size is decreased. (Section 2.4.1.1.4)
All this adds up to one fact, and that is as standards are raised, the initial cost of the direct development is increased.

(2) Maintenance costs are directly proportional to initial costs[1], while initial costs depend on standards, hence maintenance costs increase as standards are raised.
Subsidies arise when the rent requested is beyond the household's ability to pay for it. Rent is a function of initial costs, since it is based on the amortization of initial costs, and the recovery of maintenance costs. Therefore subsidies must increase as standards are raised.
Hence, it follows that the future costs of the direct development of urban housing will increase as standards are raised.

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[1] Section 2.4.1.2.1.

(3) Since both the initial and future costs of the direct development of urban housing increase with rising standards, it is possible to conclude that the total physical costs represented by the initial cost plus the present value of future costs will increase as standards are raised. (See diagram 2-1).

The graph of the initial plus future costs of the physical development will be zero at no standards and will increase due to reasons given. Only one line has been shown, and this represents the minimum cost at which the particular standards can be provided under existing technology. It follows that by minimising the other factors that influence costs, the gradient of the line can be minimised (i.e. the locational and technological considerations).

On adding the two cost lines, i.e. the social costs and physical costs, the total cost line can be obtained.

It will be observed that the total cost line decreases to a minimum and then increases again, and that this occurs at the point A, where the social costs vanish.

Referring to diagram (2-1), it will be observed that if standards are lowered indiscriminately, the primary objective of solving the problem is not achieved, and at the same time the total costs to be incurred increase. This reveals the fallacy that if developing countries are to solve their problem due to limited resources they should lower their standards till standards are in line with resources.

On the other hand, increasing standards with no regard to their relationship to social problems results in eliminating the social problems no doubt, but at a cost much greater than the minimum. This has been the present trend in most developing countries where standards used are a mere repetition of western standards which are far too much, resulting in a few houses with the limited resources available.

Hence the solution lies as will be observed from the diagram in using standards based on the elimination of related social problems, which result in the total minimum cost for achieving a solution to the problem, and at the minimum physical cost.

It will be appreciated that the physical cost must then be further minimised by determining the acceptable minimum values of the other factors that contribute towards it.

2.4.2.2 The objectives

The objectives for achieving the solution at minimum physical costs can now be stated and are as follows.

(1) The standards used must be the minimum required to satisfy the socio-economic values of the population. Since theoretically there exist an infinite number of combinations of social and economic values, within a population, the objective should be to evaluate a range of standards, and not a single set.

(2) These standards must be provided at the minimum initial costs within the limits of technology, and location.

(3) The cost of subsidies that thus arise must be minimised. This objective is partly achieved by achieving objective (2) above, as will be seen in Chapter 6.

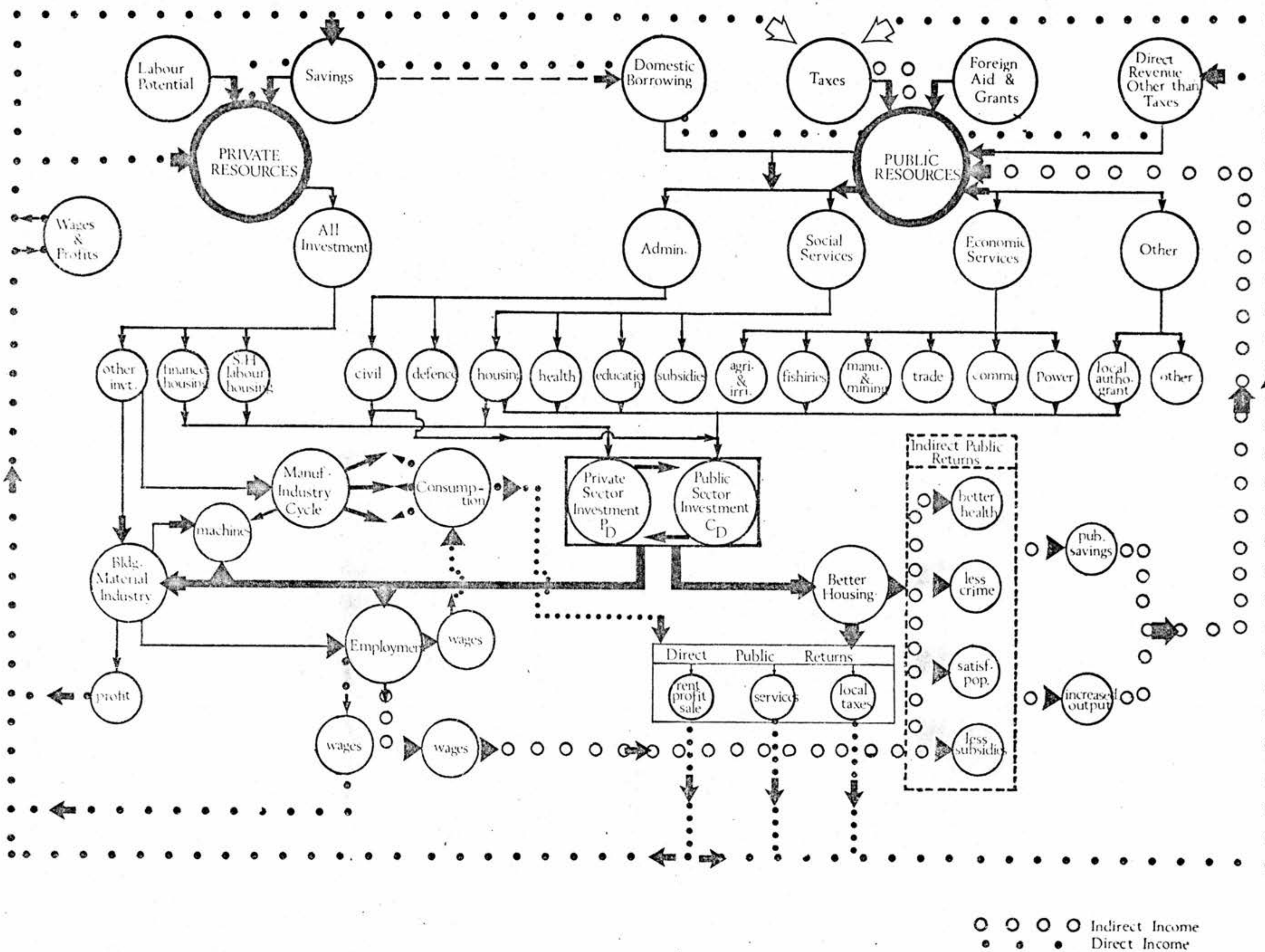
2.5 Maximising the generation of economic growth

Ceylon like most developing countries has been faced with problems resulting from a slow rate of economic growth. In addition, the lack of resources both local and foreign has compelled that investment should be in fields which produce the maximum rate of economic growth.

Investment in the direct development of housing has been argued by many economists to be a social overhead investment. However, this view is now changing. Irrespective of the theoretical arguments, if the public sector is to invest in the direct

Diag. 2-2

Direct Development of Urban Housing And The National Economy "CEYLON"



development of urban housing in Ceylon, it can no longer afford to treat it as a social overhead investment. Thus the third objective of public sector investment in the direct development of housing must be to ensure that it generates economic growth, and that the rate of growth generated is a maximum.

With this in view, investment in the direct development of housing is analysed briefly in the following section, with the objective of proving that it does generate economic growth, and identifying the objectives of public sector investment that would maximise this growth.

2.5.1 The generation of economic growth via investment in the direct development of housing in Ceylon

Diagram (2-2) represents graphically:

(1) Resources for investment in the direct development of urban housing in Ceylon.

(2) How investment takes place via the private and public sectors; and

(3) The effect of investment under three major headings, viz.

   (a) Direct returns

   (b) Indirect returns

   (c) Generation of industry and employment.

Economic growth via the investment can be said to take place if overall outputs are increased and/or overall inputs are decreased. Starting from the stage where input into housing takes place, the effects of this input are as follows:

(1) An increase of direct returns both in the private and public sectors via direct returns, provision of services, and taxes; these returns more or less balance the input.

(2) The net benefits or marginal increase in output occurs via:

   (a) The indirect returns as shown in the diagram which results in a marginal increase in productivity of the labour force, and a reduction in social costs by the elimination of the related social problems.

(b) The generation of employment in the materials and machines industries. This employment in turn increases both public and private sector resources as shown in the diagram.

It is true that there are leakages via consumption, but increased consumption is after all the result of wage increases.

Overall it can thus be seen that investment in housing is not a social overhead investment but has a positive effect on economic growth.

2.5.2 Maximising the generation of economic growth

The important question is how to maximise this growth. If marginal inputs are minimised and marginal outputs maximised the net result would be the maximisation of growth.

By achieving the primary objective of eliminating related social problems, the indirect returns will be maximised.
By achieving the secondary objective of minimisting costs, not only will the initial marginal inputs be minimised but so will subsidies. Hence, the only variable left for maximisation is the marginal employment generation . Therefore the first objective to be achieved is to maximise marginal employment generation via the investment. This objective is true for a country like Ceylon where unemployment is around 15% of the labour force. In a country where unemployment is very low this may not be as important an objective.

From the foregoing discussion it was observed that investment in the direct development of housing can aid growth. However, there is a proviso, and that is the effect of these policies on economic stability. Ceylon like most countries in the world is suffering an increased rate in inflation. Hence, will the policy of maximising employment generation aid inflation? As mentioned, Ceylon has a very high rate of unemployment, and needs to create more jobs, hence an increase in the supply of jobs will have little or no effect on the price of labour, and thus the rate of inflation. There is, however, the effect of increased materials consumption on the price of materials and thus on the rate of inflation. It thus appears that this investment will tend to increase inflation, unless there is a control of prices. Ceylon has already taken steps in this direction by setting up a building materials co-operation which is responsible for the import, manufacture, and distribution of building materials in the country. It is thus hoped that the total effect of investment in the direct development of urban housing in Ceylon, on the rate of inflation, and thus on economic stability, will be negligible.

It will be observed that the discussion has so far centred on the effects of investment in the direct development of housing on the domestic economy. However, an important point that arises is the consumption of foreign resources via the investment.

Ceylon like most developing countries has had an adverse balance of payments situation[1] for more than the last decade. This has been one of the major setbacks to economic growth. Hence, the second objective is to minimise the marginal use of foreign exchange via investment in the direct development of urban housing.

Therefore, if economic growth via the direct development of housing is to be achieved and maximised, the investment must in addition to achieving the two basic objectives set out to try to -

(1) maximise marginal employment generation, and

(2) minimise the marginal foreign exchange consumption.

The case of Ceylon is discussed in Chapter 5, wherein policies for maximising marginal employment generation and minimising the marginal foreign exchange consumption, via public sector investment in the direct development of urban housing, are developed.

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[1] Report of the Central Bank of Ceylon for 1971 gives the relevant details about the balance of payments situation.

2.6 Conclusion

To conclude this chapter on defining conditions for and objectives of public sector investment in the direct development of urban housing in Ceylon, the main conclusions are restated briefly, followed by a format on which the detailed analysis presented in the following chapters are based.

The first conclusion reached was that in order to establish the need for public sector investment in the direct development of urban housing, the objective of an analysis should be to determine the proportion of investment necessary, to achieve a specified level of investment both in monetary terms and in physical terms. The specified level is determined by estimating the level of investment necessary to meet the requirements of the population.

On establishing the need for public sector investment the objectives to be achieved were set out, and in order to achieve these objectives the detailed objectives that must be achieved were set out. They are as follows.

(1) To solve the housing problem, provide standards that, other than the provision of a potable supply of water and sewage and waste water disposal, are such that they are compatible with the socio-economic levels of the population.

(2) To achieve the solution at minimum costs, in addition to objective (1), which minimises total cost, provide the standards at the minimum physical costs by analysing and selecting values of the other variables that minimise initial and future costs.

(3) To achieve maximum economic growth via public sector investment in the direct development of urban housing in Ceylon, in addition to achieving objectives (1) and (2), they must be achieved so that

  (a) The marginal employment generated is maximised.

  (b) The marginal rate of foreign exchange consumed is minimised.

2.6.1 Format for detailed analysis

The format for detailed analysis can now be presented, and is as follows.

(1) Determine the need for public sector investment in the direct development of urban housing in Ceylon. Presented in Chapter 3.

(2) Investigate the possibility of raising the necessary resources. Presented in Chapter 4.

(3) Determine policy for maximising marginal employment generation and minimising the marginal rate of foreign exchange consumption via public sector investment in the direct development of urban housing. Presented in Chapter 5.

(4) Determine the detailed range of standards for the direct development of urban housing based on compatibility with socio-economic levels of the population. Presented in Chapters 7 and 8.

(5) Analyse the physical costs of the direct development of urban housing, and determine policy for minimising the costs, while achieving the prescribed standards. Presented in Chapters 6, 9, and 10.

PART II. THE NEED AND RESOURCES FOR PUBLIC SECTOR INVESTMENT IN THE DIRECT DEVELOPMENT OF URBAN HOUSING IN CEYLON.

CHAPTER 3. **An Analysis of Investment Trends.**

CHAPTER 4. **Resources for Investment.**

CHAPTER 3

An Analysis of Investment Trends

3.0 Introduction

In Chapter 2, section 2.1.2, it was stated that public sector investment may be necessary to ensure that -

(1) the desired physical output is achieved, and

(2) the desired level of investment to produce this ouput is achieved, subject to prevailing overall national policy.

It was also stated that an analysis of past investment trends, with the above objectives in view, would lead to a conclusion which would define the role of the public sector, and enable an approximate estimate of the level of public sector investment required.

The purpose of this chapter, therefore, is to analyse past trends of investment in the direct development of housing in Ceylon, with special reference to the urban areas, hence defining the future role of the public sector, and the level of investment expected from the public sector if the total level of investment is to be attained.

3.1 Method of analysis

The word investment as used in this analysis is as defined within the definitions of public and private sector investment in sections 1.4 and 1.5. Hence, since investment represents net capital formation via the direct development of housing it includes infrastructure development and the housing units. The value of land is excluded from the definition.

The following analysis is devoted mainly to investment in the direct development of urban housing in Ceylon. However, since rural housing is equally important, and since resources stem from the same source, it is necessary to include this aspect within the analysis.

The inclusion of rural housing in this analysis is also useful in determining the proportions of public sector investment which should be devoted to urban and rural housing in Ceylon.

The method of analysis used is described briefly below.

(1) An approximate estimate of the annual number of housing units required is made, both for the urban and rural areas, at a specified point in time.
This estimate is made by making an approximate evaluation of population and population growth, in relation to an estimate of household sizes. This gives an approximate estimate of the annual quantity of houses required.
The backlog is estimated on the assumption that the median household size is more representative of real household size than the mean, since the mean includes extremes of overcrowding and under use, while the median represents the central value, thus eliminating the fringe effects.

(2) The size and resulting cost of a minimum standard house is then defined. Since standards and costs form an important part of this study it may seem illogical to define a minimum standard and cost at this stage. However, since what is being analysed at this stage are trends, and not details, the use of an approximate standard and cost can be justified.

The standards used represent the minimum being used for low cost housing in Ceylon at the present time, and the costs are the real costs of the present low cost housing programme.

(3) From (1) and (2) above it is thus possible to estimate approximately the minimum level of investment necessary at the particular point in time for meeting the current year's requirements and clearing the backlog. These values can then be expressed as a percentage of the current year's G. N. P. at factor cost prices.

On the assumption that the rate of population growth and household size was approximately the same for periods before and after the specified point in time at which the estimates are made, the annual targets as a percentage of the current G. N. P. at factor cost prices can be assumed to be the same. This would, of course, include the safe assumption that the use of current values of G. N. P. would offset the effects of inflation.

(4) Real estimates of investment for periods of time before and after the point at which estimates of targets were made are then evaluated, and expressed as a percentage of the current year's G. N. P. The estimates are detailed down to public sector and private sector, and further to urban and rural areas (see section 3.4.1 and Table 3-1).

(5) By using the targets, and the real levels of investment, it is then possible to show how the backlog developed over time. (See diagrams 3-1 and 3-2.)

(6) The variation in the trends developed are then explained with reference to policy existing at the time periods under consideration, and thus used to predict possible trends in future investment by the private sector, taking into account policy proposed within the five year plan (1972-1976).

(7) If the predicted trends of private sector investment are shown to be inadequate, public sector investment is then proposed, and the level of investment required estimated.

3.2 Data for use in the analysis

The year at which the first estimates are made is 1970. The year 1970 was selected since the data available was the most comprehensive and reliable, as it was a result of the 1969-1970 Socio-Economic survey. The basic data was taken from the official document prepared by the

Department of Census and Statistics in Ceylon, while some evaluated data used was taken from the I. L. O report, "A programme of action for Ceylon", which was itself based on raw data from the1969-70 Socio-Economic survey.

Data for evaluating real investment, the growth of G. N. P. etc., was taken from the report of the Central Bank of Ceylon for 1971. Further details were obtained from unpublished data available from the Department of National Housing in Ceylon, the building materials co-operation, and the Department of Census and Statistics.

There were no grounds on which the reliability of any of the above sources of data could be questioned. It will be appreciated that one of the most difficult problems of working in the developing countries is the non-availability of statistical data, hence it must be agreed that even approximate data is better than no data at all.

3.3 An approximate estimate of the resources[1] needed for investment in the direct developing of housing in Ceylon

The population of Ceylon in 1970 was estimated at 12.29 million, out of which 18% was urban and 82% was rural[2]. Migration was estimated at +1.7% for the urban areas, and overall natural growth at 2.5% per annum. It was further estimated that 1.5% of the urban population and 2.5% of the rural population needed rehousing each year due to obsolescence.

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[1] Here resources include only, the cost of the house and infrastructure. Land cost is not included, and it is also not recorded as G. D. C. F.

[2] Socio-Economic Survey of Ceylon (1969/70). Department of Census and Statistics, Ceylon. October, 1971. page ii.

3.3.1 Resources for the direct development of urban housing (1970)

1) **Urban population** = 18% of 12.29 million = 2.21 million

2) Current housing requirements - per 1000 population

Demographic[1] growth @ 2.5% = 0.025 x 1000 = 25

Migration[1] @ +1.7% = 0.017 x 1000 = 17

Replacement[1] @ 1.5% = 0.015 x 1000 = 15

Persons requiring new houses/1000 population = 57

mean[2] household size = 6.3

median[2] " " = 5.2

Therefore: New houses required/1000 population = $\frac{57}{6.3}$ = 9

Total number of new houses required = 19,890 (for 1970)

3) Backlog

The backlog is estimated on the assumption that the mean household size overestimates the size due to involuntary overcrowding and underuse; thus the median is taken to be more realistic.

$$\text{Backlog}/1000 = 1000\left(\frac{1}{5.2} - \frac{1}{6.3}\right) = 33$$

Total urban backlog - 72,930 (as at 1970) for the population of 2.21 million).

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[1] The above figures were estimated by the I.L.O. team, and reported in "A programme of action for Ceylon." (1971) p.136. I.L.O. Geneva.

[2] Socio-Economic Survey of Ceylon (1969/70) page 51 - Tab. 31.

(4) Size of house

The minimum size of house required is estimated as follows:

Space standards recommended have been -

(a)[1] 50 sq. ft. /person with a minimum house size of 350 sq. ft., i.e. for a 6 person household.

(b)[2] 250 sq. ft. for a 2 person household, together with 50 sq. ft. for each extra person, i.e. 450 sq. ft. for a 6 person household.

(c)[3] 100 sq. ft. together with 50 sq. ft. for every person housed, i.e. 400 sq. ft. for a 6 person household.

We use standard (c) above, i.e. 400 sq. ft., since it was developed in Ceylon, and is the average of (a) and (b).

5) Cost per house[4]

Experience of the department of national housing in Ceylon has shown that the cost/sq. ft. for construction and basic infrastructure could be estimated at Rs. 25/= for current low cost housing in the urban areas. This, of course, excludes the cost of land. Thus the minimum cost per house is estimated at Rs. 10,000/=. i.e. (400 x 25).

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[1] Franklin, G.H. (1969). The place of housing in the national plans of developing countries. Dublin May (1969) page 19 of paper presented.

[2] A programme of action for Ceylon. Technical papers, page 138.

[3] Self (1971) - For use in low cost housing programme. Ceylon.

[4] £1 = Rs. 15.

6) Estimated resource requirement

Current requirements (1970) Rs($19,890 \times 10^4$) = Rs.198.9 million

G.N.P.[1] at current prices (1970) = Rs. 11,617.8 million

current requirements as % of G.N.P. = 1.7%

Backlog (1970) Rs ($72,930 \times 10^4$) = Rs. 729.3 million

Backlog as % of G.N.P.(1970 = 6.25%

3.3.2 Resources for the direct development of rural housing

1) Rural population = 82% of 12.29 million = 10.05 million

2) Current housing requirements per 1000 population.

Demographic[2] growth @ 2.5% = 0.925×1000 = 25

Migration[2] @ $(- 1.7\% \times \frac{0.18}{0.82})$ = -0.004×1000 = -4

Replacement[2] @ 2.5% = 0.025×1000 = 25

Total persons requiring new houses/1000 population = 46

mean[3] household size = 5.8

median[3] household size = 5.0

New houses per 1000 = $\frac{46.0}{5.8}$ = 8

$\therefore$ Total number of new houses required = $10.05 \times 10^3 \times 8$ = 80,400 (for 1970).

3) Backlog

The backlog is estimated on the assumption that the mean household size, overestimates the size due to involuntary overcrowding and underuse - thus the median is taken to be more realistic.

Backlog per 1000 = $1000 \left(\frac{1}{5.0} - \frac{1}{5.8} \right)$ = 28

Total backlog (1970) = $10.05 \times 10^3 \times 28$ = 281,400 houses.

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1. Annual report of the Central Bank of Ceylon for 1971. Appendix II Tab.4

2 A programme of action for Ceylon (1971) - page 136 I.L.O. Geneva

3 Socio-Economic Survey of Ceylon (1969/70) page 51 - Tab.31.

4) Size of house

The same size as that in section 3.3.1(4), i.e. 400 sq.ft./household is used as the standard, since there is little or no difference in household size.

5) Cost per house

In the urban areas the cost of construction is Rs 25/= per sq.ft. In the rural areas, however, where more traditional materials are used, the cost of the house per sq.ft. and basic infrastructure, i.e. well for water, and a sokage pit for sewage disposal, can be estimated at Rs 15/= per sq. ft.

Therefore the cost per house could be estimated at Rs 6000/= (i.e. 400 x 15).

6) Estimated resource requirements (1970)

Current requirements Rs. (80,400 x 6000) = Rs.482.4 million

As % of 1970 G.N.P. = 4.15%

Backlog Rs (281,400 x 6,000) = 1688.4 million

As % of 1970 G.N.P. = 14.5%.

3.3.3 Total Resources needed for the direct development of housing

From the foregoing analysis it appears that for the country as a whole 5.85% of G.N.P. should have been invested in housing in 1971 to meet the year's requirements. Of this, 1.7% should have been in the urban areas and 4.15% in the rural areas. It must be noted that this investment envisaged was the minimum. The U.N. recommendation is about 6% of G.N.P. It must also be noted that this estimate does not include land costs. Further we see that in 1971 if the backlog was to be cleared a further 20.75% of G.N.P. would be needed of which 6.25% was for the urban areas, and 14.5% for the rural areas. The magnitude of the problem is thus obvious.

3.4 An analysis of investment trends in the direct development of housing from 1967-71

Section 2.3 provided an approximate estimate of the annual investment required to meet recurring housing requirements, and the backlog as it existed in 1970. This section is devoted to analysing investment in the direct development of urban housing from 1967-1971, with a view to identifying the reasons for the short-fall, which has resulted in the backlog.

3.4.1 Preparation of table (3-1)

In order to carry out a systematic analysis of investment in the direct development of housing it is necessary to break down this investment into urban and rural, and further break down each of these investments into public sector and private sector investment. The breakdown is carried out for the years 1967 to 1971 inclusive, as follows, and is presented in table (3-1). The columns in the table represent the respective years, and the lines represent data of the breakdown. The method of obtaining the figures for each line is as follows. Sources from which the raw data used for preparing table (3-1) are given.

Line 1 Gross national product at current factor cost prices. This data was obtained from the annual report of the Central Bank of Ceylon (1971). Appendix II, table 4.

Line 2($U_D + R_D$) Total investment in the direct development of housing, excluding land costs. Appendix II, table 4, of the annual report of the Central Bank of Ceylon for 1971 gives the gross national product of the country for various years. Of this ownership of dwellings was considered to be a total (public and private) investment in the direct development of housing. The figures tally closely with those given by Hanson[1] for 1967, the I.L.O. report[2] for 1968, and Ganesan[3], 1971.

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[1] Hanson, D.R. (1967). Report on the financing of housing and low cost housing in Ceylon. Annexure vi. page 8, Table 3.

[2] A programme of action for Ceylon. I.L.O. Geneva (1971). Technical papers. Table 1, page 124.

[3] Ganeson, S. Paper presented to the Institution of Engineers, Ceylon (1971). Fundamental considerations towards formulating a national housing policy and a long term housing programme. page 9.

<u>Line 3.</u> Total investment in the direct development of housing expressed as a percentage of G.N.P., i.e. Line 2 expressed as a percentage of line 1.

<u>Line 4</u> ($C_{UD} + C_{RD}$) The public sector investment in the direct development of housing (urban and rural). This data was prepared using original data from table IX, page 67 of the Report of the Planning Committee on Education, Health, Housing, and Manpower (1967), adjusted for real expenditure using the data from the annual report of the Central Bank of Ceylon for 1971, Appendix II, table 36.

<u>Line 5</u> Public sector investment in the direct development of housing expressed as a percentage of G. N. P., i.e. line 4 expressed as a percentage of line 1.

<u>Line 6</u> ($P_{UD} + P_{RD}$) Private sector investment in the direct development of housing. This data was obtained by subtracting line 4, the public sector investment, from line 2, the total investment.

<u>Line 7</u>, which is the private sector investment in the direct development of housing expressed as a percentage of G. N. P. was obtained by expressing line 6 as a percentage of line 1.

<u>Line 8</u> (C_{RD}) Public sector investment in the direct development of rural housing. This data was obtained using the original from table VIII, page 67 of the Report of the Planning Committee on Education, Health, Housing, and Manpower (1967), and making adjustments for real expenditure using data from Appendix II, table 36 of the annual report of the Central Bank of Ceylon for 1971, and unpublished data from the Department of National Housing in Ceylon. The main adjustment was the division of funds spent by the Department of National Housing in Ceylon in the ratio 3:1, for urban[1] to rural.

<u>Line 9</u> Public sector investment in the direct development of rural housing expressed as a percentage of G. N. P. This is obtained by expressing line 8 as a percentage of line 1.

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[1] Here urban is considered as those areas within municipal and urban councils only. Other areas are considered as rural.

<u>Line 10</u> (C_{UD}) **Public sector investment in the direct development of urban housing. This data was obtained by subtracting the public sector investment in rural housing, line 8, from total public sector investment in the direct development of housing, line 4.**

<u>Line 11</u> **Public sector investment in the direct development of urban housing, expressed as a percentage of G. N. P. This is obtained by expressing line 10 as a percentage of line 1.**

<u>Line 12</u> (P_{UD}) **Private sector investment in the direct development of urban housing. This data was obtained by:**

(1) **Obtaining data from the Department of Census and Statistics in Ceylon on the number of housing units constructed in the urban areas of Ceylon from 1967 to 1971. Here urban means those areas governed by municipal and urban councils only.**

(2) **Obtaining data of the average cost of construction including water supply, some form of sewage disposal and access.**

(3) **Multiplying the number of units by the average cost.**

<u>Line 13</u> **Private sector investment in the direct development of urban housing as a percentage of G. N. P. This is obtained by expressing line 12 as a percentage of line 1.**

<u>Line 14</u> (P_{RD}) **Private sector investment in the direct development of rural housing. This data is obtained by deducting the private sector investment in the direct development of urban housing, line 12, from the total private sector investment in the direct development of housing, line 6.**

<u>Line 15</u> **Private sector investment in the direct development of rural housing as a percentage of G. N. P. This data is obtained by expressing line 14 as a percentage of line 1.**

<u>Lines 16, 17, 18</u> **Ratio of private sector to public sector investment in the direct development of urban, rural, and all housing respectively. These ratios are obtained as follows:**

1.	line 16	=	line 12/ line 10	P_{UD}/C_{UD}
2.	line 17	=	line 14/line 8	P_{RD}/C_{RD}
3.	line 18	=	line 6/line 4	$(P_{UD}+P_{RD})/(C_{UD}+C_{RD})$

TABLE (3-1) Breakdown of investment in direct development of housing, Ceylon (1967-1971) Excluding land costs.

	Description Year:		1967	1968	1969	1970	1971
1	Gross National Product. Current factor cost prices		8264.5	9876.0	10,747.7	11,617.8	11,828.0
2	Total investment in direct development of housing	$(U_D + R_D)$	332.5	332.9	388.6	398.9	406.7
3	(2) as a % of (1)		4.02	3.37	3.61	3.43	3.44
4	Public sector investment in direct devel. of housing	$(C_{UD} + C_{RD})$	73.2	78.2	93.9	105.4	85.7
5	(4) as % of (1)		0.885	0.792	0.874	0.907	0.725
6	Private sector investment in direct development of housing (2) - (4)	$P_{UD} + P_{RD}$	259.3	254.7	294.7	293.5	321.0
7	(6) as % of (1)		3.14	2.58	2.74	2.53	2.71
8	Public rural	C_{RD}	43.2	30.2	46.9	47.4	31.7
9	(8) as % of (1)		0.523	0.306	0.436	0.408	0.268
10	Public urban (4)-(8)	C_{UD}	30.0	48.0	47.0	58.0	54.0
11	(10) as % of (1)		0.362	0.486	0.437	0.499	0.456
12	Private urban	P_{UD}	42.5	47.0	57.0	63.0	68.5
13	(12) as % of (1)		0.514	0.476	0.530	0.542	0.579
14	Private rural (6)-(12)	P_{RD}	216.8	207.7	237.7	230.5	252.5
15	(14) as % of (1)		2.62	2.10	2.21	1.98	2.13
16	Ratio $\frac{\text{Private urban (12)}}{\text{Public urban (10)}}$	$\frac{P_{UD}}{C_{UD}}$	1.416	9.979	1.212	1.086	1.259
17	Ratio $\frac{\text{Private rural (14)}}{\text{Public rural (8)}}$	$\frac{P_{RD}}{C_{RD}}$	5.01	6.88	5.07	4.86	7.96
18	Ratio $\frac{\text{Total Private (6)}}{\text{Total Public (4)}}$	$\frac{P_{UD}+P_{RD}}{C_{UD}+C_{RD}}$	3.54	3.25	3.14	2.784	3.74

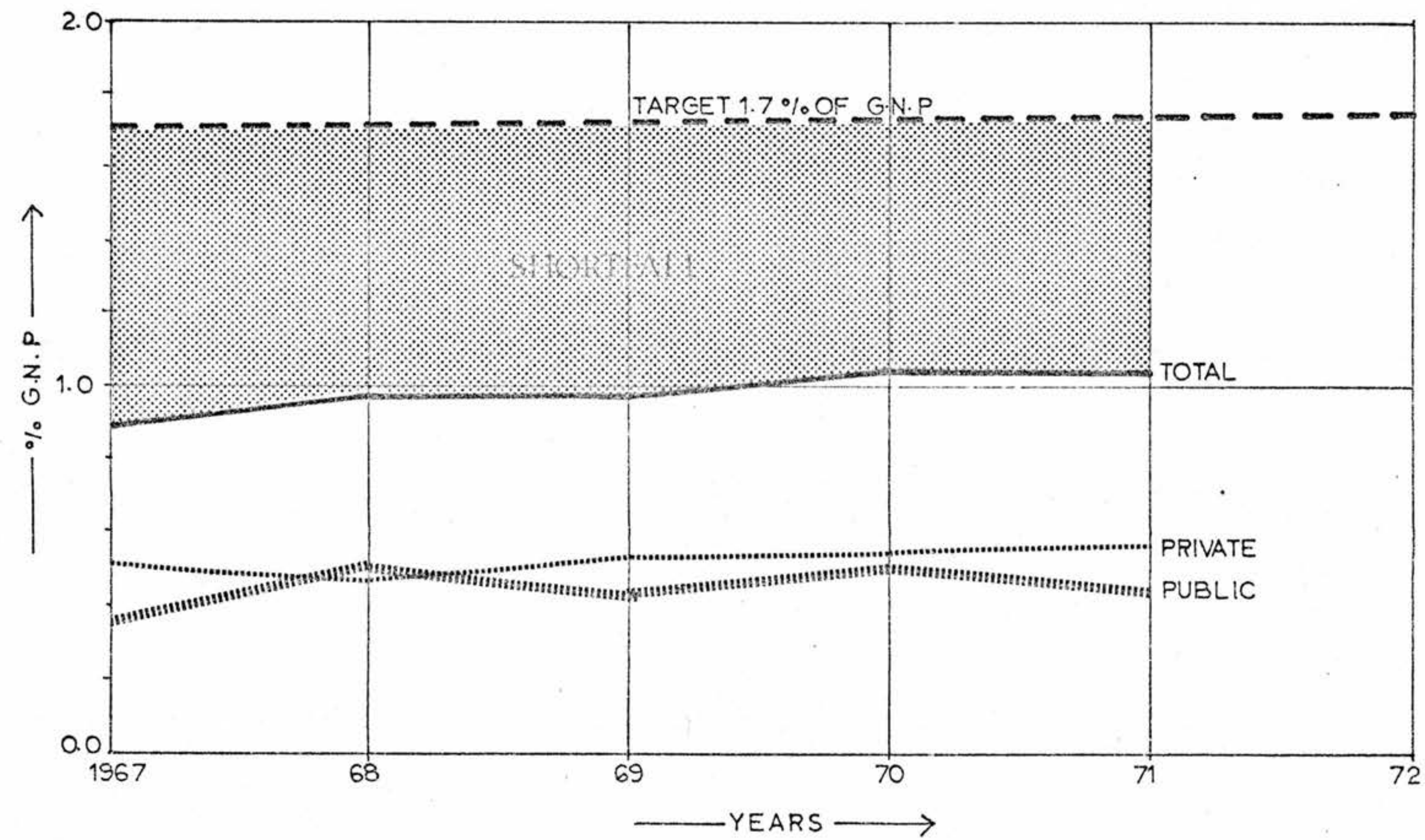
Note (1) The figures given above are in millions of rupees.

(2) Converstion rate: £1 - Rs.15/=

(3) The investment figures do not include land costs.

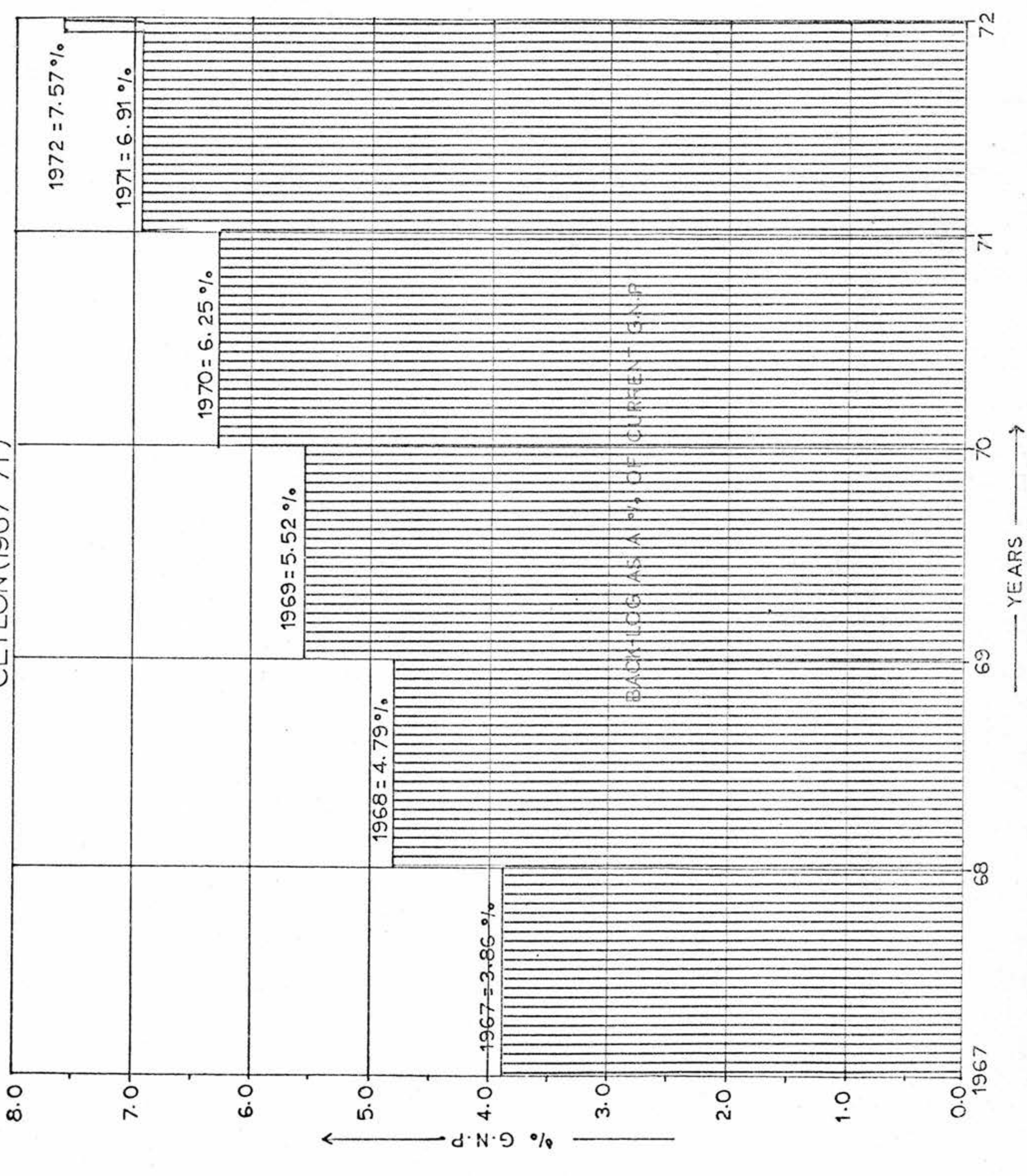
DIAG·3·1A

INVESTMENT IN THE DIRECT DEVELOPMENT OF URBAN HOUSING AS A % OF G.N.P CEYLON (1967-71)



DIAG.3-1B

BACKLOG OF DIRECT DEVELOPMENT OF URBAN HOUSING AS A % OF G.N.P CEYLON (1967 71)



3.4.2 An analysis of investment in the direct development of urban housing from 1967 to 1971

3.4.2.1 Diagramatic representation

Diagram (3-1A) represents graphically the investment pattern in the direct development of urban housing from 1967 to 1971 by the public and private sectors as a percentage of G.N.P. Also indicated is the annual target as 1.7% of G.N.P. from 3.3.1(6) for the year 1970. Here, the assumption that this could have been the past and future target too, has been made. This is based on the fact that as G.N.P. (at current prices) increases so will the cost of construction due to inflation. The error therefore will not be appreciable. Also indicated is the backlog target for 1970 as 6.25% of G.N.P. from 3.31(6). Further, past backlog targets have been built up by deducting the annual shortfall from the 1970 target, and for the years 1971 and 1972 the shortfalls have been added. Diagram (3-1B) indicates the backlog as a percentage of current G.N.P. at the beginning of the years 1967 to 1972.

3.4.2.2 Description and analysing of public sector investment, 1967-1971

Up to 1971 the public sector has invested in the direct development of urban housing as follows:

(1) Grants to public institutions for the construction of houses for their employees.

(2) Loans to the public at 11% interest through a national housing fund, administered through the national housing department. These loans vary from Rs 2000/= to Rs 25,000/= and are payable over a maximum of 20 years. Land with a clear title must be mortgaged for obtaining the loan, if it is over Rs 2000/=. Loans below Rs 2000/= are given on a personal guarantee.

(3) The construction of houses for rent, or rent purchase using the national housing fund.

(4) Loans by other public institutions such as the Insurance Corporation of Ceylon, State Mortgage Bank, Peoples Bank, and Loans Board, on a similar basis to that in (2) above.

(5) Partial grants to local authorities for the construction of houses for the public.

Overall the Department of National Housing invested the greatest part of the total investment, i.e. about 35%.

The funds for investment were derived mainly from public sector resources via budgetary allocations. Institutions such as the National Housing Department derived further funds via public debentures, while the Insurance Corporation, Peoples Bank, and State Mortgage Bank were diverting private sector savings into the direct development of urban housing via the public sector.

From table (3-1) and diagram (3-1A) it will be noted that over the period 1967 to 1971 public sector investment in the direct development of urban housing has varied between 0.362% to 0.499% of the current G.N.P. It will also be noticed that the investment pattern has been completely erratic. These fluctuations can be explained as follows:

(1) The government considered investment in the direct development
11 of housing as a social overhead, rather than an economic investment. Due to this reason, when allocations for housing are made at the beginning of a financial year, these allocations are the first to be cut during the year, when it is found that there will be a shortfall of general public sector income.

(2) As mentioned, loans for housing depend on a clear title deed to be mortgaged to the lending institution. Thus loans depend on the number of clear title deeds which are mortgaged. This number can fluctuate over a wide range, thus varying the volume of funds utilised, as loans for the construction of houses.

It is relevant at this stage to identify what section of the urban population benefited from public sector investment up to 1971.

Grants to public institutions were used mainly to produce middle and upper class housing. The rents charged were 23% of the basic salary, which worked out to about 17% of the gross salary. The period of occupation was limited to a fixed time, thus enabling a rotation of tenants, with the idea of giving a greater majority of employees the benefit of these houses. It must be noted that if these houses were rented in the open market, the rents would be over twice what is being presently charged. A few houses have been produced for the lower income groups as well, and rents in this case are subsidised.

On the other hand, public sector investment in the direct development of urban housing for the general public was via loans, and the construction of houses for rent, or rent purchase. In this connection it may be observed that,

(1) Loans for housing provided through the National housing fund served only the upper middle and upper income groups because, (1) land is needed as mortgage security and (2) the high rate of financing (11%) could only be afforded by them.

(2) Houses for rent and rent purchased served again, only the upper middle and upper income groups due to the high cost of financing. However, at the inception of the fund the rate of interest was of the order of 7%. Thus it was possible to provide houses for the lower income groups at this stage. Diagram (3-2)[1] presents a picture of the public sector housing gap, with reference to provision through the national housing fund. This proves the point made.

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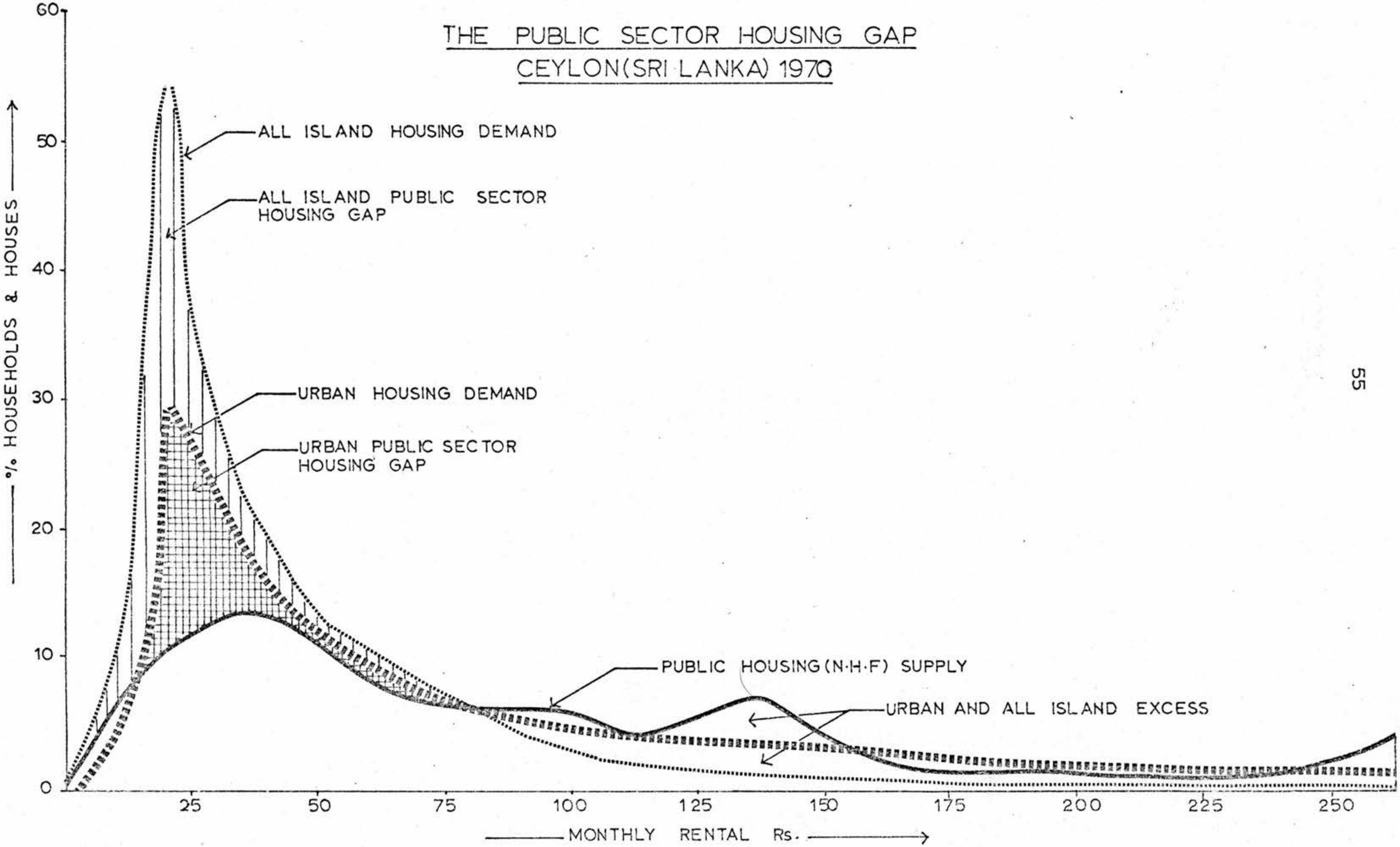
[1] Diagram (3-2) was prepared by using the income distribution obtained from the 1969/70 Socio-economic survey (Table 30), and computing rents payable as 10% of income for the lowest income groups, increasing uniformly to 25% for incomes of Rs 1,000/- and above. The supply curve was drawn by obtaining data of rents charged by the National housing department from a 10% random sample. The diagram presents relative frequency curves.

DIAG. 3-2

THE PUBLIC SECTOR HOUSING GAP
CEYLON (SRI LANKA) 1970



It can thus be observed that the public sector investment in the direct development of urban housing has helped mainly the upper and middle income groups. The hump in diagram (3-2) of the 125 to 150 rent group, and over 250 rent group, supports the point.

From the foregoing analysis, it is possible to make some general observations, and suggest some policy modifications to future public sector investment in the direct development of urban housing in Ceylon, if a positive attempt is to be made toward achieving the target of investment.

(1) It appears that public sector investment in the direct development of urban housing has catered mainly for the middle and upper income groups, while the heart of the problem lies in low cost housing for the lower income groups. This therefore suggests that future investment by the public sector in the direct development of urban housing should as far as possible be aimed at low cost housing for the lowest income groups, with the hope of nearing the physical target at no extra cost.

(2) It appears that public sector investment in the direct development of urban housing has not been used as a source of stimulation of private sector investment. This thus suggests that future public sector investment should be used more as a stimulant of private sector investment, rather than how it has been used in the past.

This stimulation could be achieved by the public sector programmes being geared to the following:

(a) Use of the labour potential in aided self help housing.

(b) Provision of developed blocks of land, to private individuals who can raise the capital for building from private resources, either via the public sector or the private sector.

For Ceylon it has been shown that the cost of the direct development of urban housing (excluding land costs) can be broken up into[1]

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[1] Unpublished data - building materials corporation of Ceylon.

Table (3-2)

Urban households who cannot afford economic rent. Ceylon (1970).

Household size (persons)	Percentage of all households		Percentage of households unable to afford an economic rent.
2	5.4		72
3	10.2		61
4	12.0		57
5	14.8		52
6	13.7		51
7	14.3		50
8	10.5		49
9	7.9		48
10	5.0		48
11 and over	6.2		-
	100.0	Average	54

Source

Matching Employment Opportunities and Expectations. A programme of action for Ceylon. Technical Papers, pg. 138. I.L.O. Geneva, 1971.

65% materials and 35% labour. Assuming that the public sector investment is p% of G. N. P. for a particular year, in the direct development of urban housing, and that 50%[1] of this investment is spent on the provision of complete houses and loans for buildings, and the balance 50% is used for aided self help housing: the extra private sector investment stimulated via labour potential will be given by:

$$p \times 0.5 \times \left(\frac{35}{65}\right) = 0.27p \text{ \% of G. N. P.}$$

i. e. p% of G. N. P. as public sector investment will generate 1.27 p% of G. N. P. as total investment of which 0.27 p% of G. N. P. is private labour potential, provided 50% of public sector investment is in aided self help housing. The balance 50% is assumed to be used to provide houses for public sector employees, and provide loans for those who have lands to mortgage, or life insurance policies to surrender. The average investment by the public sector in the direct development of urban housing from 1967 to 1971 was 0.45%. If 50% of this had been devoted to self help housing, a further 0.12% per annum of private sector investment could have been generated.

3.4.2.3 <u>Description and analysis of private sector investment 1967-1971</u>

Investment in the direct development of urban housing by the private sector has been motivated by two basic reasons:

(1) The desire for home ownership
(2) Profit.

The desire for home ownership has been basically utilised by two groups of people. They are:

(1) The very rich who own land, and either have ready capital to invest in the construction of the house, or are able to mortgage the land and thus obtain a loan for the purpose of constructing the house.

---

[1] Table (3-2) Urban households who could afford economic rent of a house 46% of all households.

(2) The very poor who have constructed illegal houses on unserviced land, with scrap materials, and their own labour. This squatter problem is common among most developing countries. The 1963 census showed that this type of housing[1] constituted about 38% of all urban housing in Ceylon.

On the other hand the profit motive has generated a fair proportion of Ceylon's urban housing. The 1969/70 socio-economic survey showed that 47.7%[2] of urban houses were rented. Of these the older houses are in the form of tenements and are now completely obsolete. However, the newer houses are large and expensive and could thus be used mainly by the upper income groups who could afford the rent (see Table 3-2). Thus private sector investment has not helped the lower income groups.

Table (3-1), and diagram (3-1A) give details of the private sector investment in the direct development of urban housing. It will be noticed from diagram (3-1A) that the private sector has been consistent in its investment in the direct development of urban housing. There has been a tendency for investment to increase with time. As mentioned a major part of this is for home ownership while the balance is for housing to be rented. The 1963 census of Ceylon showed that in the urban[3] areas 156,270 units were rented out of a total of 318,140 units. The socio-economic survey of 1970 showed that in the urban[4] areas out of a total of 349,030 houses 166,330 were rented.

Therefore we see that of the new houses 32% were rented, the balance 68% being used for owner occupation. Based on the observations

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[1] The census classified this type of housing as semi-permanent and temporary.

[2] Socio-economic survey of Ceylon 1969/70. Table 46.

[3] Census of population and housing 1963. Ceylon.

[4] Socio-economic survey of Ceylon 1969/1970. Table 46.

that the average cost of a house built by the private sector[1] is apprlximately the same as that of a house built by the public sector, and that in the urban areas the public sector builds equal numbers[2] of housing for rent and ownership, the following facts emerge[3]:

(1) Of the new houses 32% are rented of which the government is responsible for 22.8% and the private sector 9.2%.

(2) Of the 68% built for owner occupation, the private sector is responsible for 45.2%, resulting in an average investment of 0.45% of G.N.P, where the total average investment is 0.528% of G.N.P. per annum.

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[1] The average cost of a house built by the private sector is low due to the fact that a large number of the houses are of a semipermanent nature. This offsets the high cost of luxury houses. This average cost equals that of houses built by the public sector.

[2] Houses for owner occupation built by the public sector include loans, and houses built for sale on a rent purchase basis.

[3] Calculated as follows:

If the public sector is responsible for (x+y)% of all houses built, x% being for rent and y% for owner occupation. Then -

$$\frac{100-(x+y)}{(x+y)} = 1.19 \text{ . -(1)}$$ (FromNote (1) above, and using 1.19 as the average ratio of private urban to public urban from line 16, table (3-1).

$$\frac{x}{y} = 1. \text{ - (2).}$$ (From note (2) above).

Solution of equations (1) and (2) give:

$x = 22.8\%$, $y = 22.8\%$

Private sector investment in home ownership $= \dfrac{(68-22.8)}{(100-45.6)} \times 0.528$

$= 0.45\%$

It may thus be concluded that future private sector investment in the direct development of housing, under any conditions will be at least 0.45% of G.N.P; that is, by those who can afford to invest for home ownership. Investment for rent will depend on the overall policy of government, as will be seen later.

Overall it is possible to draw the following conclusions regarding private sector investment in urban housing up to 1971.

(1) Housing for owner occupation has been by (a) the very rich who have built luxury houses, and (b) the lower middle class group who have built semipermanent housing, resulting in an average investment of about 0.45% of G.N.P.

(2) Private sector investment in housing for rent has been mainly for the upper income groups, and constituted an average investment of about 0.078% of G.N.P.

Taking the above into consideration, it will be evident that the private sector alone cannot be expected to make any significant contribution towards solving the urban housing problem. The solution lies in greater public sector participation, espeically in the field of aided self help housing for the lowest income groups, and the provision of developed land, for middle class private individuals who are able to afford the cost of finance to build houses with, but are unable to purchase outright the necessary land. This can only be achieved by large scale public sector investment.

3.4.2.4 <u>Total investment in the direct development of urban housing (1967-1971)</u>

The two previous sections have been devoted to separate analyses of the public sector and private sector investment in the direct development of urban housing. Considering the overall investment pattern, diagram (3-1A) indicates the total investment as a percentage of current G.N.P. It will be observed that total investment has increased slightly over the years, but has always been less than the required target of 1.7%. The shortfall is indicated in the diagram. This annual shortfall has accumulated over time and resulted in a tremendous backlog as indicated in diagram (3-1B). The backlog at the beginning of 1972 was approximately equal to an investment of 7.57% of the year's G.N.P. at current prices.

To prevent the housing situation becoming worse in the future it appears that the total investment must reach 1.7%. It was seen in section 3.4.2.3. that pure private sector investment will be a minimum of 0.45%. In section 3.4.2.2. it was shown that if 50% of public sector investment is diverted towards generating private sector investment in the form of labour, p% of public sector investment will generate a further 0.27p % of private sector investment. As seen earlier, pure private sector investment will not be diverted to the lowest income groups. Thus the investment target must be reached via the public sector. As will be indicated later this means the diversion of more private sector resources via the public sector rather than pure private sector investment. Therefore, if the total percentage investment in the direct development of urban housing is given by t_u% of G.N.P., then -

$$t_u = 0.45 + (1.27\,p) + \delta r \,........\quad (3\text{-}1)$$

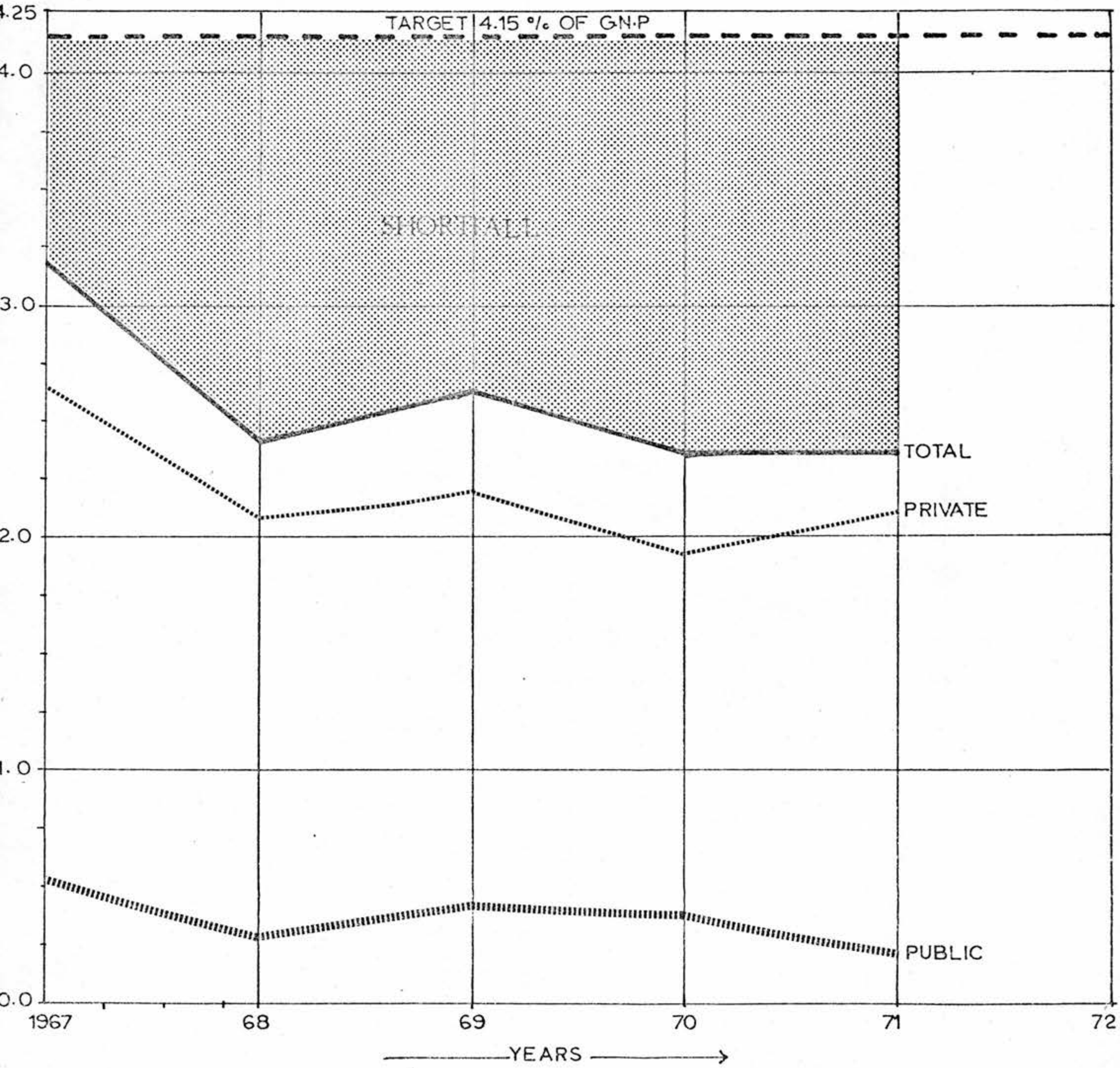
where p is the percentage of G.N.P. investment by the public sector, and δr the percentage of G.N.P. invested by the private sector in housing for rent.

3.4.3 An analysis of investment in the direct development of rural housing, 1967 to 1971

This section is devoted to a brief analysis of investment in rural housing. This analysis is necessary as will be seen later in order to develop a policy which on implementation will generate the total resources necessary for the direct development of housing. It will be appreciated that both urban and rural housing need resources, and must thus be looked at together, since resources for investment originate from the same sources.

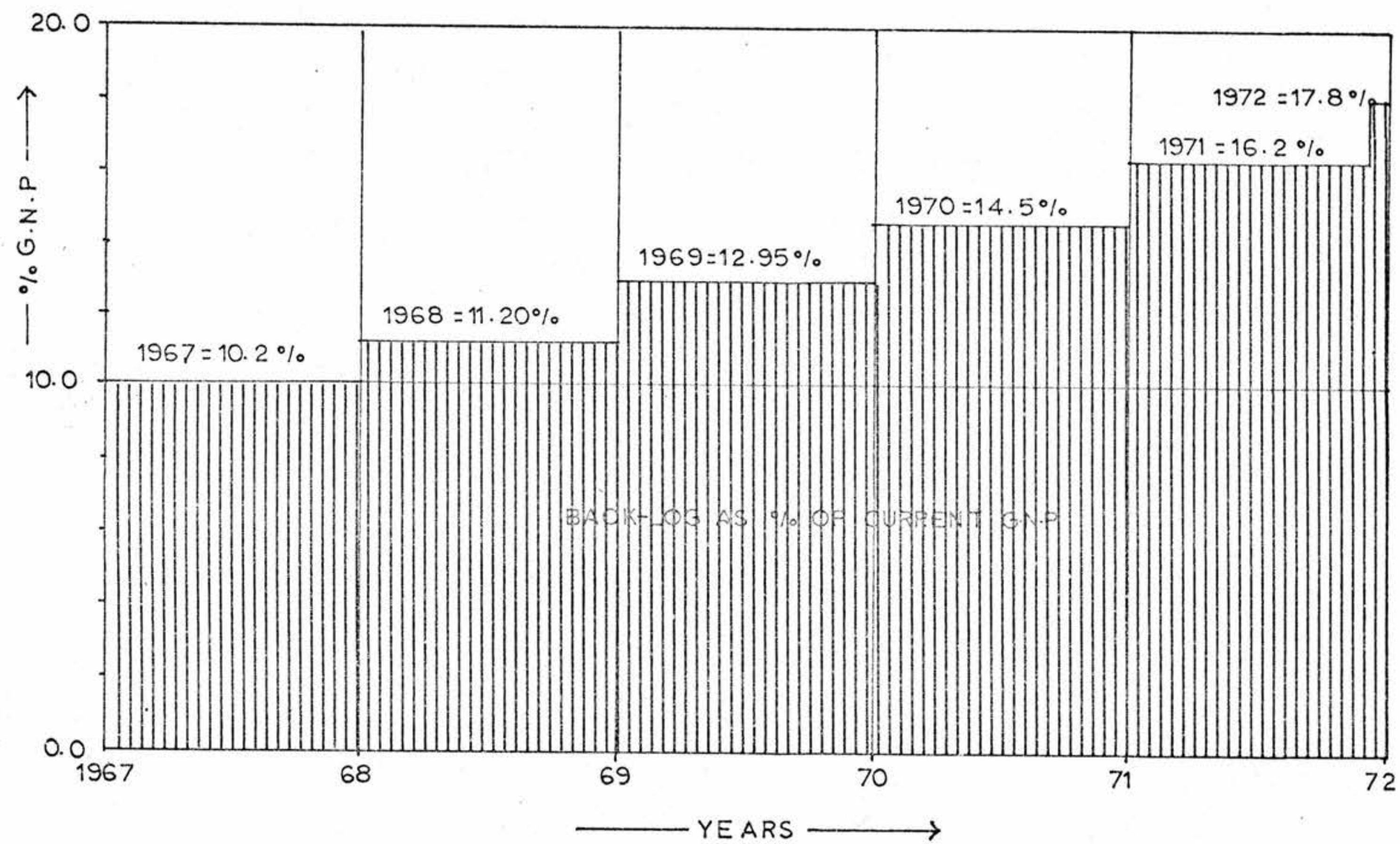
DIAG · 3-3A

INVESTMENT IN THE DIRECT DEVELOPMENT OF RURAL HOUSING AS A % OF G·N·P CEYLON (1967–71)



DIAG. 3-3B

BACK LOG OF DIRECT DEVELOPMENT OF RURAL HOUSING AS % OF G.N.P CEYLON (1967 71)



3.4.3.1 Diagramatic representation

Diagram (3-3A) represents graphically private, public, and total investment in the direct development of rural housing. The shortfall below the target of 4.15% (section 3.3.2) is indicated.
Diagram (3-3B) indicates the backlog of the direct development of rural housing, and is prepared in a similar manner to diagram (3-1B) (section 3.4.2.1).

3.4.3.2 Description and analysis of public sector investment from 1967-1971

In addition to the general pattern of public sector investment in the direct development of urban housing, though much less, the public sector invested in the direct development of housing for colonists in colonisation schemes, and housing for fishermen. In certain cases housing was of the self help type.

The funds for investment were derived as for the urban sector, mainly from budgetary allocations, and through public debentures for the national housing fund. The national housing fund concentrated only on making loans available, and did not construct houses for rent in the rural areas.

Public sector investment in the rural areas was about the same as in the urban areas. Similar to the case of the urban areas, public sector investment has been inconsistent. The reasons for this are the same as those attributed to fluctuations in the urban areas. (Section 3.4.2.2)

Apart from providing housing for public sector employees in the rural areas, the public sector did not consciously maximise the use of the vast labour potential available for self help housing. As in the urban areas, loans were granted to those who owned land, or were able to furnish a personal guarantee, while some slight effort was made to promote self help housing in colonisation schemes, and fishing villages. Incomes in the rural areas are low, and so is the demand for rented housing, thus we cannot expect the private sector to produce housing for rent. It is thus evident that future housing in the rural areas should be attacked mainly on a self help basis, with the idea of maximising the use of the labour potential, and the use of traditional materials and techniques. This is possible only by public sector investment.

For future investment in rural housing by the public sector, let us assume thatjq% of G. N. P. is invested in the direct development of rural housing. Of this, the proportion that should be invested in complete houses in the form of housing for government employees and loans for those who own land is[1] 25%. The balance should be devoted mainly to self help housing. For modern housing in the urban areas we gave a breakdown of costs in terms of materials to labour as 65% to 35 % (section 3.4.2.2). For traditional rural housing the breakup of labour to materials is estimated at 50% to 50%. Therefore, q% of G. N. P. as public sector investment generates a further

$$q \times (0.75) \times \left(\frac{50}{50}\right) = 0.75\, q \text{ of G.N.P. as private}$$

sector investment

i.e. q% of G. N. P. as public sector investment will generate 1.75 q % of G. N. P. as total investment, of which 0.75 q % of G. N. P. is as private labour potential, provided 75% is invested in aided self help housing. The average investment by thepublic sector between 1967 and 1971 was 0.39% of G. N. P. If 75% had been diverted to self help a further 0.29% of G. N. P. as private sector investment could have been generated.

3.4.3.3 <u>Description and analysis of private sector investment (1967/1971).</u>

What has motivated private sector investment in the direct development of rural housing is home ownership. The profit motive has not played an important role, as can be seen from

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[1] This figure is based on incomes above 1/24th the minimum cost of a house, i.e. Rs.6000/= (section 3.3), and a further Rs.1500/= for land. Income distribution table 30 of the socio-economic survey of Ceylon (1969/70).

the following figures. The 1963 census showed[1] that out of 1,653,600 houses in the rural areas 144,600 were rented, while the socio-economic survey (1970) showed[2] that out of a total of 1,763,105 houses 115,710 were rented. This actually meant a decrease in the number of rented houses over the seven years. We may thus conclude that private sector investment in the direct development of urban housing has been mainly motivated by home ownership up to 1971. This will be a useful guide to evaluating the future investment by the private sector.

From table (3-1) and diagram (3-3A) it will be noticed that private sector investment in the rural areas has not been as consistent as private sector investment in the urban areas. On the average, however, the quantity of private sector investment in the rural areas has been about four times as great as in the urban areas. It will also be noticed that private sector investment is about six times public sector investment, in the rural areas, as compared to approximately equal levels of investment in the urban areas. The basic and most important reason for this greater level of private sector investment in the rural areas is the absence of stringent building codes, which allow people in the rural areas to (1) use traditional materials and techniques, and (2) use traditionally existing standards[3], and thus produce houses for themselves that are economically, socially, and culturally satisfying.

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[1] Census of population and housing 1963 - Ceylon Department of Census and Statistics, Ceylon. Table 22.

[2] Socio-economic survey of Ceylon 1969/1970 table 45.

[3] Some form of standards exist in the rural areas. These standards have come down from past generations, and though generally believed to be astrological, are based on scientific principles, which consider light, ventilation, and monsoonal rains.

The foregoing analysis suggests that future private sector investment in the direct development of rural housing will be mainly for house ownership, and could be estimated as the minimum over the last five years, i.e. 2.0% of G.N.P.

From diagram (3-3A) it can be observed that there appears to be a positive correlation between public and private sector investment. It thus appears that aided self help housing may be more successful in the rural areas than the urban areas, where no correlation seems to exist. Hence, stimulation of future private sector investment may be given as 0.75 q % of G.N.P. where q% of G.N.P. is the public sector investment in the direct development of rural housing, where 75% of q is devoted to aided self help housing.

3.4.3.4 Total investment in the direct development of rural housing

Sections 3.4.3.2 and 3.4.3.3 were devoted to looking separately at public and private sector investment in the direct development of rural housing.

The total investment as can be seen from diagram (3-3A) has followed closely the pattern of private sector investment. Total investment has always been below the minimum target of 4.15%, resulting in the backlog as indicated in diagram (3-3B), as a percentage of the current year's G.N.P. It will be observed that the backlog at the beginning of 1972 was 17.8% of the year's G.N.P.

If the future housing situation in the rural areas is not to worsen then the minimum investment required must be 4.15%. However, future housing investment will adhere to the following. If the total investment as a percentage of the current year's G.N.P. is given by t_r, then;

$$t_r = 2.0 + (1.75\,q) \quad \ldots\ldots\ldots\ldots \quad (3\text{-}2).$$

where 2.0% of G.N.P. will be invested purely by the private sector (section 3.4.3.3), and q % of G.N.P. is invested by the public sector generating a further 0.75 q% of G.N.P. as private sector investment (section 3.4.3.2). Note that no allowance has been made for private sector investment in the direct development of housing for rent (section 3.4.3.3).

3.4.4 Total investment in the direct development of housing

Sections 3.4.2 and 3.4.3 were devoted to an analysis of investment in the direct development of housing under the headings of urban and rural. It was observed that overall there has been a shortfall in each section, resulting in tremendous backlogs. Conclusions reached on how the private sector would invest in the urban and rural areas in the future resulted in suggesting the need for greater public sector investment in order to achieve the respective targets of investment.

Looking at the future, it can thus be concluded that if targets of investment are to be achieved for both sectors a minimum total level of investment of (1.7 + 4.15) i.e. 5.85% of current G.N.P. must be achieved, to prevent a deterioration of the housing situation, and that if a complete solution to the problem is to be found the level of investment as at 1972 must be increased by (7.57 + 17.80) i.e. 25.37% of G.N.P.

It was shown in section 3.4.2.4 that the level of investment in the urban sector can be expressed as t_u% of G.N.P;

where $t_u = 0.45 + (1.27p) +$ . . . . (3-1)

and in section 2.2.3.4 that the level of investment in the rural sector can be expressed as t_r% of G.N.P.;

where $t_r = (2.0 + 1.75q)$. . . . . (3-2)

Therefore the total level of future investment can be expressed as t

where $t = t_u + t_r$ (as % of G.N.P.

$t = 2.45 + 1.27\,p + 1.75\,q + \delta r$ . . . . (3-3)

where public sector investment = (p + q) % of current G.N.P. and private sector investment = $(2.45 + 0.27\,p + 0.75\,q + \delta r)$

in which δr is the private sector investment in rented housing in the urban areas.

BREAKDOWN OF INVESTMENT IN DIRECT DEVELOPMENT OF HOUSING

CEYLON, 1972 TABLE (3 - 3)

Table (3-3A) Urban

Sector:- / Investment		Pure Public	Public and Private joint* Public	Private	Generation Ratio - Priv./Pub.	Pure Private	Total	Ratio Priv/ Public
Expected - As per 5 year	(a)	51.0	7.0	25.0	3.57	57.0	140.0	1.41
plan	(b)	0.42%	0.06%	0.21%	-	0.47%	1.16%	-
Probable -	(c)	51.0	7.0	3.8	0.54	54.0	115.8	0.99
	(d)	0.42%	0.06%	0.03%	-	0.45%(3)	0.96%	-

Table (3-3B) Rural

As per 5 year	(a)	29.0	12.5	45.5	3.64	273.0	360.0	7.2
plan	(b)	0.25%	0.10%	0.38%	-	2.28%	3.0%	-
Probable -	(c)	29.0	12.5	12.5	1.0	240.0	294.0	6.1
	(d)	0.25%	0.10%	0.10%	-	2.0% (3)	2.45	-

Table (3-3C) Overall (Urban and Rural

As per 5 year	(a)	80.0	19.5	70.5	3.6	330.0	500.0	4.0
plan	(b)	0.67%	0.16%	0.59%	-	2.75%	4.17%	-
Probable -	(c)	80.0	19.5	16.3	0.84	294.0	409.8	3.12
	(d)	0.67%	0.16%	0.13%	-	2.45%	3.41%	-

Note (1) Amounts in Rupees million.

(2) Percentages given are amounts expressed as a percentage of projected G. N. P. for 1972 ie Rs.12,000 million (current prices)

(3) Probable based on author's calculations, using conclusions reached in section 3.4.

(4) The above data was obtained from the Ministry of Housing and Construction, Ceylon.

* This includes self help and co-operative housing.

3.5 A critical appraisal of investment in the direct development of housing as envisaged in the five year plan (1972-1976).

At the end of 1971 the government proposed a five year development plan covering the period 1972 to 1976. Investment in the direct development of housing was to be Rs. 500 million in 1972 increasing to Rs. 625 million in 1976, of which 80% was to be by the private sector and 20% by the public sector.

The previous section was devoted to an analysis of private and public sector investment in the direct development of housing till the end of 1971. These conclusions will now be used to appraise the investment proposed within the five year plan.

3.5.1 Investment in 1972

Table (3-3) indicates the investment pattern proposed for 1972 in the five year plan, in line (a) of each of the tables. Line (b) indicates the investment as a percentage of the projected G.N.P. for 1972.

Comparing the proposed investment with the past as indicated in table (3-1) and the conclusions reached by section 3.4, line (c) and line (d) which represent the probable level of investment, are presented, from which the following observations can be made.

3.5.1.1 Urban housing

In the direct development of urban housing it will be observed that:

(1) The public sector has made a slight reduction in its investment, as compared to the previous years.

(2) The plan proposed greater co-operation between the private and the public sector. It expected a generation ratio[1] of (Private/Public) of 3.57. This was expected to come via self help housing. However, it was observed in section 3.4.2.2. that the maximum generation ratio that can be expected in the urban areas is 0.54. This results in a Rs. 3.8 million private sector investment for a Rs. 7.0 million public sector investment, rather than the expected Rs. 25.0 million.

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[1] Generation ratio is defined as the ratio of the cost of labour generated in self-help or private funds to the cost of materials and machines provided by the public sector, i.e. 65% materials and 35% labour is equal to a generation ratio of 0.54, while 50% materials and 50% labour is equal to a generation ratio of 1.

(3) A pure private sector investment of Rs. 57 million or 0.47% of G.N.P. was expected. This is lower than the past, and is understandable due to three recent policies that will change the pattern of private sector investment. They are:

(1) The imposition of a stringent rent control act, which not only controls rents, but gives the tenant virtually absolute security of tenure.[1]

(2) The announcement that there is to be a limit on the ownership of houses. This law will allow one house for a man, one for his wife, and one for each child over 18 years of age.[2]

(3) The announcement in the 1971 and 1972 budget proposals that incomes are to be limited to Rs. 2000/= per month, excluding savings. The excess is to be collected in a compulsory savings fund.[3]

Policies (1) and (2) will result in a drastic cut in the rate of private sector investment in housing for rent. Policy (1) will further create a lethargic attitude among existing tenants towards building their own house, due to the virtually complete security of tenure. These arguments have also been supported by Jose Fonseka[4] (1970), and Wallace F. Smith[5]

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[1] Rent Act No. 7 of 1972 - Parliament of Ceylon - Date of Assent March 1, 1972. Ceylon Government Press.

[2] Ceiling on housing property law No. 1 of 1973, of the national state assembly. Certified on 13th January 1973. Sri-Lanka Government press.

[3] In force from 1.4.73. (Budget 1973/74)

[4] Housing finance in developing countries - Paper presented to the 30th world congress of I.F.H.P., Barcelona, Spain, 1970, pages 21-22.

[5] Housing - Wallace F. Smith, page 12.

Policy (3) will further cut down any investment in housing, because any excess that would have been available would have been diverted into the compulsory savings fund.

Thus with the present policies, one could only expect investment by the private sector in the direct development of housing in Ceylon to be:

(a) The construction of a house for owner occupation[1], by those who either have the land and capital, or are able to raise the necessary finance.

(b) The labour potential that will be diverted into aided self help housing.

In section 3.4.2.3. it was shown that pure private sector investment would be 0.45% of G.N.P. in home ownership, while any excess would be for rental. It could thus be concluded that due to the new policies the rental component will be zero, leaving a minimum level of investment of 0.45% i.e. the 54.0 million (Note (3) table 3-3).

(4) Overall an investment pattern as shown in line (c) of table (3-3a) could be expected. This indicates a total investment of Rs.115.8 million, or 0.96% of G.N.P. rather than the total expected in the five year plan of the 140.0 million or 1.16% of G.N.P. From diagram (3-1A) it will be observed that this will be a drop in investment rather than an increase. It is also seen that with this drop in private sector investment the overall ratio of private to public will drop to 0.99 rather than increase to the expected value of 1.41.

(5) This therefore suggests that future investment levels can only be raised by greater public sector investment, rather than dependence on private sector investment. As shown in section 3.4.2.2, at least 50% of public sector investment must be diverted to aided self help housing. It must also be noted that as defined in Chapter 1,

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[1] This conclusion has been supported by the special committee on Housing in Ceylon (1970). pg. 33, para. 124 of the interim report "Rental housing" states "We have endeavoured to make various recommendations which in total amount to making the best of a bad situation. As far as future housing is concerned, it would be unrealistic to expect the private sector to contribute towards rental housing on a commercial scale, as it will no longer be possible to charge economic rents due to the high cost of land and building. The only houses we could reasonable expect to be constructed are those which people will need for their own immediate occupation.

public sector investment does not mean the investment of public sector resources alone, but a diversion of otherwise dormant private resources through the public sector into the direct development of housing.

3.5.1.2 Rural housing

It is necessary to look briefly at the proposed investment pattern in rural housing, as proposed in the five year plan in the light of the previously mentioned policies.

The major error in the proposals seems to be once again in the over-estimation of the generation ratio. The proposals envisaged a ratio of 3.64, while we showed in section 3.4.3.2 that the maximum ratio will be 1.

Further, as shown in section 3.4.3.3, private sector investment in rural housing for rent is practically zero. Therefore it can be concluded that the rent control act will not affect the rural sector. This will thus eliminate the effect of limit on income, and ownership of houses.

Overall, using the minimum level of investment of 2.0% of G.N.P. by the private sector, as derived in section 3.4.3.3, it is possible to compute values for line (c) of table(3-3B). Due to the over-estimating of the generation ratio, it is seen that the overall ratio of private to public will be around average, i.e. 6.1 as compared to the 5 year plan value of 7.2.

One basic conclusion that can be reached is that if the target of investment is to be achieved greater public sector investment is needed, and that via aided self help housing, rather than pure private sector investment.

3.5.1.3 Total investment in the direct developing of housing (1972)

Overall it is observed from table (3-3C) that investment proposals for 1972 envisaged a larger private sector participation in the direct development of housing. However, overall government policy seems to have negatived the objective of the five year plan. Thus on the whole the overall level of investment will be about the same as the past, if not less.

3.5.2 Investment from 1973-1976

Analysis in section 3.5.1 has shown that overall the policies of the five year plan have not increased investment in the direct development of housing, the main reason being, discouragement of private sector investment by implementation of the policies of rent control, limit on income, and limit on the ownership of houses.

There are two ways of increasing investment in housing in the future. They are:

(1) Removal of all restrictions and thus encouraging private sector investment

or

(2) Greater public sector investment.

In general it was observed that for rural housing, what is needed is greater co-operation between the public and private sector via methods of aided self help housing, section 2.5.1.2. Policies implemented affected mainly urban housing, and thus the following section is devoted to establishing a basic need for public sector investment in the direct development of urban housing in Ceylon.

3.6 The need for public sector investment in the direct development of urban housing in Ceylon

In section 3.4.2.4 it was shown that future investment in urban housing could be govered by the equation,

$$t_u = 0.45 + (1.27p) + \delta\tau \quad \ldots\ldots\ldots (2.1)$$

It was also shown that government policy will make $\delta\tau \longrightarrow 0$.

Thus, there are two alternatives to achieving a solution. They are:

(1) Alter government policy so that $\delta\tau$ is increased, leaving p at its present value,

or (2) Increase p, retaining existing policies which make $\delta\tau \rightarrow 0$.

If the policies of rent control, limit on income, and limit on the ownership of houses were relaxed, there would be a reversal back to pre 1972 conditions, i. e.

(1) Construction of houses by the private sector for rent. These houses would be mainly for the upper income groups, section 3.4.2.3.

(2) Insecurity of tenure and thus a greater urge for people to build their own homes.

(3) Cut in savings and an increase in consumption, which is not advantageous to economic growth.

(4) Social unrest and political instability created by rents being beyond the financial capacity of the lower and middle income groups.

(5) The construction of a few luxury houses, rather than more low cost houses, with the same level of investment.

The only advantage appears to be from (2) above, while the major disadvantage is from (5) above. This suggests that the future urban housing situation in Ceylon cannot be improved by encouraging the private sector. The solution lies in greater public sector investment. It may thus be concluded that the existing policies should not be relaxed, excepting for a slight alteration in the rent control act, which will reduce the security of tenure. Therefore, for all practial purposes δr may be treated as zero.

Future public sector investment in the direct development of urban housing in Ceylon must also be guided by the equation

$$t_u = 0.45 + 1.27p$$

where the value of p is the value of public sector investment expressed as a percentage of current G. N. P., and t_u the total investment required expressed as a percentage of G. N. P. p will be guided by the condition that 50% should be in aided self help, and 50% in the construction of complete houses.

The value of t_u must be at least equal to 1.7% is the minimum required to prevent the present situation deteriorating. It thus follows that in order to clear the backlog the value of t_u must be greater than 1.7%.

CHAPTER 4

Resources for Investment

4.0 Introduction

An analysis of past investment patterns in the direct development of housing in Ceylon (Chapter 3) has indicated that private sector investment alone will not achieve the targets of investment required to solve the country's housing problem. This led to the conclusion that if the targets of investment were to be achieved in the future there was a need for more public sector investment, which would result in total investment patterns governed by the following models for the urban and rural areas respectively. The models are:

$$(1) \qquad t_u = 0.45 + 1.27\,p$$

where t_u is the total investment in the direct development of urban housing expressed as a percentage of current G. N. P., and p the public sector investment expressed as a percentage of current G. N. P. The model is subject to the condition that 50% of p is devoted to aided self help housing.

$$(2) \qquad t_r = 2.0 + 1.75\,q$$

where t_r is the total investment in the direct development of rural housing expressed as a percentage of current G. N. P., and q the public sector investment expressed as a percentage of current G. N. P. The model is subject to the condition that 75% of q is devoted to aided self help housing.

Ceylon like most developing countries suffers from a tremendous scarcity of resources. The targets of investment to be attained, if a positive effort to solve the housing problem is to be made, have been defined in Chapter 2. The basic question that arises then is - how can the necessary resources be raised, and what time period would elapse before the supply of housing will be sufficient to meet the requirements?

This chapter is thus devoted to developing a model for financing the direct development of housing in Ceylon, with special reference to public sector investment in the urban areas.

The model will indicate the sources from which the resources can be drawn, and indicate the time period before the current requirements can be met, followed by an indication of the time period for clearing the backlog. The base year used is 1973.

4.1 Meeting the annual requirements of resources

Targets worked out for current requirements in Chapter 3 indicated that to prevent a worsening of the situation the urban areas needed 1.7% of current G. N. P. while the rural areas needed 4.15% of current G. N. P. per annum. Substituting these values in the models given in section 4.0, the public sector investment required could be estimated.

Therefore, public sector investment required is[1]:

$(1.7 - 0.45)/(1.27) = 0.99\%$ for the urban areas,

and

$(4.15 - 2.0)/(1.75) = 1.23\%$ for the rural areas

in a ratio of $(p/q) = (0.99/1.23) = 0.805$.

Hence, the total level of public sector investment should be 2.22% of G. N. P. in the ratio 0.805:1 for urban to rural, and 50% of the urban investment should be in aided self help housing, while 75% of the rural investment should be in aided self help housing.

From Table 4, Appendix II, of the report of the Central Bank of Ceylon for 1971 it is observed that the G. N. P. in 1963 at current factor cost prices was Rs.5893.3 million, and in 1971, Rs.11,828 million. The rate of increase can be approximated to a linear form resulting in an average rate of increase of 8.4% per annum over the period. Therefore, the G. N. P. at the base year of 1973 can be estimated at Rs.12,800 million (current prices). Using 1973 as the base year

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[1] Substituting target values in the two basic equations of the model.

and an average rate of increase of 8% (linear), the G.N.P. at year (1973 + n) will be given by

$$G_n = 12,800 \left(1 + \frac{8n}{100}\right) \quad \ldots\ldots\ldots \quad (4\text{-}1)$$

where G_o is at 1973. G_n is in Rs. million.

If the public sector investment required is P_n, where P_n = 2.22% of G_n :

Then $P_n = 284 \left(1 + \frac{8n}{100}\right) \quad \ldots\ldots\ldots \quad (4\text{-}2)$

where P_n is in Rs. million.

The question that arises now is: from where can the necessary resources be obtained? From equation (4-2) we see that

$$n = \left(\frac{P_n}{284} - 1\right) \frac{100}{8}$$

i.e. if the public sector can invest Rs. 284 million in 1973 it can meet its current requirements. However, as is seen from the 5 year plan the level of investment anticipated was around 106 million, i.e. 0.83% of G.N.P. It thus appears that additional resources to finance the direct development of housing, via the public sector, have to be found. Following is a suggested model of financing, that will attain the level of investment required.

4.1.1 <u>The use of existing sources of finance</u>

The proposed public sector investment according to the 5 year plan is 0.83% of G.N.P.[1]. Assuming that this investment will not be reduced, and that this comes from the existing traditional methods of financing, an amount of $\frac{0.83}{100} \times 12,800 \left(1 + \frac{8n}{100}\right)$ million rupees is assured, i.e. $106 \left(1 + \frac{8n}{100}\right)$.

It is therefore necessary to find a balance of $(284 - 106)\left(1 + \frac{8n}{100}\right)$

$$= 178 \left(1 + \frac{8n}{100}\right)$$

This balance is financed as follows.

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[1] Table (3-3c) (0.67 + 0.16) = 0.83%

4.1.2 The use of compulsory savings

It is not possible to divert further public sector resources into housing due to the fact that the annual budget is already run on a deficit[1]. This deficit has been financed by domestic and foreign borrowing. The only alternative left is to create more private savings. Ceylon already has an existing system of "compulsory savings"[2].

It therefore appears that one of the available sources of finance for the direct developing of housing via the public sector is to utilise the compulsory savings generated.

The diversion of these private sector savings into housing has tremendous advantages, the most important being the investment of private sector resources in low cost housing, thus the advantage of rent control, limit on incomes, and limit on the ownership of houses.

Many authors have suggested the creation of savings systems whereby the small scale saver can be guided towards investment in housing. This will be useful in an environment where it is possible to save, i.e. where the cost of living is low when compared to income. But in Ceylon, where wages are hardly sufficient to meet the basic costs of living this system will not be practical.

Compulsory savings are based on the income tax payable, and have been estimated as a percentage of income tax. The only guide available since the Act was passed in January 1971 is that the estimated savings was Rs.40 million[3] and income tax in that year (1971) was Rs.444 million, i.e. 9.2%.

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[1] See Table 36 - Appendix II - Report of the Central Bank of Ceylon for 1971.

[2] Compulsory Savings Act, No.6, of 1971. Date of assent 29.1.71. page IV, Appendix I, Report of the Central Bank of Ceylon 1971.

[3] Report of the Central Bank of Ceylon for 1971.

Thus a safe level of 9.0% of income tax, as a guide to estimating future compulsory savings, may be assumed.

Income tax increased from Rs. 281.0 M. in 1962 to Rs. 444.1 million in 1971. Assuming a linear rate of increase it appears that income tax increases at the rate of 5.85%. Assuming a safe rate of 5.0% (1973 onwards) since future tax proposals are unpredictable, and using the rate of 5.85% to estimate income tax for the year 1973, (i.e. $281.0\left(1 + \frac{5.85 \times 11}{100}\right)$ = Rs. 462 million) the income tax at year Tn, i.e. n years after the baseyear, would be given by:

$$T_n = \text{Rs.}462\left(1 + \frac{5 \times n}{100}\right) \text{ million.}$$

Compulsory savings which would be 9% of T_n would be given by

$$C_n = \text{Rs. } 41.58\left(1 + \frac{5n}{100}\right) \text{ million} \;.\;.\;.\;.\;.\; (4\text{-}3).$$

It was shown in section 2.4.1 that the balance required was Rs.$178\left(1 + \frac{8n}{100}\right)$. If the above savings C_n are used to finance this deficit, then

$$C_n \geqslant 178\left(1 + \frac{8n}{100}\right), \text{ i.e. } 41.58\left(1 + \frac{5n}{100}\right) \geqslant 178\left(1 + \frac{8n}{100}\right).$$

From these equations it is seen that the reverse condition exists for $n > 0$. i.e. compulsory savings are initially insufficient, and the gap increases with time. This thus necessitates a further source of finance.

4.1.3 Diversion of provident and pension fund savings, by gradual removal of food subsidy

Since a further source of finance is needed, it appears that the only source would be the diversion of other savings such as pension and provident funds into the direct development of housing.

Table (4-1)

Current and Capital Expenditure of the Government of Ceylon 1966/67 to 1970/71 in millions of rupees

		1966/67		1967/68		1968/69		1969/70		1970/71	
			% of (1)		% of (1)		% of (1)		% of (1)		% of (1)
(1)	Total[1]	2824.6	100	3152.6	100	3578.1	100	3916.5	100	3992.7	100
(2)	Health[1]	189.3	6.7	220.6	7.0	247.5	6.4	273.7	6.9	265.8	6.64
(3)	Food Subsidies[1]	465.5	16.4	578.7	16.4	625.2	17.5	574.3	14.4	601.4	15.0
(4)	Other Subsidies[1]	21.8	0.8	31.6	1.0	48.4	1.4	48.5	1.2	50.8	1.3

[1] Data from Table 36 of the report of the Central Bank of Ceylon for 1971.

It was mentioned earlier, as can be seen from the report of the Central Bank of Ceylon, that these savings have already been utilised for financing the budget deficit. It therefore appears that the only solution lies in a gradual reduction in food subsidies and a diversion of an equivalent amount of savings presently borrowed into the direct development of housing.

Subsidies, especially food subsidies, have been one of the major setbacks to Ceylon's economic development. Table (4-1) shows an average budgetary allocation of 15% on food subsidies, and 6.5% on a free health service, while other subsidies including a minute proportion for housing subsidy constituted about 1.4% of the annual budget.

From diagram (2-2) it will be seen that the gradual removal of the food subsidy will result in more employment, thus reducing the necessity for it. This view has also been taken in the I. L. O. report, A programme of action for Ceylon, quote[1]: "While we are well aware of the social value of the rice subsidy, cutting it is the only way to finance a programme that would markedly reduce unemployment. It is a direct stimulus to consume one of Ceylon's leading imports".

Further investment in housing, we saw, will eliminate the related social problems of the population, and will thus result in a cut in expenditure on health services, and the establishment of social and political stability, which is necessary for economic development.

Hence housing has to be viewed from the aspect that it is economically more beneficial than a subsidy, provided it is aimed at those who will benefit from it, i.e. "the urban slum dwellers". To quote[2] again from the I. L. O. report, "Essentially, rice subsidies are a less effective form of welfare than a combination of more selective

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[1] page 205, para.696.

[2] page 205, para. 697.

payments to those in need and measures to eliminate chronic unemployment. To switch money purposefully to these objects would increase welfare, not reduce it. And if general sacrifices have to be made to meet an emergency, such as the present payments crisis, it is surely better and more effective to sacrifice this, than to cut back on social services".

On the other hand the issue is highly political and if the food subsidy is to be removed it must be phased over a period of time.. For the purpose of this model, a phasing period of ten years is tried out, starting in 1973, i.e. a reduction of 10% in the annual estimated subsidy over a period of ten years. Using this, the following expression can be formulated.

The annual budget has increased approximately in a linear fashion over the years[1] 1962 to 1970. The average rate of increase was 10%. Thus the budget as estimated for 1973, the base year, would be Rs. 5050 million. The budget at year n could then be approximated to -

$$B_n = 5050 \left(1 + \frac{10n}{100}\right) \quad \text{(Rs. million)}$$

Food subsidy estimated at 16% of the budget in year n would be given by -

$$S_n = 16\% \text{ of } B_n = 810 \left(1 + \frac{10n}{100}\right)$$

Using the proposal that subsidy was to be reduced by 10% starting from 1973 this subsidy reduction in the nth year after base year would be $(n + 1)$ 10% where $n \leqslant 9$.

It follows then that an amount $\frac{(n+1).\ 10}{100}$ of S_n will be reduced in the nth year's expenditure on food subsidy; thus this amount of borrowing from provident and pension funds could be released for housing. If this is H_n, then:

$$H_n = 81 \left(1 + \frac{10n}{100}\right) (n+1) \quad \text{(Rs. million)} \ldots\ \ldots \quad (4\text{-}4)$$

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[1] Report of the Central Bank of Ceylon for 1971. Appendix II. Tab. 36.

Table (4-2). Proposed Investment in the direct development of housing. Ceylon 1972-1976

Ratio Pub. urban/pub. rural = 0. 805

Invest. % of G. N. P. (current)	1972	1973 n= 0	1974 n = 1	1975 n = 2	1976 n = 3	Remarks
Private urban	0. 45	0. 45	0. 45	0. 45	0. 45	Pure Private
Private rural	2. 00	2. 00	2. 00	2. 00	2. 00	
Public) urban	0. 06	0. 33	0. 40	0. 49	0. 57	Joint public and private.
Private) urban	0. 03	0. 18	0. 21	0. 26	0. 31	50% S. H. in urban
Public) rural	0. 10	0. 62	0. 72	0. 91	1. 06	areas G. R. =0. 54
Private) rural	0. 11	0. 62	0. 72	0. 91	1. 96	and 75% in rural areas G. R. =1. 0
Public urban	0. 42	0. 32	0. 40	0. 49	0. 57	Pure Public
Public rural	0. 25	0. 20	0. 26	0. 30	0. 35	
Total	3. 42	4. 72	5. 16	5. 81	6. 37	
Current target	5. 85	5. 85	5. 85	5. 85	5. 85	
Backlog	2. 43	1. 13	0. 69	0. 04	- 0. 52	
Exist. backlog	25. 37[1]	27. 80	28. 93	29. 62	29. 66	Beginning of year
Total backlog	27. 80	28. 93	29. 62	29. 66	29. 14	End of year

Explanatory Notes

(1) Existing backlog 25. 37% of G. N. P. at 1972. Diagrams (3-1B) and (3-3B)

(2) G. R. is the generation ratio.

(3) Investment for 1972 as per tables (3-3A) and (3-3B), line (d).

(4) For $3 \geq n \geq o$, total public sector investment estimated from

$$\left[0.83 + \left\{ 41.58 \left(1 + \frac{5n}{100}\right) + \frac{81}{2}\left(1 + \frac{10n}{100}\right)(n+1) \right\} 100 \Big/ 12{,}800\left(1 + \frac{8n}{100}\right) \right]$$

where $12{,}800\left(1 + \frac{8n}{100}\right)$ is the G. N. P. at year n, current prices.

(5) The total investment is broken down into urban/rural in the ratio 0. 805, of which for urban areas 50% is in joint public-private investment with a generation ratio of 0. 54, and for the rural areas 75% is in joint public-private investment with a generation ratio of 1.

(6) Pure private sector investment as per conclusions in Chapter 3.

Therefore $(C_n + H_n)$ must be $\geqslant 178\left(1 + \frac{8n}{100}\right)$ if the current level of investment required is to be attained.

i.e. $41.58\left(1 + \frac{5n}{100}\right) + 81\left(1 + \frac{10n}{100}\right)(n+1) \geqslant 178\left(1 + \frac{8n}{100}\right)$

Solution of this gives : $n \geqslant 0.65 >$ i.e. $n = 1$ in 1974.

However, due to the scarcity of resources in the country, the chances of diverting the total saving as a result of the gradual elimination of the food subsidy are remote. It may be more practical to assume that only 50% of this saving will be available for the direct development of housing, which results in altering equation (4-4), giving

$41.58\left(1 + \frac{5n}{100}\right) + 81\left(1 + \frac{10n}{100}\right)(n+1)\ \tfrac{1}{2} \geqslant 178\left(1 + \frac{8n}{100}\right)$

solution gives $n \geqslant 2.33$ i.e. $n = 3$, i.e. 1976.

Table (4-2), prepared by using the above conditions, shows the annual investment from 1972 to 1976. It will be observed that between 1975 and 1976, the current level of investment required could be reached, and that by 1976 the problem of clearing the backlog can be approached. For a graphical representation see diagram (4-1).

4.4.2 Clearing the backlog

In section 4.1 it was shown that the current level of investment required could be achieved at the end of the five year plan, i.e. in 1976, subject to the method of financing and policies developed being adopted.

From diagrams (3-1B) and (3-3B) it will be observed that the backlog at the beginning of 1972 was 25.37% of the G.N.P. (current). From table (4-2), it is observed that the backlog increases up to 29.66% of the current G.N.P. by the end of 1975, and reduces to 29.14% by the end of 1976. It thus follows that the continued use of the same system of financing and the same policies after 1976 will begin to reduce the existing backlog. However, this system cannot be utilised for an

Table (4-3) Proposed Investment in the direct development of housing: Ceylon (1977-1982)

Ratio Pub. urban/Pub. rural 0.85

Investment as % of G. N. P.	Year:	1977 n = 4	1978 n = 5	1979 n = 6	1980 n = 7	1981 n = 8	1982 n = 9	Remarks
Private urban		0.45	0.45	0.45	0.45	0.45	0.45	Purely Private
Private rural		2.00	2.00	2.00	2.00	2.00	2.00	
Public) Urban		0.65	0.70	0.79	0.86	0.99	1.03	Joint Public and Private 50% in S. H. in urban areas G. R. = 0.54
Private) Urban		0.35	0.38	0.43	0.47	0.53	0.56	
Public) Rural		1.21	1.29	1.44	1.59	1.74	1.99	75% S. H. in rural areas G. R. = 1.0
Private) Rural		1.21	1.29	1.44	1.59	1.74	1.99	
Pub. urban		0.65	0.70	0.79	0.86	0.99	1.03	Pure Public
Pub. rural		0.41	0.43	0.48	0.53	0.58	0.63	
Total		6.93	7.24	7.82	8.35	9.02	9.68	See notes in table (4-2) for method of estimation $9 \geq n \geq 3$
Current target		5.85	5.85	5.85	5.85	5.85	5.85	
Backlog		-1.08	-1.39	-1.97	-2.50	-3.17	-3.83	
Existing Backlog		29.14	28.06	26.67	24.70	22.20	19.03	Beginning of year
Total Backlog		28.06	26.67	24.70	22.20	19.03	15.20	End of year

indefinite period. This is because by the end of 1982 the food subsidy would have been done away with completely, and invariably because there will be a limit to the % of G. N. P. that can be diverted into the direct development of housing. This limit depends on the overall economic development plan for the country. It appears that in the Republic of Ireland 12% of G. N. P. is being diverted into housing. A reasonable level of investment for Ceylon will be 10% of G. N. P., till such time as the backlog is cleared, and thereafter a regular investment of 6% of G. N. P. Using this as a basis, table (4-3) is presented, indicating investment from 1977 to 1982 as a percentage of current G. N. P.

From table (4-3) it is observed that at the end of 1982 when the food subsidy has been abolished, most savings currently being used for other purposes would have been diverted into the direct development of housing, achieving 9.68% of G. N. P. as investment in that year. The backlog at the beginning of 1983 would then be 15.20% of G. N. P. (1983).

From 1983 onwards, investment will be governed by the following, expressed as a percentage of current G. N. P.

1) From private resources via the private sector 2.45%.

2) Diversion of compulsory savings, via the public sector. $41.58\left(1 + \frac{5n}{100}\right) \Big/ 12{,}800\left(1 + \frac{8n}{100}\right)$.

3) Traditional public sector investment was 0.83% up to 1982. Let us give this a variable value of P%, 1983 onwards. (From traditional sources, mostly budgetary).

4) Diversion of provident and pension funds via the public sector may then be assumed as a variable S% of G. N. P.

(2), (3) and (4) will be divided between rural to urban in the ratio 1:0.805, of which in the urban areas 50% will be for aided self help with a generation ratio of 0.54, and in the rural areas 75% will be for self help with a generation ratio of 1.0. Also $(P + S) = (p + q)$.

The theory is then based on the statement that the total investment must be equal to 10% of current G. N. P. for $n \geqslant 10$. Of this, for each year 5.85% will be needed to meet the current requirements, while the balance is diverted to clear the backlog of 15.20% existing at the beginning of 1983. We may then write the following conditions, which are represented by equations.

(1) The total investment must be equal to 10% of current G. N. P. where $(P + S) = p + q$ and $\frac{p}{q} = 0.805$, applied to equations of basic model, section 4.0 .

$$\text{i.e. } 2.45 + \left[\frac{41.58\left(1 + \frac{5n}{100}\right)}{12{,}800\left(1 + \frac{8n}{100}\right)} + P + S \right] \left(1 + \frac{1}{1.805} \times 0.75 \times 1 + \frac{0.805}{1.805} \times 0.5 \times 0.54\right)$$

must be equal to 10

$$\text{i.e. } \left[41.58\left(1 + \frac{5n}{100}\right) \Big/ 12{,}899\left(1 + \frac{8n}{100}\right) \right] + (P + S) = 4.94 \quad \ldots\ldots (4\text{-}5).$$

This equation becomes a policy decision making condition, i. e. at the beginning of each financial year from 1983 savings can be estimated i. e. S%, and the value of P can then be decided, on the requirement of a total investment of 10% of G. N P.

(2) Since out of the 10%, 5.85% will be used for current requirements, then, 4.15% can be utilised for meeting the backlog, i. e. 15.20% from 1983 onwards. This therefore results in a complete clearance of the backlog by the end of 1986 - see diagram (4-1).

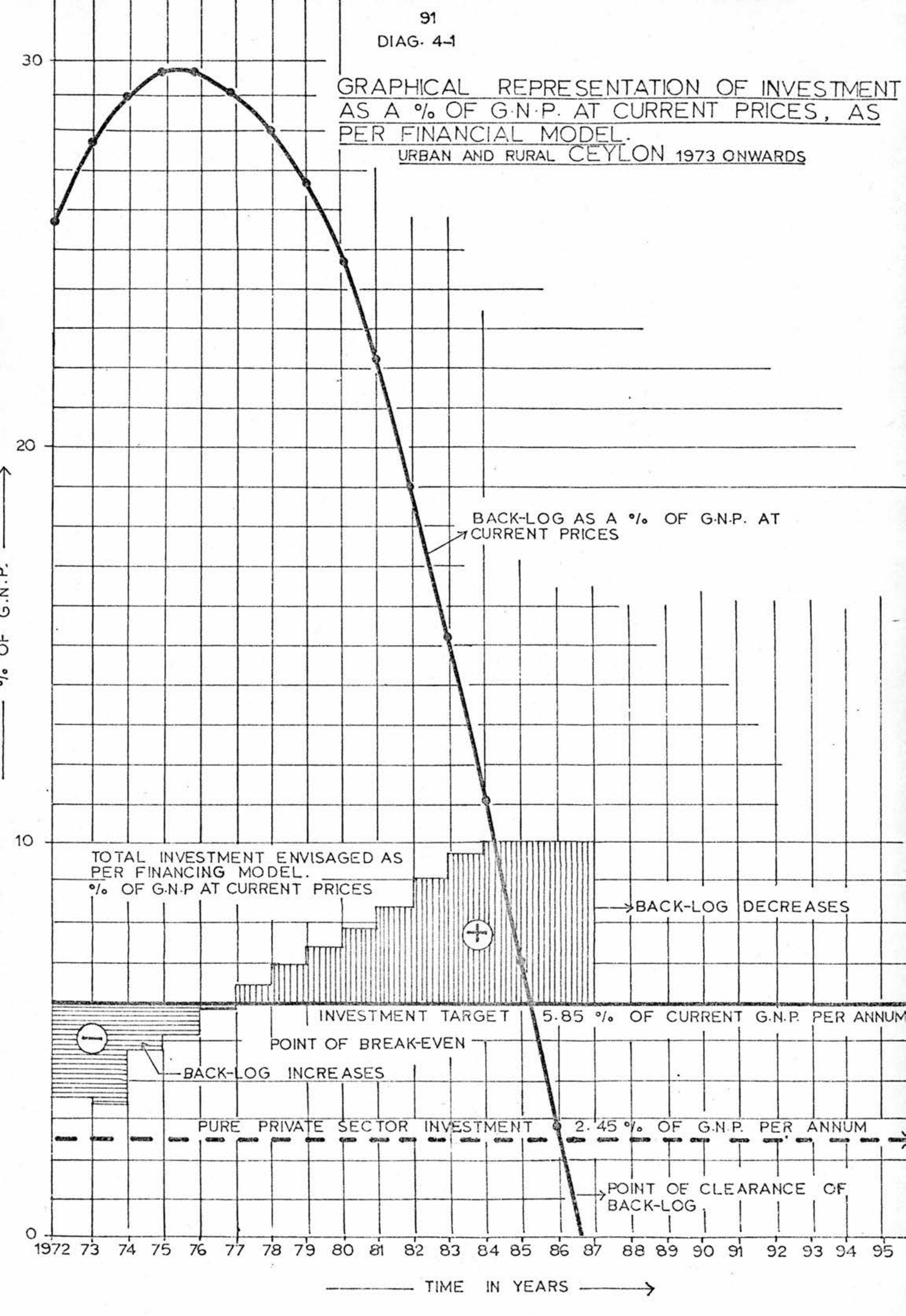
4.2.1 Public sector investment after 1986

After 1986 equation (4-5) above will become:

$$\left[41.58\left(1 + \frac{5n}{100}\right) \Big/ 12{,}800\left(1 + \frac{8n}{100}\right) \right] + (P + S) = 2.32 \quad \ldots\ldots (4\text{-}6)$$

which can be used for policy decision making thereafter. It may even be

DIAG. 4-1


GRAPHICAL REPRESENTATION OF INVESTMENT AS A % OF G.N.P. AT CURRENT PRICES, AS PER FINANCIAL MODEL.
URBAN AND RURAL CEYLON 1973 ONWARDS
% OF G.N.P.
30
20
10
0
BACK-LOG AS A % OF G.N.P. AT CURRENT PRICES
TOTAL INVESTMENT ENVISAGED AS PER FINANCING MODEL. % OF G.N.P AT CURRENT PRICES
BACK-LOG DECREASES
INVESTMENT TARGET 5.85 % OF CURRENT G.N.P. PER ANNUM
POINT OF BREAK-EVEN
BACK-LOG INCREASES
PURE PRIVATE SECTOR INVESTMENT 2.45 % OF G.N.P. PER ANNUM
POINT OF CLEARANCE OF BACK-LOG.
1972 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95
TIME IN YEARS

possible to eliminate P , thus excluding the use of public resources, and thus utilising pure savings for public sector investment in the direct development of housing, after 1986. Out of a total public sector investment of 2.32% of current G.N.P. 1.07% must be in the urban areas with 50% in self help, and 1.25% must be in rural areas with 75% in self help. See diagram (4-1).

4.3 The financing of urban land costs

The discussion so far has centred around raising the reeources for the construction of houses, with basic infrastructure. However, an important consideration from the urban point of view is financing the cost of land.

Urban land in Ceylon, like any country, is a costly item in planning a housing programme. From the foregoing discussions an obvious fact that emerged is that resources for the construction of the houses alone is difficult enough to raise, how then can resources for land costs be raised. There are two possibilities. They are -

(1) The use of state owned land, and

(2) Acquisttion of private land, payment for the land being spread over a long period.

Considering the first possibility: the Government owns a fair proportion of undeveloped as well as developed urban land in Ceylon. Therefore the solution lies in using this land before any private land is acquired. This has two benefits -

(1) It does away with the need to raise the resources necessary for land costs.

(2) If the land is used for housing, the rent or sale value generates income to the government.

?

However, due to the availability of insufficient state land, or its location, it may be necessary to acquire either undeveloped private land, or private land on which the development is obsolete, and can therefore be redeveloped. The existing practice has been to have these lands valued by the Government valuer, and pay for the acquisition in cash. This means the diversion of already scarce resources to purchasing land, which results in less houses being built. To overcome this problem, the cost of the land should be paid for in terms of government bonds[1] redeemable after a fixed period of time. The time can be related to the time over which the prospective tenant pays for the land. The face value of the bond may be such that it includes interest at a specific rate on the original value of the land. This system will thus give the government the advantage of developing housing without meeting the cost of land directly. A system such as this could only be operated effectively by the public sector, and thus reinforces the arguments for public sector investment in the direct development of urban housing.

4.4 Conclusion

In conclusion, the main arguments are summarised, which prove that if a solution to the urban housing problem is to be achieved, it can only be done mainly by public sector investment with a little co-operation from the private sector, rather than pure dependence on the private sector.

On analysing investment patterns in the direct development of urban housing (Chapter 3) it was seen that the public sector, considering it as a social overhead investment, did not maintain a consistent level of investment, while on the other hand the private sector maintained a fairly consistent level of investment of which around 0.45% of current G.N.P. was in housing for owner occupation. It was seen that both the public and private sectors had concentrated on investment for the middle and upper income groups, while the heart of the problem was "housing for the low income groups". Together the investment fell far short of the target of 1.7% of the G.N.P., resulting in a backlog of 6.25% of G.N.P. (1970).

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[1] This system was adopted successfully when the bus companies in Ceylon were nationalised.

In 1971 the five year plan was proposed. However, it appears that not being aware of investment patterns in the past, too much emphasis was placed on private sector investment. As shown in section 3.5, the plan would not achieve any significant increase in the level of investment. One of the main causes was the fact that the policies of rent control, limit on ownership of houses, and limit on incomes, conflicted with the objective of greater private sector investment in the direct development of urban housing.

There were then two courses of action to be taken from 1973 onwards if a solution to Ceylon's urban housing problem was to be found. - Either do away with the conflicting policies and encourage the private sector, or retain the policies and have greater public sector investment. On the basis that the first alternative would result in reverting back to the pre 1972 conditions, which meant housing for the middle and upper income groups, ignoring the low income groups, it was rejected. This left the only other alternative, i.e. greater public sector investment.

From the past it was shown that if public sector investment was to effectively solve the problem, it had to act as a stimulant to private sector investment from the lowest income groups. This meant that at least 50% of the public sector investment should be in aided self help housing.

Once it was established that if the problem was to be solved it was by public sector investment, the question of resources arose. A target of 1.7% of G.N.P. for current requirements, and a target of 8.5% of G.N.P.(1973) for clearing the backlog had to be achieved for the urban sector alone. One fact that arose was that the financing of urban housing could not be considered in isolation, it had to be treated with rural housing. Thus the financing model presented in this chapter was tried out.

The main features of the model were that it accepted certain minimum levels of private sector investment for owner occupation, and traditional methods of financing as envisaged in the five year plan. The extra resources needed could only be drawn from private sector resources, due to the scarcity of public rescurces. Thus the sources utilised were (1) compulsory savings and (2) diversion of provident and pension funds into the direct development of housing, by a gradual reduction in food subsidies. The model had two main advantages, viz.

(1) The diversion of private resources into housing for the lowest income groups via the public sector, and

(2) The removal of rice subsidy, which has stunted Ceylon's economic growth for more than the last twenty years.

On the basis of this model it was shown that the annual levels of investment required could be achieved by 1976, and the backlog cleared by 1986. This included both urban and rural housing. It was also seen that after 1986 the annual level of investment may be achieved by the use of savings, rather than the diversion of public resources into housing.

Finally, the question of urban land costs was considered, where it was seen that the system of payment via government bonds would remove the burden of immediate payment of land costs, and that in the long run the public sector would only act as an agent for the new tenant to pay the original owner for the land over a fixed period of time.

Thus overall the solution to Ceylon's urban housing problem lies mainly in public sector investment, proving "the need for public sector investment in the direct development of urban housing in Ceylon."

PART III TOWARDS ACHIEVING THE OBJECTIVES OF PUBLIC SECTOR INVESTMENT IN THE DIRECT DEVELOPMENT OF URBAN HOUSING IN CEYLON. THE NATIONAL SCALE.

CHAPTER 5

Maximising Employment Generation and Minimising Foreign Exchange Consumption

5.0 Introduction

In Chapter 2, section 2.5, it was seen that one of the objectives of public sector investment was to ensure that the investment produced economic growth and that this growth was the maximum possible.

The discussion in section 2.5.1 showed that investment in the direct development of housing would generate economic growth provided objectives (1) and (2) , viz. that the standards must satisfy socio-economic levels of the population and that these standards must be provided at the minimum physical costs, are achieved. It was also seen that the two variables that affected the rate of growth were the marginal employment generation, and the marginal consumption of foreign exchange via the investment. Hence, it was concluded that in order to maximise economic growth marginal employment generation must be maximised, and marginal consumption of foreign exchange must be minimised.

The purpose of this chapter, therefore, is to analyse the generation of employment and foreign exchange consumption via investment in housing. This will be accomplished by building and analysing a theoretical model of employment generation and foreign exchange consumption leading to broad policies necessary for the maximisation of marginal employment generation, and minimisation of marginal foreign exchange consumption.

The theoretical model will then be applied to public sector investment in the urban areas of Ceylon, for which detailed policies will be formulated, which must form the basic framework within which a detailed urban housing programme can be formulated.

5.1 A theoretical model of employment generation and foreign exchange consumption via investment in the direct development of housing.

The model developed here is general and applicable to both urban and rural areas.

In general investment in housing generates a need for labour, materials and machinery. The production of materials requires labour and machinery. This thus sets off a demand for labour on the one hand and a demand for machines on the other. The demand for machines sets off a further need for labour and materials. The net effect, therefore, is (1) a generation of employment, (2) a stimulation of the manufacturing industry and (3) a need for raw materials, both local and imported, for the manufacture of finished materials and machinery for housing.

This multiplier effect has been dealt with fully by Keynes (1936)[1] as reported by Hansen (1953)[2] where he says: (1) the multiplier effect is not continuous due to leakages into the consumption sector, (2) the multiplier effect is greater in poor countries than in richer ones.

The overall effect of this investment therefore is to provide employment for the unemployed, which generates income and thereby increases: (1) the private sector resources by profit and savings, and (2) the public sector resources by direct returns, increased taxes and a cut in subsidies.

Diagram (2-2) illustrates the effect of investment in the direct development of urban housing in Ceylon.

Based on the fact that investment in the direct development of housing generates both direct and indirect employment, and consumes foreign resources, the model presented tries to take these into consideration. It further considers the effect of diverting part of the investment into self help housing.

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[1] J.M. Keynes. - The general theory of employment, interest and money (1936). pages 125-6.

[2] A.H. Hansen - A guide to Keynes (1953), page 99.

5.1.1 Assumptions on which the model is based

The following assumptions, and definitions, are used for building the model.

1. In housing the cost of materials and machinery is (100 - m)% of the total cost. Therefore the cost of labour is m%.

2. In housing we require two grades of labour, skilled and unskilled. Assume that for (1) skilled labourer, (u) unskilled labourers are needed for support.

3. The average number of days worked per year by a labourer is (n), both for the construction as well as the manufacturing industry.

4. The daily wage of a skilled labour is W_s units and that of an unskilled labourer W_u units.

5. For housing i% of materials and machines are imported. Therefore (100 - i)% of materials and machines are local (i. e. either raw or manufactured).

6. The average cost of a job in the manufacturing industry is a units/annum. (This therefore includes the cost of the raw materials, the machines, and the labour content.)

7. The annual wage of a worker in the manufacturing industry is W_m units.

8. s% of the total investment is spent on self help housing, and (100- s)% on the construction of complete houses.

5.1.2 The theoretical model

Consider an investment of H units of money in housing. Let the total number of jobs produced by this investment be J, and the total consumption of foreign exchange be F units of money.

The theoretical model can now be developed, and the intention is to express J as a function of the variables u, i, and s,

$$\text{i.e.} \quad J = \psi(u, i, s)$$

and also express F as a function of the variables u, i and s

$$\text{i.e.} \quad F = \phi(u, i, s)$$

where u, i, and s are as defined in 5.1.1 and signify unskilled labour percentage import content of materials, and percentage of investment spent on self help housing.

For housing the cost of a labour gang per annum would be $(1 \times W_s + u \times W_u) \times n = n(W_s + uW_u)$ units. Since this forms m% of the total cost of creating employment in housing for one gang per annum, the total cost would be

$$n(W_s + uW_u) \quad \frac{100}{m} \text{ units.}$$

$\therefore$ The average cost per annum of one direct job in housing construction would be $\dfrac{n(W_s + uW_u)}{(1 + u)} \; \dfrac{100}{m}$ units.

Since an amount H units is spent annually on the direct development of housing via the public sector, of which s% is on self help, then

$$\frac{(100 - s)}{100} \; \frac{H(1 + u)\ m}{n.100(W_s + uW_u)}$$

jobs can be created directly with the public sector.

Further, since (100 - m)% of H(100 - s)/100 and 100% of Hs/100 is spent on materials and machines, and (100 - i)% of this is local, this investment H will create a further $\dfrac{(H)}{100^2} \; \dfrac{(100 - i)}{a} \left(100 - m + \dfrac{sm}{100}\right)$ jobs/annum in the manufacturing industry. This will also create a demand for $\dfrac{H}{10^4} \,.\, i.\left(100\text{-}m + \dfrac{sm}{100}\right)$ units in foreign exchange.

Therefore total number of jobs (J) created by investing H units annually in housing would be the sum of the direct employment and the indirect employment in the manufacturing industry.

$$J = \frac{H}{100^2}\left[\frac{m(1+u)(100-s)}{n(W_s + uW_u)} + \frac{(100-i)}{a}\left(100-m+\frac{sm}{100}\right)\right] \quad \ldots \quad (5-1)$$

The number of units demanded in foreign exchange would be

$$F = \frac{H}{10^4} \cdot i. \left(100-m+\frac{sm}{100}\right) \quad \ldots\ldots\ldots\ldots\ldots \quad (5-2)$$

where $100 \geqslant i \geqslant 0 \quad 100 \geqslant s \geqslant 0$ and $100 \geqslant m \geqslant 0$

If we make the assumption that the total cost will not vary by varying the distribution between materials including machines and labour, basing it on the fact that as the use of machines is reduced an equivalent amount is spent on labour, we can state the following condition.

$$m \propto (W_s + uW_u)$$

i.e. the percentage spent on labour will be proportional to the cost of employing one gang. The size of the gang depends on u, the number of unskilled labourers, attached to one skilled labourer. Therefore we can write:

$$m = k(W_s + uW_u) \quad \ldots\ldots\ldots\ldots\ldots\ldots \quad (5-3)$$

where k is a constant.

Substituting this equation in (5 - 1), and rearranging, we get

$$J = \frac{H}{10^4}\left[\frac{k}{n}(1+u)(100-s) + \frac{(100-i)}{a}\left\{100 - k(W_s + uW_u)\left(1-\frac{s}{100}\right)\right\}\right]. \quad (5-4)$$

Hence equations (5-1), (5-2), and (5-3) form the basic model which describes employment generation and foreign exchange consumption via investment in the direct development of housing.

5.2 An analysis of the theoretical model leading to a formulation of general policy

The basic model described in section 5.1 by equations (5-1), (5-2) and (5-3) can now be analysed with two objectives in view. They are:

(1) to maximise the marginal employment generation, and
(2) to minimise the marginal consumption of foreign exchange.

5.2.1 Maximising marginal employment generation.

Employment generation is governed by:

$$J = \frac{H}{10^4}\left[\frac{m(1+u)(100-s)}{n(W_s + uW_u)} + \frac{(100-1)}{a}(100 - m + \frac{sm}{100})\right] \quad \ldots (5-1)$$

where $m = k(W_s + uW_u)$ ....(5 - 3)

and $100 \geqslant i \geqslant o$, $100 \geqslant s \geqslant o$, $100 \geqslant m \geqslant o$

The marginal employment generation is given by $\frac{\partial J}{\partial H}$

Hence marginal employment generation is:

$$\frac{\partial J}{\partial H} = \frac{1}{10^4}\left[\frac{m(1+u)(100-s)}{n(W_s + uW_u)} + \frac{(100-i)}{9}(100 - m + \frac{sm}{100})\right] \quad \ldots (5-5)$$

where m is governed by equation (5-3).

If u, i and s were continuous over all values between - and + p the normal methods of calculus could have been used to determine their values that maximise $\frac{\partial J}{\partial H}$. However since the ranges are limited it will be possible only to determine how $\frac{\partial J}{\partial H}$ varies with each of the variables, i.e. u, i, and s, and conclude broadly in what direction policy should guide them if $\frac{\partial J}{\partial H}$ is to be maximised.

The variation of $\frac{\partial J}{\partial H}$ with respect to u, i and s, can now be analysed.

(1) Variation of $\frac{\partial J}{\partial H}$ with u.

The rate of change of $\frac{\partial J}{\partial H}$ with u is given by $\frac{\partial}{\partial u}\left(\frac{\partial J}{\partial H}\right)$

i.e. $\frac{\partial^2 J}{\partial u.\partial H}$ i.e. differentiating equation (5-5) partially with respect to u.

$$\frac{\partial^2 J}{\partial u.\partial H} = k(100-s)\left[\frac{1}{n} - \frac{(100-i)}{100a} \quad W_u\right]$$

Since $100 \geqslant s \geqslant o$, $(100-s)$ is always positive.

If the marginal generation of employment is to increase as u increases, then

$$\left[\frac{i}{n} - \frac{(100-i)}{100.a}\right] W_u \geqslant 0$$

i.e. $i \geqslant 100\left\{1 - \frac{a}{n.W_u}\right\}$

Since nWu is the cost of an unskilled labourer in the building industry, and a is the cost of a job in the manufacturing industry including materials and machines, a will be $\geqslant n.W_u$

i must always be $>$ a negative value, which is true since $100 \geqslant i \geqslant o$.

<u>Broadly labour intensification of the construction industry leads to a maximisation of marginal employment generation via investment in housing.</u>

(2) Variation of $\frac{\partial J}{\partial H}$ with i.

The rate of change of $\frac{\partial J}{\partial H}$ with i is given by $\frac{\partial^2 J}{\partial i . \partial H}$.

i.e. $\frac{\partial^2 J}{\partial i \partial H} = -\frac{1}{a}\left[100 + m\left(\frac{s}{100} - 1\right)\right]$

Since $100 \geqslant m \geqslant o$, and $100 \geqslant s \geqslant o$ $\frac{\partial^2 J}{\partial i . \partial H}$ is always $<$ o.

Therefore, this leads to the conclusion that

<u>Increasing the import of materials and machines tends to minimise the marginal generation of employment in the housing industry.</u>

(3) Variation of $\frac{\partial J}{\partial H}$ with s.

The rate of change of $\frac{\partial J}{\partial H}$ with s is given by $\frac{\partial^2 J}{\partial s . \partial H}$

i.e. $\frac{\partial^2 J}{\partial s . \partial H} = (W_s . n - a) - u(a - n.W_u)$

If $\frac{\partial^2 J}{\partial s . \partial H}$ is $>$ o then $u < \frac{(W_s . n - a)}{(a - n.W_u)}$

$(a - nW_u)$ is generally $>$ o.

But $(W_s . n - a)$ may be $>$ or $<$ o.

If it is $>$ o then self help housing will increase employment, and this would be in an area where skilled labour in the construction industry was scarce and expensive in comparison to providing a job in industry.

If on the other hand it was $<$ o, then self help will only tend to negative marginal employment generation, and will be detrimental rather than helpful. This will happen where skilled labour is plentiful and cheap.

It appears therefore that the decision for a particular country must be made with reference to real values, as will be seen when the case of urban Ceylon is considered. It must also be noted that a certain proportion of self help may be necessary to achieve the level of investment required, which reinforces the fact that the decision depends on the conditions prevailing in the country under consideration, and therefore cannot be generalised.

5.2.3 <u>Minimising marginal foreign exchange consumption</u>

Foreign exchange consumption in the direct development of housing is governed by:

$$F = \frac{H}{10^4} \cdot i. \left(100 - m + \frac{sm}{100}\right) \quad \ldots\ldots\ldots\ldots (5-2)$$

and $m = K (W_s + uW_u)$ .... (5 – 3)

where $100 \geqslant i \geqslant 0$ $\quad 100 \geqslant s \geqslant 0$, and $100 \geqslant m \geqslant 0$

The marginal foreign exchange consumption is given by $\frac{F}{H}$

$$\text{i.e. } \frac{\partial F}{\partial H} = \frac{i}{10^4} \left(100\ m + \frac{sm}{100}\right) \quad \ldots\ldots (5-6)$$

Here again since s, i, and m are only valid for a fixed range, therefore it is not possible to minimise $\frac{\partial F}{\partial H}$, but to give broad policy that makes $\frac{\partial F}{\partial H}$ -ve and decreases its value.

Analysing the variation of $\frac{\partial F}{\partial H}$ with u, i and s, we get:

(1) Variation of $\frac{\partial F}{\partial H}$ with u.

$$\text{i.e. } \frac{\partial^2 F}{\partial u . \partial H} = \frac{1}{10^4} \left(\frac{s}{100} - 1\right). \ K.W_u.$$

which is - ve since 100 s 0.

$\therefore$ <u>Labour intensification of the construction industry reduces the marginal foreign exchange consumption.</u>

(2) Variation of $\frac{\partial F}{\partial H}$ with i.

i.e. $\frac{\partial^2 F}{\partial i . \partial H} = \frac{1}{10^4}\left[(100 - m) + \frac{sm}{100}\right]$

Since $100 \geqslant m \geqslant o$, $\frac{\partial^2 F}{\partial i . \partial H}$ is + ve.

<u>Therefore increase of imports of materials and machines increases the marginal foreign exchange consumption.</u>

(3) Variation of $\frac{\partial F}{\partial H}$ with s

i.e. $\frac{\partial^2 F}{\partial s . \partial H} = \frac{i}{10^4}\left[\frac{m}{100}\right]$

which is + ve since $100 \geqslant m \geqslant 0$

<u>Therefore self help housing tends to increase the marginal foreign exchange consumption, as it is increased.</u>

5.2.3 <u>Broad policy for maximising employment generation and minimising foreign exchange consumption</u>

From the foregoing analysis it is now possible to state a broad policy for maximising employment generation and minimising foreign exchange consumption via investment in the direct development of housing.

(1) From 5.2.1. (1) and 5.2.2. (1) it will be observed that labour intensification of the construction industry results in increasing the marginal employment generation and decreasing the marginal consumption of foreign exchange.
<u>Hence the construction industry should be labour intensive.</u>

(2) From 5.2.1. (2), and 5.2.2 (2) it is seen that increasing the import content of materials and machines leads to a reduction in the marginal employment generation and an increase in marginal foreign exchange consumption.

Hence the housing should depend more on local materials (import substitution), and the local manufacture of materials and machines where no substitute is available, using imported raw materials.

(3) Finally it is seen that self help housing has the adverse effect of increasing the marginal foreign exchange consumption.? On the other hand it may or may not increase the marginal employment generation. More likely it tends to decrease it. However, it was observed that self help was necessary to achieve the level of investment required. Since the provision of housing was the primary objective, the policy should be such that self help housing is used only when the provision of complete houses is economically beyond the household's capacity to pay, and when it is required to achieve the level of investment. It, of course, has the advantage of reducing subsidies. Overall, the detrimental effects of self help housing may be overcome by its advantages.

5.3 An application of the model to Ceylon

The theoretical model developed and analysed can now be applied to Ceylon. In applying the model the objectives will be:

(1) to formulate policy that maximises the marginal employment generation, via public sector investment in the urban areas and thus the total employment generated, subject to the restriction that a certain proportion of investment must be in self help housing. Self help housing is necessary as seen in Chapter 3 to achieve the total level of investment, and bring housing as far as possible within the household's ability to pay for it, thus minimising subsidies.

(2) to formulate policies that minimise the marginal foreign exchange consumption. Here again the restriction due to self help housing will apply. However, this analysis will cover both urban and rural areas and also both the public and private sector, since what matters in this case is the overall marginal consumption.

5.3.1 Employment generation via public sector investment in the direct development of urban housing in Ceylon

This section presents a picture of unemployment in Ceylon, and tries to formulate policy by adjusting the independent variables in the model with a view to maximising the marginal employment generation, and thus the total employment generated.

5.3.1.1 Unemployment in Ceylon

Ceylon has a chronic unemployment problem. In the last decade unemployment has increased from around 10% to nearly 15%[1,2] of the active labour force. This shows that out of a total labour force of 3.8M, of which 1/6[3] was in the urban sector, a total of about 552,000 were unemployed. Of the unemployeed, 119,000[4] were in the urban areas of which 78,000[4] were males. Table (10) of the report cited in footnote 1 of this page, states that out of 220,000 persons never employed 150,000 were males, of which 102,000 were prepared to take any job, and 8,000 wanted semi-skilled or skilled employment. The balance, 40,000, wanted white collar jobs.

5.3.1.2 Selection of variables

The theoretical model is now applied to public sector investment in the direct development of urban housing, by substituting real values for the variables. The values adopted are

(1) Value of u

Present construction techniques in Ceylon show that for one skilled labourer an average of 2 unskilled labourers are needed, i.e. $u = 2$. This is due to the fact that tractors and cranes are being used extensively. It appears that if more manual

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[1] The figure of 15% is given in the I.L.O. "report" matching employment opportunities and expectations. A programme of action for Ceylon, page 3, Geneva 1971.

[2] The Central Bank of Ceylon report for 1971 quotes a figure of 14% for 1971, page 205.

[3] op. cit. 1 page 22, para. 100.

[4] op. cit. 1. table 6.

workers are used, the value of u could be increased to about 2.75. If we increase u above this we will find that the labour will be underemployed, and that the condition $m=k(W_s + uW_u)$ will not be valid. This view has also been supported by the I.L.O. report[1]. We thus see that future public sector investment in the direct development of urban housing should aim at increasing the value of u from 2 to about 2.5 in order to increase the marginal employment generation conclusion reached in section 5.2.3.

(2) Value of i

In 1968 the estimated value of the import content of materials in housing was[2,3] $i = 18\%$. However, this value of i can be reduced by (1) using less imported machinery as a result of labour intensive techniques: (2), reduction in the import of cement which constitutes 8%, since we will be virtually

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[1] Recommendation by the I.L.O. - a Programme of action for Ceylon, report page 190 para. 636 and footnote 1.

"Employment in the construction sector (excluding rural public works could be raised by about 50,000 between 1970 and 1976, which is in line with the expectations of the planners. A condition for achieving this is a steadily growing demand created by the government programme, especially for housing. Another is that care should be taken not to introduce mechanisation indiscriminately. (An objection sometimes raised to labour intensive methods is that they are slower, but in the case of Ceylon one must allow for the time between ordering imported machines and taking delivery.) "

[2] Human settlements. An experiment in housing policy and programming. Table 2, page 39, Vol. 1, No.4 of October (1971). Issued by Centre for Housing, Building and Planning, New York.

[3] 18% of materials is 11.7% of total gross output when 65% is spent on materials and 35% on labour.

self-sufficient due to increased production: (3) by encouraging the use of less steel in building: (4) by encouraging the local manufacture of metal plumbing products. This will enable the reduction of i to about 6%. This view has also been supported by the I. L. O. report[1].

(3) Value of s

For all practical purposes the value of s as per the five year plan is[2] 12%. This is understandable as one of the main objectives of the plan was the maximisation of employment generation. However, we saw in Chapter 3, 50% of all urban households could not afford an economic rent, and on this basis and for the purpose of utilising the labour potential available we saw that on the average s must be equal to 50%. The value of s however is the average, and therefore will vary for different urban areas, as we will see in Part IV of this study. Hence from the national point of view we see that the average optimum value for s is 50%, for public sector investment in the direct development of urban housing in Ceylon.

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[1] As per I. L. O report, A programme of action for Ceylon, para. 638, page 190, states:

> "The great advantage of construction is that imports of materials and some finished products account for only 10 to 15 per cent. of total gross out-put. This could be lowered still further by developing local production, by encouraging the expansion of this sector in smaller towns and villages, which would fit the general principle of encouraging development in rural areas rather than in the cities, and by concentrating on maintenance."

[2] Table (3-3A) Line (a) $7/58 \times 100 = 12\%$.

(4) Values of n, W_s, W_u, a.

The average number of days (n) worked by a construction worker has been 300. This is a reasonable figure, and may be used for future estimates.

The average wage of a skilled worker (W_s) is Rs. 8/= per day, and that of an unskilled worker (W_u) RS. 5/= per day. These rates may rise with time, but should be controlled as far as possible. However, these rates may be assumed to cover the period of the five year plan.

The average cost of producing a job in the manufacturing industry, and keeping it going is estimated at[1] Rs. 15,760/= per annum.

5.3.1.3 Appraisal of past vs. proposed policy (1972-1976)

Let us now try to compare the policy of the five year plan versus proposed policy changes.

Using the values of $s = 12\%$, $u = 2$, $i = 18\%$, $n = 300$, W_s = Rs. 8/=, W_u = Rs. 5/=, and a = 15,760 in equation (5-5), and estimating k from $m = k(W_s + uW_u)$, where[2] $m = 35\%$. (Section 5.3.1.2)

$$\frac{\partial J_1}{\partial H} = 204$$

where J refers to policy existing.

However, on implementation policy changes recommended, The values for the variables would be $s = 50$, $u = 2.75$, $i = 6\%$, $n = 300$, W_s = Rs. 8, W_n = Rs. 5/=, $a = 15,760$ and $k = 2$. On substitution in equation (5-5) the value of $\frac{\partial J_2}{\partial H}$ is obtained.

i.e. $\frac{\partial J_2}{\partial H} = 157$. On the other hand, if s had been maintained at its original value of 12%, $\frac{\partial J_2}{\partial H}$ would be equal to 273.

[1] Human settlements, as per note (2) on page 107.

[2] Unpublished research by the building materials corporation of Ceylon showed the division between labour and materials in housing to be 35% and 65%.

From this analysis it appears that policies that maximise the use of labour and foster the use of locally manufactured materials will increase the marginal employment generation from 204 to 273, if the amount diverted to self help housing was 12%. However, it is seen that as a result of increasing the amount diverted to self help housing to 50%, the marginal employment generation has reduced from 204 to 157. This leads us to an important conclusion, that is, public sector investment should aim at diverting the minimum required into self help housing. In the case of Ceylon it was observed in Chapter 3 that if a solution to the urban housing problem was to be achieved, there arises a need to increase investment to 1·7% of G. N. P., and that this can be done by diverting 50% into self help housing. Further, it was observed that 50% of households could not afford the cost of complete houses, and thus self help was a way to bring down the cost to the consumer, and avoid subsidy. It is thus possible to state a general principle on the use of self help housing in Ceylon, i. e.

> "The benefits of self help housing increase as the level of unemployment decreases."

A corollary to this would be that

> "Self help housing would be most useful in areas where the level of employment was high, and the cost of housing is high in comparison to wages."

5.3.1.4 <u>Total employment generated within the five year plan</u>

From the foregoing analysis it appears that increasing the proportion of investment in self help housing has resulted in a 23% drop in marginal employment generation. However, this drop is much less than the drop that would have occurred if u and i were maintained at the same level as before. Despite this setback it will be seen that overall total employment can be brought more in line with the expectations of the plan. The

Table (5-1)

Employment generation via proposed public sector investment in the direct development of urban housing, Ceylon 1972-1976

Year / Investment	(1) 1972 Table (2-3a)	(2) 1973 n = 0	(3) 1974 n = 1	(4) 1975 n = 2	(5) 1976 n = 3	(6) 1971 Table (2-1)	Net Employment generated over 5 years (5) - (6)	Remarks
in Rs. M.								
1 Public urban (H) as per 5 year plan[1]	58.0	61.7	66.6	71.6	76.6	54.0	-	Column(2) to (6) as per footnote 1 below.
2 Total employment generated by (1) above	11,850	12,600	13,600	14,600	15,600	11,000	4,600	J = 204H, H in millions
3 Public urban in Rs. million as per proposed investment model (H)	58.0	84.5	110.0	145.0	181.0	54.0	-	Column (2) to (6) is from table (2-4) expressed in rupees million
4 Total employment as per (3) above	11,850	13,300	17,300	22,800	28,400	11,000	17,400	J = 157H, except column (1) and column (6). J=204H

[1] Calculated from $(0.83)(0.58)\left[128\left(1 + \frac{8n}{100}\right)\right]$ for $n = 0, 1, 2, 3$

i.e. 0.83% of G.N.P. where (urban/total) = 0.58.

comparison is between:

(1) The period 1972-1976, as per investment envisaged in the five year plan, using values for the variables as per the five year plan; and

(2) the period 1972-1976, using (1) above for 1972, and investment proposed as per investment model in Chapter 4, using the new values for the variables from 1973-1976.

The figures are presented in Table (5-1).

On the whole the five year plan proposed to produce 225,000 jobs in industry, of which 50,000 were in the construction industry. It appears from Table (5-1) that the public sector would have produced 4,600 jobs in the urban area if it adhered to the existing financing and implementation policy, and that it would have produced 17,400 jobs in the urban area by adopting the new financing and implementation policy, while moving toward a solution of the urban housing problem in Ceylon.

5.3.2 Foreign exchange consumption via investment in the direct development of housing in Ceylon

Between the years 1952 to 1970, Ceylon has had an ever increasing external resource deficit[1]. This has been one of the major causes for the slow rate of development. Thus, as stated in section 5.0, investment in housing must try to use the minimum foreign resources possible. In section 5.2.2 it was shown that the marginal foreign exchange consumption $\frac{\partial F}{\partial H}$ is given by :

$$\frac{\partial F}{\partial H} = \frac{i}{10^4}\left(100 - m + \frac{Sm}{100}\right) \quad \ldots\ldots \quad (5-6)$$

It was seen in the last section that for urban housing i could be reduced from its existing value of 18% to 6%, by import substitution and local manufacture.

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[1] I.L.O. report. A Programme of action for Ceylon. Technical papers, page 243. Table 1.

The public sector may achieve this by deliberately using local materials, but it would be difficult to control the private sector. Since foreign resources affect overall development, it is necessary to look at investment in the direct development of housing both by the public and private sector, in urban and rural areas, and not only cut down the use of foreign resources by the public sector, but evaluate a controlling policy that reduces the use of foreign resources by the private sector.

Overall policy could thus include the following:

(1) Public sector investment in the direct development of urban housing should aim at using no more than 6% of the value of materials and machines via imports ($s = 50\%$) section 5.3.1.2,(2).

(2) Public sector investment in rural housing should aim at using no more than about 4% of the value of materials and machines via imports. This could be achieved by promoting traditional methods of construction in the rural areas, rather than modern methods. ($s = 75\%$).

(3) There can be a gradual reduction in imports from $i = 18\%$ in 1973 to $i = 7\%$ in 1976 where the urban private sector is concerned. This gradual reduction will allow the setting up of industries by 1976 to substitute for the imported materials (I.L.O. recommendation cited approves this principle).

(4) There can be a gradual reduction in imports[1] from $i = 10\%$ in 1973 to $i = 5\%$ in 1976 where the rural private sector is concerned. As before this gradual reduction will allow time for the setting up of industries to produce materials.

The figures cited above are approximate extrapolations.

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[1] The rural areas presently use more local materials, and i is estimated at 10% for the private sector.

In order to justify policies (1) and (4) it is possible to compare the marginal foreign exchange consumption under existing policy, and by incorporating the policy changes. Equation (5-6) is used for this purpose.

5.3.2.1 <u>Public sector investment</u>

(1) <u>The urban sector :-</u>

Under existing policy for an investment H_1, the foreign exchange component is calculated using $s = 12\%$, $m = 35\%$, and $i = 18\%$. This gives:

$$\frac{\partial F_1}{\partial H_1} = 0.12456, \text{ i.e. } 12.46\% \text{ of public sector investment.}$$

Since $s\%$ is in self help, and total investment is $H\left[1 + \frac{sm}{100(100-m)}\right]$

i.e. F_1 is 11.7% of total investment[1].

If policy (1) is implemented the value of $s = 50\%$, $m = 43.5\%$ (from $m = k(W_s + uW_u)$, where $k = 2$, and $m = 35$, where $u = 2$, changed to $u = 2.75$ and $i = 6\%$. This gives

$$\frac{\partial F_1}{\partial H_1} = 0.0477 \quad \text{i.e. } 4.77\% \text{ of public sector investment}$$

Since 50% is in self help, this becomes 3.85% of total investment.

It thus appears that if the policy changes are incorporated, public sector investment in urban housing can increase by (12.46/4.77) i.e. 2.6 times, without demanding more foreign resources than have been earmarked for the direct development of housing within the five year plan. Since the plan proposed a total public sector investment of 0.48% of current G.N.P. in urban housing, this could be increased by 2.6 times without requiring more foreign resources, i.e. to a value of 1.25% of current G.N.P. From table (4-2) it is seen that the maximum requirement occurs in 1976 and that is 1.14% of G.N.P. Therefore policy change (1) attains the objective of minimising the use of foreign exchange.

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[1] Op. cit. footnote 1, page 108. This value of 11.7% is within the values suggested by the I.L.O. report, i.e. between 10-15%. This is evidence in supporting the validity of the model.

(2) <u>The rural sector</u>

Under existing policy for an investment H_2, the foreign exchange component is calculated using $s = 30\%$ (table 3-3B), $m = 50\%$, and since a modern form of building is stipulated $i = 18\%$.

This gives:

$$\frac{\partial F_2}{\partial H_2} = 0.1170 \quad \text{i.e. } 11.7\% \text{ of public sector investment.}$$

Since 30% is in self help, this gives 9.0% of total investment.

If policy change (2) is implemented ; the value of $s = 75\%$, m is estimated to remain at the same value of 50%, as otherwise there will be underemployment created, which negatives the objective of economic growth. i however can be reduced to 4% as stated in policy (2). This gives:

$$\frac{\partial F_2}{\partial H_2} = 0.025 \quad \text{i.e. } 2.5\% \text{ of public sector investment.}$$

Since 75% is in self help housing, this becomes 1.43% of the total investment generated (i.e. public + private labour).

It is thus seen that implementation of the policy change can increase public sector investment in the rural areas by 4.7 times its present level, without demanding more foreign resources. Since the five year plan estimated 0.35% of G.N.P. as the level of investment, this could be safely raised to (0.35 x 4.7) i.e. 1.65% of current G.N.P. The maximum envisaged in the financing model (Chap.4) within the period of the plan is 1.41% (table 4-2) in 1976.

Thus policy (2) achieves the required objective of minimising the foreign exchange consumption.

Overall it is seen that by implementing the policy changes the public sector achieves its desired level of investment, and uses less foreign resources than envisaged in the five year plan, whose policies did not even achieve the level of investment required.

5.3.2.2 Private sector investment (Pure)

(a) The urban sector

The private sector in the urban areas has invested mainly in modern housing. As such the value of m is estimated at the average of 35%, while i = 18%. In this case since no private sector investment has been directed towards organised self-help, s = 0.

Equation (5-6) thus becomes:

$$\frac{\partial F}{\partial H} = \frac{i}{10^4} \quad (100 - m)$$

Using the values above, for an investment H_3, the marginal foreign exchange consumption is given by

$$\frac{\partial F_3}{\partial H_3} = 0.1170 \quad \text{i.e. } 11.7\% \text{ of the investment.}$$

If on the other hand policy (3) is implemented, m will remain at 35%, since the amount of labour employed by the private sector is difficult to control. i however may be reduced as stated, by a gradual cut in imports and the subsequent setting up of industries, to manufacture the requirements[1]. Since i may be reduced to 7% by 1976, it is possible to use the average value of i = 12.5% over the years 1973 to 1976, in order to estimate the foreign resources utilised. This gives:

$$\frac{\partial F_3}{\partial H_3} = 0.0815 \quad \text{i.e. } 8.15\% \text{ of the investment.}$$

In Chapter 3 it was shown that the level of investment by the private sector will be 0.45% of G.N.P. and not 0.47% of G.N.P. as expected in the five year plan. Thus this will result in an overall saving of foreign resources.

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[1] It is useful to note that steps have been taken in this direction, where the size and cost of private housing is now controlled by law. Ceiling on house and property law No.1 of 1973, Part II, sections 40-43. Government Printing Press - Sri Lanka - certified on 13th January, 1973.

(b) The rural sector

In the rural areas, private sector investment has utilised more traditional methods of construction, and thus i is estimated at 10%, m as mentioned earlier is around 50%. The value of s is estimated as zero, since the labour content has been included in the estimation of overall investment. Thus equation (5-6) modified as under the urban sector is used to estimate the foreign resources required. Hence, for an investment H_4, the foreign resources used under the present policy is given by :

$$\frac{\partial F_4}{\partial H_4} = 0.05 \text{ i.e. } 5.0\% \text{ of total investment}$$

If, however, policy (4) is implemented, the average value of i becomes 7.5%, while m remains the same at 50%, i.e.

$$\frac{\partial F_4}{\partial H_4} = 0.0375 \text{ i.e. } 3.75\% \text{ of total investment.}$$

It was shown in Chapter 3 that private sector investment in the rural areas will be about 2.0% of current G.N.P. and not 2.28% as expected. Thus the net result will be a saving of foreign exchange.

5.4 Policy for maximising employment generation and minimising foreign exchange consumption via public sector investment in the direct development of urban housing in Ceylon

It is now possible to draw up a broad policy to guide public sector investment in the direct development of urban housing in Ceylon, so that employment generation is maximised and foreign exchange consumption minimised, resulting in the maximisation of economic growth via the investment. Broadly the policy is as follows.

(1) It appears that public sector construction of housing should use labour intensive methods, thus increasing the number of unskilled workers per skilled worker from 2 to about 2.5.

(2) Public sector housing should be designed and constructed using more local materials, thus trying to reduce its present import content from 18% to about 6%.

(3) Self help housing has detrimental effects on employment generation and foreign exchange consumption. Hence it appears that self help housing must be used cautiously, and preferably in areas of high employment, where the ratio of the cost of conventional housing to household income is high.

These, then, form the basic policy framework within which detailed housing programmes for the urban areas in Ceylon should be formulated.

CHAPTER 6

A concept for solving the housing problem at minimum physical costs

6.0 Introduction

The conclusion reached in Chapter 2 stated that subject to achieving the objective of maximising economic growth via public sector investment in the direct development of urban housing, the primary objective should be to solve the urban housing problem at minimum physical costs.

From the analysis in section 2.4 it was seen that the objective of solving the housing problem at minimum physical costs was equivalent to achieving the objective stated below, i. e.

> "Standards used for the direct development of urban housing must reflect the socio-economic values of the population, thus resulting in a range of standards, which must be achieved at the minimum physical costs within the limits of technology."

It thus follows that any concept for solving the housing problem at minimum physical costs, must contain the built in assumption that standards will be a function of the social, economic, and cultural values of the population. It was also stated in section 2.4 that the cultural values could be assumed to be the same for the urban population of Ceylon, thus considering only the effect of the socio-economic factors.

The purpose of this chapter, therefore, is to propose a concept which achieves the objective of providing housing at the minimum physical costs, subject to the condition that the concept accepts standards for housing which are a function of the socio-economic factors. As seen, the acceptance of this condition accepts the existence of a range of standards and not one single set of minimum standards.

The approach used here will be to develop a broad concept by analysing the problem at the national scale. This analysis at the national scale will hold certain variables constant at their average values.

However, in applying this broad hypothesis at the urban scale, the variables held constant will be relaxed, thus resulting in a detailed model for guiding public sector investment in the direct development of urban housing. (This model is presented in Chapter 7.)

6.1 Basic Assumptions and Definitions

Listed below are the basic assumptions and definitions used in the following analysis. As mentioned in the introduction some assumptions made at this stage will be relaxed when applying the resulting concept at the urban scale.

6.1.1. Basic assumptions

(1) The following assumptions will be held constant both for analysis at the national and urban scale. They are:

(a) The urban population is classified into three social classes(S), based on job classification of the household head. (See Chapter 2, section 2.3.3.1.4.)

The social classes are:

(1) Blue collar workers = working class (S_1)

(2) White collar non professionals = middle class (S_2)

(3) White collar Professional and Managerial workers = upper class. (S_3)

(b) The annual normal or long run income of the household (E) defines the economic status of the household.

(c) The cultural factor (C) of the household is assumed to be constant for all urban areas in Ceylon. (See Chapter 2)

(d) Interest rates are held constant at the prescribed values.

(2) The following assumptions will be held constant at the national scale, but will be relaxed at the urban scale so that the effects could be fed into the development of the detailed model.

(a) The basic unit of consumption is the household, and is represented by an average household in size at the national scale, while at the urban scale variations in household size are considered.

(b) Land costs are assumed constant at an average value as a result of ignoring the locational factor at the national scale. The effect of location on ability to pay for housing is also neglected at this scale. However, the locational factor is considered at the urban scale.

(c) The form of housing is held constant at the national scale, while at the urban scale all forms within the limits of technology are considered.

(d) Tenure is held constant, while at the urban scale it is varied.

6.1.2 Definitions

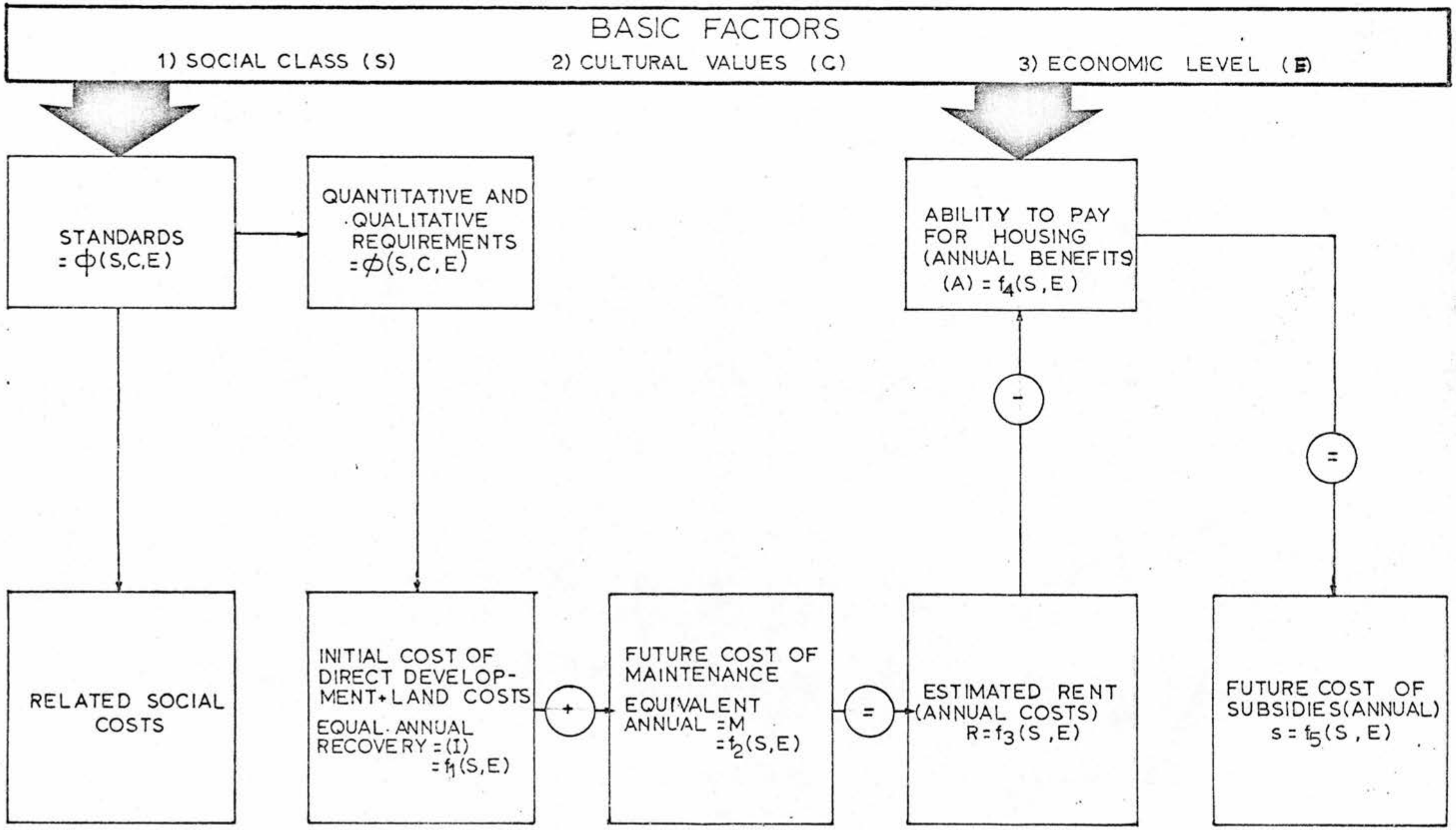
(1) The initial costs of land development per housing unit and house are represented by the amortization of these costs, given by the annual value (I). Since interest rates are held constant at their prescribed values, and the method of amortization is fixed, i.e. an equal instalment basis on a depreciating capital, the above definition is true.

(2) The annual average cost of maintenance per housing unit is given by (M).

(3) The real annual rent (R) is the sum of the recovery of the initial costs, i.e. (I) plus the recovery of the annual maintenance costs(M). This represents the real cost to the consumer.

DIAG. 6-1

THE BASIC FACTORS AND THEIR RELATIONSHIPS TO STANDARDS, COSTS, BENEFITS & SUBSIDIES



(4) The real amount a household pays annually, given by (A) represents the household's ability to pay for the benefits the household derives.

(5) The annual subsidy per household (s) is given by the difference between the real rent (R), and the ability to pay (A).

i.e. $R - A = s$. . . . . (6 - 1)

(6) The physical costs per household are represented annually by the amortization of the initial costs (I), the annual maintenance costs (M), and the annual subsidies that must be met (s). If there are n households, the total annual physical costs P are then given by

$$P = n(I + M + s) \quad \dots\dots\dots\dots \quad (6-2)$$

6.2 The relationship of annual costs, benefits, and subsidies to the socio-economic factors, (S, E).

Using the basic assumptions, and the definitions stated in section 6.1, it is possible to establish the relationships that exist between the costs, benefits, subsidies, and the socio-economic factors (S, E).

The main link occurs in using the necessary condition for solving the housing problem, i.e. the standards used must reflect the socio-economic values of the population.

6.2.1 Cost to the consumer (R), and its relationship to the socio-economic factors (S, E).

By definition (3) the real cost to the consumer (R) is given by:

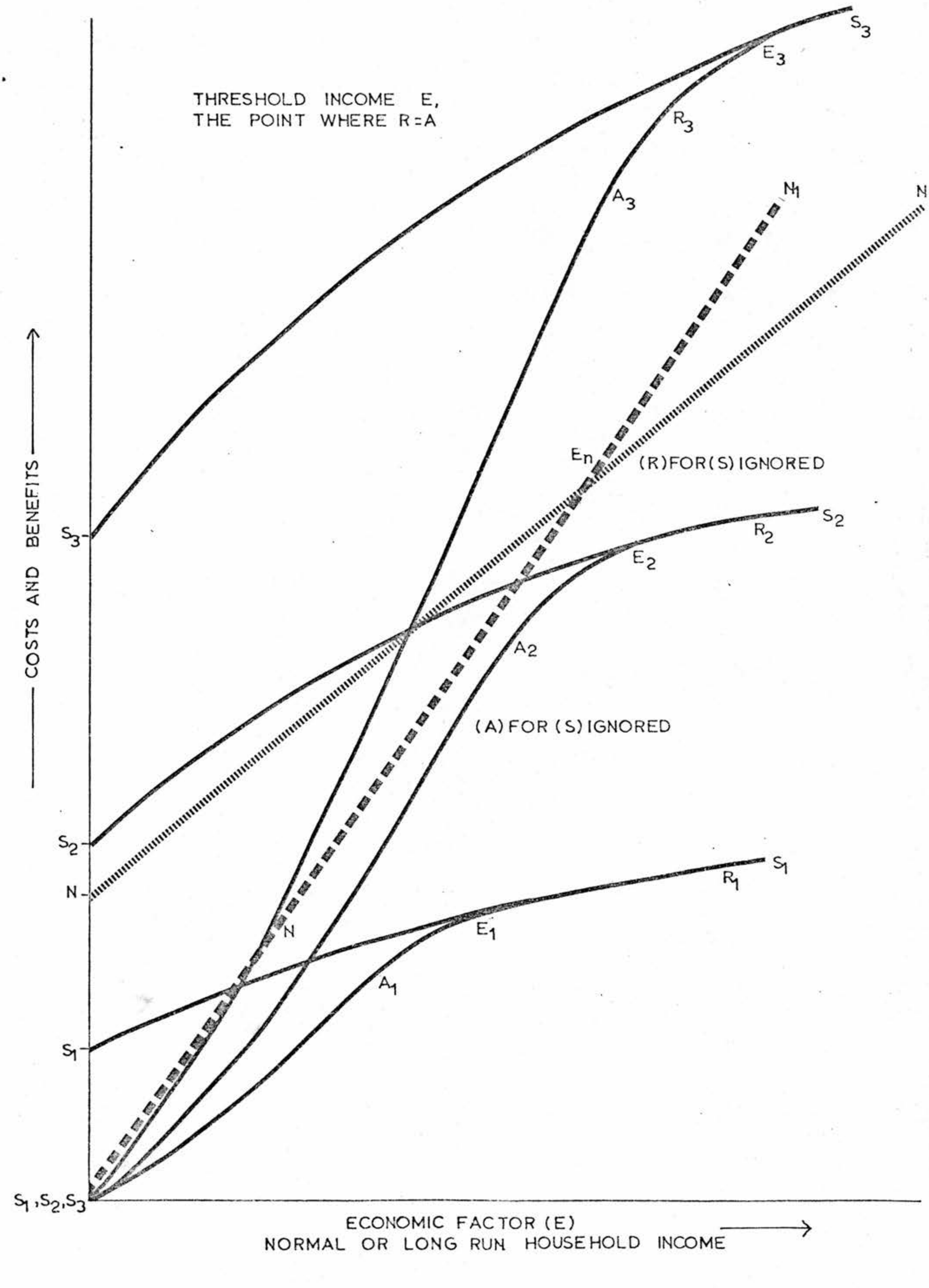
$$R = I + M \quad \dots\dots\dots\dots \quad (6-3)$$

The initial costs under the mentioned assumptions are a function of the standards (section 2.4.2.1). But standards are represented by a function of the socio-economic factors. This follows from the first objective for solving the problem. Therefore, initial costs are a function of the socio-economic factors. Diagram (6-1), i.e.

$$I = f_1\,(S, E). \quad \dots\dots\dots\dots \quad (6-4)$$

DIAG. 6-2

COSTS AND BENEFITS OF HOUSING TO THE CONSUMER BY SOCIO-ECONOMIC GROUPS



Maintenance costs are a function of initial costs (section 2.4.1.2.1). Therefore maintenance costs are a function of the socio-economic factor,

i.e. $M = f_2(I) = f_2(f_1(S, E))$ . . . . (6 - 5)

Substituting in equation (6 - 3), the real cost (R) is given by

$$R = f_1(S, E) + f_2(f, (S, E)).$$

i.e. $R = f_3(S,E)$ . . . .(6 - 6)

i.e. the real cost (R), depends on the socio-economic factors.

A generally observable phenomenon in any society is that social classes tend to maintain their social status by adhering to norms dictated by their social class. This is very evident in housing where both for functional and prestige reasons, as social class rises so do the standards. Statistical evidence of this is presented in Chapter 8 for the city of Colombo in Ceylon. This thus reflects an increase in (R) with (S). The economic factor contributes further and is used as an objective variable within the social group. Thus (R) reflects an increase with (E). However, the marginal increase in (R) decreases with an increase in (E) since the higher the standard the less the satisfaction gained by the marginal increase.

If therefore a graph of real costs (R) is plotted against the normal or long run income of the household (E), using social class as a subjective variable, the graphs shown in diagram (6-2) should be obtained[1]. It will be noted that at zero (E), (R) has fixed values which increase as (S) increases. This follows from the observation that irrespective of the economic factor social class determined the minimum standard. Thus the need for a range of standards with the lowest social class at E=0 dictating the minimum, and the theoretical maximum for the highest class at the maximum value of (E). It will also be observed that the marginal increase in (R) is greater for

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[1] The graphs are plotted for the three classes. Assumption (1) i.e. R_1 R_2, and R_3.

higher (S), for the same income, due to the fact that the higher social classes are more susceptible to changes than the lower classes.

Theoretically what happens if (S) is ignored. The value of (R) in this case is based on some hypothetical standards which ignore social values, while slight modifications are made for increases in (E), neglecting the fact that (R) increases at a diminishing rate with (E). This is represented by line (N N) on the graph. This form represents the currently accepted concept of "need" as will be discussed later. Hence, if a housing programme is based on (NN), it does not achieve the objective of solving the housing problem and is thus completely meaningless. In short, (NN) overstates the aspirations of the working class, understates that of the upper class, and is somewhat representative of the middle class.

From the foregoing discussion it appears that the real costs of housing to the consumer (R), represent his socio-economic aspirations in regard to housing. This, in fact, represents a situation where a housing programme has been formulated on standards based on socio-economic values, thus achieving a solution to the housing problem. It also represents the real rents that should be charged. On the other hand the line NN represents a situation where a housing programme has been based on a hypothetical set of minimum standards, which has made a small allowance for change in the economic factor (E). Thus (NN) does not really solve the problem, and thus the real rent it depicts is meaningless.

6.2.2 Benefits to the consumer (A) and its relationship to the socio-economic factors (S, E).

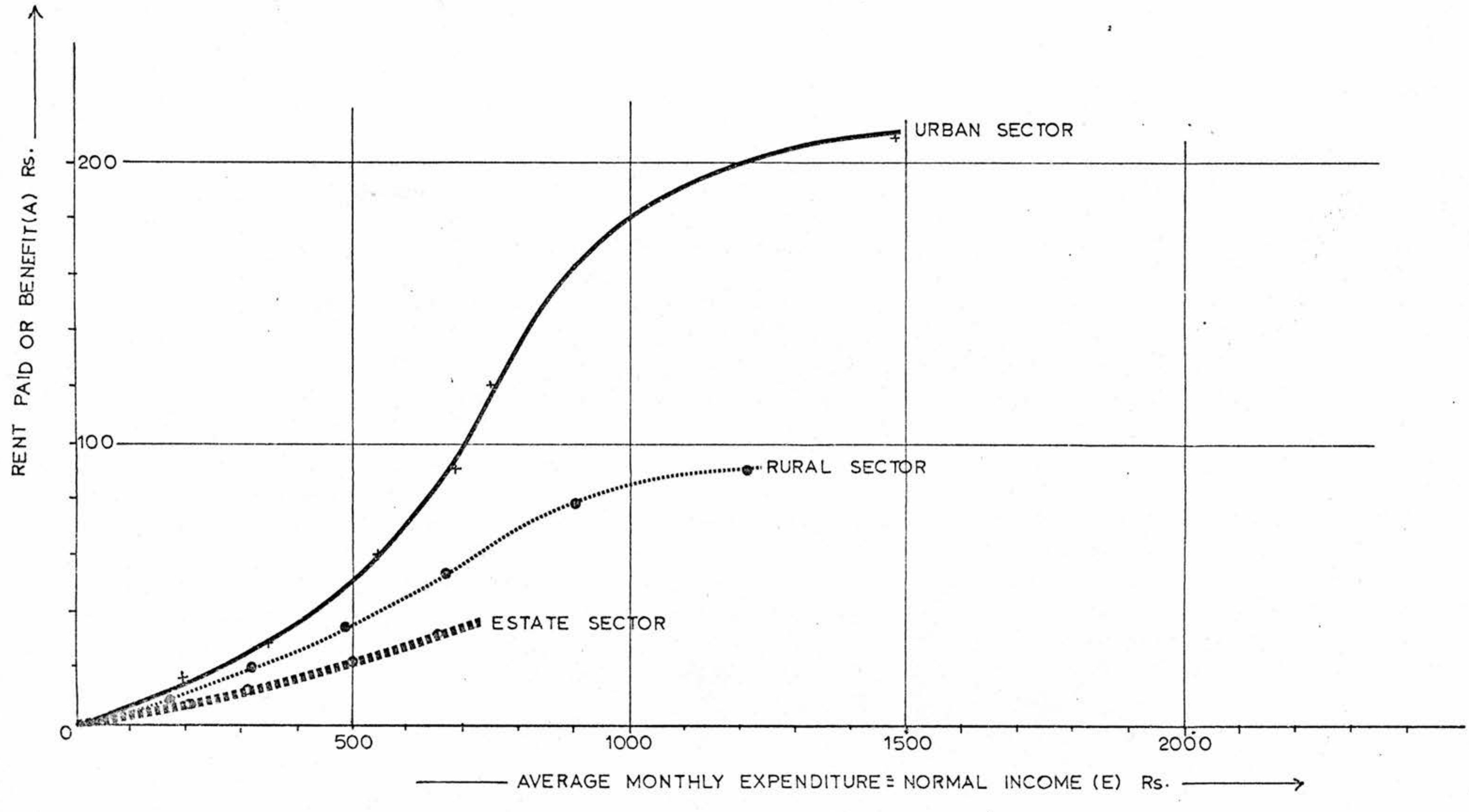
By definition (4), the benefits a consumer derives from housing are defined by the amount a householder is prepared to pay for housing.

At this stage of the analysis the assumption that both form and location are ignored is important. It will be seen that these factors as well as variation in household size may have significant effects on the benefits or amount a household is prepared to pay.[1] (See Chapter 10).

[1] David, M.H. 1962. Family composition and consumption. Chapter 5. North Holand publishing company, Amsterdam.

DIAG· 6–3

RENT PAID OR BENEFITS (A) VS NORMAL INCOME
CEYLON, URBAN, RURAL, ESTATE SECTORS
SOCIO ECONOMIC SURVEY (1969–70)



For the same income levels a general observation will show that higher social groups are prepared to pay more for housing and thus maintain their social status. Statistical evidence for the urban area of Colombo in Ceylon will be given in Chapter 10. However, at this stage, if the broad assumption that populations can be classified socially as urban, rural and estate for Ceylon, is made, the above mentioned tendency is found to be fairly accurate. Diagram (6-3) indicates graphs of average rent versus average total expenditure for various income groups, for the urban, rural, and estate sectors.[1] Hence, benefits may be considered to be a function of social class (S).

The variation of rent paid versus household income has been studied as far back as 1875 by Engels[2], who suggested that the marginal rate of increase was constant. This was challenged by Schwabe[2], who suggested that the marginal rate decreased with an increase in household income.

However, more recent studies (1962) done by Reid[3] showed that the marginal increase tends to increase with the normal or long run component of income, while if the random component is added the relationship tends to act in accordance with Schwabe's law.

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[1] Socio-economic Survey (1969-70) of Ceylon. Tables 40.1, 40.2 and 40.3 give the data used for plotting the graphs. The tables mentioned give the expenditure patterns of an average household at different income ranges. The total expenditure of the family was thus an approximation of the normal income, of which the amount paid as rent represented the household's ability to pay for housing.

[2] Stigler, George. (1954). The early history of empirical studies of consumer behaviour. Journal of Political Economy. April 1954, page 98.

[3] Reid, Margaret G. (1962). Housing and Income. Chicago University Press, page 6.

From a theoretical point of view it may be argued that at the early stages the relationship will follow Reid's law as households try to move faster toward achieving their aspirations. However, at the latter stages when they are approaching the cost curve there will be a tendency to slow down and follow Schwabe's law, thus meshing with the cost or aspiration curve and continuing along it. Diagram (6-3) tends to confirmthe shape argued out here. The point at which the two curves mesh is where $A = R$, i.e. when a household is able to achieve its aspirations. This point may thus be defined as the 'threshold income". It appears that if the curve is approximated to Reid's law throughout the error in estimating the threshold income will not be appreciable. The threshold points are shown as E_1, E_2, and E_3 on diagram (6-2). The curves are denoted by A_1, A_1, and A_3 for the three social classes.

Hence the benefits derived are a function of socio-economic grouping, other factors being constant,

i.e. $A = f_4 (S, E)$ . . . . (6 - 7)

It is useful to look briefly at current practice, which suggests that households should pay between 20-25% of household income toward housing. This is in keeping with Engel's law, which is depicted by line N_1N_1 in diagram (6 - 2). The threshold income E_n is a purely hypothetical point, since $N_1 N_1$ does not depict the real world situation. If E_n lies along one of the curves R_1, R_2, or R_3, beyond the points E_1, E_2, or E_3, then it may have satisfied one socio-economic group. The present concept of 'heed" uses this principle and will be discussed later. The result of using N N and N_1 N_1 will be the production of houses too low in standard for part of the middle and upper socio-economic groups, and too high in standard and cost for the lower socio-economic groups.

The analysis shows that the main factor that deters a household from achieving its aspirations is the economic factor (E). Since the amount a household pays for housing shows the benefits it derives, it will be observed that maintaining a social status is an important aspect of the benefits derived and thus higher social classes are prepared to pay more than lower social classes at the same economic level, for better housing.

Hence -

$$A\ ' = f_4(S, E) \quad \ldots\ldots\ldots \quad (6 - 7).$$

6.2.3 Subsidies

In the last two sections, two aspects have been analysed, namely the real cost of socio-economic aspirations, and the benefits or ability to pay at different socio-economic levels.

Ideally, if the costs and benefits were the same at all socio-economic levels, it would represent a perfect situation. However, this situation can never exist, since there exists a stage where socially the household aspires to certain standards which economically it can not achieve. The curve(A) cannot be altered since it reflects the real world situation, and altering it would only result in a situation similar to the use of line N_1N_1. On the other hand if the problem is to be solved the real cost curve must exist. This thus results in the need for a subsidy.

By definition (5) subsidies (s) are given by -

$$s = R - A. \quad \ldots\ldots\ldots\ldots \quad (6 - 1)$$

Since R and A are functions of (S, E) from equations (6-5) and (6-7) it follows that

$$s = f_5\,(S, E) \quad \ldots\ldots\ldots\ldots \quad (6 - 8)$$

Referring to diagram (6-2) it would appear that theoretically the subsidies increase with social status, and decrease with increase in normal household income. Practically, however, rise in social status is normally accompanied by rise in household income. Hence, as may be seen from the data obtained for Ceylon, the minimum income for the highest social class will be nearly equal to E_3, while the mean income of the middle class will be about equal to E_2, and the maximum for the lowest class may be just greater than E_1 (Chapter 10). Hence, it is the lowest social class or working class who will need the most subsidy. The inference that subsidies will reduce with an increase in normal income is both theoretically and practically true.

The effect of using Engel's law for all social classes in general for defining the ability to pay, which is one of the principles accepted under the currently accepted concept of need, leads to an increase in subsidies. This fact is evident from diagram (6 - 2), wherein it will be observed that the line $N_1 N_1$ is greater than R_1 or R_2, resulting in that class of population not accepting the houses unless the gradient of $N_1 N_1$ is lowered in keeping with their capability to pay, thus resulting in an increase in subsidy. Even though $N_1 N_1$ may be lower than R_3, the houses are not socially acceptable to that class and are thus rejected. It will be noted that theoretically under present practice it appears that the most feasible solution lies in housing for the middle income groups, i.e. the line E_n is closest to a real world situation. This phenomenon has been observed to occur practically in Ceylon[1,2], where housing originally intended for the working classes, on ultimate costing are found to be so high that they either end up as lower middle class housing or highly subsidised working class housing.

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[1] An example is the Wanathamulla housing scheme, situated in the city of Colombo, Ceylon.

[2] The general occurrence of this situation is described in Chapter 3.

6.3 Analysis of relationships leading to a definition of a concept.

The relationships established in section 6.2 can now be used to analyse the situation, thus arriving at a concept that will achieve a solution to the urban housing problem at minimum physical costs, subject to the assumptions stated in section 6.1.

6.3.1 Objectives of the analysis

The relationships used in the following analysis have the inbuilt condition that standards for the direct development of housing are based on the socio-economic values of the population, assuming uniform cultural values. Hence, the objective of the analysis is to minimise the physical costs, using the desired relationships.

The physical costs defined in Chapter 2 consist of two components - the initial costs of the direct development of urban housing, and the future costs of maintenance and subsidies.

The initial costs can be represented by the annual recovery of these costs and are depicted by (I), definition (1), section 6.1.2.

The future costs can be represented by the annual costs of maintenance (M), and the annual cost of the subsidies (s).

Hence the annual equivalent of the total physical costs (P) for n households is given by:

$$P = n(I + M + s) \quad \ldots\ldots\ldots\ldots\ldots \quad (6 - 2)$$

If the factors that influence the conversion of costs to annual equivalents are considered to be constant, definition (1), the minimisation of the physical costs, will be achieved by minimising P, given by equation (6-2) above.

From equation (6-2) it will be observed that P is built up of two parts. Theyare (n) and ($I + M + s$). Hence the objectives to be achieved if P is to be minimised are:

(1) Minimise ($I + M + s$), the annual physical cost per household or housing unit, and
(2) Minimise n, the number of housing units.

6.3.2 Minimising the physical cost per unit $(I + M + s)$

From section 6.3.1, the physical cost per housing unit is given by $(I + M + s)$.

$$\text{i.e.} \quad u = (I + M + s) \qquad \ldots\ldots\ldots\ldots \quad (6-9)$$

But $M + I = R$ from equation (6-3), and $R - A = s$ from equation (6-1).

From equation (6-9) the minimisation of u can be achieved by individually minimising I, M and s. However, since M is a function of the cost I, the objective can be achieved by minimising I and s. Since R is the sum of M and I from equation (6-3), the minimisation of I will result in a minimisation of R. Since s is given by (R-A), and A is fixed for a defined socio-economic group, subject to the defined assumptions, s can be minimised by minimising R, i.e. minimising I. Thus the objective of minimising P can be achieved by minimising I, so that R is as far as possible equal to A. If R can be equal to A this will result in a complete break through. However, this is not theoretically possible, the only possibility being to minimise I within the limitations of technology and location so that the threshold income is minimised. As long as the concept that there exists a minimum set of theoretical standards based on the social factor at the economic factor (E=0) or zero income is accepted there will exist a threshold income. A similar case has been stated by Van Huyck[1] in his article on the Housing threshold for lowest income groups in the case of India, where he says:

> "I suggest that there is a housing threshold: a point along the income distribution curve below which it is not possible to provide housing, either publicly or privately, on a massive scale commensurate with the needs at any reasonable set of minimum standards."

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[1] Van Huyck. Alfred P. Urban planning in developing countries, Chapter 4.

In this connection see also diagram (3-2), which indicates the existence of a similar situation in Ceylon where public sector housing programmes cannot provide housing without a subsidy under existing minimum standards.

I, as seen, is a function of the social class (S) and economic group (E), equation (6-4), where $I = f_1(S, E)$. Thus the minimisation of I can be achieved by relating standards to the minimum necessary to satisfy the socio-economic factors. Since there exist numerous socio-economic groups in a society, it is necessary to have a range of standards. Hence solving the housing problem is providing housing to a range of minimum standards, the lowest being that which satisfied the working classes at theoretically zero income, and the highest being that which satisfied the upper class at theoretically zero income. It is inevitable that the standards should be increased from the minimum as incomes increase. This suggests that for practical purposes standards can be developed for the three social classes, at the average income for each class. (This system will be used in Chapter 8).

<u>This confirms that the use of a flexible set of standards is imperative in lowering the threshold incomes, while at the same time achieving the solution. This results in a solution to the housing problem at minimum physical costs subject to the assumptions in (6-1).</u>

6.3.3 <u>Minimising the number of housing units (n)</u>

The discussion so far has revolved around minimising the physical costs by minimising the costs related to an individual housing unit. However, an important consideration in minimising overall physical costs depends on the total quantity of housing units (n) to be provided. Section 6.3.1 (2).

The total quantity of housing depends on the standard used for defining the household. The formation of households[1] requiring a separate housing unit depends basically on the cultural factor(C) or ethnic origin. In Ceylon where eastern culture predominates the household does not constitute the nuclear family only, but encourages the formation of the extended household. The socio-economic factor is equally important. Socially a household would have aspirations depicted by the cost curve, but economically it would be governed by the benefit curve. Hence, in accelerating the process of achieving its social aspirations a household tends to include other members of the family or lodgers, thus increasing the economic factor(E) which results in getting closer to the desired standard of housing.

Hence, n is a function of the social, economic, and cultural factors,

$$\text{i.e.} \quad n = f_6(S, E, C) \; . \; . \; . \; . \; . \; . \; . \; . \quad (6\text{-}10)$$

As seen in section 2.4.1.1.4 the physical cost of housing per capita would decrease with an increase in household size. Hence larger households will result not only in reducing the overall quantity of housing, but satisfies the social,economic, and cultural aspirations of the population. It thus results in reducing the physical costs by (a) reducing the number of units, (b) the initial per capita cost, and (c) adding to household income which reduces further the element of subsidy involved.

It can thus be concluded that estimating the number of housing units on social, economic, and cultural considerations in relation to household formation, not only achieves a solution to the housing problem, but in the developing countries helps to minimise the physical costs.

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1 For a full disucssion of this aspect read Joachim, M.E., 1970, A model for estimating and projecting the housing demand of an urban area in Ceylon. Dissertation presented for Dip. (P.H.D.C) Department of Urban Design and Regional Planning, University of Edinburgh.

6.3.4 <u>Statement of the concept of 'housing demand"</u>

From the foregoing discussion it appears that basing standards for the direct development of urban housing on the social, economic and cultural values of the population not only achieves a solution to the urban housing problem, but does so at minimum physical costs. The physical costs are the minimum possible subject to the assumptions that location, form, tenure, and household size are held constant. The variations of location, form, tenure and household size are factors that can be included at the urban scale, as will be seen in Chapter 7.

It is now possible to state the following thesis from the national point of view.

> "In order to solve a housing problem at minimum physical costs, the basic parameters that define the programme should be based on the social, economic and cultural values of the population for whom the programme is designed."

It will be observed that the concept reflects what the population really want from housing, and not what they should want. What they should want can be based on hypothetical assumptions which is the present practice called 'housing need". What people really want is what they demand socially, economically and culturally, and is thus termed "housing demand".

The concept of demand broadly incorporates the following:

(1) The total quality of housing demanded by a population is equal to the number of households formed within the social, economic and cultural framework of the population, and depicts the minimum.

(2) The standard of housing demanded is reflected by the social, and economic factors which describe the population. This results in a range of standards. However, for practical application standards are based on the major social classes, and the average income of each class. The resulting annual costs (R) depict the socio-economic aspirations, and the real rent.

(3) The benefits or the ability to pay for housing (A) is reflected by social class, and normal or long run income. This depicts the maximum rent chargeable.

6.4 An appraisal of the concept of 'housing need"

The current concept for formulating a housing programme is termed the concept of "housing need". In this section it is proposed to appraise this concept with a view to determining whether it achieves the objective of solving the housing problem at minimum physical costs. This appraisal is carried out in the light of the conclusions reached in the previous sections.

6.4.1 The concept of 'housing need"

The concept of housing need is based on three principles, namely:

(1) The existence of one set of minimum standards. These standards have evolved over time and are related to the elimination of socio-physical problems only. Here standards also include type, and thus exclude~~s~~ self help housing.

(2) That the ideal situation for determining the total quantity of housing should provide one house per nuclear family. It considers the extended family as overcrowding, and the split up of the nuclear family as underuse.

(3) That all households will pay the same proportion of their income towards housing. In short it assumes the validity of Engel's law for all socio-economic groups as a whole.

6.4.2 Appraisal

The primary objective of a housing programme is to solve the housing problem. It was seen in Chapter 2 and section 6.1 that to achieve this objective standards should be based on social and economic considerations. As a result of the range of socio-economic classes in a society this would result in a range of standards.

The concept of need in accepting one set of minimum standards, which increase slightly with the economic factor though not necessarily, assumes a socio-economically homogeneous population, which is absolutely incorrect. It is in other words a very bad approximation of the real world situation. Thus the concept of need violates the first principle necessary. See also section 6.2.1, where this point has been made with reference to diagram (6-2), line (NN). Thus the use of the concept of need does not solve the housing problem.

The second principle, namely assuming that each nuclear family requires a separate house, is also highly theoretical.

In the real world households are formed as a result of the social, economic and cultural factors. The cultural factor plays an important part, especially in S.E. Asia where culture dictates the formation of the extended family. This cultural factor is so strong that it is evident amongst all social groups. The economic factor tends to influence further the formation of the extended household due to the fact that this increases household incomes and thus enables the household to achieve the aspirations faster. The very same factors tend to reverse conditions in the developed countries, where both socially and culturally a split in the nuclear family is fostered. This has been further amplified due to increasing incomes in relation to the cost of housing. This has been demonstrated by Eversley, Jackson, and Lomas in their study[1] of the West Midlands region of Britain, where they showed that Cullingworth's estimate of need fell far short of the demand.

Thus quantitative estimates based on the concept of need are true for a point in time in any society. This point in time provides conditions ideal for the application of the concept of need. In developing countries this ideal point in time has not been reached while in the developed world it has been surpassed.

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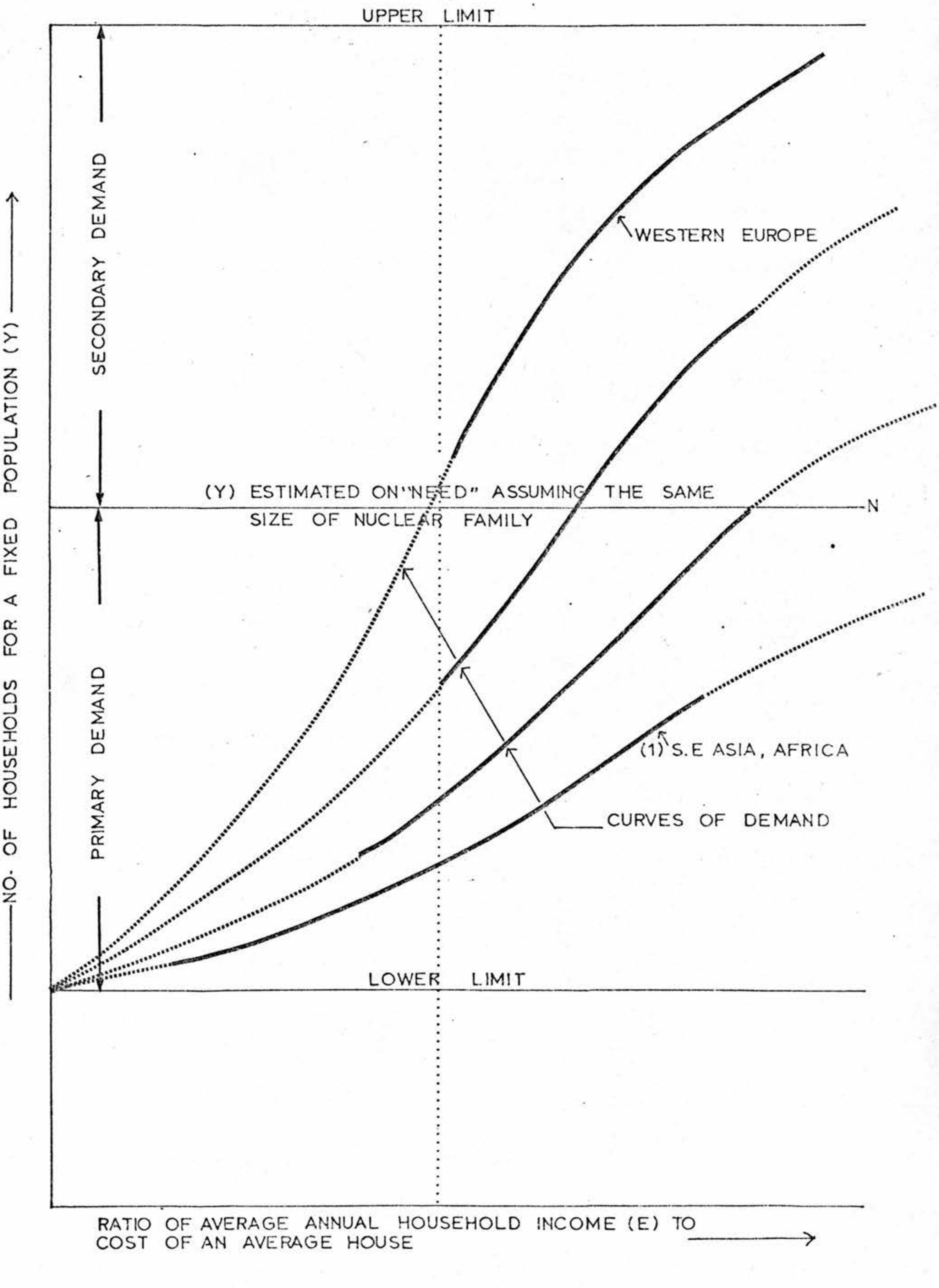
[1] Eversley, Jackson and Lomas (1965). Population growth and planning policy. Frank, Cass & Co. Ltd.

DIAG. 6-4

VARIATION OF QUANTITATIVE HOUSING REQUIREMENTS USING THE CONCEPT OF HOUSING "NEED" AND HOUSING "DEMAND"



Thus quantitative housing need is a point along the line of quantitative housing demand. Those below the point of quantitative need are in a stage of primary demand, and those above are in a stage of secondary demand. Hence, most of the developing countries are in a stage of primary demand and the developed countries in a stage of secondary demand. Diagram (6-4) depicts graphically the situation discussed.

As discussed earlier in Chapter 2, the cost of housing per capita decreases with an increase in household size.

The concept of "housing need" therefore overstates the quantitative housing problem of the developing countries and thus overstates the real physical costs for solving the problem. In the developed countries housing need understates the quantitative problem and thus the physical costs.

The third principle assumes that all socio-economic groups will pay the same percentage of household income towards housing. (See line $N_1 N_1$ diagram (6-2), and section 6.2.2.)

As seen in section 6.2.3, this assumption is far removed from the real world situation, which results in:

(1) a need for large subsidies to induce the lower income groups to move above their demand.

(2) A rejection on socio-economic grounds of the housing by the middle and upper groups due to the fact that the benefits they can derive are far more than are provided by the above mentioned housing.

Overall, the use on the conept of "housing need" for formulating a housing programme results in:

(1) A programme that will not solve the problem since it is not in keeping with the social, cultural and economic values of the population.

(2) Overstating the quantity and physical costs in the developing countries, while understating the quantity and physical costs in the developed countries. Diagram (6-4).

Implementation of such a programme in the developing countries results in:

> Producing too few houses, of too high a standard, with the limited resources available. This is further aggravated by having to meet a large subsidy bill which not only reduces further investment in housing but retards economic growth.[1]

6.5 Conclusion

From the foregoing analysis it appears that viewing the urban housing situation in general (i.e. holding household size, location, tenure, and form constant), the solution to the problem at minimum physical, and thus total costs, lies in using the concept of "housing demand" for formulating and implementing a housing programme.

This conclusion is true not only for Ceylon, but the developing countries in general.

The result of using the concept of "housing need" was discussed in section 6.4. Theoretically it was shown to be a failure. This is practically visible in all urban areas of the developing countries, and has been described by many authors on the subject.

The actual solution to the urban housing problem lies in formulating and implementing housing programmes at the urban scale. At this scale the factors held constant will become variables. Thus the broad concept of housing demand becomes the foundation on which a detailed model for formulating and implementing a housing programme should be based. Hence, Part IV of this study is

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[1] See Chapter 2 for the effect of subsidies on economic growth.

devoted to developing and calibrating a model for guiding public sector investment in the direct development of urban housing in Ceylon, based on the concept of "housing demand", and applicable at the urban scale.

This model will also be guided by the broad policies necessary for maximising economic growth. This aspect was discussed in Chapter 5, which led to the conclusion that the construction industry should be labour intensive, and use self help methods only when absolutely necessary.

PART IV A MODEL AND ITS CALIBRATION, FOR GUIDING PUBLIC SECTOR INVESTMENT IN THE DIRECT DEVELOPMENT OF URBAN HOUSING IN CEYLON AT THE URBAN SCALE

CHAPTER 7

The Theoretical Model

7.0 Introduction

Part III of this study was devoted to developing broad policy and a broad concept for achieving the objectives of public sector investment in the direct development of urban housing in Ceylon, by viewing it from an overall national level.

Two broad conclusions reached in Part III stated that:

(1) To solve the urban housing problem at minimum physical costs, the main parameters that determine the programme must be based on the concept of "housing demand", i.e. on the social, economic, and cultural factors that determine a population (Chapter 6).

(2) That the construction industry should -

- (a) be labour intensive;
- (b) use a minimum of imported materials, and
- (c) limit self help housing techniques to an absolute minimum.

Since the analysis in Part III was overall it kept the variables, namely,

- (a) household size
- (b) location of house
- (c) form of house, and
- (d) tenure of house,

constant throughout. It was also mentioned that in applying the two conclusions at the urban scale the variables held constant must be relaxed, thus arriving as close as possible to the real world situation.

This part of the study is therefore devoted to developing a model and calibrating it for application at the urban scale using the two conditions stated as the base.

The purpose of the model will be to aid the public sector in detailed policy formulation at the urban scale, for guiding investment in the direct development of urban housing in Ceylon.

In this chapter a theoretical model will be developed, which will be tested and calibrated in Chapters 8, 9 and 10. Chapter 11 will be an explanation of the use of the model for formulating a public sector housing programme for an urban area in Ceylon. The data for calibrating the model was obtained by a 2% sample survey of the city of Colombo, and the collection of hitherto unpublished data from the records of the department of national housing in Ceylon. A description of the survey and the data obtained therefrom is given in Appendix I.

7.1 The basis of the model

The objective of public sector investment in the direct development of urban housing was to solve the housing problem, and do so at minimum physical costs subject to the conditions necessary for maximising economic growth via the investment.

The conclusion reached in Chapter 6 showed that this objective could be achieved by using the concept of "housing demand" to determine the basic parameters of a programme, bearing in mind the broad controlling policy for maximising employment generation and minimising foreign exchange consumption.

The two major factors that determine a housing programme, as seen in Chapter 6, are:

(1) The total quantity of housing, and

(2) The physical cost per housing unit.

Thus the basis of the model is to determine -

(1) The minimum quantity of housing units required, and

(2) The minimum physical cost at which a unit could be provided.

The model is thus divided into five basic parts. They are:-

(1) A model for determining the total minimum quantity of housing required.

(2) Models for determining the minimum standards for households of average income for each of the three major social classes.

(3) A model for expressing the real costs of housing to the household, provided to the standards derived in (2) above. The model is subdivided by class, form, and tenure, and considers further the location of the house, and the size of the household occupying it.

(4) A model for describing the maximum benefits of, or ability to pay for, or economic demand of, housing. This model once again considers the influence of class, form, location, and household size.

(5) The use of models (3) and (4) for determining the "housing threshold", and the use of the threshold to minimise the subsidy content in housing, by defining a policy for the location of different forms, classes, and size of housing.

Finally, the facts that emerge from each of the above models, are combined to formulate a housing programme that will solve the housing problem of the particular urban area at minimum physical costs.

7.2 Assumptions and notations for development of the theoretical model.

Following are basic assumptions used in the model, and a list of notations.

7.2.1 Assumptions

(1) The model will be developed to represent a typical urban area. For the purpose of calibration and testing it is applied in the later chapters to the city of Colombo.

(2) The population will be assumed to consist of the three major social classes, i.e. -

Class I = Blue collar workers = working class

Class II = White collar non-professional workers = middle class

Class III = White collar professional and managerial workers = upper class.

(3) The standards will be estimated for the average household income of each class, in order to limit the range of standards. This is necessary for practical application of the model. This will thus represent three classes of housing, i.e.

(1) Class I = working class

(2) Class II = middle class

(3) Class III = upper class.

(4) The forms of housing will be represented by:

(1) The complete house

(2) The core house, to be completed by the prospective tenant on a self help basis.

(3) The developed plot of land to be used for self help housing.

The details of each system will be discussed under the consideration of form, on the initial cost of constructing a housing unit C_c.

(5) Tenure will be limited to two basic forms. They are:

(1) House and land on a rental basis.

(2) House and land on a rent purchase basis.

These two basic forms can be combined to produce other systems of tenure, which will be discussed under the sections dealing with the effect of tenure on the cost of housing to the consumer.

(6) The detailed study of interest rates is beyond the scope of this study. Thus, this model will accept interest rates stipulated by the Central Bank of Ceylon.

7.2.2. Notations

Following are notations used throughout this model, and the following chapters.

(1) <u>Notations describing the population, households, and economic factors</u>:

(1) P = The total population of the urban area.

(2) H = The number of households = P/h_a.

(3) F = The number of females from (20-49) years.

(4) $r = \frac{F}{P} \times 100$, as a percentage.

(5) h = household size;

(6) h_a = household size = $\frac{P}{H}$ (Average)

(7) Social classes of population are defined by the suffix (g).

$g = 1$; working class or Blue collar workers

$g = 2$; middle class or white collar non professionals.

$g = 3$; upper class or white collar professionals.

(8) E = normal or long run income of household.

(9) R = Real cost of housing to the household.

(10) A = Ability to pay for housing by the household or benefits.

(11) M = Annual costs of maintenance to the consumer.

(2) <u>Notations describing the residential area, and costs of housing</u>

(1) U = Gross residential density in units/acre.

(2) $\phi = h_a . U$ = gross residential density in p. p. a.

(3) u = net residential density in units/acre.

(4) $\rho = h_a . u$ = net residential density in p. p. a.

(5) q = occupancy rate in persons/habitable room.

(6) S = net density in shells/acre.

(7) f = floors/shell

(8) n = units/floor

(9) L_n = Land required for net residential area for population P.

(10) L_s = Land required for support facilities for population P, where per capita requirement $l_s = L_s/P$.

(11) a = base area of a house

(12) B = Base area of a shell = $a.n.$

(13) d = radial distance from city centre to house.

(14) C_L = land cost/acre.

(15) y = Form of house, where -

$y = 1$, complete house
$y = 2$, core house to be completed by self-help.
$y = 3$, developed block of land for self-help house.

(16) Initial costs of development are:

(a) C_l = land cost/housing unit = C_L/u

(b) C_{dl} = land development costs per housing unit.

(c) C_c = cost of constructing a housing unit.

(d) $C_u = (C_l + C_{dl} + C_c)$ = total initial cost per housing unit.

(e) $C = (C_c + C_{dl})$ = initial costs less land costs.

(17) x = Tenure of housing.

$x = 1$, (house + land) on a pure rental basis.
$x = 2$, (house + land) on a rent purchase basis.

(18) i = interest rate for amortization.

(19) t = age of house in years

(20) L = Life of house in years.

(21) I = Annual equivalent of amortizing initial cost C.

(22) T = period for amortization of initial costs.

(23) s = The element of subsidy.

(24) K represents constant terms with a numerical suffix to denote a different constant.

(25) $p, \alpha, \beta, \gamma, \delta$, represent the power to which a variable or constant is raised. A numerical suffix denotes a different value.

7.3 A model for estimating and projecting the housing demand of an urban area in Ceylon[1].

A model for estimating and projecting the housing demand of an urban area in Ceylon was developed by the author and presented for the diploma in planning and housing in the developing countries in June 1970. Hence, what follows is a brief synopsis of the mentioned dissertation, stating the important points of the analysis, and the developed model.

7.3.1 Fundamental concepts of the model

As discussed in Chapter 6, most countries pass through three stages, namely, the stage of primary housing demand, the stage of need, and the stage of secondary housing demand, where demand is dependent on the social, economic, and cultural factors that dictate the formation of households.

It was seen that the developing countries are in the stage of primary demand, while the developed are in the stage of secondary demand. It was also seen that countries like Ceylon situated in S.E. Asia have a very strong cultural tendency towards the extended household. Hence the fundamental concept of a model was to determine the nucleus of the household and use this to determine the number of primary households, by determining the number of nuclei within a population.

7.3.2 Analysis leading to a determination of the nucleus of the household

In order to determine the nucleus of an urban household in Ceylon the following method of analysis was developed. (This aspect is described in detail in Chapter 1 of the mentioned study.)

The method of analysis was as follows:

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[1] For a full discussion on this see Joachim, M.E. (1970). A model for estimating and projecting the housing demand of an urban area in Ceylon. Dissertation presented for Dip.(P.H.D.C.). Department of Urban Design and Regional Planning, University of Edinburgh.

(1) A household was split up into its basic elements called the elements of fission.

In this case the elements selected were:

(a) Males between (25-55), i.e. between average age of marriage and retirement from work.

(b) Females between (20-49), i.e. between average age of marriage, and average age of wife when husband retires from work at 55.

(c) All males 55+ and females 50+, i.e. because this group tend to join an existing household.

(d) All males (15-25), because they form part of an extended household as children or lodgers till marriage.

(e) All females (15-20), since they form part of a household till marriage at 20.

(f) All children (0-15), as they form part of a household.

These elements were then calculated for 23 urban areas in Ceylon for the census years 1946, 1953, and 1963, by dividing the population in each town into the five age groups mentioned, and dividing each group by the number of households .

The changes that occurred by place and time in the elements[1] were then analysed with respect to socio-economic changes that occurred during the periods. All elements except one showed a different value for different areas at different times. The element that appeared to have a constant value was the number of females per household between the age of (20-49). The variation was only between -10% and +20% of 1. It was thus possible to conclude from this analysis that the females between (20-49) appeared to be the nucleus of the household, and confirmed the existence of the extended household since the value was approximately equal to 1. This also confirmed that the cultural factor seemed to overshadow the socio-economic factors. The variation of the value from unity could be

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[1] Table 1 of study mentioned in 1. page 149 gives the values for the elements of fission for the years 1946, 1953, and 1963. Tables 2 and 3 indicate the changes as increases or decreases.

explained by the presence of resident domestic help who are mainly females within the age group (20-49). Thus, richer urban areas showed an increase on unity, while the poorer urban areas showed a decrease. Hence, the number of females between age (20-49) appeared to be a perfect indicator of the number of primary households within an urban population in Ceylon.

7.3.3. The model

Based on the findings of the analysis, a regression analysis was carried out using the number of households(H) as the dependent variable and two independent variables, namely:

(1) The number of females from (20-49) denoted by (F).

(2) The percentage this number of females bore to the total population to account for the presence of resident domestic help (r).

The data used was for twentythree urban areas for the years 1946 and 1963. The 1953 data was not used as the census in that year indicates the number of housing units and not the number of households. The result obtained confirmed the initial findings and gave the following equation.

$$H = 7109 + 0.98759F - 401.43r \text{ ....} (7\text{-}1)$$

The coefficient of multiple correlation was 0.9993 explaining 99.87% of the variation at a 0.1% level of significance[1].

For practical use this model was converted into a nomogram[2], and is given in diagrams(7-1A) to (7-1E).

for $80,734 \geq H \geq$, 2045 $81,673 \geq F \geq 1846$, $21.21 \geq r \geq 15.96$

The above model can now be used for estimating or projecting the primary housing demand of an urban area in Ceylon, by using estimated values of F, and r for reading off H.

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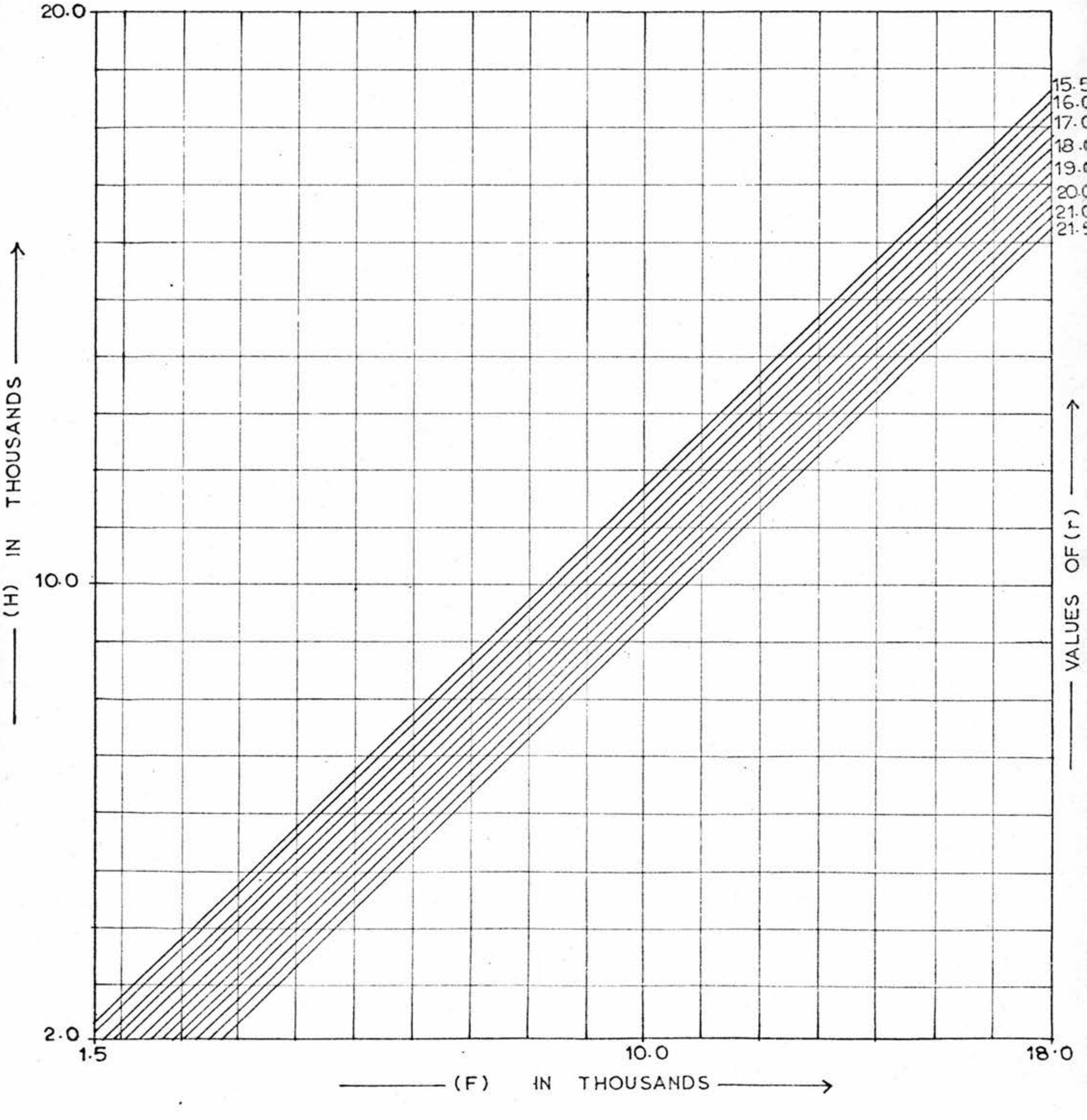
[1] The computer print out is given in Appendix I of the dissertation mentioned in 1. page 149.

[2] For details of preparation see Appendix II. of the dissertation mentioned in 1. page 149.

DIAG. 7–1A

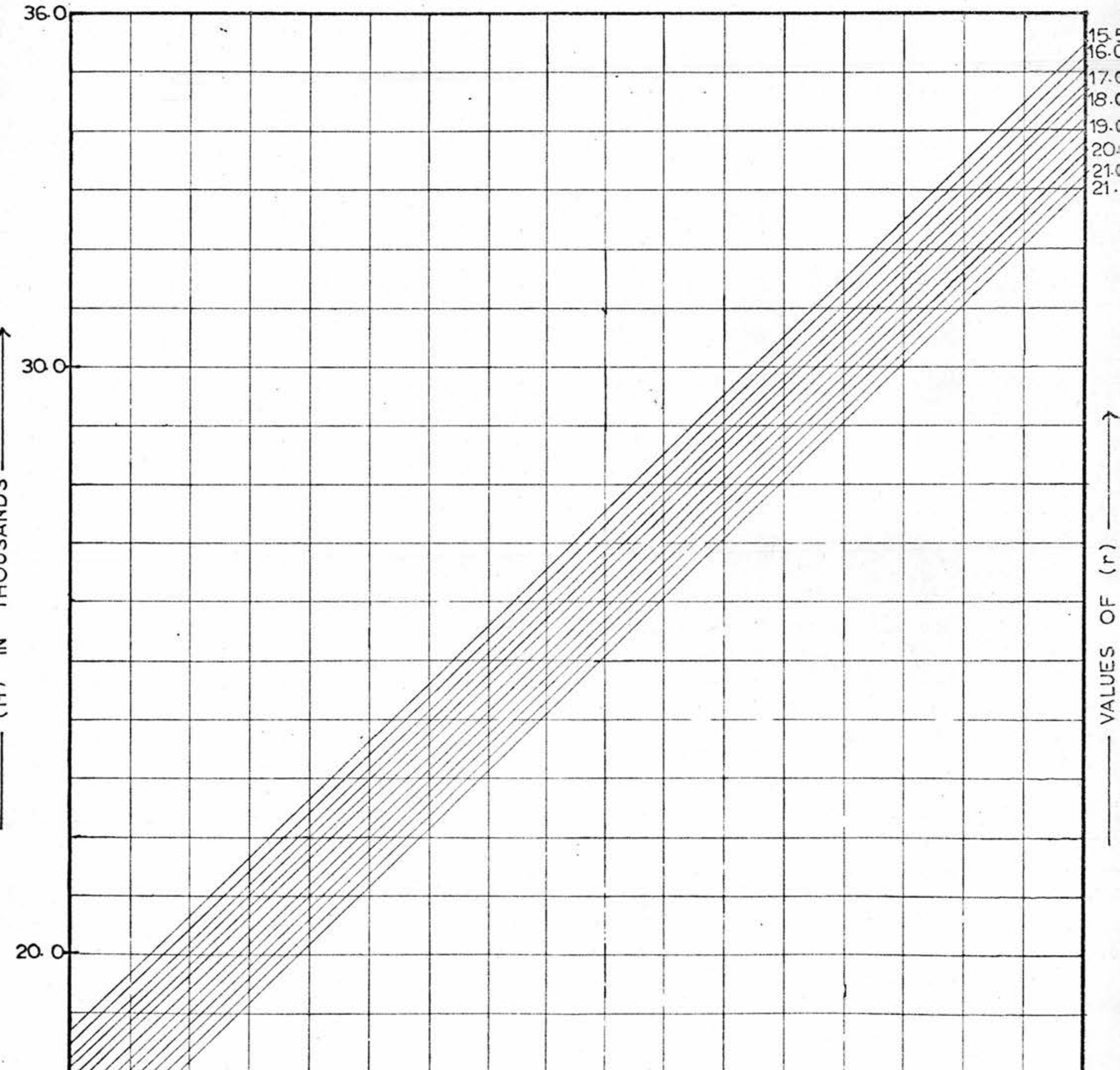
NOMOGRAM FOR ESTIMATING THE HOUSING DEMAND OF AN URBAN AREA IN CEYLON

$18000 \geqslant F \geqslant 1500$



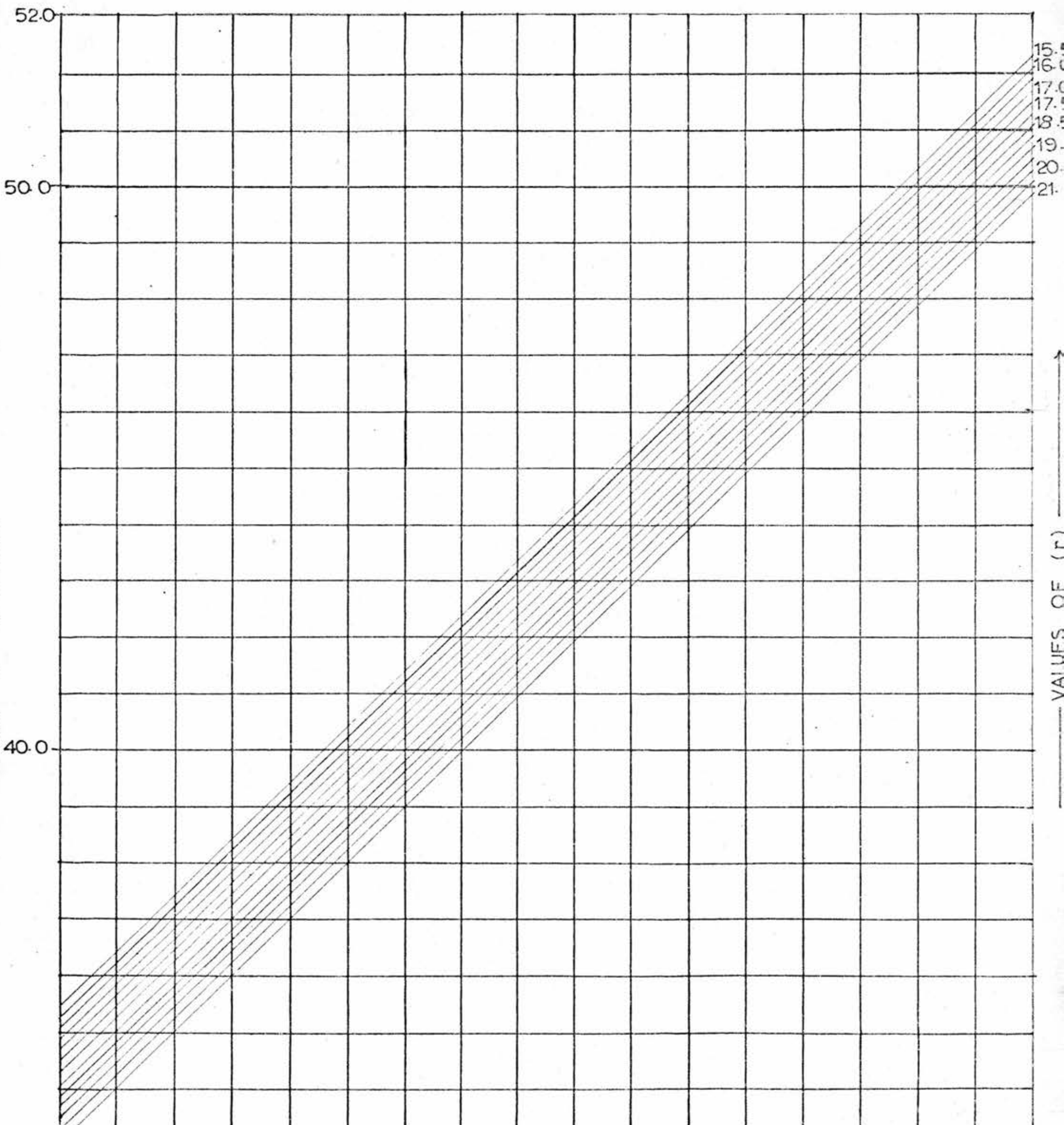
DIAG. 7–1B

NOMOGRAM FOR ESTIMATING THE HOUSING DEMAND OF AN URBAN AREA OF CEYLON
35000 ≥ F ≥ 18000



DIAG. 7–1C

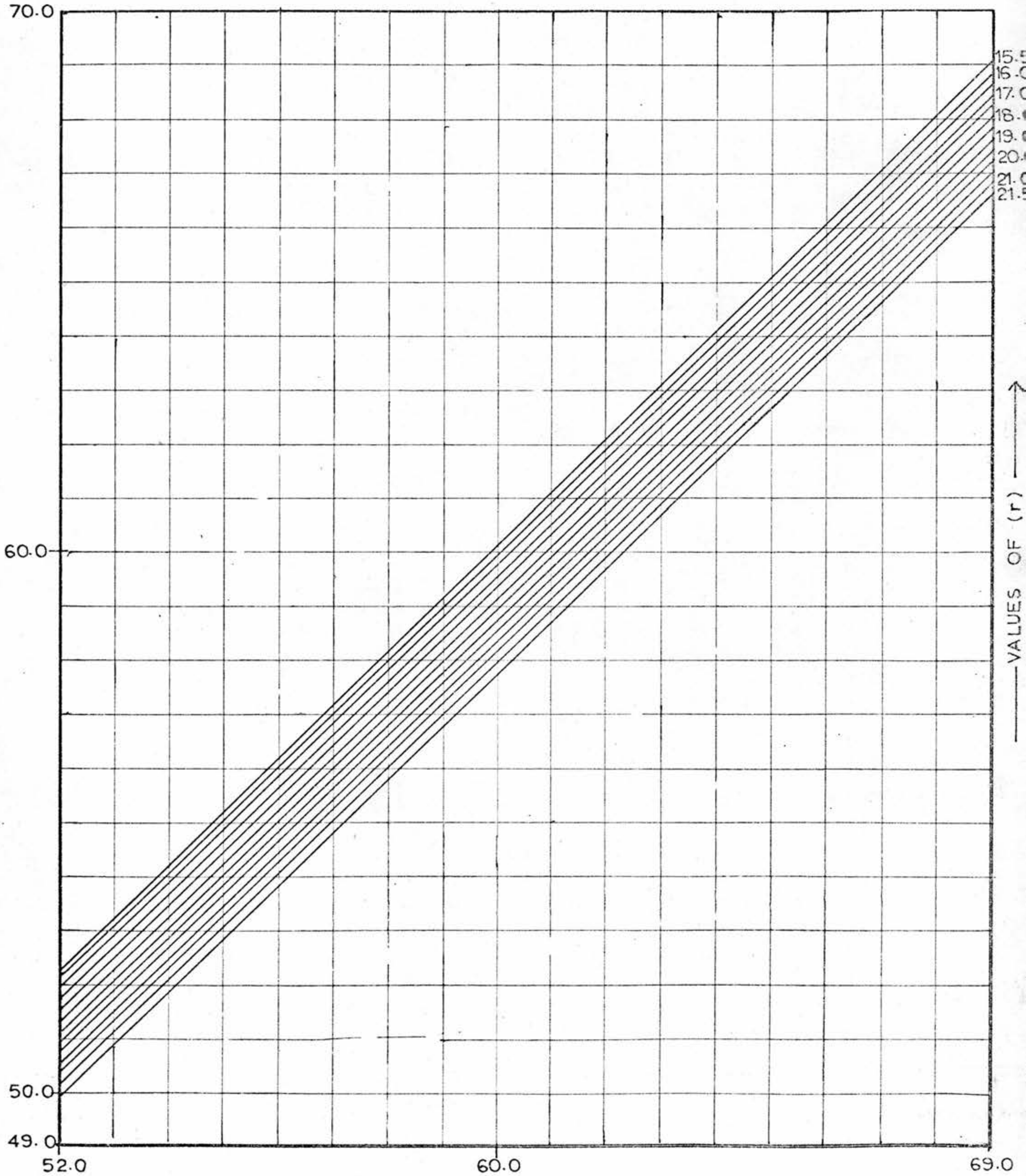
NOMOGRAM FOR ESTIMATING THE HOUSING DEMAND OF AN URBAN AREA IN CEYLON
52000 ≥ F ≥ 35000



DIAG, 7–1D

NOMOGRAM FOR ESTIMATING THE HOUSING DEMAND OF AN URBAN AREA IN CEYLON

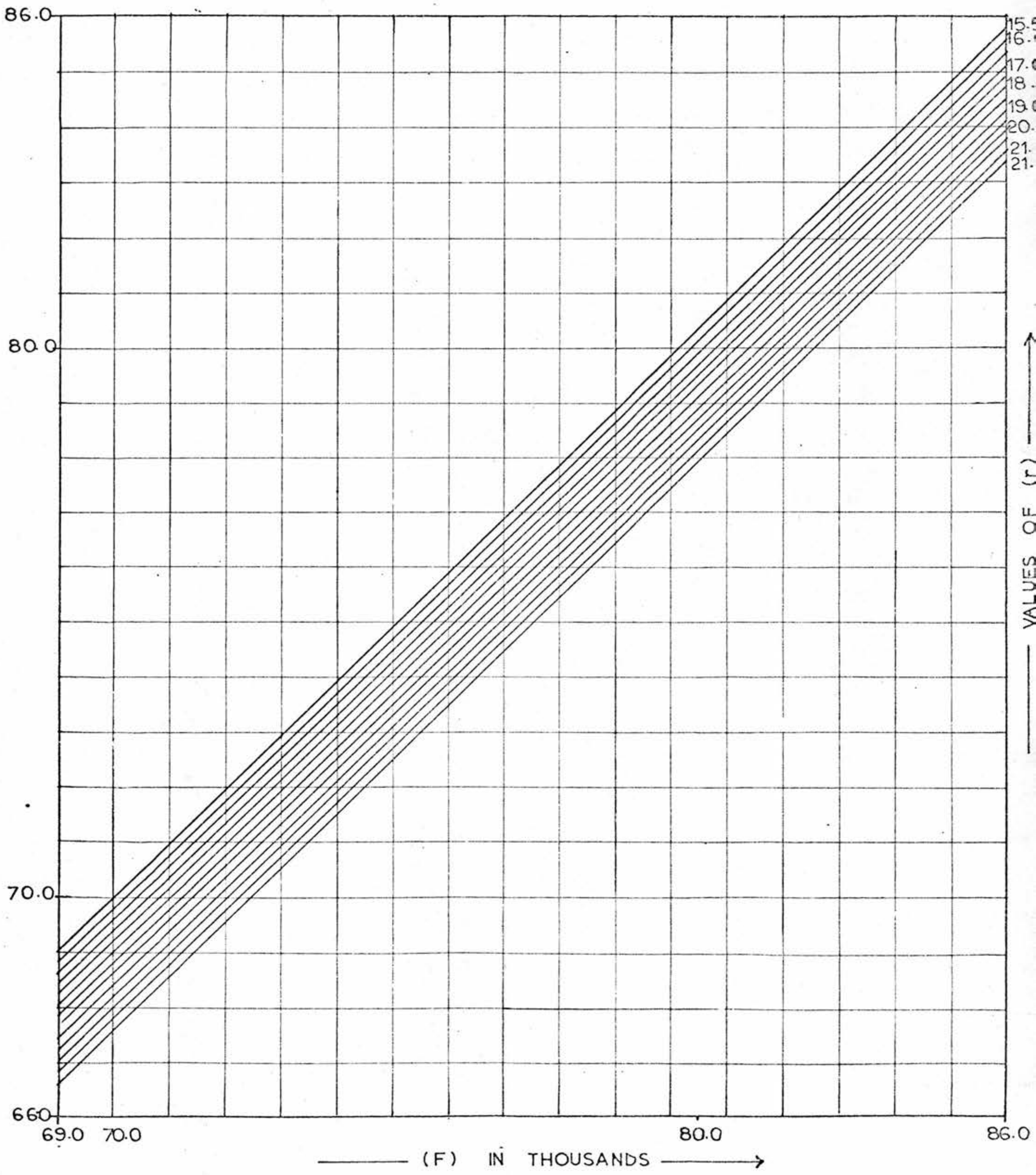
69000 ⩾ F ⩾ 52000



DIAG. 7—1E

NOMOGRAM FOR ESTIMATING THE HOUSING DEMAND OF AN URBAN AREA IN CEYLON

86000 ⩾ F ⩾ 69000



The model is simple and uses only readily available data. For projecture purposes the model is accurate since the value of F can be projected using the life table and data on migration. The total population can be projected by the usual methods, thus estimating r. The fact that the model was valid over the period 1946-1963 suggests that socio-economic changes have had little or no effect on the cultural values of the population. This is an advantage, since time will not be a major source of error in using the model for predictive purposes. Hence, though the model appears to be static, it may be used in a dynamic context.

To illustrate the validity of the model in estimating the minimum quantitative requirements of an urban area in Ceylon, it will be useful to compare estimates based on the concept of "housing need" and "housing demand, using data from the 1969-1970 socio-economic survey.[1]

From Table 2 of the survey housing need may be estimated as equal to half the married people, plus the widowed, divorced, and separated. This is based on the observation that need assumes each of these form a separate household and therefore need a separate housing unit. This works out to 462,100 houses. ($h = 4.75$)

Applying the model developed, using data from Table 1 of the survey, $F = 418,700$, $r = 19\%$, giving a demand of 408,000 houses, ($h = 5.40$).

Hence need overestimates the real demand by 54,000 houses or 13.3%. The household size has been underestimated by 0.65 or 12%.

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[1] Socio-Economic survey of Ceylon (1969-1970). Department of Census and Statistics, Government of Ceylon - October, 1971.

Table 1. Population classified by age and sex for different sectors.

Table 2. Population classified by marital status and sex for different sectors.

7.4 Models for determining the standards for the direct development of urban housing in Ceylon

There are three basic standards necessary for formulating an urban housing programme, and determining its cost. They are:

(1) The net, and gross densities for the direct development of urban housing. This may be expressed basically in (ρ, ϕ) persons per acre, and using an average household size (h), in housing units per acre. (u, U)

(2) Another way of expressing densities is in rooms per acre. To express persons per acre in rooms per acre, occupancy rate (q) in persons/habitable room is the conversion factor. Thus the standard of occupancy rate must be defined, in order to determine the distribution of houses in a programme by size expressed in the number of rooms.

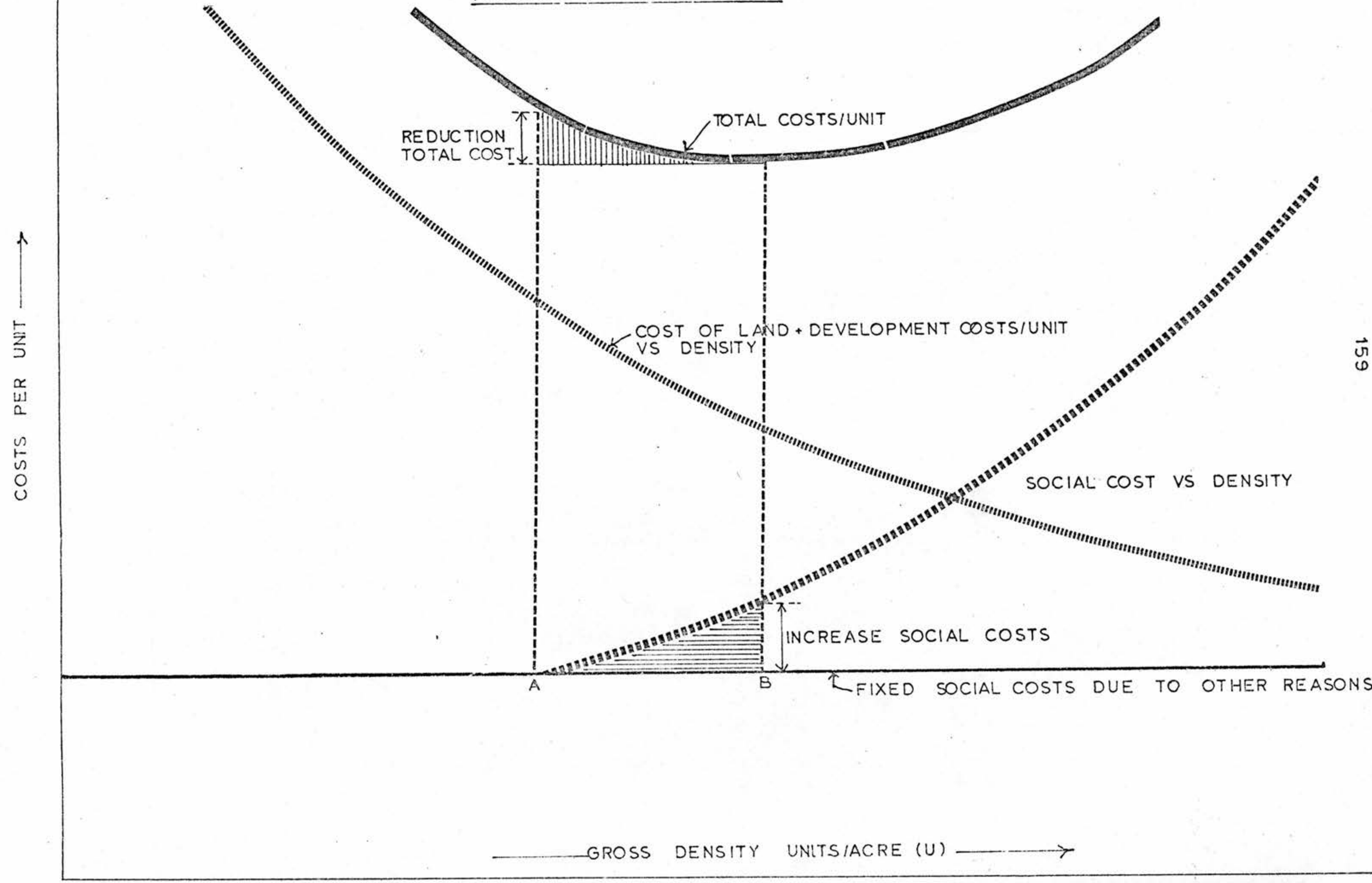
(3) Space standards are equally important in determining the size and thus the cost of a housing unit. It is also necessary to determine the distribution of houses by size in relation to the distribution of households by size.

In this section theoretical models will be developed for determining each of these standards based on the social and economic factors which determine the population. These theoretical models are calibrated and tested by means of a survey, and are presented in Chapter 8. Their use is explained in Chapter 11, by applying them to the city of Colombo in Ceylon.

7.4.1 A model for determining the net and gross densities for the direct development of urban housing.

The objective in determining standards is to base them on the socio-economic factors that determine the population, thus satisfying the demand and eliminating any related social problems. Density is no exception to this rule, and must therefore be representative of the socio-economic demand, while at the same time minimising the physical costs, by using the maximum allowable.

THEORETICAL RELATIONSHIP OF COSTS V'S DENSITY
(GROSS IN UNITS/ACRE)



To develop the model it is therefore necessary to look more closely at the relationship between gross residential density and costs, and use the conclusion to determine the related net residential density.

7.4.1.1 <u>The relationship between gross density(U), land costs, development costs, and social costs.</u>

It was mentioned in Chapter 2, section 2.4.2.1, that the initial costs of land and land development can be minimised by the use of high densities. However, it was also stressed that there may be social problems related to high density housing, and thus densities should be determined on a basis that satisfies the population, rather than on purely economic considerations which are immediate, ignoring those of the future.

Considering the effect of density on overall residential development, there are two factors to consider. They are -

(1) The net density which comprises the residential units and incidental open space together with access roads. This may be measured in (u) units/acre, (p) persons/acre.

(2) The gross density which includes the net residential area, and all other support facilities. Thus the more the support facilities the less the gross density, and denoted by (U) and (Ø) respectively.

If the cost of land/unit plus development costs per unit are therefore plotted against gross density in units/acre, the case shown in diagram (7-2) will be obtained.[1,2] (see section 2.4.2.1.)

It thus appears as stated before that on purely economic grounds the maximisation of densities is advisable.

However, as seen, this consideration alone is insufficient, since the indiscriminate increase in densities may aggravate social problems

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[1] Stone, P.A. - Urban development in Britain. Standards, costs, and resources, 1964-2004. Table 7.17, page 131.

[2] This relationship will be true if all the housing units are of the same size and form. From a theoretical point of view these conditions can be said to exist.

that nullify the major objective of eliminating the social problems related to unsatisfactory housing.

There are little or no specific studies that have been done to identify housing density and related social costs. This is mainly due to the difficulty in obtaining relevant statistics on the one hand, and the long term period over which a study will have to be carried out in order to obtain significant results. However, observation of areas of unsuitable housing has shown that overcrowding and the lack of community facilities may tend to increase social costs arising in the form of social pathology. Hence, increasing gross densities in new housing areas, by doing away with community facilities such as playgrounds, open spaces etc., may reduce the initial costs related to the development of urban housing, but is bound to recreate existing conditions in the future, thus not eliminating the social costs which must be borne by the community .

Pearl Jephcott[1], in a study of high density housing in Glasgow, has shown the above conclusions to be generally true. Theoretically it is thus possible to describe increase in future social costs, due to increase in gross density in units/acre as shown in diagram (7-2). The basis on which the curve is drawn is as follows.

(1) There exist social costs created by conditions other than overcrowding and lack of community facilities (section 2.3.3.1.3)

(2) Social costs begin to increase at a particular density level. This level of density will depend on factors such as the social economic, and cultural characteristics of a population, and climatic conditions of the particular urban area. Thus this level of density may vary for different countries, andn for different areas within countries.

If the curves of initial, and the present value of future, costs related to the direct development of urban housing are added, the result will be a curve showing the total costs. (Diagram 7-2).

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[1] Jephcott, Pearl. - Homes in high flats (1971). Oliver and Boyd, Edinburgh.

From diagram (7-2), it is seen that related social costs can be minimised at a certain level of density A, while total costs can be minimised at a level B, where $B > A$. The question is whether one should select A, or B as the density at which future housing should be developed. On purely economic grounds one must select B. But, if one moves back to one of the original objectives of public sector investment in housing, i.e. the elimination of related social costs, one is bound to select alternative A, rather than B.

It may be thus concluded that the gross density of development should be the maximum possible that satisfies the population. Since there are three social classes, of different economic status, this will result in a range of different standards. However, from a practical point of view three standards of density may be developed, i.e. one for each of the three social classes, using the household of oaverage income for each class as representative of the class.

7.4.1.2 A model for determining the maximum allowable gross density for residential development

The conclusion reached in the last section stated that the objective for determining residential densities should be to satisfy the population and thus eliminate the related social costs, while at the same time achieve the maximum gross density possible in order to minimise the physical costs.

To arrive at this objective it is necessary to examine the possible relationships between

(1) gross densities and net densities

and (2) densities and satisfaction

leading to a model that satisfies the population, and use it to determine the maximum density possible.

The analysis will be carried out using densities measured in persons per acre, i.e. ρ for net densities, and ϕ for gross densities.

Net population density (ρ):

The net population density of a residential area is the total population per unit area, where the area includes roads and intermittent open spaces, and the space occupied by the housing units.

Gross population density (ϕ):

The gross population density of a residential area is the population per unit area where the area includes the space required for the net residential area defined above together with the space required for the support facilities, i.e. playgrounds, shops, parks, schools, service and administrative centres etc.

In order to consider the possible relationships between the net and gross densities, and select a suitable model, it is necessary to move briefly through the history of the design of residential areas.

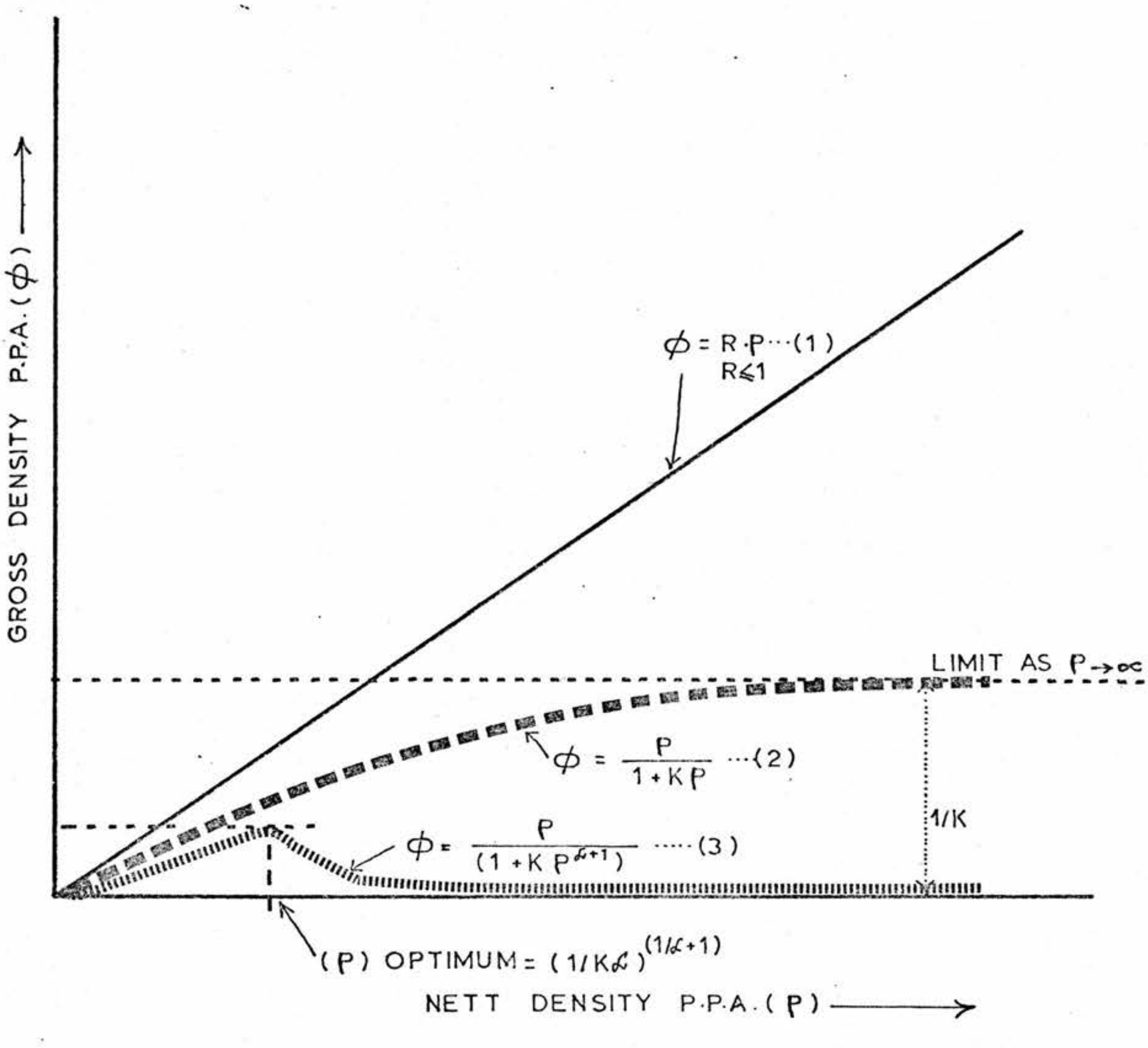
Let us consider the period just after the industrial revolution. During this period it was necessary to house workers in industry close to the factories. This housing was provided purely in terms of housing units packed closely together. No allowance was made for other human needs, and the result of this can still be seen in cities like Glasgow, in the over crowded slums. It was only much later that the other human needs of the working classes were even considered. This consideration led to the concept of the neighbourhood unit, where the housing unit together with the support facilities were provided. This concept is now regarded as standard practice. This concept is in order, but the system used to estimate the land requirements for support facilities is questionable.

Refer Diagram (7-3) and consider each case in turn.

<u>Model 1</u>: Period just after the industrial revolution. No land was provided for support facilities, so theoretically net density ρ is slightly greater than gross density ϕ Curve (1). $\phi = R\rho$. where R is a constant 1.

DIAG. 7-3

RELATIONSHIP BETWEEN NETT AND GROSS POPULATION DENSITY



(1) NO LAND FOR SUPPORT FACILITIES.

(2) LAND FOR SUPPORT FACILITES (K) ACRE/HEAD

(3) LAND FOR SUPPORT FACILITIES (KP^{α}) PER HEAD AT NETT DENSITY (P) P.P.A. $\alpha < 1$

$$\phi_m = \left(\frac{1}{\alpha K}\right)^{1/(\alpha+1)} \left(\frac{\alpha}{\alpha+1}\right)$$

Model 2: Present planning practice.

Land is allocated for support facilities at a fixed constant (K acres) per person, no regard is paid to the net density. (p).

$\therefore\ l_s = K.$

$\therefore$ For a population P the land required for the net residential area

$L_n = \dfrac{P}{\rho}$ (at the net density ρ).

Land required for support facilities $L_s = l_s.\ P = K.P.$

$\therefore$ gross density $\phi = \dfrac{\text{Population}}{\text{Total land required}} = \dfrac{P}{\dfrac{P}{\rho} + KP}$

i.e. $\phi = \dfrac{\rho}{1 + K\rho}$

as $\rho \to \infty$, $\phi \to 1/K$

and $\dfrac{d\phi}{d\rho} = \dfrac{1}{(1 + K\rho)^2}$ is always positive for all ρ.

This results in curve (2), which shows that an increase in net density results in an increase in gross density, tending to a limit of $1/_K$ persons per acre. With the present shortage of urban land the tendency has therefore been to keep increasing net densities with the hope of increasing gross densities and thus save land.

What is questioned in this model is the use of a constant K for all net densities. With this in mind, the following argument is presented against the use of a constant (K), for all (ρ).

Model 3: Consider man's change from a purely rural to an urban environment. In the purely rural setting all activities were carried out within the periphery of the house. Once man began to urbanise he began to conduct some of these activities in common, thus reducing his need for private space and increasing his need for common space. Thus it may be observable that as net densities become greater the demand for space for other activities in common becomes greater. Therefore the demand for space for support facilities per capita (l_s). appears to be a function of the net density (p). The functional relationship may take a form that increases as net density increases due to -

(a) increasing the activities in common.

(b) the greater range of activities necessary as a result of increasing the total number of people.

However, the second factor will also contribute to a decrease in the marginal rate of increase of land for each facility.

Therefore, l_s can be expressed as,

$$l_s = K\rho^{\alpha}$$

where K is a constant, ρ the net density, and α the elasticity of demand for l_s with ρ, where $0 < \alpha < 1$ representing a decrease in the marginal rate of increase.

Using this, a relationship between the net and gross population densities can be defined.

As before, for a population P at net density ρ the land required for the net residential area L_n is given by $L_n = \frac{P}{\rho}$

Land required for support facilities $= L_s = l_s . P = K.p^{\alpha}.P.$

$\therefore$ gross density $\varnothing = \dfrac{P}{L_s + L_n} = \dfrac{P}{(1 + K\rho^{\alpha+1})}$ .... (7-3)

Analysing the above equation, using differential calculas we find that the maximum gross density $\varnothing_m$, occurs at $\frac{d\varnothing}{d\rho} = 0$,

i.e. $p = \left(\frac{1}{\alpha K}\right)^{\frac{1}{\alpha+1}}$ .... (7-4) and that the corresponding value of $\varnothing_m$ is given by $\varnothing_m = \left[\left(\frac{1}{\alpha K}\right)^{\frac{\alpha}{\alpha+1}} \cdot \left(\frac{\alpha}{\alpha+1}\right)\right]$ (7-5)

This relationship is shown in curve (3) of Diagram (7-3).

The three models can now be appraised, leading to a selection of the model that achieves the objective of satisfying the population, and using the maximum gross, and corresponding net density attainable.

If the population is to be satisfied, land for all its demands must be provided. Consider Model 1. In this model housing was thought to represent the housing unit, and other human demands were not considered. The result is today's slums, where conditions are ideal for an increase in social pathology. This model can therefore be rejected as unsuitable.

The model used in present planning practice, though a tremendous improvement on the earlier model is still not satisfactory. The main defect of this model is that it has disregarded variety in the provision of community facilities, and also the fact that the increasing net densities can be achieved only by turning more individual facilities into common facilities, thus resulting in a need for more space for support facilities.

These defects have been overcome in model 3, which has allowed for factors hitherto not considered. Curve (3) in the diagram thus illustrates what happens at very high net densities, when model 3 is used. The difference between curve (2) and curve (3) may be related to social costs thus showing the effect of high net density on social pathology, by using model 2.

It thus appears that model 3 is the most suitable for determining densities. From graph 3, which describes model 3, it can be seen that the gross density increases to a maximum and then decreases. It therefore appears that the gross density of development should be this maximum and the net density should be that which corresponds to this gross density. The analysis showed that these are given by:

maximum gross density in p.p.a ($\emptyset_m$) $= \left[\left(\frac{1}{\alpha K}\right)^{\frac{1}{\alpha+1}} \frac{\alpha}{\alpha+1}\right]$ ..... (7-5)

and the corresponding net density

in p.p.a. $(\rho_m) = \left(\frac{1}{\alpha K}\right)^{\frac{1}{\alpha+1}}$ ....(7-4)

The model accepted has described in general what gross densities should be provided for different net densities, if the population is to be satisfied.

It was seen that satisfaction depends on the social, economic, and cultural values of the population. Hence, assuming a uniform culture for all urban areas in Ceylon, the socio-economic factors will vary, thus resulting in different values for ϕ_m for different urban areas. Climatic conditions are another factor which will add to the variations.

Within an urban area itself there will be variations. This will be due to the existence of different socio-economic groups within the population. However, as mentioned earlier, from a practical point of view the social classes can be three, and the average income of each group can be treated as typical of the group. It thus appears that for each urban area there should be three models, one for each class, which will describe density standards for the development of residential areas defined by working class, middle class, and upper class.

Hence it is possible to state the following general model giving the maximum gross density and corresponding net density for urban residential development.

$$\phi_{m,g} = \left(\frac{1}{\alpha_g K_g}\right)^{\frac{1}{\alpha_g + 1}} \cdot \left(\frac{\alpha_g}{\alpha_g + 1}\right) \quad \ldots\ldots (7\text{-}6)$$

and

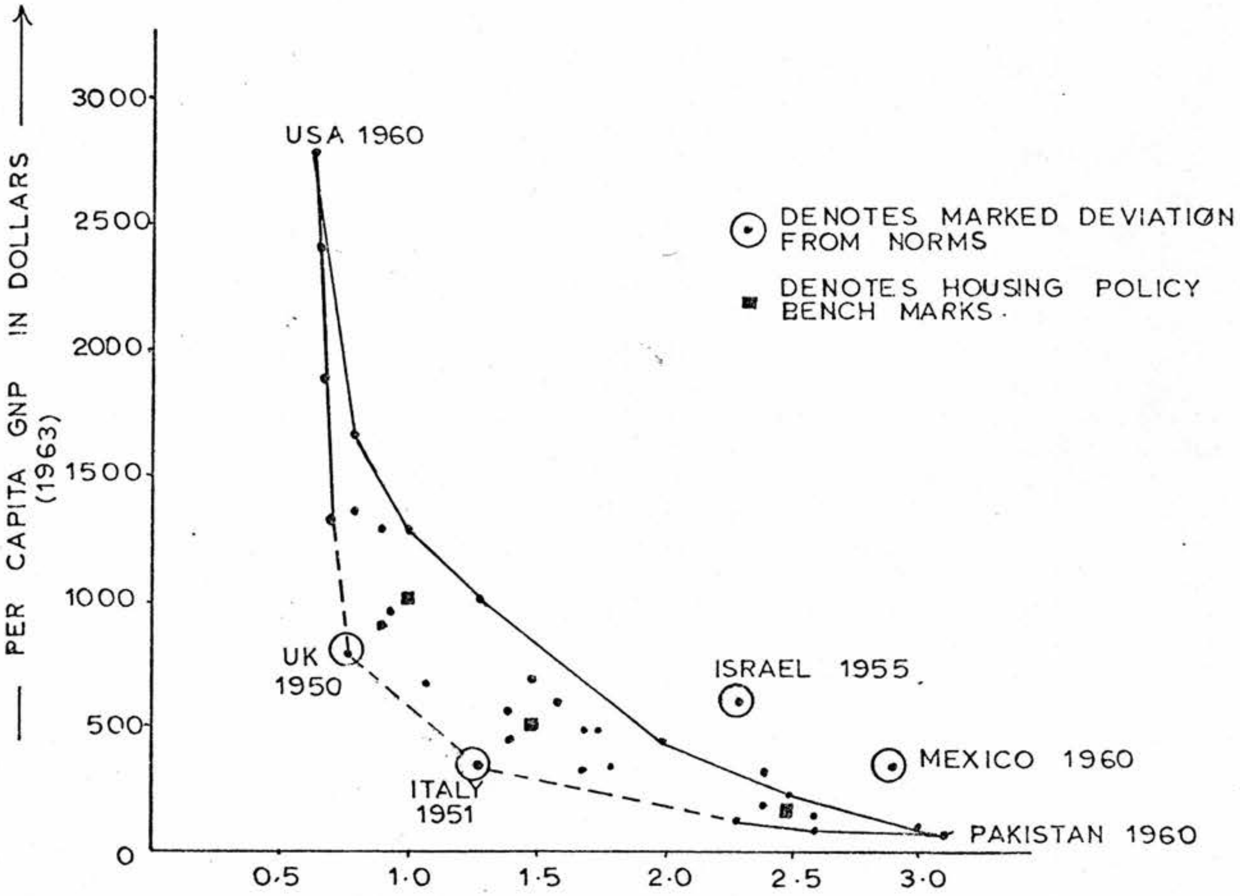
$$P_{m,g} = \left(\frac{1}{\alpha_g K_g}\right)^{\frac{1}{\alpha_g + 1}} \quad \ldots\ldots\ldots\ldots (7\text{-}7)$$

where g, represents the social grouping, i. e. g = 1 gives the working class, g = 2 gives the middle class, and g = 3 gives the upper class.

The testing and calibration of this model is described fully in Chapter 8, using data collected specifically for this purpose via the survey described in the Appendix I.

DIAG. 7–4

OCCUPANCY DENSITY IN RELATION TO PER CAPITA GNP



(SOURCE: ALFRED P. VAN HUYCK —— URBAN PLANNING IN DEVELOPING COUNTRIES)

In this chapter, however, it is considered as theoretically valid, and used in developing the theoretical model for determining the housing thresholds.

7.4.2 <u>A model for standardising the occupancy rate.</u>

Occupancy rate in persons/habitable room is sometimes used to estimate housing requirements, and to compare the housing situation of different countries.

The discussion in Chapter 2 showed that occupancy rate has little or no relationship to socio-physical problems, but that it was more related to socio-mental problems - sections 2.3.3.1.2. Hence occupancy rate must be determined using the concept of demand rather than the concept of housing need, which tends to specify an ideal rate of 1 person per habitable room.

Hence occupancy rate for urban Ceylon must be compatible with the socio-economic demand, using the assumption that cultural values are the same for the urban area. The model must thus propose a relationship between occupancy rate, social status, and economic level of the household.

The general relationship between economic level and occupancy rate can be seen from the graph developed by Van Huyck[1], (presented in diagram 7-4). Quoting from the study he says:

> "The graph reveals three interesting benchmarks which can be useful in determining housing goals and standards. First one can conclude that the 'affluent' housing standard of 1 room per person or more can be obtained only after the general standard of living has reached or is about to reach a level commensurable with a G. N. P. of $1,000 (in 1960 prices). However, occupancy ratios do not improve significantly after that level has been reached although the rise in per capita G. N. P. will continue.

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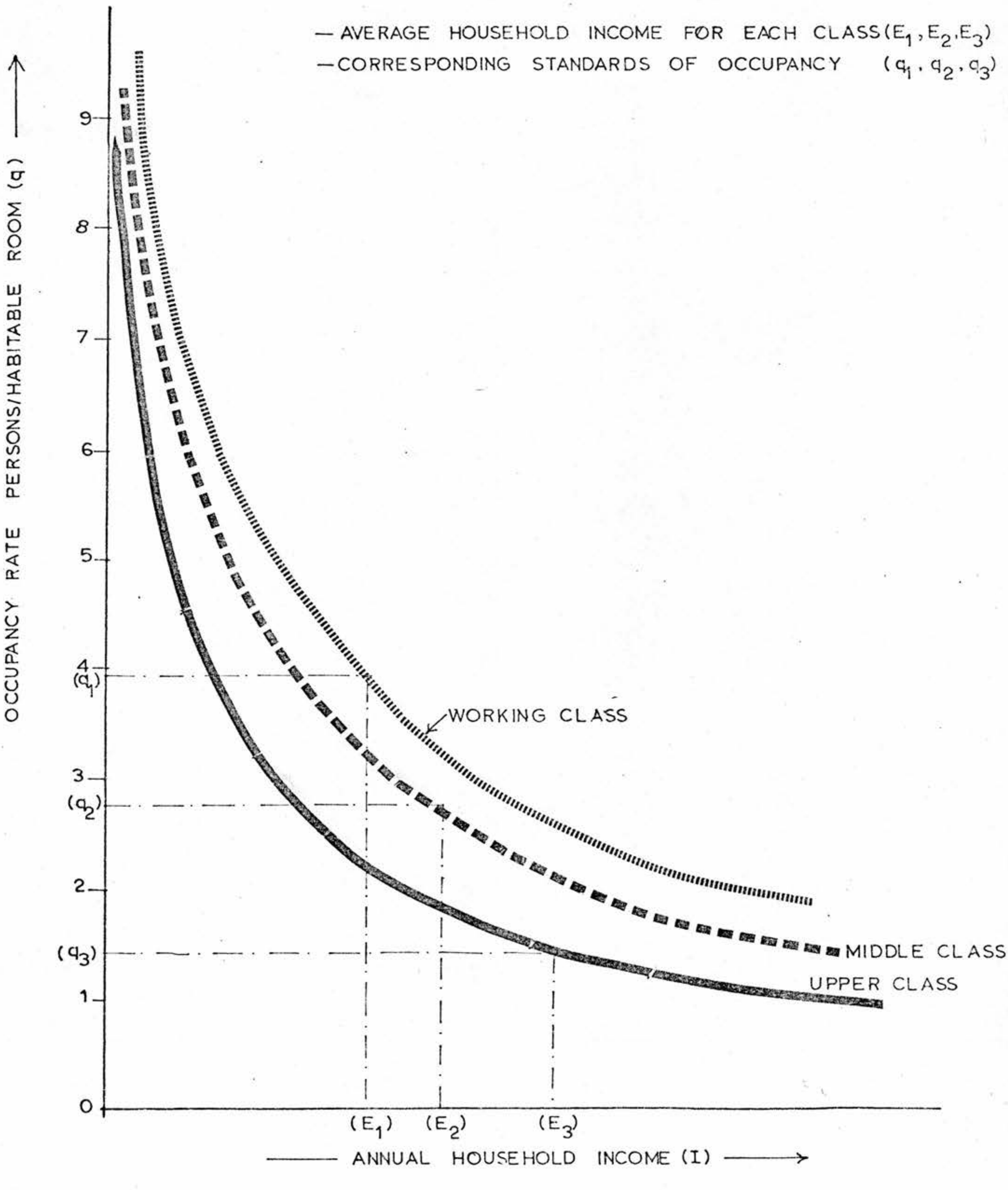
[1] Van Huyck, A. P. Urban planning in the developing countries. Graph 2, pages 85 and 86.

DIAG. 7-5

THEORETICAL RELATIONSHIP BETWEEN OCCUPANCY RATE (q) IN PERSONS/ROOM AND SOCIO ECONOMIC STATUS FOR AN URBAN AREA.



"The second bench mark occcurs at a density of 1.5 persons per room which, as previously mentioned, constitutes the crowding threshold of the U.S. housing programme. This standard seems to be obtainable at a per capita G.N.P. level of approximately $500. The cluster of nations in the vicinity of this mark include Chile, Cyprus, Greece, Japan, Puerto Rico, Poland, Venezuela and others.

"The third bench mark at 2.5 persons per room occurs at a G.N.P. level of $150. Countries in this cluster include Ceylon, India (on the low side), El Salvador, Honduras, and Yugoslavia.

"At this point the question may be asked how this kind of indicator could be used as a criterion for the programming of housing? If one takes, as an example, the case of India, it is quite obvious from the graph that a national target for the next 10-15 years could not exceed a standard of 2.5 persons per room."

A graph similar to the one constructed by Van Huyck on an international basis could be constructed for specific urban areas indicating occupany rate on the y axis, and normal or long run household income on the x axis. Diagram (7-5) indicates the probable shape of the graphs.

The graph constructed by Van Huyck showed deviations from the norm. These deviations may be due to social, cultural, and climatic variations. Assuming cultural and climatic conditions are constant for a particular urban area in Ceylon, variations may still occur due to social status. Hence the graph must be constructed separately for each social class, as shown theoretically in diagram (7-5). The graphs may take the forms indicated in the diagram, i.e. higher social classes may respond faster with increase in income, and have a higher ultimate standard in mind.

The standard to be adopted for each class may therefore be the occupancy rate indicated at the average income of each class. These are indicated in the diagram as q_1, q_2, and q_3, at incomes of E_1, E_2, and E_3, respectively.

The testing of this model and its calibration, was done using data obtained via the survey described in the Appendix,I, and is presented in Chapter 8. Its use in formulating an urban housing programme is presented in Chapter 11.

7.4.3 A model for determining space standards

Models for determining space standards are not new. Models developed so far have been based either on the very simple assumption of a fixed quantity of space per person, or on the basis of a minimum space plus a further fixed constant amount per person.

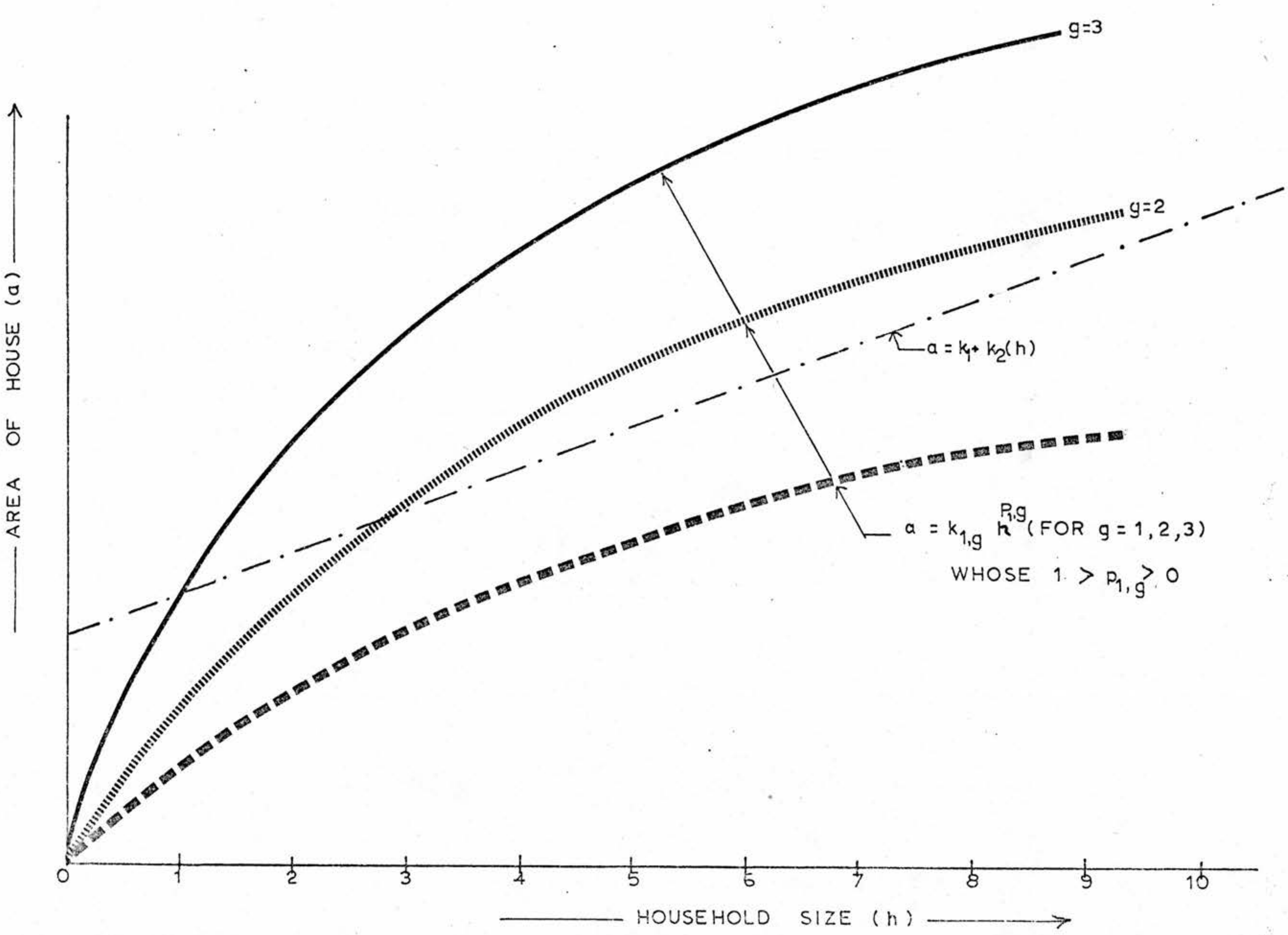
The main drawbacks of these models are:

(1) That they assume a constant consumption of space per person. This is not so in reality since at higher levels of consumption the satisfaction gained by a marginal increase is less than at lower levels. Hence, the model should be based on a decreasing marginal rate of increase.

(2) The models used have been generalised for all groups. This again is not strictly true. Observation of different social groups shows that as social class increases, so do activities within the house. This results in a demand for more space by the higher social clasees. Hence, a model of consumption of space will be true for a particular social class. The general form of the model may be the same, but the constants that determine the model will differ.

DIAG. 7-6

VARIATION OF AREA OF HOUSE (a) VS HOUSEHOLD SIZE (h)



(3) The economic factor is another important variable in the consumption of space. Though socially a household may demand a certain amount of space it may not be economically capable of paying for it. This will result in socially similar households, of the same size, being satisfied with different space standards. This may be overcome by developing a model which caters for households different in size, but of average income. This is in addition to dividing the households by social class. The use of average incomes is necessary to make the model practically workable.

From the foregoing it is possible to state the following theoretical model. The area of a house (a) for a household of size (h), which has an average income, and belongs to social class (g) will be given by:

$$a_g = K_{1,g}.h^{p_{1,g}} \quad \ldots\ldots\ldots\ldots \quad (7\text{-}8)$$

where $p_{1,g}$ represents the elasticity of demand for space with respect to change in household size. The value of $p_{1,g}$ is less than 1, and greater than zero. $K_{1,g}$ is a constant. Diagram (7-6) indicates the theoretical relationship graphically.

As mentioned, models presently use are of the form

$$a = K_1 + K_2 h \quad \ldots\ldots\ldots\ldots \quad (7\text{-}9)$$

where K_1 and K_2 are constants and h household size. These models assume that g is constant, and that p_1 is equal to 1. (Diagram 7-6 indicates the form of this model.)

In Chapter 3 a model of the form given in equation (7-9) was used to estimate overall investment. It will be useful to comment on the validity of the model in that particular context.

The objective in Chapter 3 was to estimate the area of a house required by an average household, so that using an average estimate of cost per unit area and the number of households, the total cost could be estimated.

The more detailed model presented here is for a particular urban area, hence averaging out the three models will give a model describing the average consumption of space. This model will tally closely with the net result obtained by using a model of the form given in equation (7-9). Hence when viewing the problem from the national scale use of the existing model for estimating the total costs will not produce any appreciable error. However, for reasons explained, at the urban scale for drawing up a detailed housing programme the error will be appreciable, not from the overall cost point of view, but in the distribution of houses by size envisaged within the programme.

The model presented by equation (7-8) is calibrated in Chapter 8, and used in Chapter 11 for formulating an urban housing programme for the city of Colombo. The validity of using a linear model in Chapter 3 is also established in Chapter 8 by comparing the average size of house using the two models.

7.5 A model for expressing the real costs to the consumer (R)

In Chapter 6, section 6.2.1. the real annual costs to the consumer (R) were given in equation (6-3) as $R = I + M$ where I represented the annual cost of amortizing the initial costs, and M represented the annual costs of maintenance.

It was seen that I was dependent on standards, and that standards were dependent on the socio-economic factors, when all other factors were held constant. Thus in section 7.4 the standards to be provided for the different social classes, of average household income, were developed.

The standards developed must be provided for the different social classes if a solution to the urban housing problem is to be achieved, and these standards must be provided at the minimum physical costs within the limits of technology.

Hence, in this section the initial cost(C_u) of providing these standards will be expressed in terms of a model which incorporate the factors of location, variable household size, and variable form. These costs will then be expressed as the annual equivalent of amortizing the costs, represented by (I) for various types of tenure.

Finally, an expression for the annual costs of maintenance will be developed and used to establish a model which expresses (R) in terms of all the variables. This model is then used to define the housing threshold, which is used to minimise the physical costs.

7.5.1 The detailed models to be developed

The initial cost of housing per unit is given by the sum of the initial cost of land per housing unit (C_l), the cost of developing the land per unit (C_{dl}), and the cost of constructing the housing unit (C_c). These as seen will depend on location, household size, form, and standards. Standards will be as developed for the three social classes, therefore the model must be calibrated for each social class (g). Hence the first model to be developed is one which expressed the initial cost/unit $(C_l + C_{dl} + C_c) = C_u$, of providing housing for the different social groups (g), considering the effect of variation in household size (h), location, and form, denoted by the suffix (y).

The next stage is to develop a model that converts these initial costs into the annual equivalent of amortization (I);

i.e. $I = f(C_l + C_{dl} + C_c) = f(C_u)$.

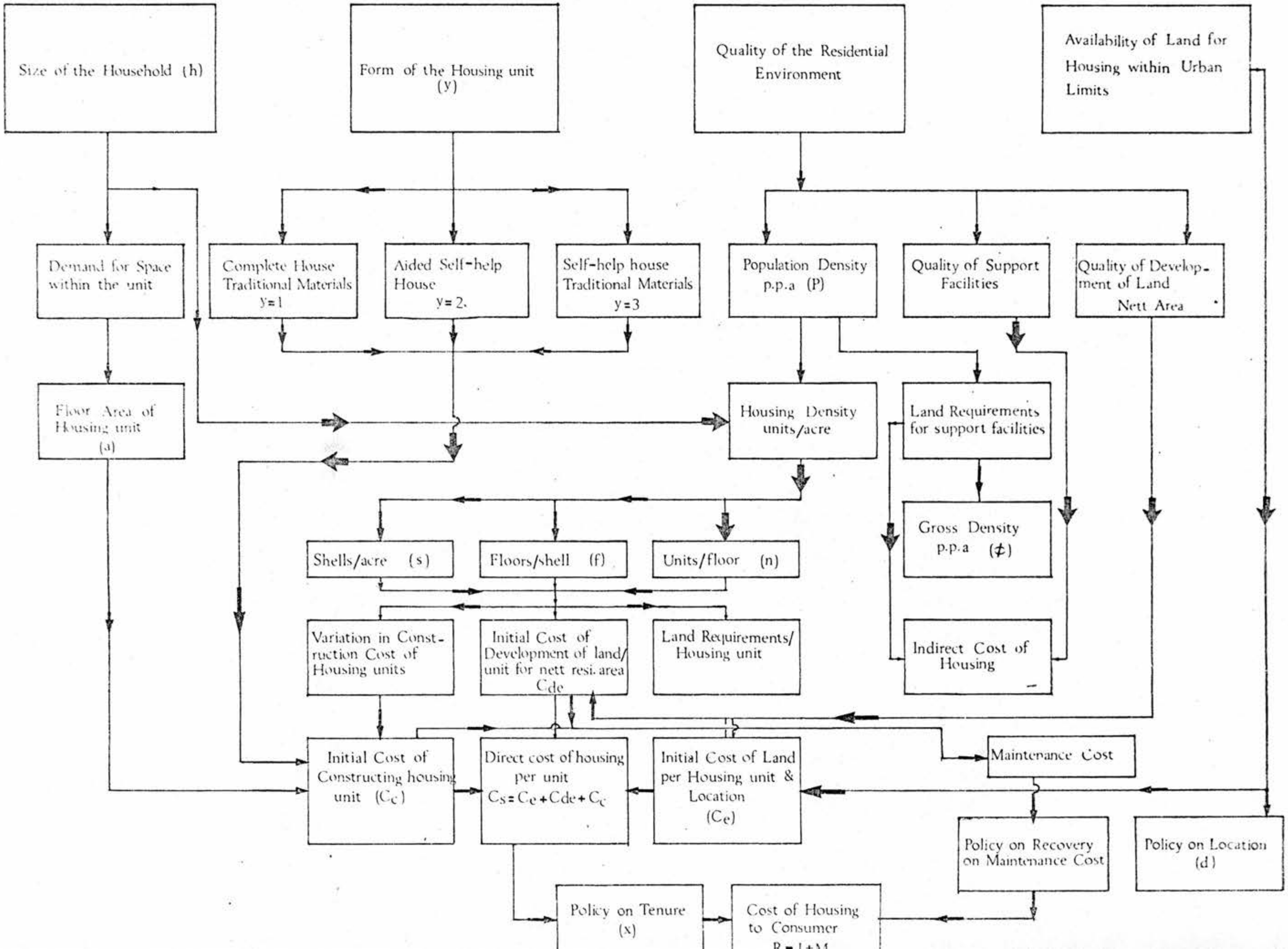
This will depend on:

(1) the interest rates charged (i)

(2) the method of amortization

and (3) the policy on tenure, denoted by the suffix (x), where x = 1 denotes rent, and x = 2 denotes purchase on a rent purchase basis.

Representation of the Real Cost of Housing to the Consumer (R)



Finally, a model relating the annual costs of maintenance to the initial costs ($C_{dl} + C_c$) excluding land costs, and the age of the house (T) in years must be developed.

These detailed models can then be used for expressing the real costs (R) in terms of social class (g), form (y) and tenure (x) for variations in location and household size. Diagram (7-7) represents the foregoing statements.

7.5.2 A model expressing the initial cost per housing unit $C_u = (C_l + C_{dl} + C_c)$

At this stage the model will be developed without including the suffix for social group (g). This suffix will be added at the final stage to distinguish the initial costs of providing housing for the different social groups. Variation in form will also be included using the suffix (y).

7.5.2.1 The initial cost of land (C_l) per housing unit.

The cost of provision of land per housing unit for the direct development of urban housing depends on two factors. They are:

(1) The price of land per acre

and (2) The net density of development measured in housing units/acre.

(1) The price of urban land

Studies done[1] have shown that the price of urban land decreases exponentially with increasing distance from the centre of the city. However, this expression is true for the average price of land at various radii. Variations along a radius have been explained by Stone to be caused by variations in density[2].

---

[1] Richardson, Harry W. (1971). Urban economics, page 50. Penguin Books, England.

[2] Stone, P.A. (1970). Urban development in Britain. Standards, Costs and Resources, page 133, which gives the variation for land costs in the london region as

$$C_L = \frac{1000}{3} (23 + 4u) e^{-d/28.}$$

However, for the purpose of this model average variation is considered sufficiently accurate, and thus land prices may be related purely to radial distances. Another reason for not considering density is because this model is concerned mainly with building houses on undevoped land where $u = 0$.

Hence the cost of land per unit area C_L will be given by:

$$C_L = K \quad C^{-k_{7}.d} \quad \ldots\ldots\ldots\ldots \quad (7\text{-}10)$$

This equation will be checked and calibrated for the city of Colombo in Chapter 9, using data of land values obtained from the planning department of the Colombo Municipality.

(2) <u>Net density of development</u>

In section 7.4.1.2 it was seen that the net density (p) of development to produce the maximum gross density, should be

$$\left(\frac{1}{dK}\right)^{\frac{1}{d+1}} \quad \text{persons per acre.}$$

For a household size h, this would mean u units per acre, where

$$u = p/h = \frac{1}{h} \cdot \left(\frac{1}{\alpha K}\right)^{\frac{1}{\alpha+1}}$$

i.e. $\frac{1}{u}$ acres per housing unit $= h.\ (\alpha K)^{\frac{1}{\alpha+1}}$

Since each housing unit requires $h.\ (\alpha K)^{\frac{1}{\alpha+1}}$ acres of land, and the price per acre is C_L, the cost of land per housing unit C_1 will be given by

$$C_1 = C_L .\ h\ (\alpha K)^{\frac{1}{\alpha+1}} \quad \ldots\ldots\ldots\ldots \quad (7\text{-}11)$$

Substituting equation (7-10) the cost of land per housing unit can be expressed as follows:

$$\underline{C_1 = K_6 \quad e^{-K_7 . d} \quad .\ h.\ (\alpha K)^{\frac{1}{\alpha+1}}} \quad \ldots\ldots\ldots (7\text{-}12)$$

Since K, K_6, K_7, and α will be known it is possible to determine the cost of land for a housing unit situated at a radial distance, d, from the city centre, consisting of households of size h, or households of different sizes having an average size h. Simplified equation (7-12) may be written as

$$C_{1,g} = C_{3,g}.\ h.\ e^{-r_5.d}$$

where $C_{3,g}$ and r_5 are constants.

Hence for various social classes (g) the general expression will be:

$$C_{1,g} = K_6\ e.^{-K_7.d}\quad h.\ (\alpha_g K_g)^{\frac{1}{\alpha_g + 1}} \quad \ldots\ldots \text{(7-12a)}$$

for all g.

There will be no variation in the constants that describe variation in land prices with distance. There will also be no effect due to variation in form, and tenure. Only the density of development will be affected due to variations in social class.

7.5.2.2 <u>An expression for the net density (u) in housing units/acre, expressed in terms of shells (S) /acre, floors (f)/shell, and and housing units per floor (n)</u>

Density expressed in housing units/acre is an important factor in developing expressions for the cost of land development, and the cost of construction per housing unit. However, this broad definition will be useful only if all housing development is to be of the same type, i. e. of the same design.

In practice this is not so, and therefore it is necessary to define more fundamental variables, which will be capable of describing various types of design.

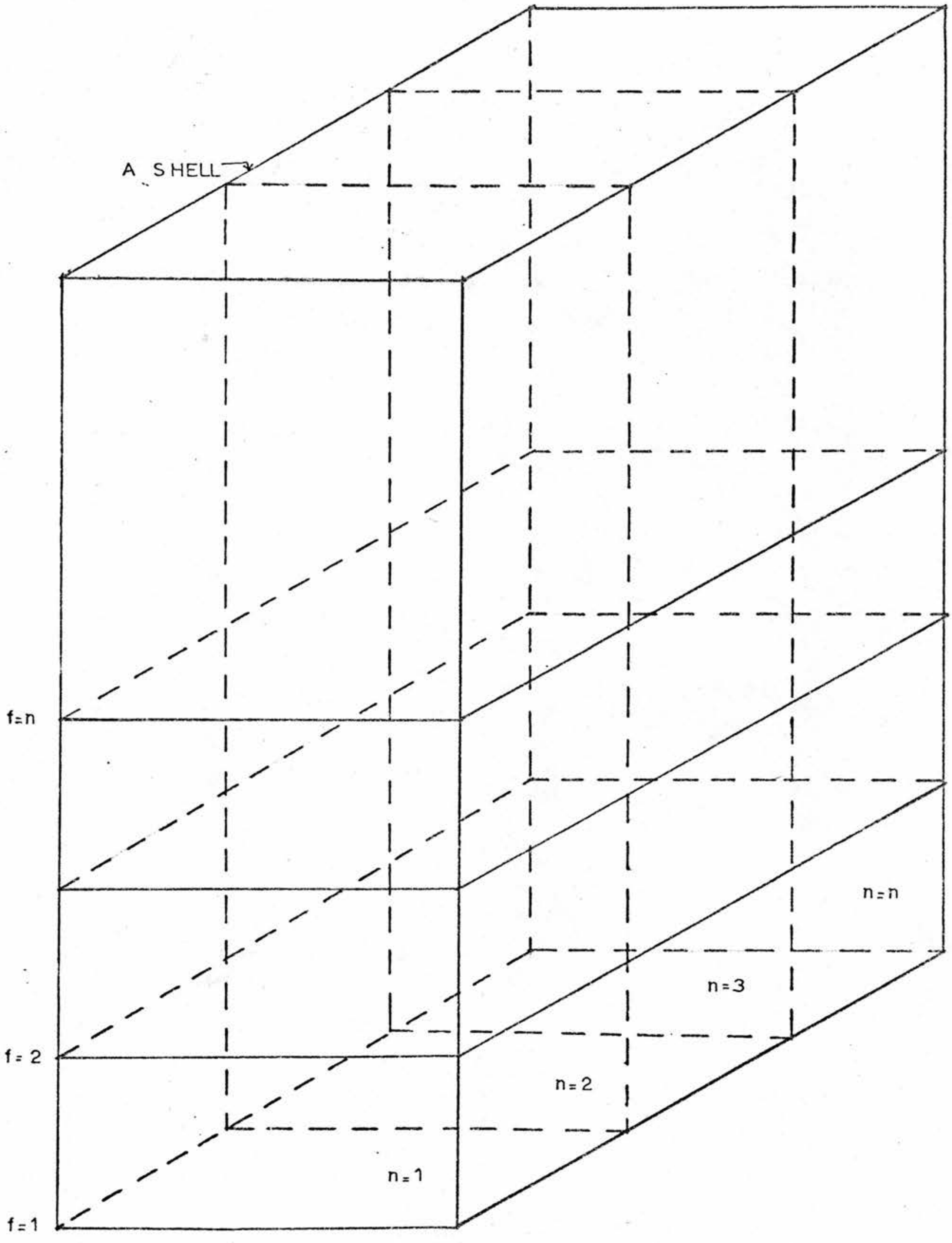
The fundamental variables selected are:

(1) Shells/acre (S)
(2) Floors/shell (f)
(3)) housing units/floor (n)

These variables are defined and related as follows. Diagram (7-8) is useful in explaining the definitions.

DIAG. 7 — 8

A DIAGRAMATIC EXPLANATION OF NET HOUSING DENSITY IN UNITS/ACRE



u (UNITS/ACRE) = s (SHELLS/ACRE) × f (FLOORS/SHELL) × n (UNITS/FLOOR)

7.5.2.2.1 <u>Definitions</u>

<u>Shell</u>: A shell is bounded by the base, outer surface walls, and roof of a residential block.

A block of flats or a single detached house would then be described as a shell. Hence, Shells/unit area will be the basic definition of net residential density.

<u>Floor</u>: A floor is a vertical divider of a shell, which is used as a base on which a unit or part of a unit is constructed.

Therefore, considering the base as floor 1, a shell can then be said to have f floors where f is any +ve integer.

<u>Unit</u>: A unit is a housing unit. It is possible to have many units/floor as in a block of flats or even half a unit/floor as in a detached two floor house.

Suppose a residential area can be described to have S shells/unit area, and each shell has f floors, and each floor n units. Then the density in units/acre (U) will be given by -

$$U = S.f.n. \quad \ldots\ldots\ldots\ldots \quad (7\text{-}13)$$

Using this equation it is now possible to study variations in cost for the same density, due to difference in the design of building which is described adequately by S, f, and n.

7.5.2.2.2 <u>The derivation of some general relationships which will be used in the following analysis</u>

1. The base area B of a shell is given by -

$$B = n.a. \quad \ldots\ldots\ldots\ldots \quad (7\text{-}14)$$

The common space of corridors etc. are divided equally among all the units of the floor.

2. The number of shells/acre will decrease with an increase in the base area B of the shell. As the number of floors increases it will be necessary to move the shells further apart when taking day lighting into consideration. Therefore the number of shells per acre should decrease with an increase in

the number of floors. Therefore the number of shells per acre can be expressed as

$$S = K_3 \quad B^{-p_3} \; f^{-p_4} \; \ldots\ldots\ldots (7\text{-}15)$$

where p_3 and p_4 are most probably fractional powers.

The above equation can be expressed as

$\log S = \log K_3 - p_3 \log B - p_4 \log f.$ which can be used for determining K_3, p_3, and p_4. This will be done by studying various net residential areas within the city of Colombo, and using the data to fit a least square regression line. This calibration is presented in Chapter 9.

(3) $\rho = u.\ h$ by definition

i.e. $\frac{\rho}{h} = S.n.f.$ From equation (7-13)

$S = K_3 B^{-p_3}.f^{-p_4}$ Equation (7-15)

$\therefore \frac{\rho}{h} = K_3.\ f^{(1-p_u)}\ n.\ B^{-p_3}$

$B = n.a.$ Equation (7-14)

$\therefore \frac{\rho}{h} = K_3.\ n^{(-p_3+1)}.\ a^{-p_3}.\ f^{(1-p_4)}$

$a_g = K_{1,g}\ h^{p_{1,g}}$ Equation (7-8) for $g = 1, 2, 3$

$\therefore \frac{\rho}{h} = K_3.\ K_1^{-p_3}.\ h^{-p_1 p_3}.\ n(1-p_3)\ f^{(1-p_4)}$

$$\text{i.e. } f = \left[\frac{K_1^{\;p_3}}{K_3}.\rho.\ h^{(p_1 p_3 - 1)}\right]^{\frac{1}{(1-p_4)}} .\ n^{\left[\frac{p_3 - 1}{1 - p_4}\right]}$$

For the particular case where $\rho = \left(\frac{1}{\alpha_g K_g}\right)^{\frac{1}{\alpha_g + 1}}$ for $g = 1, 2, 3$

$$f = \left[\frac{K_{1,g}^{\;p_3}}{K_3}\left(\frac{1}{\alpha_g K_g}\right)^{\frac{1}{(\alpha_g+1)}} h.^{(p_1 p_3 - 1)}\right]^{\frac{1}{(1-p_4)}} n^{\left(\frac{p_3-1}{1-p_4}\right)} \ldots (7\text{-}16)$$

for $g = 1, 2, 3.$

Thus for a particular household size (h), of a particular social group, the number of floors in a shell and the number of units per floor are governed by the relationship (7-16), at maximum net population density -

$$\rho = \left(\frac{1}{\alpha_g K_g}\right)^{\frac{1}{d_g + 1}}$$

7.5.2.3 The initial cost of land development (C_{dl}) per housing unit

The development of land for the net housing area includes the provision of roads, potable water supply, sewage and waste water disposal, and power (electricity).

It thus includes the basic amenities to be provided in order to eliminate the socio-physical problems related to the direct development of urban housing (section 2.3.3.1.2), together with power.

Since the discussion here refers to urban housing, roads will be considered to be motorable, the supply of potable water will be through a pipe borne system, i.e. individual wells for each house are not considered. The disposal of sewage and waste water will be limited to a system which carries away the waste water and sewage through a pipe network, which carries the effluent away for treatment of some form. Individual soakage systems may be adoptable for low density areas.

Studies[1] done to date have shown that in general the cost per housing unit of land development tends to decrease with housing density, and appear to be related logarithmically.

---

[1] (a) Stone, P.A. (1970) Urban development in Britain: Standards, Costs and Resources. Page 131.

(b) Stone, P.A. (1963) Housing, Town Development and Land Costs, Estates Gazette Ltd. London.

It will be appreciated that these relationships will be true for housing similar in design. However, the treatment of the subject here tries to incorporate the possible changes in design, though having the same density. To do this the definition of housing density developed in section 7.5.2.2 will be used.

According to the studies carried out and mentioned previously,

$$C_{dl} = K_5 . u^{-x} \quad \ldots\ldots\ldots\ldots (7\text{-}17)$$

where $1 > x > 0$.

But $u = s.f.n.$ $\quad\ldots\ldots\ldots\ldots\ldots\ldots\ldots (7\text{-}13)$

Hence the use of u represents the average effect of individual changes in S, f, and n.

To incorporate the effect of these more fundamental variables, C_{dl} can be expressed as

$$C_{dl} = K_5 . S^{-p_8} . f^{+p_9} . n^{-p_{10}} \quad \ldots\ldots (7\text{-}18)$$

p_8 is treated as negative since it can be compared as similar to equation (7-17) where each shell can be considered a unit.

The value of p_9 on the other hand may be +ve. This may be due to the fact though increases in f increase u, the pressure head in the water mains must be increased to reach greater heights. It also becomes necessary to use cast iron instead of earthenware for exposed sewage pipes.

p_{10} on the other hand may be -ve, since increase in n will lessen the overall length of roads and piping needed

Equation (7-18) was calibrated using unpublished data collected from the records of the department of national housing in Ceylon, and is presented in Chapter 9.

Assuming at this stage the theoretical validity of this model, the cost of land development per housing unit can be expressed as a function of household size (h), and the number of units per floor (n). This relationship will be similar for the three social classes but will have a variation in the constants due to the variation of density and space standards for each class. Therefore, for a specific class, using the relationships derived, i.e.

$$S = K_3 \, B^{-p_3} \, f^{-p_4} \quad \ldots\ldots\ldots\ldots (7\text{-}15)$$

$$B = na \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (7\text{-}14)$$

$$A_g = K_{1,g} \, h^{p_{1,g}} \quad \ldots\ldots\ldots\ldots (7\text{-}7) \text{ for } g = 1, 2, 3$$

and

$$f = \left[\frac{K_{1,g}^{\,p_3}}{K_3} \left(\frac{1}{\alpha_g K_g} \right)^{\frac{1}{\alpha_g + 1}} \cdot h^{\left(p_{1,g} \, p_3 - 1\right)} \right]^{\frac{1}{(1 - p_4)}} \cdot n^{\left(\frac{p_3 - 1}{1 - p_4}\right)} \quad \ldots\ldots (7\text{-}16)$$

for g = 1, 2, 3.

and substituting in equation (7-18), an equation of the form given below will be obtained.

i.e. $$C_{dl,g} = C_{2,g} \, h^{r_{3,g}} \, n^{r_{4,g}} \quad \ldots\ldots (7\text{-}19) \text{ for a social class } g.$$

where the constants C_2, r_3, and r_4 can be derived using equation (7-18) and the equations given above. The theoretical expressions derived using simple algebra are tedious and have thus been omitted.

The practical derivation of this equation is presented in Chapter 9, using the practically derived equation mentioned above.

7.5.2.4 <u>The initial cost of constructing a housing unit.</u> (C_c)

The initial cost of constructing a housing unit depends on two factors. They are:

(1) The area of the housing unit (a in sq. ft.)

(2) The cost per sq. ft. ($\frac{Cc}{a}$)

The area of the housing unit will depend on the household size (h), and the relationship between the area (a) and household size (h).

In section 7.4.3. it was shown that the relationship between area and household size is given by

$$a_g = K_{1,g} \cdot h^{p_{1,g}} \quad \ldots\ldots\ldots \text{(7-8)}$$

where g, represents the social class for which the housing unit is being provided.

The cost per sq. ft. ($\frac{Cc}{a}$) will depend on:

(1) The total area of the house. Stone[1] has shown that ($Cc/_a$) appears to decrease as (a) increases, but at a decreasing rate of change.

(2) The number of floors (f). Here again the work done by Stone[2] shows that Cc/a tends to increase at a decreasing rate with an increase in the number of floors (f).

(3) The third factor is (n), the number of units per floor. An increase in (n) may tend to reduce ($Cc/_a$) due to economies of scale. The relationship may once again be described as ($Cc/_a$) decreasing at a rate which reduces with an increase in (n).

Hence, the cost of construction/sq. ft. ($Cc/_a$) may be described by the following equation.

$$(Cc/a) = K_4 \cdot a^{-p_2} \cdot f^{p_6} \cdot n^{-p_7}$$

where from the earlier statements it may be inferred that p_2, p_6, and p_7 are fractions.

---

[1] Stone, P.A. (1970). Urban Development in Britain. Standards, Costs, and Resources. 1964-2004. Fig. 7.2. page 114.

[2] Op.cit. 11 Fig. 7.3. page 119.

The equation above may be also expressed as

$$C_c = K_4 \,.\, a^{(1 - p_2)} \quad f^{p_6} \,.\, n^{-p_r}$$

putting $p_5 = (1 - p_2)$, the value of p_5 will be fractional, and positive since p_2 is fractional.

Therefore:

$$C_c = K_4 \,.\, a^{p_5} \quad f.^{p_6} \,.\, n^{-p_7} \quad \ldots\ldots \text{(7-20)}$$

This model is tested and calibrated in Chapter 9 using data obtained from the records of the department of National housing in Ceylon. The data used is adjusted to a base year to make allowances for inflation or deflation in the construction industry.

Assuming at this stage the theoretical validity of this model, and using the following equations derived; i.e.

$$a_g = K_{1,g} \,.\, h^{p_{1,g}} \quad \ldots\ldots\ldots \text{(7-8)}$$

$$\text{and} \quad f = \left[\frac{K_{1,g}^{\,p_3}}{K_3} \left(\frac{1}{\alpha_g K_g} \right)^{\frac{1}{\alpha_g + 1}} \,.\, h.^{(p_{1,g}.p_3 - 1)} \right]^{\frac{1}{(1-p_4)}} .X$$

$$X = n.^{\left(\frac{p_3 - 1}{1 - p_4} \right)}$$

$$\ldots\ldots \text{(7-16)}$$

for $g = 1, 2, 3$

The following expression for $C_{c,g}$ can be derived, using the independent variables h, and n

$$\text{i.e.} \quad C_{c,g} = C_{1,g} \,.\, h^{r_{1,g}} \,.\, n^{r_{2,g}} \quad \ldots\ldots \text{(7-21)}$$

The theoretical expressions for $C_{1,g}$, $r_{1,g}$ and $r_{2,g}$ are not given here. The real values for these constants are given on practical derivation of the independent equations in Chapter 9.

It will be useful to note that equation (7-21) above is similar to that used for describing the cost of developing land for housing, per housing unit, as both depend on household size (h), and units per floor (n), as independent variables.

Equations (7-19) and (7-21) can now be used for determining the basic design variables for the provision of housing at the minimum initial costs of land development, and construction per housing unit. The methodology will be the same for all social classes (g). However, the values of the variables will be different since the constants of equations (7-19) and (7-21) depend on g.

7.5.3 <u>The minimum cost of the housing unit and land development</u> $(C_c + C_{dl})$

The preceding sections have dealt separately with the cost of the house and the cost of developing the land per house. These can now be combined to arrive at a minimum cost solution, using equations (7-19) and (7-21).

The cost of construction is given by:

$$C_c = C_1 \;.\; h^{r_1} \; n^{r_2} \; \ldots\ldots \; (7\text{-}21) \text{ for } g = 1, 2 \text{ or } 3.$$

where C_1 is a constant, r_1 and r_2 are powers which may be positive or negative.

Similarly the cost of land development per housing unit

$$C_{dl} = C_2 \quad h^{r_3}. \quad n^{r_4}. \ldots\ldots\ldots (7\text{-}19) \text{ for } g = 1, 2 \text{ or } 3$$

where C_2 is a constant, r_3 and r_4 are powers which may be positive or negative.

$$\text{i.e.} \quad +\infty > r_1, \; r_2, \; r_3, \; r_4 > -\infty$$

Of interest now is the behaviour of the function $(C_c + C_{dl})$ for any g. Ref Diagram (7-9). Three possible cases arise, for a fixed household size h. They are (1) r_2 and r_4 both positive i.e. $r_2 > 0$; $r_4 > 0$. Diagram (7-9A). This particular case can be divided into four subsets i.e. (1a) $1 > r_2 > 0$; $1 > r_4 > 0$

(1b) $1 > r_2 > 0$; $r_4 > 1$

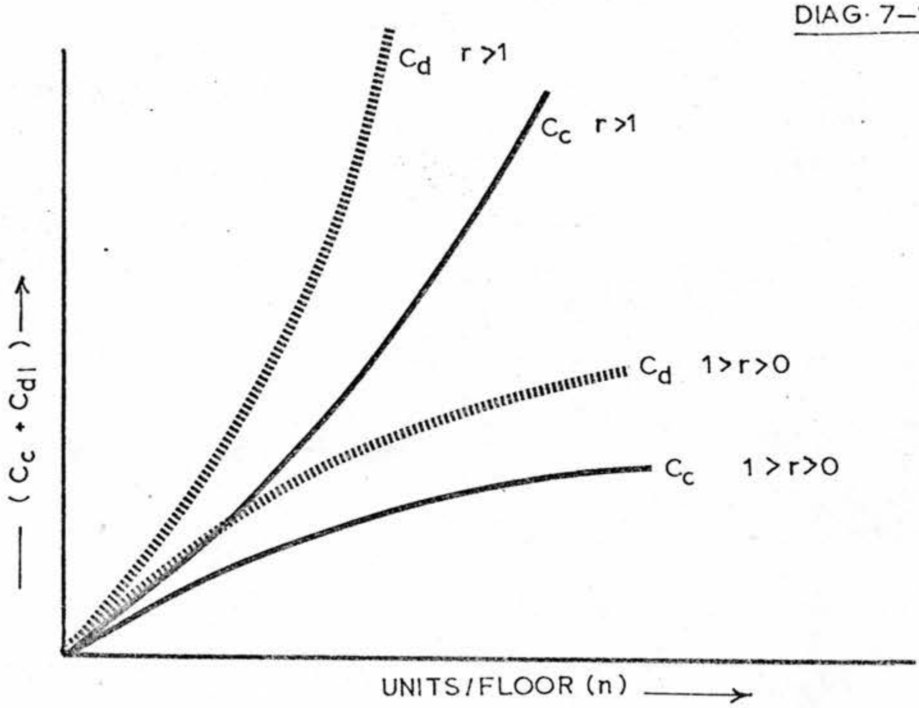
(1c) $r_2 > 1$; $1 > r_4 > 0$

(1d) $r_2 > 1$; $r_4 > 1$.

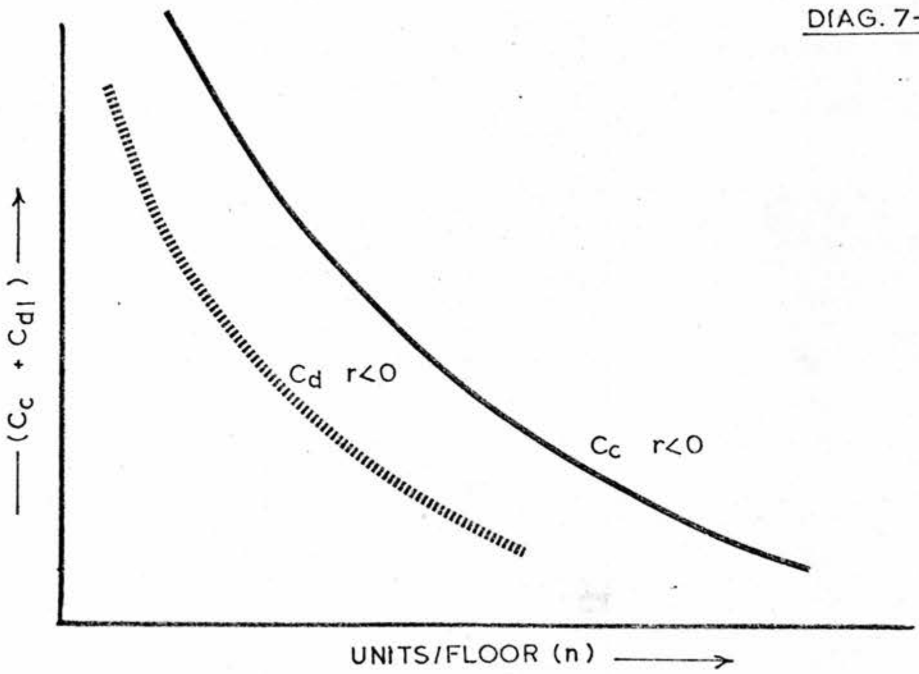
DIAG. 7–9

VARIATION IN ($C_c + C_{dl}$) WITH (n)

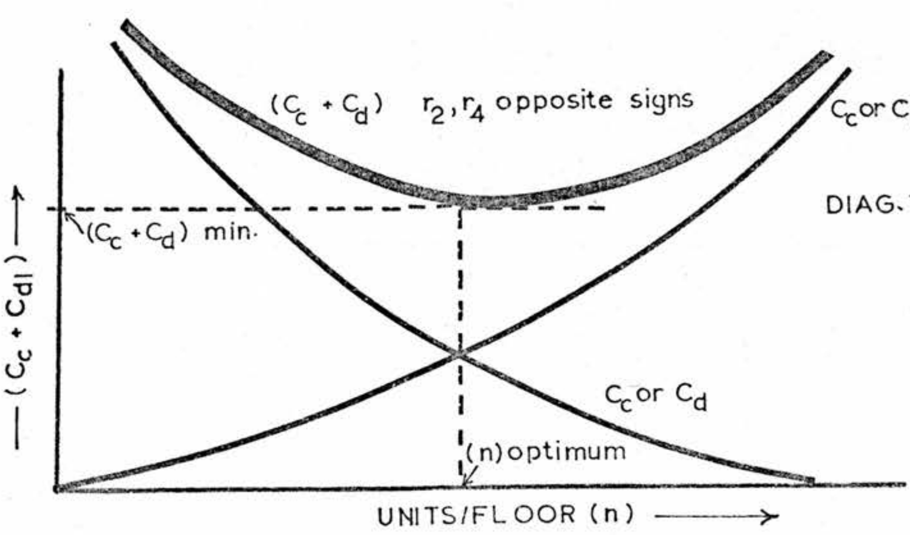
DIAG. 7–9A (CASE 1)



DIAG. 7–9B (CASE 2)



DIAG. 7–9C (CASE 3)



In this case both C_c, and C_{dl} increase with an increase in n. This therefore indicates that the minimum solution lies where n is practically smallest. This would mean $n = \frac{1}{2}$, where each housing unit is divided between two floors.

2. r_2 and r_4 both negative, i.e. $r_2 < 0$ and $r_4 < 0$.

   In this case both C_c and C_{dl} decrease with an increase in n. This therefore indicates that the minimum solution lies in using the practically largest possible value for n. Achieving a minimum cost solution depends on the ability of the architect to convert it into a design, which maximises n.

3. Where r_2 and r_4 have opposite signs, i.e. either $r_2 < 0$; $r_4 > 0$ or $r_2 > 0$; $r_4 < 0$. In this case one factor increases while the other decreases with n. This particular case results in a specified value of n which produces the minimum value of $(C_c + C_{dl})$. This value of n is then used as a basis of design.

At this stage one cannot say that a definite case will occur for all urban areas of all developing countries, but one can say that one of the above cases will occur for a specific urban area of a specific country. Hence, it will be possible to decide what basic form will be the cheapest in terms of the cost of the unit and cost of development of the land, for a specific household size h. By varying h over its entire range one will be able to make similar decisions for all h. This decision regarding the value of n could then be used to determine the values of f, and S. Thus this information will be the basic data for the design of a net residential area at minimum cost, while at the same time retaining the specified density which minimises total cost by maximising the use of land.

This analysis must also be applied to various social classes, since both equations (7-19) and (7-21) vary for different g.

In Chapter 9 of this analysis is used to define n, f, and S for the city of Colombo, for different social classes g, and varying household sizes h.

7.5.4 The effect of form on the cost of Land development (C_{dl}) and the cost of construction(C_c)

In section 7.5.2.3 and section 7.5.2.4. two general relationships were derived connecting the cost of land development and construction of a housing unit to the household size (h) and the number of units per floor (n), for the three social classes denoted by (g). These expressions were derived for a complete house.

It was seen in Chapter 3 that in order to achieve the level of investment, it may be necessary to utilise the labour potential via methods of self help housing.

At the beginning of this chapter under assumptions, three forms of housing were to be considered. They were denoted by the suffix y and are:

(1) The provision of complete houses. (y = 1)

(2) The provision of core houses, to be completed on a self help basis by the prospective owner or tenant (y = 2)

(3) The provision of serviced blocks of land, for the provision of the housing unit on a self help basis. (y = 3).

In view of this it is necessary to consider the limitations on the use of equations (7-19) and (7-21), for core housing, and complete self help housing.

The proportional distribution of costs between the public and private sectors for each of these types will be considered in the next section, which deals with the cost of housing to the consumer.

Case (1) core housing: (y = 2)

In current practice core housing is the provision of the main core of the house, with services to the tenant. The house is then completed by the tenant through his own labour or with hired labour.

In certain cases financial assistance for the purchase of materials may be obtained, while in other cases the tenant uses his private funds to improve his house with time.

There are limitations to this system. They are:

(1) This type of housing in practice can be limited only to the ground floor, i.e. $f = 1$.

(2) The number of units per floor, however, can be varied. For example, a row of terraced core houses may contain about 10 to 15 houses.

Thus when applying the equations (7-19) and (7-21) developed for the complete house, the value of f is treated as equal to 1, and the only variable left is n.

The original equations are altered as follows:

Equation (7-13) $U = S.f.n.$ becomes $U = S.n.$

Equation (7-14) $B = n.a.$ remains the same.

Equation (7-15) $S = K_3 B^{-p_3} f^{-p_4}$ becomes $S = K_3 B^{-p_3}$

Equation (7-20) $C_c = K_4 a^{p_5} f^{p_6} n^{-p_7}$ becomes $C_c = K_4 a^{p_5} n^{-p_7}$

Equation (7-18) $C_{dl} = K_5 S^{-p_8} f^{-p_9} n^{-p_{10}}$ becomes $C_{dl} = K_5 S^{-p_8} n.^{-p_{10}}$

Expressed in terms of h and n, C_c and C_{dl} become,

$$C_c = K_4 K_1^{p_5} h^{p_1 p_5} n^{-p_7}.$$

$$C_{dl} = K_5 K_3^{-p_8} A^{p_3 p_8} n^{-p_{10}}$$

$$= K_5 K_3^{-p_8} n^{p_3 p_8} K_1^{p_3 p_8} h^{p_1 p_3 p_8} n^{-p_{10}}$$

$$C_{dl} = K_1^{p_3 p_8} K_3^{-p_8} K_5 . h^{p_1 p_3 p_8} n^{(p_3 p_8 - p_{10})}.$$

We can now express C_c and C_{dl} as in the case of the completed house, for a social class (g) as

$$C_{c,g} = C_{1,g} h^{r_{1,g}} n^{r_{2,g}} \quad \ldots\ldots\ldots \quad (7\text{-}22)$$

$$C_{dl,g} = C_{2,g} h^{r_{3,g}} n^{r_{4,g}} \quad \ldots\ldots\ldots \quad (7\text{-}23)$$

These equations can now be analysed as before, and the optimum value of n obtained. Using this value of n we obtain S, and thus the basic design data.

Case (2) Self help house. ($y = 3$)

As before we encounter limitations in the practical application of this system. They are

1. as before $f = 1$.
2. In this case the number of units per floor will be limited to $n = 1$, since each house will be constructed completely by its individual owner.

Here again we save on labour, the materials for the house may be supplied, via a loan or left to the individual to purchase with his own capital.

As before we apply equations (7-19) and (7-21) to this system.

Equation (7-13) $U = S.n.f.$ becomes $U = s$.

Equation (7-14) $B = n.a.$ becomes $B = a$

Equation (7-15) $S = K_3 B^{-p_3} f^{-p_4}$ becomes $S = K_3 a^{-p_3}$

Equation (7-20) becomes $C_c = K_4 a^{p_5}$

Equation (7-18) becomes $C_{dl} = K_5 S^{-p_8}$

i.e. $C_c = K_4 . K_1^{p_5} h^{p_1 p_5}$

and $C_{dl} = K_5 K_3^{-p_8} a^{p_3 p_8} = K_b K_3^{-p_8} K_1^{p_3 p_8} h^{p_1 p_3 p_8}$

$$C_{dl} = K_1^{p_3 p_8} K_3^{-p_8} K_5 . h^{p_1 p_3 p_8}$$

i.e. $C_{c,g} = C_{1,g} h^{r_{1,g}}$ .... (7-24) and

$C_{dl,g} = C_2 h^{r_{3,g}}$ .... (7-25)

Using the foregoing it is now possible to draw up detailed policy for guiding the overall design of urban residential areas in Ceylon, which minimises the cost of land development per housing unit and the cost of the housing unit, using the technique developed in section 7.5.3, and applying it to various forms.

The data provided will include a subdivision by:

(1) Social group (g) for $g = 1, 2, 3$

(2) Form of house using,

$y = 1$, complete house

$y = 2$, core house

$y = 3$, the developed block of land.

(3) household size (h).

For each of the household sizes, the values of S, f, and n, will be defined, which will form the basic data for design of the residential area. It will, of course, be appreciated that this data will be in addition to the net density defined (p), the occupancy rate (q), and the space standard for housing given by (a).

These standards have been developed for the city of Colombo, and are presented in Chapter 9. Their use in drawing up a housing programme is explained in Chapter 11.

7.5.5 A mathematical expression for the minimum initial direct cost of housing per unit, at radial distance (d) from the city centre

The direct cost of housing per unit $C_{u,g}$ is given by:

$$C_{u,g} = C_{c,g} + C_{dl,g} + C_{1,g} \quad \text{for a social class } g.$$

where $C_{c,g}$ is the cost of construction of the unit, $C_{dl,g}$, the cost of development of net residential land per unit and $C_{1,g}$ the cost of land per unit.

We have analysed the variation of each of these costs with respect to the factors that affect them. These results will now be applied to derive an expression for $C_{u,g}$ for the three forms (g) of housing considered.

Case (1) - the complete house: (y = 1)

From equation (7-19) and equation (7-21) it is possible to decide on the residential layout that minimises $C_{c,g}$ and $C_{dl,g}$. Let the optimum value of n be then N, for a particular h.

$$\text{Then } (C_{cl,g} + C_{dl.g})_{min.} = (C_{1,g}\ h^{r_{1,g}} N^{r_{2,g}} + C_{2,g}\ h^{r_{3,g}} N^{r_{4,g}})$$

The cost of land per unit will be given by:

$$C_{1,g} = C_{3,g} \ .\ h.\ e^{-r_5.\ d.} \qquad \ldots\ldots (7\text{-}12,\ \text{simplified})$$

$$\therefore\ C_{d,g} = C_{1,g}.\ h^{r_{1,g}} N^{r_{2,g}} + C_{2,g}\ h^{r_{3,g}} N^{r_{4,g}} + C_{3,g}\ h.\ e.^{-r_5.d} \qquad \ldots\ldots\ldots (7\text{-}26)$$

This expression gives the minimum initial direct cost of providing a complete house for a household of size h, at distance d from the city centre.

Case (2) - the core house: (y = 2)

The expression is the same, but the constants C_1, C_2, C_3, r_1, r_2, r_3, and r_4, will differ, while the constant r_5 will remain the same. The value for f in this case is 1. Equation (7-27)

Case (3) - the self help house. (y = 3)

In this particular case both f and n are equal to 1. $C_{c,g}$ and $C_{dl,g}$ are then given by:

$$C_{c,g} = C_{1,g}\ h^{r_{1,g}} \text{ and } C_{dl,g} = C_{2,g}\ h^{r_{3,g}}$$

$$\text{Then } C_{d,g} = C_{1,g}\ h^{r_{1,g}} + C_{2,g}\ h^{r_{3,g}} + C_{3,g}\ .\ h.\ e^{-r_5.d} \qquad \ldots\ldots\ldots (7\text{-}28)$$

When r_1, r_3, C_1, C_2, C_3, have values different to that of the previous cases, r_2 and r_4 are non existent, and r_5 remains the same.

The above expressions represent the minimum direct cost per housing unit, for housing a household of size h at minimim initial cost, using the three specified types, at a specified point relative to the centre of the urban area. The constants will vary for housing of different classes, and therefore a set of equations must be obtained for each class.

The sets of equations for determining the minimum initial cost of providing housing per unit for the city of Colombo are given in Chapter 9.

7.5.6 Tenure and the annual cost of land to the consumer

The assumption which this model considered was that there were two basic forms of tenure applicable. They were:

(1) A pure rental basis. $x = 1$

and (2) A rent purchase basis. $x = 2$

It is therefore necessary to determine what these two forms of tenure represent to the consumer in terms of annual costs. This particular section will deal with the annual cost of land and its relationship to the two forms of tenure mentioned above.

7.5.6.1 Pure Rent

The existing system for determining land rent for land belonging to the public sector is governed by the land commissions circular[1] which states that the rent to be charged for land will be four per-centum per annum of the value of the land. It must be noted that as land values change with time, the rent can change.

This system is useful and can therefore be retained and used to guide future public sector investment in the direct development of urban housing.

However, it will be noted from the conclusion reached in Chapter 4, section 4.3, that this system will be useful only where the land is

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[1] Circular governing land rents, Land Commissioners Circular No. K. S. 2571 of 28th June, 1952. Government of Ceylon.

already owned by the public sector, and therefore excludes the initial cost of acquisition. This confirms the observation that as far as possible housing for rental purposes should be on publicly owned land.

This system is not realistic if applied to private lands which are acquired for the purpose. In this case the initial costs must be amortized over a fixed period of time and would therefore cost much more to the consumer, or create a need for a subsidy, which must be avoided. (Section 7.5.6.2)

Hence annual land rent can be expressed as:

$$I_{1,g,1} = 0.04 \cdot C_{1,g} \quad \ldots\ldots\ldots\ldots \quad (7\text{-}29)$$

for housing on a purely rental basis where $C_{1,g}$ is the cost of land per unit as defined above, for a social group (g). $C_{1,g}$ is governed by equation (7-12a).

7.5.6.2 Rent purchase

Using the conclusion in section 4.3, the annual cost of land to the consumer, if it is being purchased on a rental basis, is represented by the amortization of the initial cost over a period of time (T years) on an equal instalment basis[1] at i % compound interest per annum on a depreciating capital. $I_{1,g,2}$ may be expressed as:

$$I_{1,g,2} = C_{1,g} \cdot \frac{i}{100} \left[\frac{(1 + \frac{i}{100})^T}{(1 + \frac{i}{100})^T - 1} \right] \quad \ldots\ldots \quad (7\text{-}30)$$

This system may be applied to publicly or privately owned land. In the case of private land the original owner may be paid in bonds (section 4.3) redeemable at a face value which includes the interest rate i annually as payments are made by the new owner. Hence this initial cost of land need not be met by the public sector.

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[1] The derivation of this formulae is not given here as it is a standard form used.

7.5.7 Tenure and the annual cost of land development to the consumer

In housing either for rent or rent purchase, the infrastructure developed will always belong to the public sector. It will also be the responsibility of the public sector to maintain this infrastructure. Hence, in either case the public sector must charge a rent for this infrastructure which must comprise two components. They are:

(1) The recovery of the initial costs

(2) The costs of maintenance.

The recovery of the initial costs is necessary to avoid a hidden subsidy. This also applies to the maintenance of the infrastructure.

To the consumer these costs may be either a part of the annual rent charged, or a part of the local authority taxes. In either case the consumer must bear these costs.

In addition to these costs the consumer may have to pay for the consumption of items such as electricity, water, and gas. These costs are generally based on the unit cost of production, and the maintenance of plant. This aspect is not treated as part of the cost of housing, since it depends on the individual household's consumption patterns. This aspect therefore forms part of general household expenditure, and is a separate part of the household budget.

From the foregoing it can thus be concluded that the cost of land development to the consumer can be treated in a manner similar to the cost of construction and maintenance of the housing unit, as will be seen in the next section.

It must be noted that land development costs treated here refer only to the net residential area, and not the overall infrastructure development of the total urban area. This aspect must be treated separately and is not within the scope of this study.

7.5.8 Tenure and the annual cost of the housing unit to the consumer, including land development costs.

In section 7.5.6 expressions were developed for renting, and rent purchasing land for the housing unit. These were denoted by $I_{1,g,1}$ and $I_{1,g,2}$.

In section 7.5.7. it was seen that the recovery of the initial costs of land development and construction of the housing unit could be treated in a similar manner. Let these be represented by

$$(I_{dl,g,y,x} + I_{C,g,y,x}$$

where the suffixes denote the following

dl = land development cost/unit

C = construction cost/unit

g = the social class for which the housing is being provided, i.e. g = 1, 2 and 3.

y = the form of housing denoted by y = 1, 2 and 3 and

x = the form of tenure, where x = 1 denotes pure rent, and x = 2, denotes rent purchase.

The conversion of the initial cost C to the annual cost I is governed by the equation:

$$I = \frac{C\,it}{100}\left[\frac{\left(1 + \frac{it}{100}\right)^{T/t}}{\left(1 + \frac{it}{100}\right)^{T/t} - 1}\right] \quad \ldots . \quad (7 - 31)$$

where:

i = denotes the rate of interest

t = the time period between payments (yrs)

T = the total time of amortization (yrs)

The equation above is based on the principle of equal instalments paid every t years, starting t years after date on which the contract is signed, and going on for a total of T years. The number of instalments will be (T/t). Further, the principle includes interest calculated on a depreciating capital. The derivation of this formula is not given here, as it is a standard acceptable form. The special case of $t = 1$ year is used in this model; whence equation (7-31) becomes

$$I = \frac{C\,i}{100}\;\frac{\left(1 + \frac{i}{100}\right)^{T}}{\left(1 + \frac{i}{100}\right)^{T} - 1} \qquad \ldots\ldots\ (7\text{-}31a)$$

This form has already been used in section 7.5.6.2 to denote the rent purchase value for land.

Using equation (7-31a) it is now possible to convert

$$(C_{dl,g,y,} + C_{c,g,y})$$

to its annual equivalent

$$(I_{dl,g,y,x} + I_{c,g,y,x})$$

Equations describing the minimum initial value of $(C_{dl} + C_{c})$ have been derived for all g, y in section 7.5.5.

This is given by

$$(I_{dl,g,y,x} + I_{c,g,y,x}) = (C_{dl,g,y} + C_{c,g,y})\ \frac{i}{100}\left[\frac{\left(1 + \frac{i}{100}\right)^{T}}{\left(1 + \frac{i}{100}\right)^{T} - 1}\right]$$

$$\ldots\ldots\ (7\text{-}32)$$

Thus for both forms of tenure, i.e. rent or rent purchase, the same equation can be used. However, the real rent will finally depend on the value used for (T) the time in years over which the costs are amortized. (T) must be selected to make the annual equivalent as small as possible, and must coincide with the value of (T) used for the amortization of land costs. The rate of interest (i) is fixed in this case to the amount stipulated by the Central Bank of Ceylon.

The selection of (T) that minimises the annual equivalent cannot be selected in isolation, since (T) controls the maintenance costs (M). Thus it is necessary to first consider the variation of (M) with (T), and thus select (T) such that the total costs to the consumer (R) are minimised.

7.5.9 The annual cost of maintenance (M) to the consumer

7.5.9.1 The total cost of maintenance

Whether the house is sold on a long term mortgage or rented it needs to be maintained. Maintenance is also necessary for the infrastructure serving the nett residential area. These costs must therefore be met by the tenant.

Studies[1] have shown that the cost of maintenance (M_t) of a house and infrastructure at age t yrs. is proportional to the initial cost of the housing unit and the initial development costs per unit.

Therefore, for all g, y, and x. the cost of maintenance (M_t) in the t^{th} year is given by:

$$M_t = (C_c + C_{dl}) \times K_8 \; \frac{(100 + qt)t}{100} \; \ldots\ldots \; (7\text{-}33)$$

where q% is the average rate of inflation in the building industry, based on the price index at year 0. K_8 is a constant. The total cost of maintenance after T years is therefore

$$\int_0^T (M_t).\, dt = (C_c + C_{dl}) \frac{K_8}{100} \cdot \int_0^T (100 + qt)\ t \quad . \quad dt$$

$$\text{i.e. } M_T = (C_c + C_{dl}) \frac{K_8}{100} \left[\frac{100T^2}{2} + \frac{qT^3}{3} \right] \; . \; . \; (7\text{-}34)$$

7.5.9.2 Recovery of maintenance costs

The maintenance of housing provided by the public authority is necessary from the point of view of maintaining the housing stock in a satisfactory condition and retaining its value.

If a house is sold on a mortgate it will be necessary that the house be maintained at least till the mortgage is paid up. If it is rented it will be necessary to maintain it throughout its life. In either case the cost of maintenance must be recovered over a period of time,

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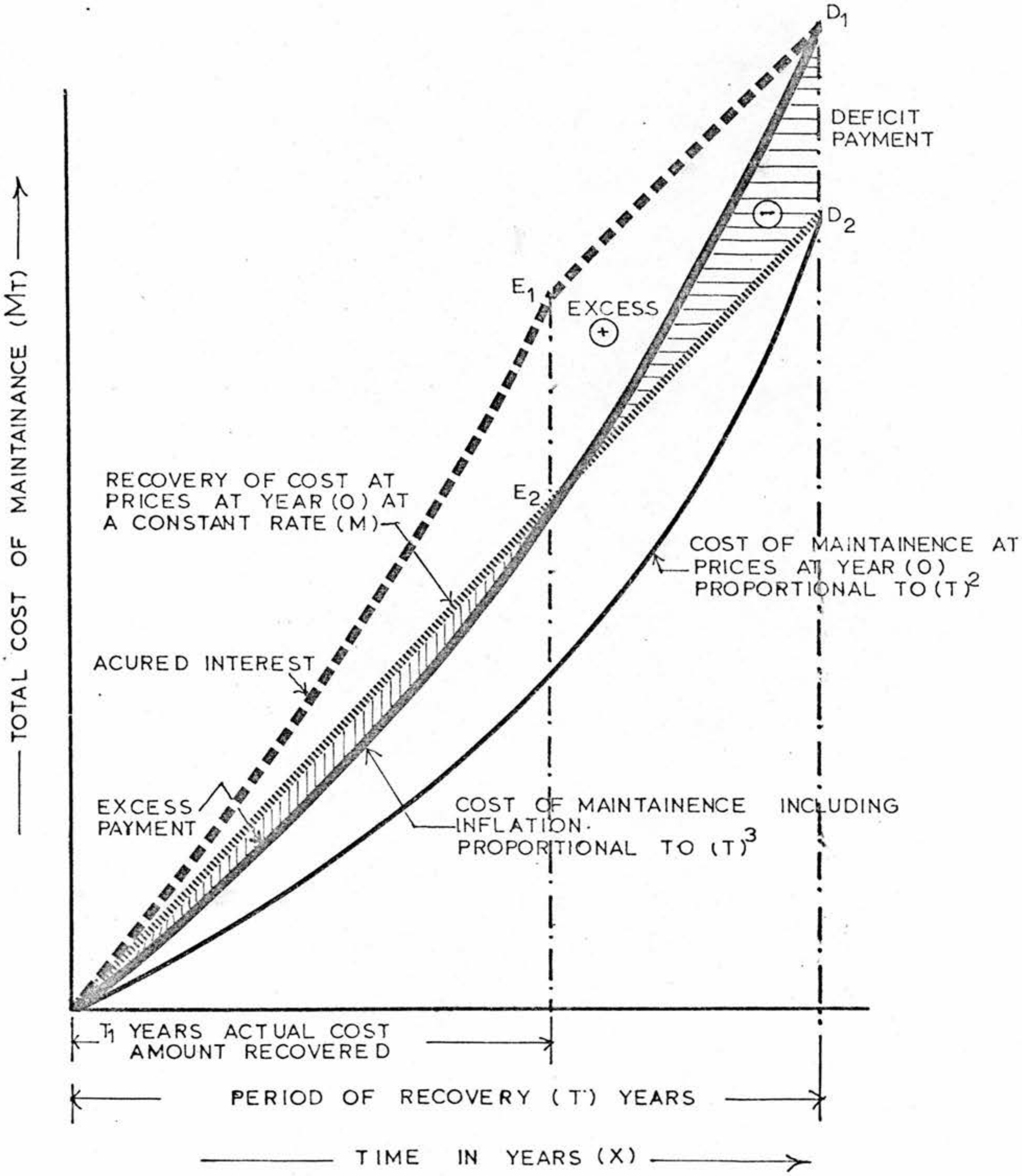
1 (a) Stone, P.A.(1970). Urban development in Britain. Standards, costs and resources, 1964-2004.

(b) Stone, P.A. Building design evaluation. Appendix B. Statistical treatment of durability and maintenance data, pages 179-188.

DIAG· 7–10

COSTS AND RECOVERY OF MAINTAINENCE



AT T_1 TOTAL EXCESS = $E_1 \cdot E_2$

AT T TOTAL DEFICIT = $D_1 \cdot D_2$

BUT $E_1 \cdot E_2$ IS $\geqslant D_1 \cdot D_2$ ∴ BALANCING PAYMENT say T years. If these costs are recovered monthly the money lies dormant, since maintenance is normally carried out annually or in special circumstances when it is required.

In view of the above circumstances it is proposed that the costs of maintenance should be recovered, but the rate of inflation be excluded. At a first glance one may then think that the public authority will have to bear the cost of inflation. This in fact is not so, since the money instead of lying dormant is used for further housing which is recovered with interest. In most cases this interest will be sufficient to meet the increased cost due to inflation. Diagram (7-10) explains the argument graphically. This policy, therefore, reduces the cost of maintenance to the consumer and provides resources for investment in new housing, which offsets the effect of inflation.

It can thus be concluded that the total maintenance cost to be recovered in T yrs. is given by

$$M_T = (C_c + C_{dl}) \cdot K_8 \frac{T^2}{2} \quad \ldots\ldots (7\text{-}35)$$

which disregards the increase due to inflation.

7.5.9.3 <u>The annual cost of maintenance</u>

From the discussion in 7.5.9.1 the annual cost of maintenance to the consumer can be given by (M), where:

$$M = \frac{M_T}{T}.$$

$$\text{i.e. } M = (C_c + C_{dl}) \; K_8 . \frac{T}{2} \quad \ldots\ldots\ldots\ldots (7\text{-}36)$$

To obtain the constant K_8 for this equation, a study of public sector housing in Ceylon was done using data from the records of the department of National housing in Ceylon. Equation (7-33) was used, and the data was adjusted to a base year thus overcoming the effects of inflation. The adjusted form of equation is:

$$M_t = (C_c + C_{dl}) \cdot K_8 . t \quad \ldots\ldots\ldots (7\text{-}33a)$$

The results of this analysis are presented in Chapter 9.

7.5.10 The minimum real cost of housing to the consumer (R)

In introducing section 7.5., by using the conclusions arrived at in Chapter 6 it was seen that the real costs are represented by R, where:

$$R = I + M \quad \ldots\ldots\ldots\ldots\ldots (6\text{-}3)$$

The objective of the theoretical analysis so far has been to arrive at the minimum initial cost C_u of providing housing, and express it as the annual equivalent cost of amortizing these costs, represented by (I).

The cost of maintenance was then analysed and expressed as a function of the initial costs of land development and construction of the housing unit.

It was seen that both, (I) and (M), are functions of time (T). Hence, it is now possible to arrive at an optimum value of (T), which minimises (R) using the following analysis.

7.5.10.1 Minimisation of (R) for a general case

Consider a general case, i.e. for all social classes (g), all forms of housing (y) and all forms of tenure (x), but excluding land costs. The real cost of housing to the consumer is represented by R, where

$$R = I + M \quad \ldots\ldots\ldots\ldots (6\text{-}3)$$

I is governed by the relationship,

$$I = C\frac{i}{100}\left[\frac{\left(1 + \frac{i}{100}\right)^{T}}{\left(1 + \frac{i}{100}\right)^{T} - 1}\right] \quad \ldots (7\text{-}31a)$$

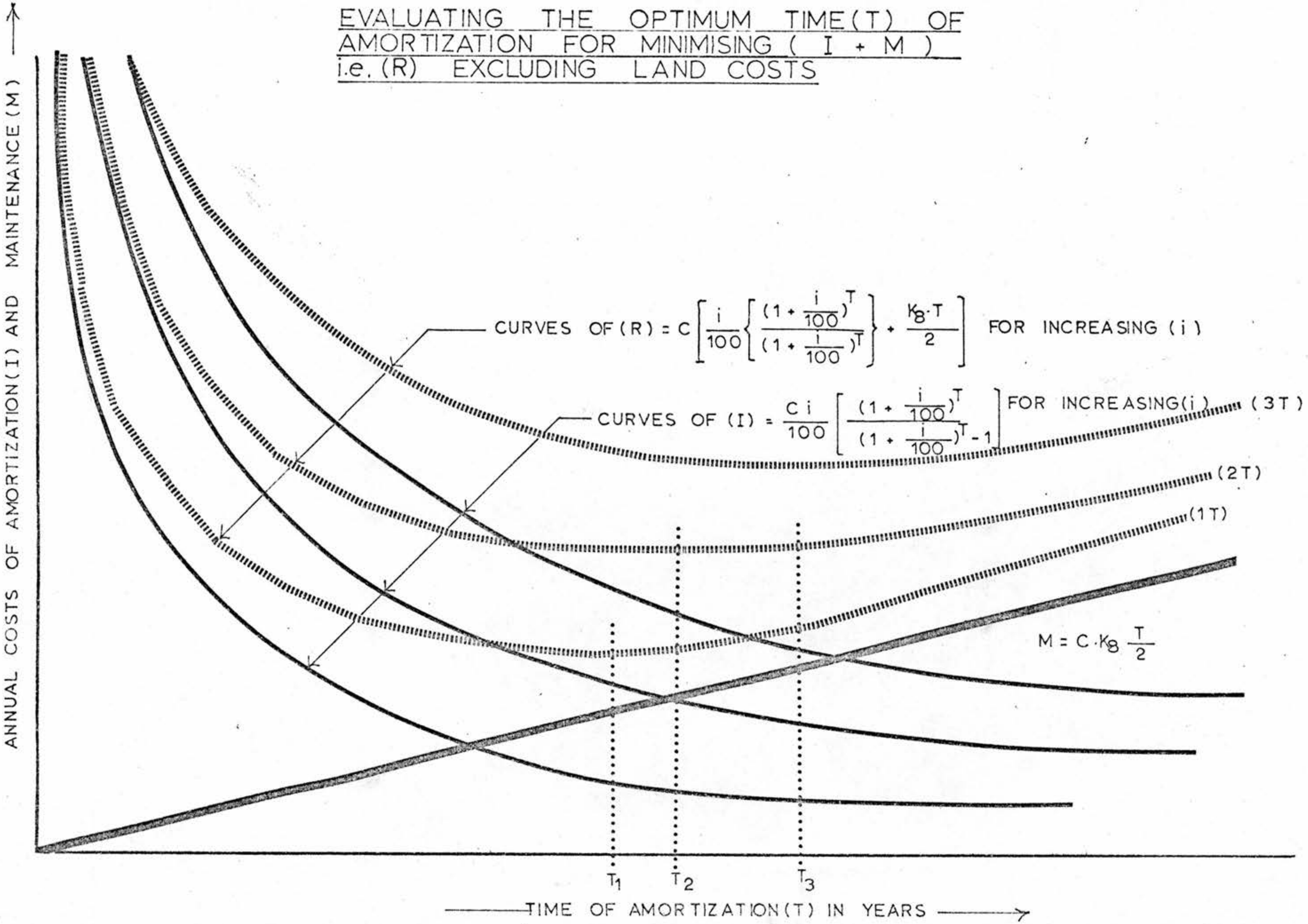
where $C = (C_{dl} + C_c)$., and C_{dl} and C_c are in turn governed by equations (7-29 and (7-21) for various g, and y. The cost of land $I_{l,g,x}$ does not affect (m) and is thus considered separately.

M is governed by the relationship

$$M = C.\ K_8.\ \frac{T}{2} \quad \ldots\ldots\ldots\ldots (7\text{-}33a)$$

DIAG. 7—11

EVALUATING THE OPTIMUM TIME(T) OF AMORTIZATION FOR MINIMISING (I + M) i.e. (R) EXCLUDING LAND COSTS



From these two equations it will be observed that the annual cost of amortizing the initial cost decreases, while the annual average cost of maintenance increases. Diagram (7-11) represents the two graphs. Hence, R is represented by the sum of these two and is also represented graphically. It will be observed R decreases to a minimum, and then increases again. Theoretically this will occur at the time when $\frac{d}{dT}(R) = \frac{d}{dT}(I + M)$ is equal to zero.

Thus, analysing the function theoretically,

$$R = I + M.$$

i.e.

$$R = \frac{C\,i}{100}\left[\frac{(1 + \frac{i}{100})^{T}}{(1 + \frac{i}{100})^{T} - 1}\right] + C\,\frac{K_{8}.\,T}{2} \qquad ..(7\text{-}37)$$

$$\therefore \quad \frac{dR}{dT} = 0 \;, \quad \text{gives}$$

the optimum value of T, governed by the relationship

$$50.K_{8}.\left[(1 + \frac{i}{100})^{T} - 1\right]^{2} = i.\,T.\,(1 + \frac{i}{100})^{T-1} \quad ...(7.38)$$

The value of T may be arrived at more easily from the graphical solution, diagram(7 -11). It will be observed that as the interest rate increases the optimum time that minimises R, increases.

The analysis so far has excluded land costs. However, land costs must be included. For the case where $x = 1$, i.e. where the housing unit is for rent, the value of $I_{1,g}$ is calculated using equation (7-29). This equation is independent of T.

For the case $x = 2$, where the house and land is on rent purchase, C_1 must be added to $(C_{1d} + C_c)$ and used in equation (7-31a), while equation (7-33a) remains the same. This will result in the amortization curve moving up due to the increase in C. This would therefore result in a higher annual payment, and also in a longer period if this payment is to be the minimum.

These curves are determined practically for the direct development of urban housing in Ceylon in Chapter 9, subject to the following special limitations, and conditions.

7.5.11 Limitations and conditions for the practical determination of the minimum real cost of housing to the consumer (R)

In concluding this section of the overall model it is useful

(1) To state briefly the steps in arriving at the minimum cost of housing (R) to the consumer

and

(2) to state the practical limitations and conditions for this model.

Summing up the foregoing discussions, the following procedure can be drawn up for determining the minimum initial cost of housing to the consumer (R).

(1) Determine standards as described in sections 7.4.1 and 7.4.2, i.e. density and space standards. These will be for each social group of the population described by g, for g = 1, 2, and 3.

(2) Determine the general models for evaluating the initial cost of land C_l, land development C_{dl}, and housing unit C_c, to the standards prescribed for each social group above. These are given by equation (7-12a), section 7.5.2.1; equation (7-19) section 7.5.2.3; and equation (7-21) section 7.5.2.4. It must be noted that each of these models has household size (h) as an independent variable, and C_l includes location (d).

(3) Adjust the equations for variation in form (y). At this stage important practical limitations arise. Consider each social group in turn.

<u>g = 1: Blue collar workers</u>

This group of the population already lives in the three forms of housing suggested, i.e. complete houses (y=1), semi-permanent houses, which are equivalent of core houses (y=2), and temporary structures which are equivalent to self help housing (y=3). Therefore for this group all forms could be considered, for all household sizes (h).

<u>g = 2, and g = 3: White collar non professional and professional or managerial workers</u>

An observation of this class of society in urban Ceylon shows that this group even at very high rents, and the discomforts of sharing a house, tend to live in permanent houses. Hence the social desire appears to be for permanent housing at any cost. This therefore creates a practical limitation. Hence, in providing housing for these groups core housing, or self help housing cannot be considered. Therefore only the model for the complete house i.e. (y=1) can be used for g = 2, and g = 3.

Therefore for practical application there exist three models for the working class, and one model each for the middle class, and upper class.

(4) For each set of equations developed in (3), determine the design variables S, f, and n for all household sizes (h). Of course, core housing for group 1, will have f = 1, and self help housing will have both f and n = 1. The design variables are determined using the technique described in section 7.5.3., and equations (7-19) and (7-21) for g = 1, y = 1, 2, 3 , g = 2, y = 1 , g = 3, y = 1 .

(5) The next stage is to determine expressions for the minimum cost to the consumer (R) for each social group, subdivided by possible form, for possible types of tenure for a household of size (h). Here, once again consider each case in turn.

(1) <u>$g = 1, y = 1, x = 1$</u> i.e. a complete house for a working class household, on a pure rental basis.

The land rent is determined using equation (7-29). The period of amortization (r) is determined using equations (7-31a) and (7-33a) for $g = 1$, $y = 1$, and the technique described in 7.5.10. The resulting value of T is used, and the resulting expression for R is:

$$R_{1,1,1} = 0.04\, C_{1,1} + (C_{dl,1,1,} + C_{c,1,1}) \left[\frac{i}{100} \cdot \frac{(1 + \frac{i}{100})^T}{(1 + \frac{i}{100})^T - 1} + \frac{K_8 \cdot T}{2} \right] \quad \ldots (7\text{-}39)$$

Since the costs are a function of household size (h) and distance (d) annual minimum cost R is a function of (h, d). See Chapter 9 for the practical determination of this equation for the city of Colombo. The value of T determined may in certain cases be greater than the life of the house L. In this case L is selected as the value of T to be used.

(2) <u>$g = 1, y = 2, 3, x = 1$</u>

In this case the only change is in the form of housing. In the case of $y = 2$, the form is core housing, and $y = 3$ gives self help housing. The same procedure as given in (5)(1) above is used, but when calculating R for core housing, i.e. $y = 2$. The value of C_c only is multiplied by a fraction (F_2). This denotes the actual monetary expenditure, as the balance comes in the form of payment via self help labour. For self help housing it is the same, but the fraction is F_3, where

$F_3 < F_2$ since all labour is provided by the prospective tenant. However, is this system practically workable? It will be workable only if the prospective tenant is guaranteed tenancy for the useful life of the house. Hence, this is a condition that must be borne in mind when applying the system practically. This form includes the assumption that maintenance of the house will also be on a self help basis, except for structural maintenance.

This equation is determined practically, and presented in Chapter 9.

(3) $g = 1,\ y = 1,\ x = 2$

This is a case where both land and house are on a rent purchase basis.

The basic difference here is that the land rent is determined using equation (7-30) which is the same as the equation used for amortizing the costs of land development and the cost of constructing the housing unit.

Hence in applying the technique in section 7.5.10, the equation (7-31a), which shows $C = (C_{dl} + C_c)$ must also include C_l i.e. $C = (C_l + C_{dl} + C_c)$, while equation (7-33a) remains the same. This results in a greater value for I, and an increased period of amortization. If the value of (T) determined exceeds the period over which the household is capable of paying the annual cost (R), due to retirement of the head of the household, or split up by marriage, death etc, then T must be limited to 30 years. The value of 30 is selected on the basis that the average age of marriage of the head of the household will be about 25, and the age of retirement from active work in Ceylon is 55. This allows a maximum of 30 years during which the household may safely pay the cost without any hardship.

Therefore R in this case is expressed as:

$$R_{1,1,2} = (C_{1,1} + C_{dl,1,1,} + C_{c,1,1}) \frac{i}{100} \left[\frac{\left(1 + \frac{i}{100}\right)^T}{\left(1 + \frac{i}{100}\right)^T - 1} \right]$$

$$+ \left(C_{dl,1,1} + C_{c,1,1}\right) \cdot \frac{K_8 \cdot T}{2} \quad \ldots (7\text{-}40)$$

where $T \leqslant 30$

(4) <u>$g = 1,\ y = 2, 3,\ x = 2$</u>

These cases are treated similarly to (5)(3). The only difference is that the final expression for R must include the reduction factor F_2 for C_c in the case of the core house, and the reduction factor F_3 in the case of the self help house.

Chapter 9 gives the practical determination of these two cases.

(5) <u>$g = 2, 3,\ y = 1,\ x = 1$</u>

For the middle and upper social groups the only form is the complete house $y = 1$. Thus the only variable is the tenure x. For this case where $x = 1$, the expression for R can be derived as in case (5)(1), i.e. $g = 1$, $y = 1$, and $x = 1$. The only difference will be in the constants which depend on (g) for determination. Chapter 9 gives the derived practical equations.

(6) <u>$g = 2,3,\ y = 1,\ x = 2$</u>

Here once again this can be treated as in case (5)(3). As before the constant terms that depend on (g) will vary. The practical equations in this case are given in Chapter 9.

From the foregoing it can now be seen how this model provides housing for the different social groups, within the limits of technology and tenure at the least possible real cost (R) to the consumer. All the models have two independent variables. They are (1) household size (h) and (2) location defined by radial distance from the city centre (d). These two variables must be selected depending on the size of the household and the location of the house, resulting in the least possible value of (R) for a particular (h, d).

7.6 <u>A model describing the household's benefits or ability to pay for housing (A)</u>

A broad analysis in Chapter 6, section 6.2.3, showed that for Ceylon in general

(1) The benefits (A) derived from housing, represented by the household's ability to pay for housing increases with rise in social class

(2) The amount paid for housing (A) tends to increase with normal or long to run income (E), and may be approximated throughout by Reid's law which states that:

$$A \propto E^{\delta}$$

where $\delta > 1$

The analysis at that stage was broad and therefore ignored the effect of the following factors:

(1) Household composition

(2) Form of house ((y)

(3) Type of tenure (x)

and (4) The location of the house.

At this scale these factors must be considered, as they form the basic parameters in the formulation of a housing programme for an urban area.

David[1] has shown that an analysis of the amount paid for housing begins with the following basic equation:

$$A = \text{(quantity of housing consumed)} \times \text{(price/unit quantity)} \quad \ldots . \; (7\text{-}41)$$

David has measured the quantity in terms of rooms. The use of rooms as a measure may lead to discrepancies, as the size of the room may vary. Hence, the measure of quantity proposed here is the area (a) in sq.ft. of the housing unit. Further, the price/unit quantity measured by David was price/room. The measure used here will be the price per sq.ft. i.e. price/unit area. Therefore the basic equation (7-41) can be expressed as:

$$A = (a) \times (p), \quad \text{where} \quad P = A/a \quad \ldots . \; (7\text{-}42)$$

The components (a) and (p) can now be analysed, from which a theoretical function describing A in terms of the basic independent variables can be derived.

---

[1] David, M.H. (1962). Family composition and consumption. North Holland Publishing Company, Amsterdam. Chapter 5. Family composition and the consumption of housing, page 53.

7.6.1 The consumption of space, in sq. ft.

Ignoring all other factors, space (a), household size (h), and disposable income (E) being the only considerations, the area of housing consumed under ideal conditions will increase with h at a decreasing marginal rate of increase, and also increase with E at a decreasing marginal rate of increase.

These facts were used in section 7.4.2 to establish a theoretical model for determining space standards.

However, under the general existing distribution of households and houses other factors such as location, availability of housing etc. will also affect the consumption of space. Hence, the relationship derived for all households may not be as significant as the model derived using satisfied households, for establishing space standards.

However, the work done by David suggests that the trends observed in both the satisfied as well as the general population are the same. Therefore the consumption of space may be described by:

$$a = K_9 . \quad E^{\delta_1} \quad h^{\beta_1} \quad \ldots\ldots \quad (7\text{-}43)$$

where K_9 is a constant, δ_1 the income elasticity of space consumption, and β_1, the elasticity of consumption with respect to change in household size. It is expected that $1 > \delta_1 > 0$, and $1 > \beta_1 > 0$.

Incorporating the conclusion reached in Chapters 6 and 7 on the effect of social class, equation (7-43) can be made more realistic by using the subjective variable of social class by occupation (g) as defined. Thus, in general

$$a_g = K_{9,g} E^{\delta_{1,g}} h.^{\beta_{1,g}} \quad \ldots\ldots \quad (7\text{-}43a)$$

7.6.2 The price paid per sq. ft. of housing

Referring once again to the work done by David, he has shown that the price/unit room tends to be positively correlated with disposable income. Theoretically, therefore, it can be said that the price/sq. ft. will also increase with income (E). However, the marginal satisfaction gained may be less at higher incomes. Therefore the price / sq. ft. (P) may be proportional to E^{δ_2} where $1 > \delta_2 > 0$.

David has shown that household size (h) is more significant in explaining variation in (A) than (E) was. He has shown that as P decreases h increases. This is logical since larger households have to meet other basic commitments such as food and clothes, thus left with less to spend on housing at a fixed disposable income. Therefore P will be proportional to $h^{-\beta_2}$. Social class is an important variable in analysing expenditure patterns of households. As stated earlier higher social classes not only consume more space, but tend to look for a better quality of space. Thus, in general,

$$P_{g,d} \quad E^{\delta_{2,g}} \cdot h^{-\beta_{2,g}}$$

David in his study has left out the important consideration of location. Location affects the cost of land as seen. Further, housing located closer to the city centre in general will bring the household closer to a greater range of facilities, and also reduce overall costs of travel incurred by the household. Thus it may appear that if the house is defined for the purpose of location in terms of the radial distance (d) from the city centre, as d increases P will decrease. Therefore,

$$P \propto E^{\delta_{2,g}} \; h^{-\beta_{2,g}} \; d^{-\gamma_g}$$

The inclusion of the factor (g) will take into account mode of travel, and the benefits of living in the suburbs of a city. Hence one may find that as social class increases the value of γ may reduce.

It is now possible to state that

$$P,g = K_{10,g} \quad E^{\delta_{2,g}} \; . \; h^{-\beta_{2,g}} \; . \; d^{-\gamma,g} \quad \ldots . \; (7\text{-}44)$$

7.6.3 A theoretical model of the household's ability to pay for housing

Substituting equations (7-43a) and (7-44) in equation (7-41), the following expression for A is obtained.

$$A,g = (K_9 . K_{10}) \; . \; E^{(\delta_1 + \delta_2)\, g} \; h^{(-\beta_2).g.} \quad d^{-\gamma,g.}$$

From the work done by Reid, Chapter 6, and the diagram (6-3), it appears that $(\delta_1 + \delta_2) = \delta$, will be greater than 1.

The work done by David suggests that $\beta_2 > \beta_1$, therefore $\beta_1 - \beta_2 = -\beta$

The value of γ may be as suggested above.

Hence,

$$A,g = K_{11,g} \quad E^{\delta g} \; h^{-\beta,g} \; d^{-\gamma g} \quad \ldots \ldots (7\text{-}45)$$

Two important factors arise at this stage. They are the form of housing and the tenure.

The forms suggested use the labour of the prospective tenant in building the housing unit. This therefore suggests that for variation in form (y), the constant $K_{11,g}$ will decrease as more intensive self help methods are used.

The other factor to contend with is tenure. In this case it may appear that for rent purchase housing the constant may be greater than for pure rental housing. This may be due to the attitude taken by the tenant that in rent purchase housing he becomes the ultimate owner.

In general, therefore, the benefits, or the ability to pay for housing, may be described by the general model,

$$Ag,y,x = K_{11,g,y,x} \quad E^{\delta g,y,x} \quad h^{-\beta g,y,x} \quad d^{-\gamma g,y,x}$$

$$\ldots . \; (7\text{-}46)$$

The equation is calibrated using a special survey carried out (Appendix I) and the results are presented in Chapter 10, with a discussion on the variations of the constants K_{11}, δ and β and γ under the different conditions.

For the purpose of developing the overall theoretical model, the validity of the theoretical model above is assumed. This model can now be used with the model describing the real costs (R) to the consumer to achieve the objective of solving the housing problem of the urban area under consideration, at minimum physical costs.

7.7 The housing threshold and its use in minimising the subsidy content

In Chapter 6, the subsidy content in housing was defined by s, where

$$s = (R - A) \quad \ldots\ldots\ldots \quad (6\text{-}1)$$

i. e. the subsidy is equal to the real cost of housing to the consumer less the amount the household is able to pay for the house.

The relationship between subsidy and the socio-economic factors were discussed in section 6. 2. 3, and it was shown that in order to minimise subsidies, R must be reduced so that it is as far as possible equal to A. This as shown could be achieved to a greater extent by using the concept of demand rather than need.

The housing threshold was defined in section 6. 2. 2. as the household income level at which the real costs (R) are equal to the household's ability to pay for housing (A). From equation (6-1) this gives $s = 0$. Thus, the objective of the model at this stage is to define the variables that make s equal to zero as far as possible, and use these variables in determining a housing programme so that s is minimised.

7.7.1 The housing threshold

From the discussion in section 7. 7. the housing threshold can be defined by estimating the variables that make $s = 0$, i. e. $R = A$.

In section 7.5 expressions for minimum R were developed incorporating all the possible combinations of social class (g), form of house (y), tenure (x), household size (h), and location of house from the city centre (d). These expressions incorporated the standards necessary for the elimination of related social problems, and thus if implemented would solve the housing problem of the urban area under consideration. In general an expression for minimum R is given by

$$R_{g,y,x} = \emptyset\left[(g,\ y,\ x,)\ ,\ h,\ d\right] \quad .\ .\ .\ .\ .\ (7\text{-}41)$$

ie a function of the above mentioned variables, for a fixed rate of interest i for amortizing the initial cost.

In section (7-6) an expression was developed for the ability to pay for housing, incorporating various combinations of social class (g), form of house (y), tenure (x), household size (h), location (d), and normal or long run household income (E). In general this can be expressed as

$$A_{g,y,x} = \psi\left[(g,y,x),\ h,d,\ E\right] \quad .\ .\ .\ .\ .\ .\ .\ (7\text{-}48)$$

The objective now is to make R = A. Thus when using a combination of g, y and x for expressing R, the same combination of g, y and x must be used for expressing A. It is now possible to write the following expression.

$$R_{g,y,x} = A_{g,y,x}$$

i. e.

$$\emptyset_{g,y,x}\left[h,\ d\right] = \psi_{g,y,x,}\left[h,d,E\right] \quad .\ .\ .\ (7\text{-}49)$$

Using the above expression it will be noted that for a defined h, the threshold income (E) for a specified g, y, x, is a function of the location of (d).

From the expression it will be seen that a particular point in the urban area defined by (d) can provide housing for different threshold incomes. This occurs by changing (h), for different combinations of g, y, and x.

It is now possible to estimate theoretically the number of thresholds for a given location defined by (d).

Let the number of social classes be = g.
Let there be h different household sizes within each class.
Let there by y forms of house, and x possible tenure policies.
Then theoretically the number of thresholds (MT) possible are given by,

$$(MT) = {}^{g}C_1 \times {}^{h}C_1 \times {}^{y}C_1 \times {}^{x}C_1 \quad \ldots\ldots\ldots \quad (7\text{-}50)$$

i.e. $(MT) = g.h.y.x.$ . . . . (7-51) which forms the set of thresholds.

Example

It is intended to provide houses on a specified site, in a particular urban area. There are three social classes within the population, 6 different household sizes. The housing authority can provide three types of house, which can be rented or sold on a long term lease.

Solution

$g = 3, \quad h = 6,$
$y = 3,$ and $x = 2.$
Applying equation (7-51)

$$(MT) = 3 \times 6 \times 3 \times 2 = 108$$

∴ There are 108 possible thresholds for this particular site.

In practice, however, the number of thresholds will be less as seen in section 7.5.11. This occurs where a particular site is suited for less social classes than exist, and further when the tenure for each type will be limited. It can be further reduced by restricting a particular area for housing a particular household size. Further restrictions may occur in specifying a particular form of housing for the particular site within the urban area.

7.7.2 Use of the housing threshold for minimising the subsidy content (s)

The population of an urban area can be defined by social class (g), distributed by household size (h), and household income (E).

The public sector can provide housing of various forms (y), systems of tenure (x).

The urban area will have sites suitable for housing defined by (d).

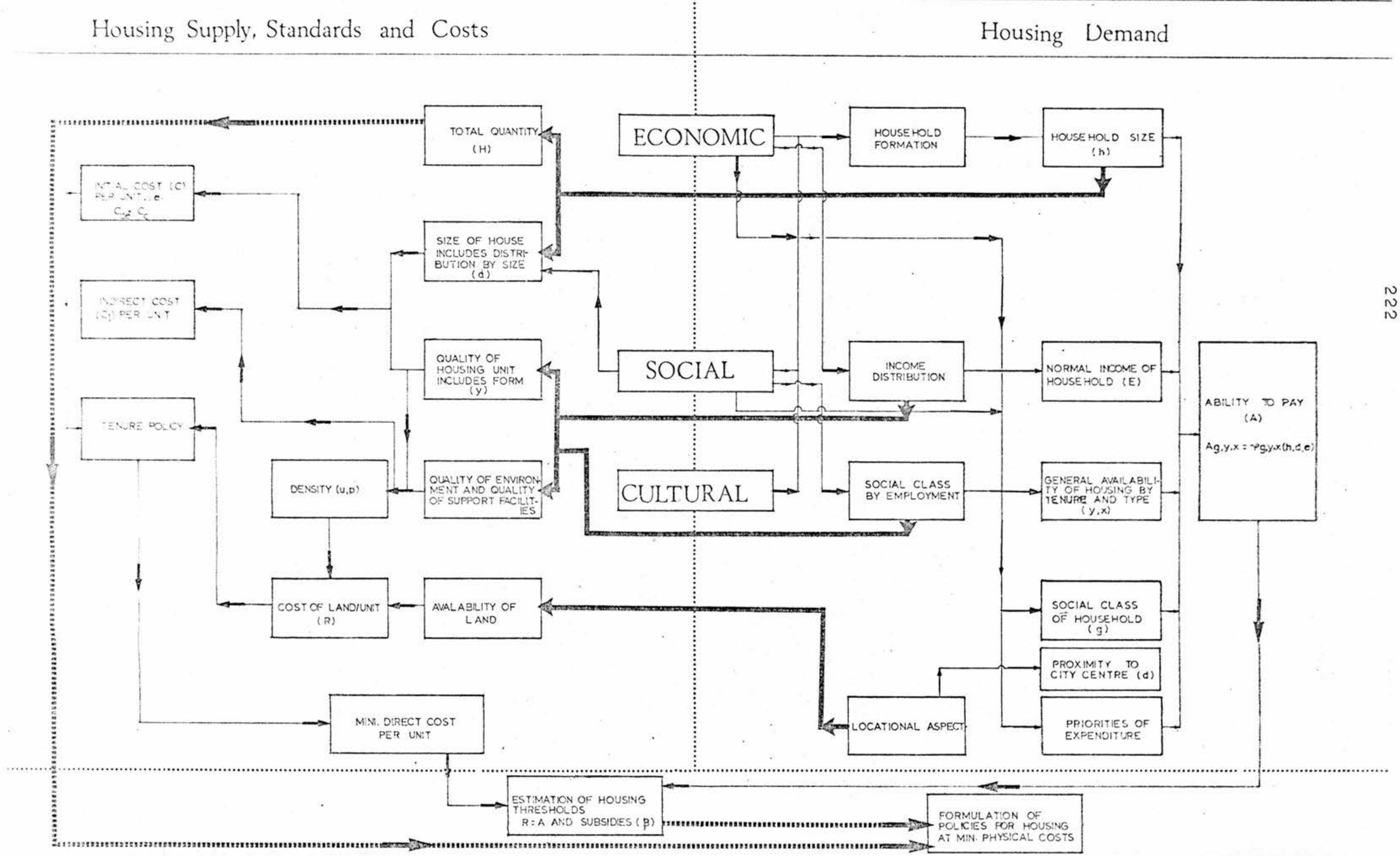
Hence in formulating a housing programme for the urban area it is possible to draw up the requirements in terms of class of house to be provided, and subdivide this by household size (h) and income groups (E). The class of house to be provided can be classified under the possible forms of house, and systems of tenure applicable.

Using the above data it will be possible to select the most suitable locations defined by (d), where d is obtained from equation (7-49). This results in a minimisation of the subsidy (s). The section of form must begin with the complete house and move down to other forms to be in accordance with section 7. 0(2c).

It will be appreciated that a section of the population will have incomes below the lowest threshold possible. This section of the population therefore can qualify for a subsidy where the subsidy is calculated using equation (6-1) where $s = R - A$.

For practical application and broad policy making "threshold tables" and "threshold maps" can be prepared for specified urban area. In Chapter 10 equation (7-49) is determined for the city of Colombo in Ceylon. This is then used to prepare a set of "threshold tables" and "threshold maps" for the city. The detailed use of these maps and tables is described in Chapter 11.

Model for Solving an Urban Housing Problem at Minimum Physical Costs



7.8 Conclusion

In conclusion, the model can be appraised in the light of the objectives it was to achieve. This poses three basic questions.

(1) Does the model solve the housing problem of the urban area, and thus the total urban housing problem?

(2) Is the solution achieved at the minimum physical costs by using the model for formulating an urban housing programme?

(3) Are self help techniques used only when absolutely necessary?

Diagram (7-12) represents an overall picture of the model, and will be used in the following discussion.

In accepting the concept of housing demand as a basis for the model, the standards developed were based on the social, economic, and cultural factors that determine the population. The discussion in Chapter 6 showed that this would lead to a solution to the housing problem. The development of standards therefore resulted in three sets of standards and described the basic parameters for formulating a housing programme. It was also seen from Chapter 6 that these standards would represent the minimum in quantity and quality, and were thus the first step towards minimising the initial costs. Therefore the model will solve the urban housing problem when applied to individual urban areas.

To achieve a solution to the housing problem at minimum physical costs there were two factors to be minimised, section 6.3. They were:

(1) The total quantity of housing

and (2) The physical cost/housing unit.

The total quantity of housing when based on the coneept of demand was shown to be the minimum required in Chapter 6, section 6.3.3. and represented the primary demand. This concept thus produced the model described in section 7.3 for determining the minimum number of housing units required for the population.

The physical costs per housing unit were defined in Chapter 6, section 6.3.2 by (I + M + s) where I represents the annual equivalent of amortizing the initial costs, C_u, M the annual costs of maintenance, and s the element of subsidy.

The discussion in section 6.3.2. showed that (I + M + s) can be minimised by minimising (I), and thus (R), since R = (I + M), resulting in a minimisation of I, M and s.

In section 7.5.5. the model developed expressed the minimum value of the initial cost C_u. This minimum (initial) cost was converted to the minimum (I) via the models in 7.5.6. Thus (I) was minimised for providing housing to the required standards.

The minimisation of C_u resulted in a minimisation of (M). Further, as seen in section 7.5.10 the variations of minimum (I) and (M) with time(t) were considered, which resulted in a minimisation of (R) by using the optimum time (T) for amortization.

Finally, using the model for describing (A) the ability to pay, or demand for housing, the subsidy factor s was minimised since s = R - A (6 - 1). This was achieved by selecting the location(d) so that s was as far as possible equal to zero. At this stage the form of housing selected began with the complete house, then used the core house, and then the self help house in order to minimise the use of self help techniques, section 7.0(2c).

Overall it will be observed that this theoretical model based on the concept of "housing demand", and applicable at the urban scale, will achieve the objective of solving the urban housing problem at minimum physical costs.

The following chapters 8, 9 and 10 will present a calibration and testing of this theoretical model by using data obtained from a survey described in the Appendix I and unpublished data collected in Ceylon.

Finally, Chapter 11 will explain the use of the calibrated model in formulating a public sector housing programme, for the direct development of housing in an urban area of Ceylon. The city of Colombo, for which the model is calibrated, is used as an example.

CHAPTER 8

Density and space standards

8.0 Introduction

The theoretical model developed in Chapter 7 indicated that three models had to be developed describing densities, occupancy rates, and consumption of space by the household.

The theoretical derivation of the above mentioned models has been carried out in section 7.4.

The purpose of this chapter is to establish the validity of the theoretical models. This is done by calibrating the models, and showing that the trends indicated in the theoretical model appear to be correct.

Finally, standards are indicated. However, it must be noted that these standards are only a guide considering the size of the sample data (i.e. 2%). For practical use of the model it may therefore be necessary to calibrate the models using a much larger sample.

8.1 Residential density

The theoretical model section 7.4.1.2 established that in a satisfied population the gross and net residential densities may be described by:

$$\phi = \frac{\rho}{(1 + K\rho^{\alpha + 1})} \qquad \ldots\ldots\ldots\ldots (7\text{-}3)$$

where ϕ is the gross residential density, and ρ the net residential density in persons per acre. It was suggested that the various social groups may have different tendencies, which result in changes in the values of the constants, K and α.

8.1.1 Method of testing the model

To test the model the following procedure was adopted.

(1) The total size of the residential area was determined.

(2) The gross residential area was determined.

(3) The net residential area was determined.

(4) The population was estimated.

(5) The gross and net densities were estimated.

(6) A survey was carried out to determine what level of satisfaction was being experienced by the population resident in the respective areas, with respect to the density levels. This was expressed as a percentage.

(7) The gross density that would exhibit a 100% level of satisfaction was then calculated.

(8) Gross densities calculated at 100% satisfaction levels were then plotted against existing net densities.

(9) The shape of the graph was then compared with the theoretically expected to confirm trends suggested by the hypotheses.

(10) Approximate values of density standards were then estimated.

The details of carrying out the above procedure, and the results, are described in the following section.

8.1.2 Practical calibration of the model

Described below are the practical details and the results obtained.

8.1.2.1 Determination of the total residential area

The fundamental difficulty of testing this model was to determine the size of the residential area.

The original approach was to use the administrative boundaries i.e. ward boundaries of the Colombo municipality[1]. However, on

[1] The map in Diagram (A1-1) shows the boundaries referred to.

detailed examination it was found that these boundaries are purely hypothetical and are used mainly as a device to divide the population more or less equally among the forty seven wards within the municipality.

This led to an important question. What criteria could be used for defining a residential area?

The population in Colombo, like many urban areas in Ceylon, tend to buy their food and consumable articles in small quantities, and at short intervals of time. This is unlike the European custom of weekly shopping. The shopping habits may be as frequent as daily or once in two days. This is probably due to the climatic conditions where food cannot be kept for long periods, unlike in the temperate areas. This was an indication as to how a residential area may be defined.

Due to the abovementioned reasons, central market areas have developed over time, which have also become the centres of transport facilities, and entertainment facilities. It must be noted that these were not planned development, but spontaneous, and have developed over time. Hence, these points are defined as nodes, and the area these nodes serve was used as the total residential area.

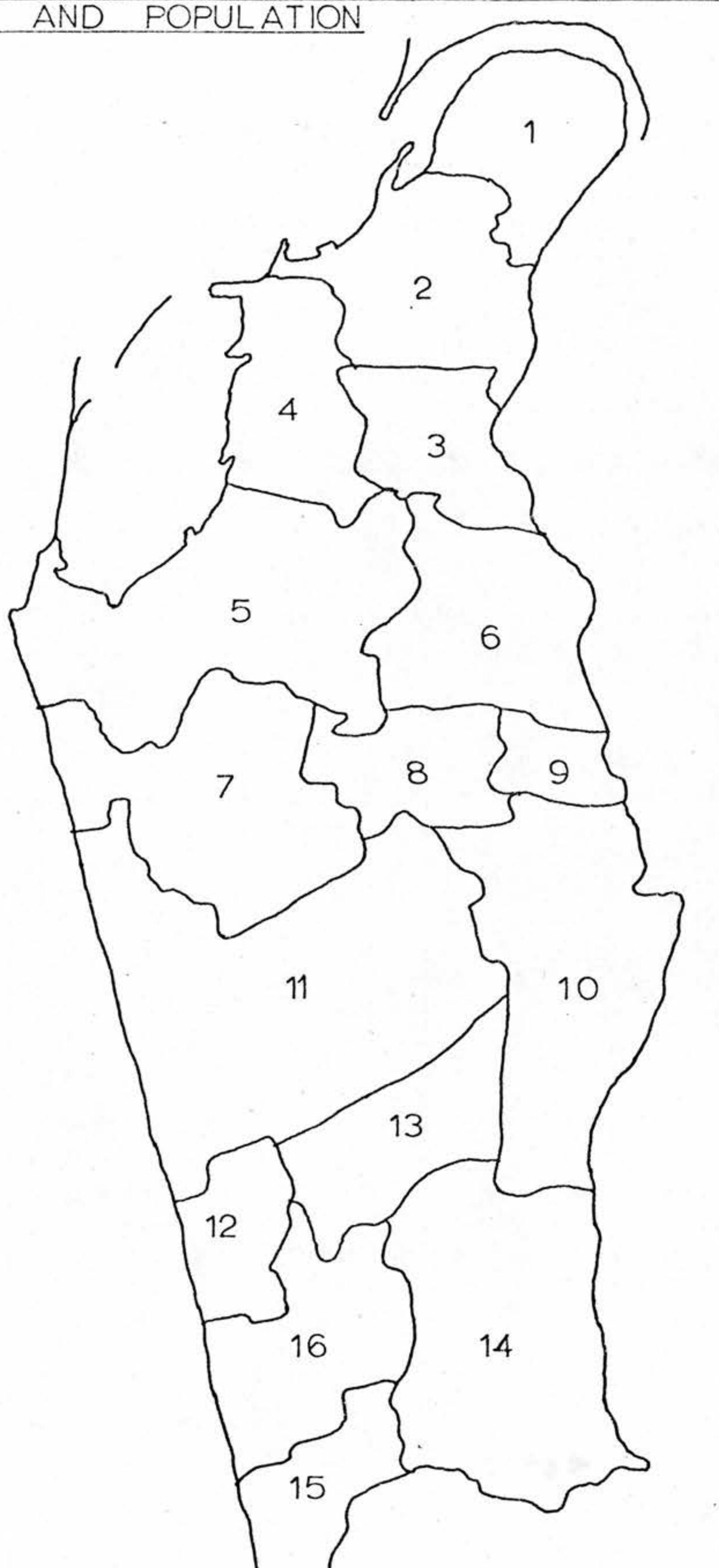
In order to determine the catchment area of the node, question 3(1) of the annexed questionnaire (Annexure 1, of Appendix I) was introduced. The question was:

> "Where do you normally shop for your food and other consumable articles"?

The nodes had been specified by code numbers (section 7, Annexure 1, Appendix I), and thus the interviewer could enter this code number in the appropriate column. The answer to this question is indicated in columns 54 and 55 of the listed data.

DIAG. 8-1

CITY OF COLOMBO CATCHMENT AREAS OF NODES AND POPULATION



(APPROXIMATE SCALE 70 CHAINS TO 1 INCH)

The exact location of the households was plotted on a map (scale 1" = 8 chains). The nodes were also indicated on the map. By joining the houses by straight lines on the periphery of the node indicated, it was possible to estimate the approximate catchment area of each node. These approximate areas were then refined to conform to the administrative boundaries of the wards within each area. This was done since population data was available by ward after the 1971 census.

There were, of course, exceptions to the rule, though not of significant importance. The main exception occurred among the upper social group (11%), who tended to move to the larger nodes, thus having a wider area of operation. This can be explained by the fact that this group uses private transport while the other groups either use public transport or travel by foot.

Since the area and population[1] of each ward was known it was possible to calculate the total area of each catchment area and the population within it. Diagram (8-1) indicates the catchment areas on a map of approximately 70 chains to 1 inch. Table (8-1) indicates the nodes, the catchment areas in acres, and population of each area. There were sixteen catchment areas, for a population of 562,160 and a total area of 9,166 acres.

8.1.2.2 Determination of gross residential area

To determine the gross residential area within each ward, the following areas were estimated from the map of 1" = 8 chains, for each catchment area.

(1) Marsh land[2]

(2) Areas covered by water.

(3) Industrial areas which included factories and railway yards.

(4) Predominantly large administrative and commercial areas. This occurred within the city centre.

These areas were then deducted from the total catchment area and the result was treated as an approximation of the gross residential area. Table (8-1) indicates the figures obtained.

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[1] Preliminary statistics of the 1971 census. Dept. of Census and Statistics. Sri-Lanka (1972)

[2] Reclamation of marshes in and around the city of Colombo. - Colombo reclamation board.

8.1.2.3 Determination of net residential area

Once again using the map of scale 1" = 8 chains, the area used specifically for housing within each catchment area was determined.

In this case there is a tendency for slight error due to the intermingling of land use mainly small commercial units within the net residential area. However, it was considered sufficiently accurate as it was virtually impossible to separate these extremely small variations in land use.

These figures are also presented in table (8-1) in acres.

8.1.2.4 Estimation of gross and net densities.

On evaluating the areas of gross and net residence, and knowing the population, the gross and net densities were estimated. These figures are presented in table (8-1).

8.1.2.5 Estimation of level of satisfaction

The first question that arose was, what criteria to use to evaluate the level of satisfaction.

The criteria used was based on the principle that the main support facilities for a net residential area in urban Ceylon are:

(1) Shopping facilities

(2) Parks and playgrounds

(3) Schools

and (4) Entertainment facilities.

Thus questions (5(1) to 5(4) were formulated as shown in Annexure (A1-5). These questions determined whether the household found each of the above facilities sufficient, insufficient, or too much. The answers to these questions are indicated in columns 70, 71, 72 and 73 of the data given in Appendix I.

Using a weighted average of 1 for shops, 5 for parks and play grounds, 5 for schools, and 1 for entertainment facilities, based on the proportional use of space, it was possible to give each positive answer the scores stated above. The maximum score possible was 12. Thus by summing the scores of individual households for each area a percentage was estimated based on the maximum possible.

It will be noted that the theoretical analysis suggested that there may exist different levels of satisfaction for the different social groups.

To verify whether such a case existed the population was classified by social group using question 1(12) of the annexed questionnaire (Annexure A1-5). The levels of satisfaction were thus calculated for each area, subdivided by social group. Table (8-1) gives the levels of satisfaction estimated for each group.

An interesting point that comes out of this analysis is that though theoretically it was expected to have a large difference in the levels of satisfaction for each social group, this did not occur in practice. The difference exists as can be seen from table (8-1), but is not large, and therefore does not warrant the use of different density levels. Thus it appears that for Colombo residential density may be similar for the different social groups measured in persons per acre.

8.1.2.6 Estimation of gross densities for a 100% level of satisfaction, relationship to existing net densities

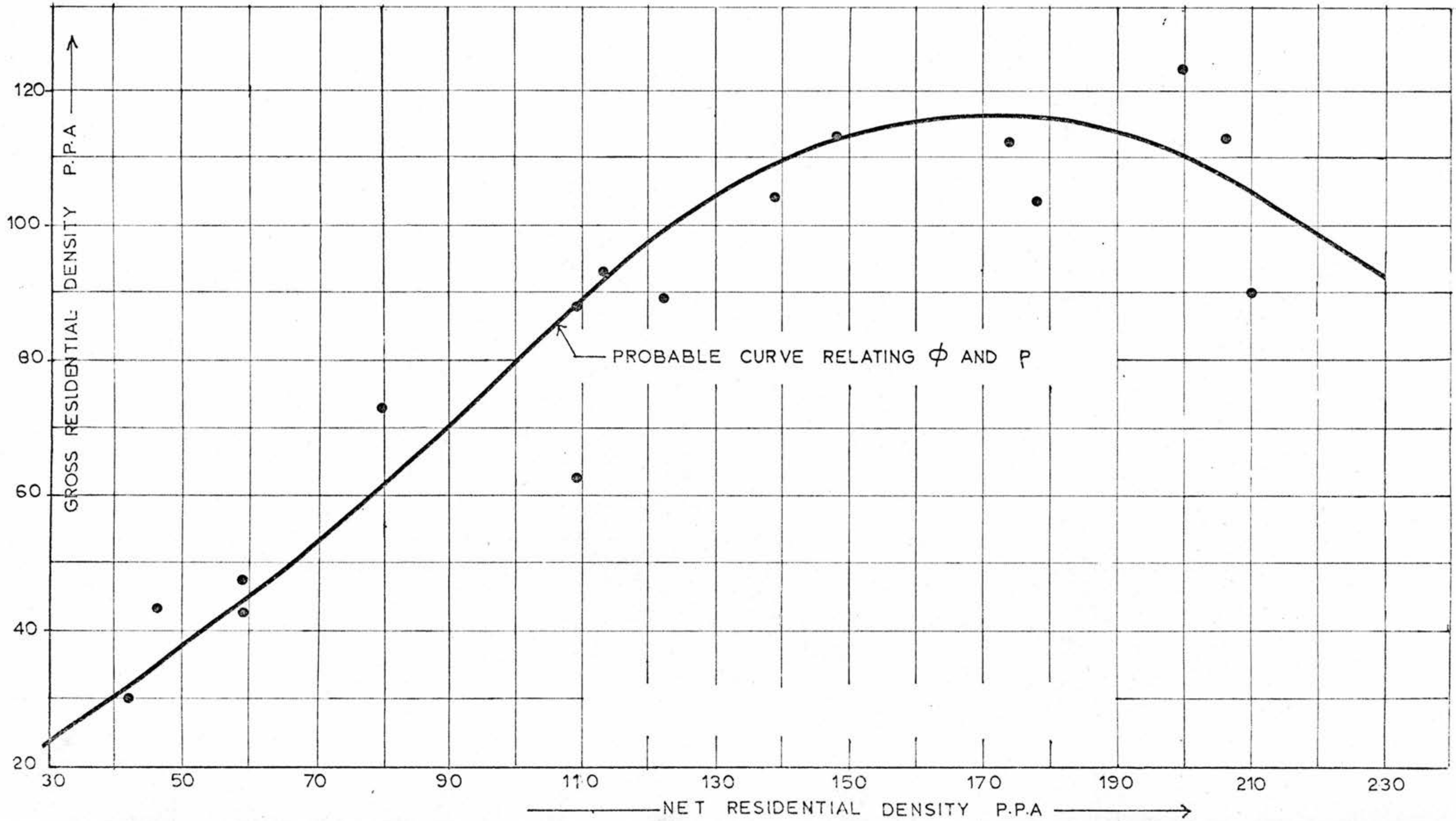
Using the calculated existing gross densities, and the average level of satisfaction of the population, a simple linear extrapolation was used for estimating the probable gross density at a 100% level of satisfaction. This was based on the principle that as gross densities increased dissatisfaction increased, where dissatisfaction was estimated at (100 - % level of satisfaction). Hence proportional estimates were made, and are given in the last column of table (8-1).

TABLE (8 - 1) Net and Gross residential densities in persons/acre, City of Colombo - 1971 - indicating level of satisfaction

Node No.	Total Area Acres	Area other than housing acres	Gross res. area acres	Total Land for supp. L_s acres	Net Res. Area Acres	Net Density ρ p.p.a.	Gross Density $\emptyset$ p.p.a.	Population P	% Sat. 1	% Sat. 2	% Sat. 3	$\emptyset$ at 100% Average
1	412	175	237	100	137	109	63	14,903	100	100	100	63
2	526	165	361	85	276	148	113	40,996	100	100	100	113
3	352	198	154	18	136	200	176	27,109	75	70	60	123
4	419	70	349	64	285	115	94	32,869	95	95	95	89
5	1,016	257	759	154	605	172	137	114,216	88	85	80	117
6	571	341	230	16	214	250	210	47,200	48	43	38	90
7	755	354	401	166	235	178	104	42,091	100	100	100	104
8	240	63	177	38	139	206	263	36,699	49	43	39	113
9	137	45	92	20	72	177	139	12,815	83	75	68	104
10	818	413	405	140	333	113	93	37,776	100	100	100	93
11	1,414	50	1364	370	994	42	30	41,787	100	100	100	30
12	250	00	250	50	200	59	47	11,814	100	100	100	47
13	438	70	368	24	344	46	43	15,781	100	100	100	43
14	885	450	435	29	406	99	92	40,450	90	100	100	88
15	321	25	296	25	271	80	73	21,657	100	100	100	73
16	504	00	504	100	404	59	48	24,016	100	90	90	43

DIAG. 8-2

RELATIONSHIP BETWEEN NET AND GROSS DENSITIES AT 100 % SATISFACTION



Using this information the graph of gross densities in p.p.a at 100% satisfaction were plotted against the existing net densities. The points are shown in diagram (8-2).

8.1.2.7 Probable relationship and standards of density

The points on the graph indicated in diagram (8-2) indicate that as net density increases gross density increases and then tends to decrease once again, at a 100% level of satisfaction. This trend is in keeping with the theoretical trend predicted, though not exact. Hence, the theoretical probable curve was drawn as indicated in diagram (8-2).

The equation of the curve was not calculated as the number of observations, namely 16, were too small to get a significant fit. However, from a practical point of view the curve drawn is sufficient for making an approximate estimate of the standards.

The reasons for the shape of the curve have been explained fully in Chapter 7, section 7.4.1.2, and confirm that as net densities are increased more land should be provided for support facilities if the social content of the housing problem is to be solved.

From the economic point of view the maximum gross density possible should be used. From diagram (8-2) this appears to be 118 persons per acre, at a corresponding net density of about 170 persons per acre. Expressed in housing units/acre for an average household of 6 persons this means a gross residential density of about 19 houses to the acre and a net density of about 28 houses to the acre. The average British standard for net density in comparison is 15 houses to the acre, which is approximately half. This may be due to the vast difference in economic levels of the two countries, which reinforces the economic aspect in the provision of housing.

Hence overall it appears that public sector investment in the direct development of urban housing in the city of Colombo should aim at residential densities of about 120 p.p.a. gross, and 170 p.p.a. net. This is about 6.0 acres per thousand people at the above mentioned net density.

8.2 Occupancy rate.

In section 7.4.2, Chapter 7, the probable relationship that would exist between occupancy rate, social class, and per capita income of a household was established.

In this section it is proposed to verify the theoretical propositions and evaluate standards of occupancy rate suitable for the various social groups.

8.2.1 Establishing the practical relationships

In the survey described in Appendix I, households were classified by social group - question 1(12), size of household - question 1(2), number of habitable rooms in house - 4(9), i.e. excluding kitchen and bathroom and toilet, and tenure of house, i.e. rented or owner occupied.

Hence the survey data as given in tables (A1-1) to (A1-8) are classified by tenure, social class, type of house. Further, columns 6 and 7 of the tables indicates the number of persons in the house, and columns 67 and 68 the number of habitable rooms in the house.

The next important question that arose was to estimate the total household income, and thus the per capita income of the household.

In order to estimate the household income one fact was obvious, which was - any question on income would result in misleading answers due to some inbuilt fear in the Ceylonese population of revealing their real incomes. Further such a question would lead to errors due to the introduction of a seasonal component within

TABLE (8 - 2a) Per capital household income($^{E}/h$) and occupancy rate (q) in persons per habitable room for satisfied households, working class, renters, Colombo. Source Survey, Appendix I

SER. NO. APP. I	($E/_h$)	(q)	SER. NO. APP. I	($E/_h$)	(q)	SER. NO. APP. I	($E/_h$)	(q)
0022	51	3.0	5092	98	1.0	3041	83	1.5
0172	52	1.5	5132	66	3.0	3421	28	4.25
0232	52	2.5	5142	44	2.0	3601	50	1.5
0312	132	1.0	5222	74	2.0	3661	50	3.5
1072	52	3.0	5792	79	1.5	3721	57	3.5
1122	51	2.0	0051	45	2.5	3771	42	1.75
1232	80	1.6	0111	66	1.0	3881	61	2.6
1452	29	3.0	0211	108	1.6	4071	76	1.5
1592	44	2.5	0231	52	1.6	4531	52	2.0
1732	55	1.6	0551	60	1.6	4541	46	2.5
1802	59	1.3	0631	51	1.6	4561	93	1.0
1842	63	0.5	0781	98	0.5	4891	128	1.0
2552	46	2.6	0831	46	2.25	4921	73	1.0
2742	58	3.5	0911	69	1.3	5091	47	3.0
2772	56	4.0	1221	68	1.5	5451	47	1.0
3002	89	1.0	1261	118	2.0	5501	82	2.0
3182	47	1.6	1881	24	1.5			
3242	77	2.0	2041	53	2.5			
3802	56	4.0	2191	175	1.0			
3872	28	3.0	2221	54	1.0			
3932	71	1.5	2331	63	2.0			
4082	51	1.75	2731	93	1.5			
4102	37	2.25	2751	44	0.75			
4202	37	1.6	2901	26	4.0			
4212	63	3.0	2911	66	1.5			
4592	191	0.6	2941	70	2.0			
5062	57	2.5	2951	114	1.0			

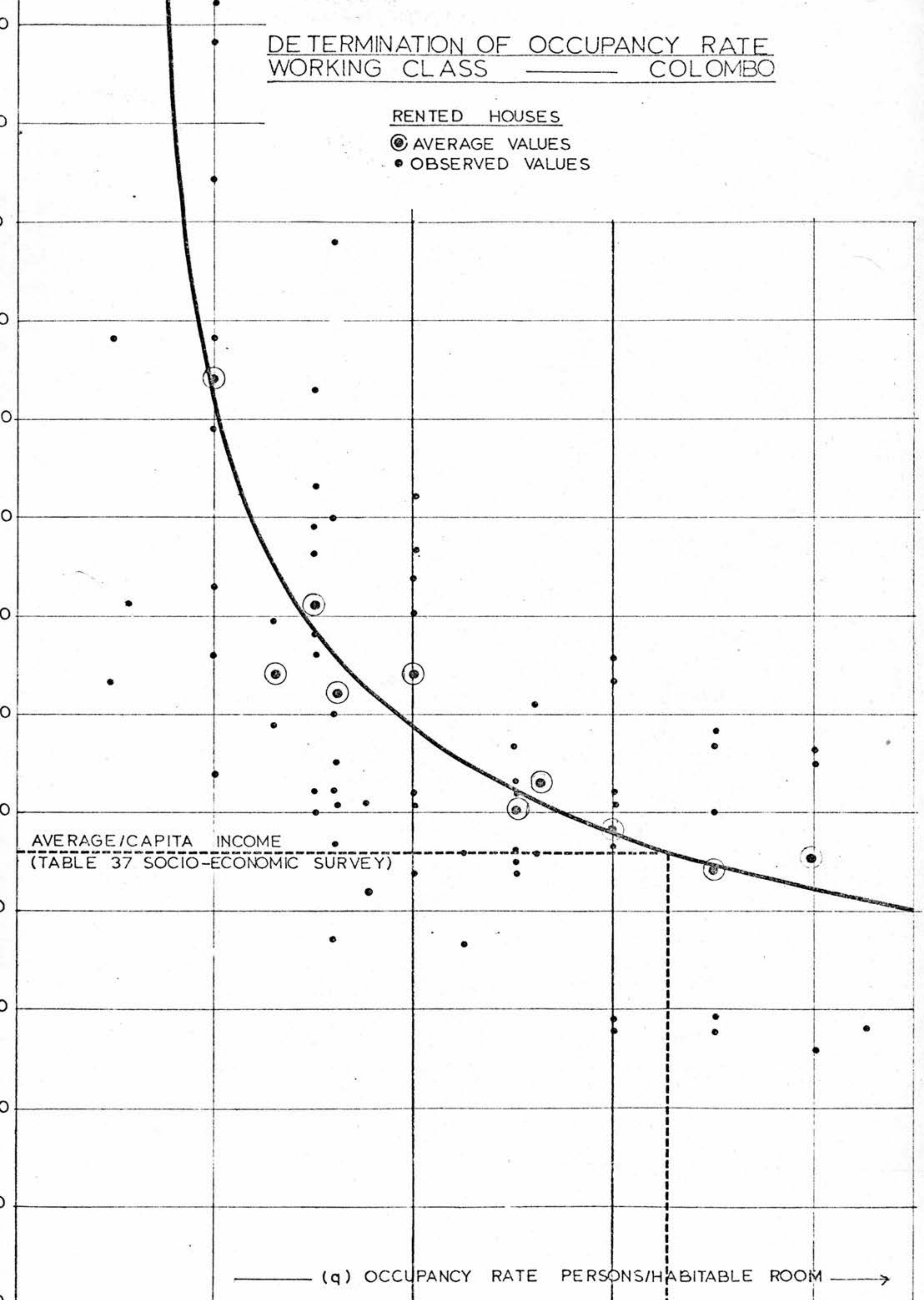
TABLE (8 - 2b) Per capita household income (E/h) and occupancy rate (q) in persons per habitable room for satisfied households, middle class renters, Colombo. Source - Survey, Appendix I

SER. NO. APP. I	(E/h)	(q)	SER. NO. APP. I	(E/h)	(q)	SER. NO. APP. I	(E/h)	(q)
0362	203	2.2	5272	193	1.0	3931	73	1.2
0812	128	1.0	5282	121	1.0	3981	49	4.5
0852	291	0.6	5552	60	1.2	4031	40	2.5
0872	109	2.5	5722	161	1.0	4051	74	1.4
0942	95	1.1	5812	40	3.0	4111	57	2.3
0972	64	1.4	5872	125	1.3	4171	71	1.2
1992	115	1.2	5882	192	0.8	4371	413	0.45
2132	165	1.0	5902	120	1.1	4481	103	2.5
2192	88	1.0	5942	101	1.2	4841	92	1.0
2562	126	1.0	0571	62	1.6	4871	96	0.8
2682	32	4.0	0751	81	1.3	4901	98	1.3
2702	57	1.5	0761	183	0.4	5081	172	1.0
2832	38	3.3	0981	115	2.3	5101	86	1.0
2872	74	1.75	0991	145	1.5	5121	155	1.0
3092	102	2.0	1021	66	2.0	5131	121	1.25
3952	83	2.0	1121	40	2.4	5181	177	0.7
4092	48	1.5	1281	70	2.1	5251	80	2.3
4832	144	1.2	1571	71	2.3	5611	76	0.9
4842	128	1.3	2091	34	2.0	5681	112	1.0
4892	160	1.2	2201	88	1.6	5741	113	1.25
4962	91	2.0	2681	70	1.6	5761	112	1.25
4972	112	1.2	2741	65	4.0	5811	74	2.25
4982	86	1.0	2761	36	3.3			
5102	94	2.2	2871	65	3.0			
5172	146	1.6	3121	80	1.6			
5192	71	1.5	3591	138	1.0			
5262	130	2.0	3761	104	0.83			

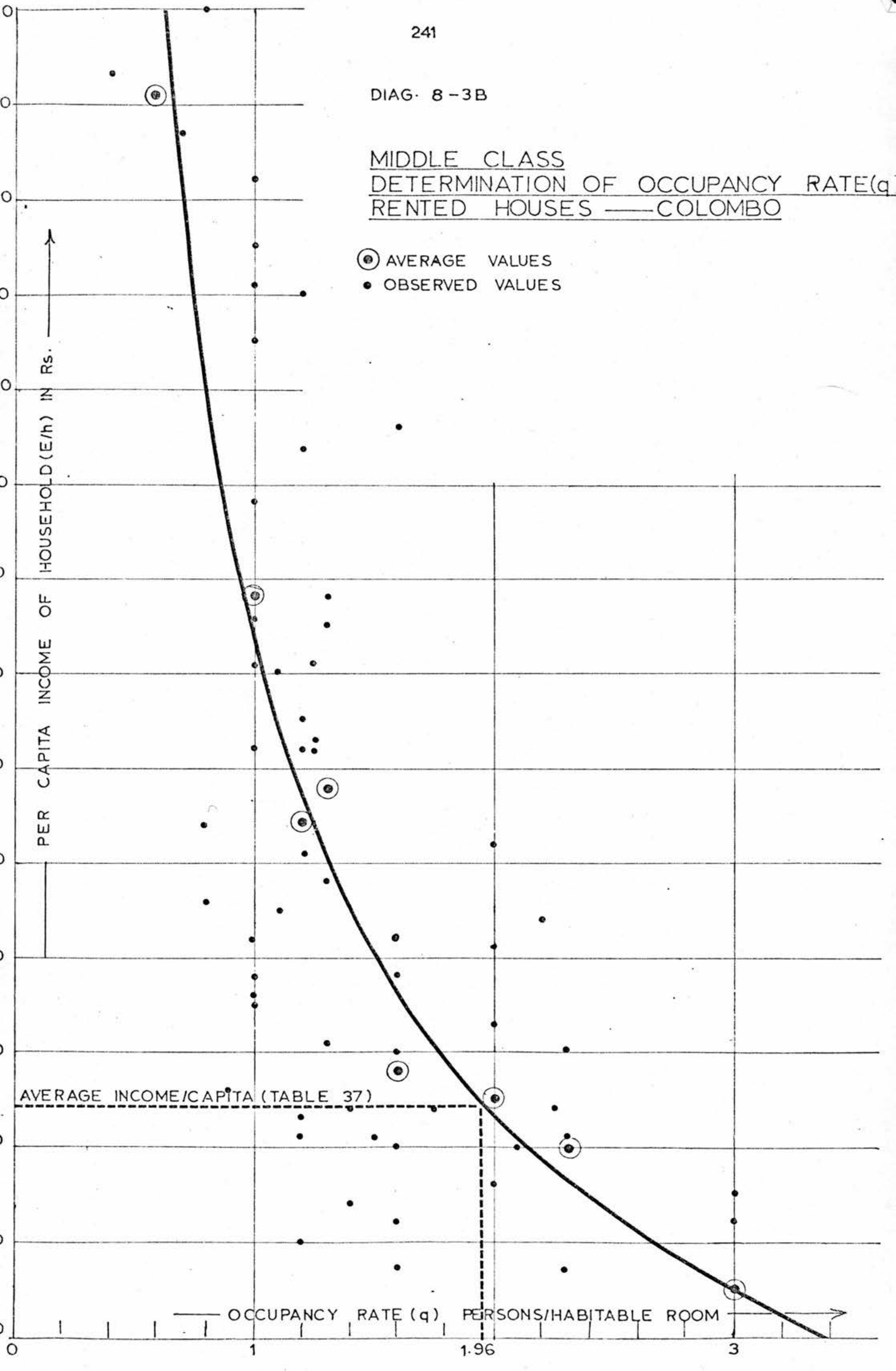
TABLE (8 - 2c) Per capita household income (E/h) and occupancy rate (q) in persons per habitable room for satisfied population, upper class renters, Colombo. Source Survey Appendix I

SER. NO. APP. I	(E/h)	(q)	SER. NO. APP. I	(E/h)	(q)	SER. NO. APP. I	(E/h)	(q)
0622	112	1.25	5492	225	0.75	4961	150	1.1
1392	258	1.25	5512	33	3.0	5171	222	1.3
1482	115	1.60	5602	140	1.2	5231	101	2.0
3782	75	2.2	5712	191	1.0	5241	131	1.25
3862	104	1.1	5732	110	1.75	5261	166	1.3
3992	143	1.4	5762	142	0.8	5271	160	2.1
4262	209	1.0	5772	77	1.1	5291	126	1.6
4282	123	1.2	5852	120	1.0	5351	184	1.0
4372	255	1.0	5862	175	1.2	5391	79	1.6
4472	167	0.9	0061	110	0.8	5401	103	1.5
4692	160	1.1	1601	200	1.3	5461	130	1.3
4722	106	1.0	1961	315	1.0	5491	100	2.0
4802	335	0.6	2261	90	1.0	5711	123	1.75
4852	127	1.1	2421	210	0.8	5781	134	2.25
4932	195	1.2	3061	121	1.1	5821	180	1.0
4952	212	0.6	3101	126	1.5	5881	212	1.3
5052	237	1.0	4081	46	3.0	5901	103	2.0
5112	209	1.2	4241	230	2.3	5911	122	1.0
5122	151	1.25	4311	294	1.25			
5242	85	1.5	4331	242	1.0			
5252	140	2.0	4361	114	2.0			
5322	174	0.9	4441	203	1.8			
5382	156	1.5	4601	270	1.0			
5432	126	1.25	4691	230	0.6			
5442	109	1.25	4731	301	1.1			
5482	106	1.25	4811	196	0.8			
			4881	192	0.6			

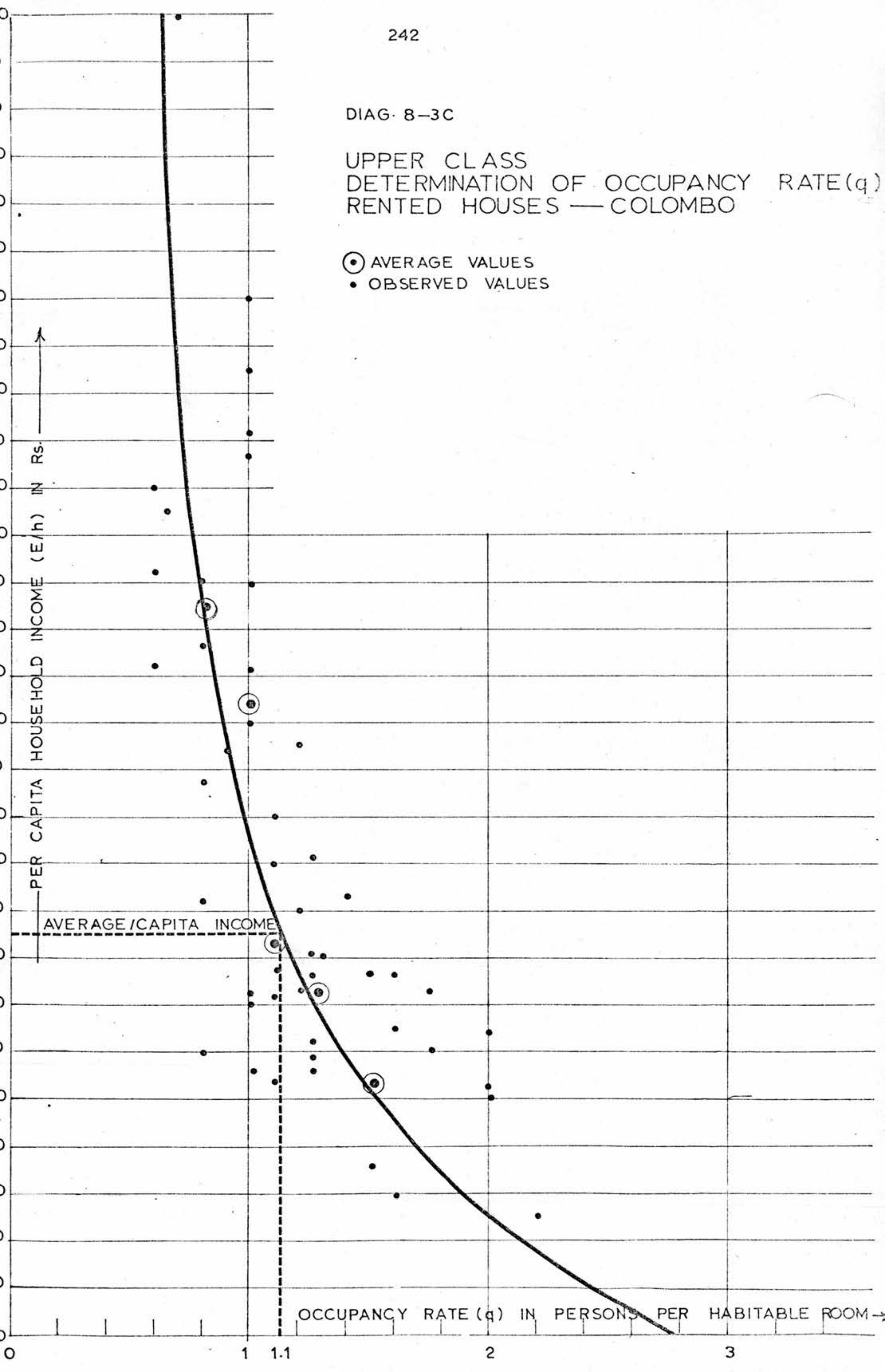
DIAG. 8–3A


DETERMINATION OF OCCUPANCY RATE
WORKING CLASS —— COLOMBO
RENTED HOUSES
AVERAGE VALUES
OBSERVED VALUES
AVERAGE/CAPITA INCOME
(TABLE 37 SOCIO-ECONOMIC SURVEY)
(q) OCCUPANCY RATE PERSONS/HABITABLE ROOM
1
2
3
3.25
4

DIAG. 8 - 3B



MIDDLE CLASS
DETERMINATION OF OCCUPANCY RATE(q)
RENTED HOUSES —— COLOMBO
AVERAGE VALUES
OBSERVED VALUES
PER CAPITA INCOME OF HOUSEHOLD (E/h) IN Rs.
AVERAGE INCOME/CAPITA (TABLE 37)
OCCUPANCY RATE (q) PERSONS/HABITABLE ROOM
0
1
1.96
3


DIAG. 8–3C
UPPER CLASS
DETERMINATION OF OCCUPANCY RATE(q)
RENTED HOUSES — COLOMBO
AVERAGE VALUES
OBSERVED VALUES
PER CAPITA HOUSEHOLD INCOME (E/h) IN Rs.
AVERAGE/CAPITA INCOME
OCCUPANCY RATE (q) IN PERSONS PER HABITABLE ROOM
0
1
1.1
2
3

the blue collar workers. Thus the method used was to establish expenditure patterns on individual items of household expenditure and use the sum of these items as an approximation of normal or long run income. Question (2) of the questionnaire (Annexure A1-5), deals with this. It will be observed that ten basic items which broadly cover the household's expenditure were used. Each of these items is given individually in columns (21-24), (25-27), (28-30), (31-33), 34-36), (37-39), (40-42), (43-45), (76-78) and (49-51), of the tables in Appendix I. These columns when added gave the approximate idea of the normal or long run income. Their values may be slightly overestimated[1] among the working class, and underestimated among the upper classes. However, they are more accurate than a direct question on income due to reasons explained.

The next question that arose was whether to use the information of both renters and owner occupiers.

Renters are not tied down, unlike owner occupiers. Hence it was felt that owner occupiers would accept conditions of overuse or underuse without complaint, and were thus excluded.

The final question that arose was once again the level of satisfaction. This was necessary since the relationship was derived theoretically for a satisfied population. Hence question 4(10) was formulated which enquired whether the household felt it had sufficient, insufficient, or too many rooms. The answer to this question is given in column (69) of the data sheets.

Thus tables (8-2a), (8-2b) and (8-2c) were drawn up which indicated the serial number of the household, the per capita income of the household, and the occupancy rate for renters who were satisfied with the number of rooms for the different social groups.

These points were then plotted in per capita income of household (E/h) along the y axis, and occupancy rate (q) along the x axis.

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[1] See Annexures 2, 3 and 4 in Appendix I, which use the reports of the interviewers.

The scatter may have occurred due to the non availability of suitable housing, locational factors, quality of housing etc.

Hence the average values of $(E/_n)$ were estimated for different (q) and a smooth curve drawn through the resulting points. Diagrams (8-3a), (8-3b) and (8-3c) refer.

It will be observed from the diagrams that on the average the tendency is for occupancy rate to increase with a decrease in per capita household income. This is in keeping with the theoretical analysis.

It will be observed that for the same income levels, higher classes appear to have a higher occupancy rate. This is explained by the fact that higher social classes demand a better quality of house, and more overall space, as will be seen in the next section on space standards. Thus they pay more per unit area for quality and more for consuming more in quantity. Thus occupancy rate is meaningless without reference to the space consumed. Variations may also occur due to the concepts of privacy each group holds. Note that higher social classes tend to ultimately smaller occupancy rates, i.e. 0.75, 0.6, and 0.6.

8.2.2 Standards of occupancy rate

The main purpose of this exercise was to establish some standards which can guide public sector investment in the direct development of urban housing in Ceylon.

To establish standards it was necessary to estimate as accurately as possible the average income of households, and thus the per capita income of an average household for each group.

The most reliable information available for this was from the socio-economic[1] survey of Ceylon for 1969-1970, Table 37 of this

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[1] Department of Census and Statistics (1972). Preliminary report of the socio-economic survey (1969-70).

survey gave the number of income earners in the major occupational groups and the total income of each group for urban areas. It was thus possible to estimate the average income of a worker in each social group.

Table 31 of the same survey gave the average number of income receivers in urban households as 1.6, and the average size of an urban household as 6.3.

Using this information the average per capita income of a household for each group was calculated. They were:

Blue collar $(g = 1)$ = Rs. 46
White collar, non.prof. $(g = 2)$ = RS. 74
White collar, prof. $(g = 3)$ = RS.135.

Using these figures the corresponding values for occupancy rate are:

Blue collar $(g = 1)$	3 persons/habitable room
White collar non-prof. $(g = 2)$	2 " " "
White collar prof. $(g = 3)$	1 person/habitable room

These figures are thus suitable standards.

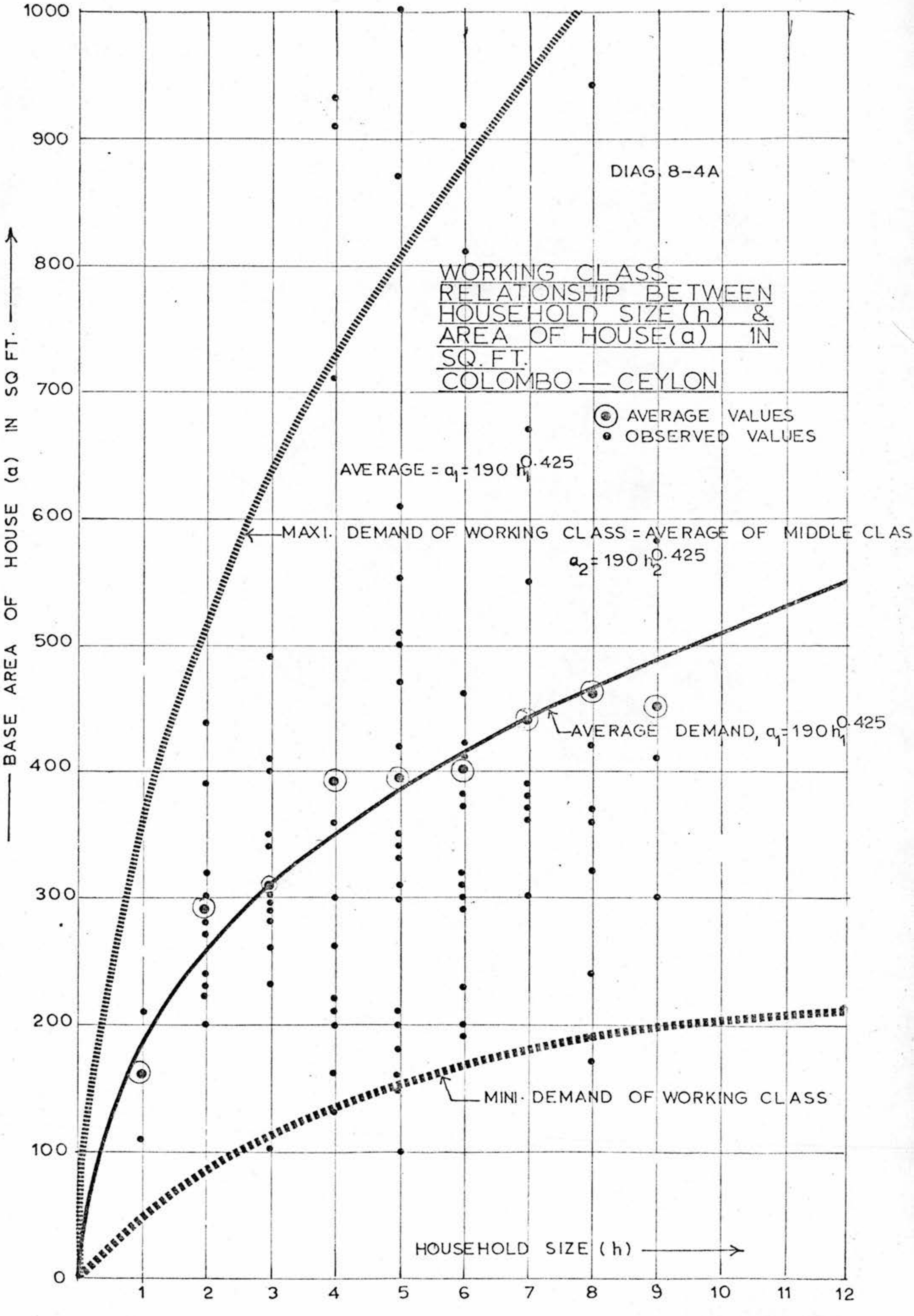
Note that these figures are in keeping with those suggested by Van Huyck for Ceylon (Chapter 7). Note further that socio-economic values are the important criteria for determining occupancy rate and not socio-physical problems as suggested in Chapter 2.

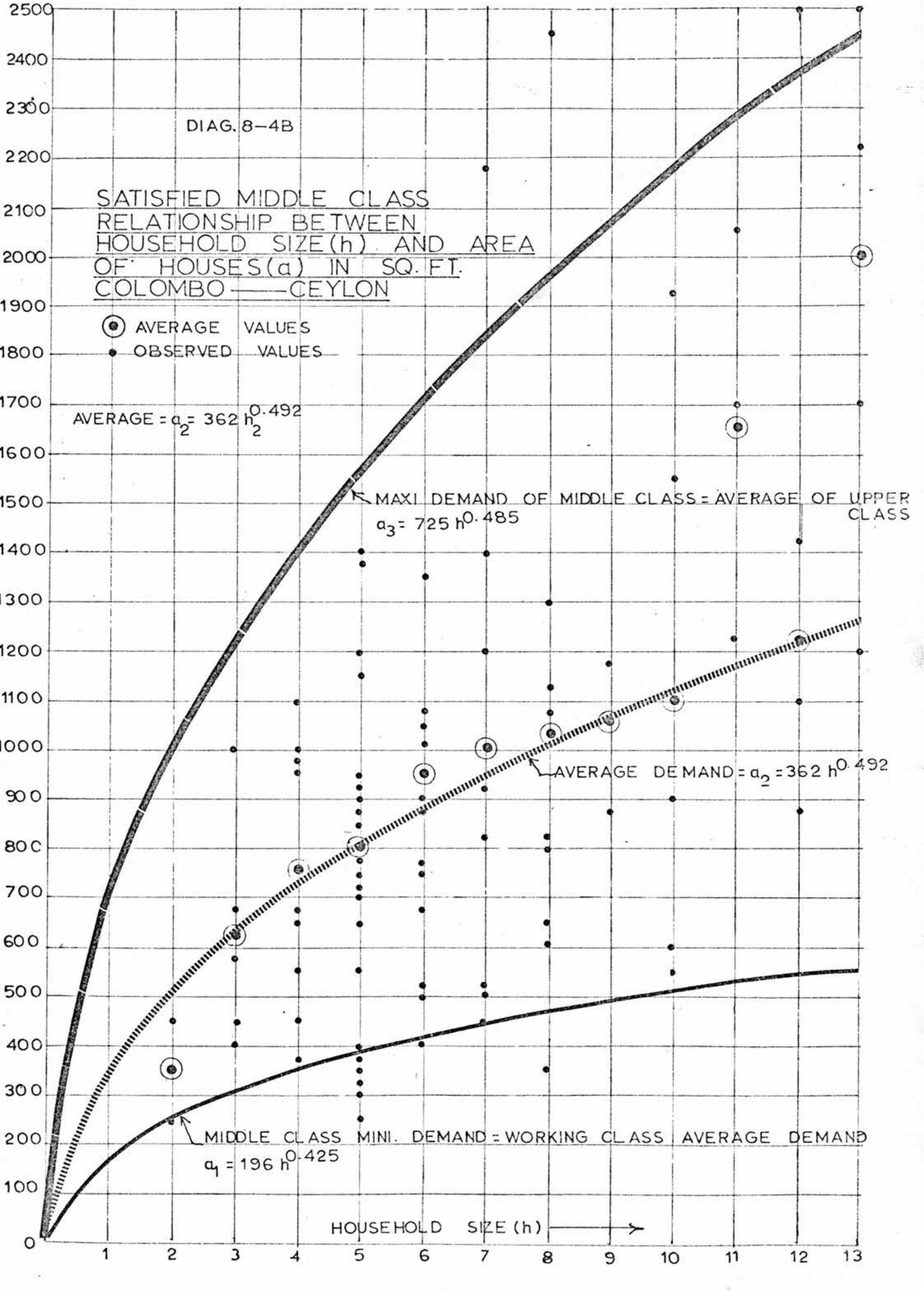
8.3 Consumption of space

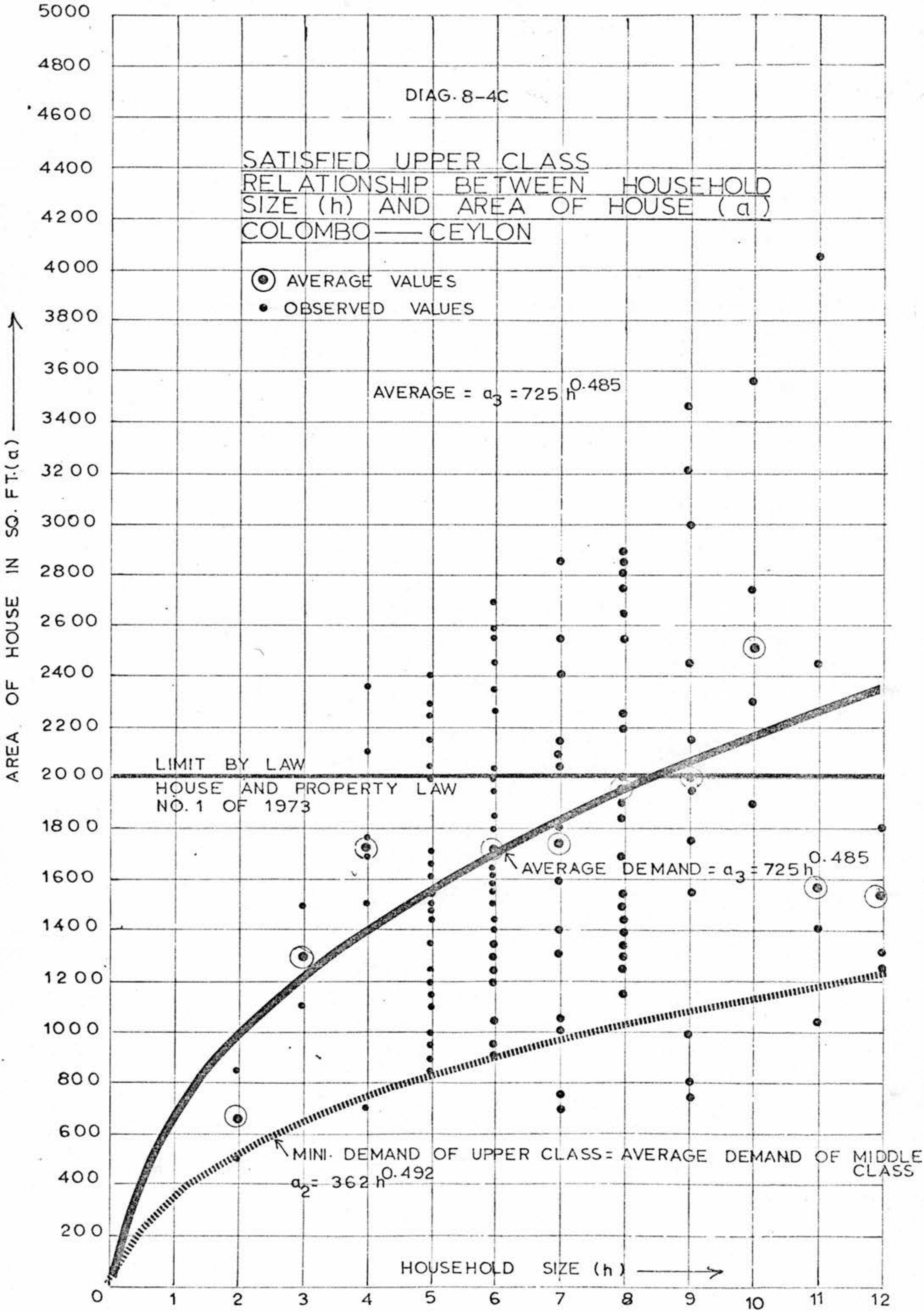
The discussion in Chapter 7, section .7.4.3, suggested that space standards for a satisfied household would be governed by the relationship:

$$a_g = K_{1,g} \cdot h^{p_{1,g}} \quad \ldots\ldots\ldots (7\text{-}8)$$

where a is the area of the house in sq.ft., and h the size of the household.


DIAG. 8-4A
WORKING CLASS
RELATIONSHIP BETWEEN
HOUSEHOLD SIZE (h) &
AREA OF HOUSE (a) IN
SQ. FT.
COLOMBO — CEYLON
AVERAGE VALUES
OBSERVED VALUES
AVERAGE = $a_1 = 190\ h_1^{0.425}$
MAXI. DEMAND OF WORKING CLASS = AVERAGE OF MIDDLE CLAS
$a_2 = 190\ h_2^{0.425}$
AVERAGE DEMAND, $a_1 = 190\ h_1^{0.425}$
MINI. DEMAND OF WORKING CLASS
BASE AREA OF HOUSE (a) IN SQ FT.
HOUSEHOLD SIZE (h)
0
100
200
300
400
500
600
700
800
900
1000
1
2
3
4
5
6
7
8
9
10
11
12


DIAG. 8–4B
SATISFIED MIDDLE CLASS
RELATIONSHIP BETWEEN
HOUSEHOLD SIZE (h) AND AREA
OF HOUSES (a) IN SQ. FT.
COLOMBO —— CEYLON
AVERAGE VALUES
OBSERVED VALUES
AVERAGE = $a_2 = 362\ h_2^{0.492}$
MAXI DEMAND OF MIDDLE CLASS = AVERAGE OF UPPER CLASS
$a_3 = 725\ h^{0.485}$
AVERAGE DEMAND = $a_2 = 362\ h^{0.492}$
MIDDLE CLASS MINI. DEMAND = WORKING CLASS AVERAGE DEMAND
$a_1 = 196\ h^{0.425}$
HOUSEHOLD SIZE (h)
0
100
200
300
400
500
600
700
800
900
1000
1100
1200
1300
1400
1500
1600
1700
1800
1900
2000
2100
2200
2300
2400
2500
1
2
3
4
5
6
7
8
9
10
11
12
13


DIAG. 8-4C
SATISFIED UPPER CLASS
RELATIONSHIP BETWEEN HOUSEHOLD SIZE (h) AND AREA OF HOUSE (a)
COLOMBO —— CEYLON
AVERAGE VALUES
OBSERVED VALUES
AVERAGE = $a_3 = 725\,h^{0.485}$
LIMIT BY LAW
HOUSE AND PROPERTY LAW NO. 1 OF 1973
AVERAGE DEMAND = $a_3 = 725\,h^{0.485}$
MINI. DEMAND OF UPPER CLASS = AVERAGE DEMAND OF MIDDLE CLASS
$a_2 = 362\,h^{0.492}$
AREA OF HOUSE IN SQ. FT. (a)
HOUSEHOLD SIZE (h)
0
1
2
3
4
5
6
7
8
9
10
11
12
200
400
600
800
1000
1200
1400
1600
1800
2000
2200
2400
2600
2800
3000
3200
3400
3600
3800
4000
4200
4400
4600
4800
5000

In order to verify this model, data from the survey was used. One was the size of the household, the other was the area of the house given in columns 57-60 of the data sheets in Appendix I. This information was obtained by noting the assessment number of the house and obtaining the area from the records of the Colombo municipality.

Here once again the question of whether renters only should be considered was thought of. In this case for the same reasons given under the discussion on occupancy rate, renters only were considered.

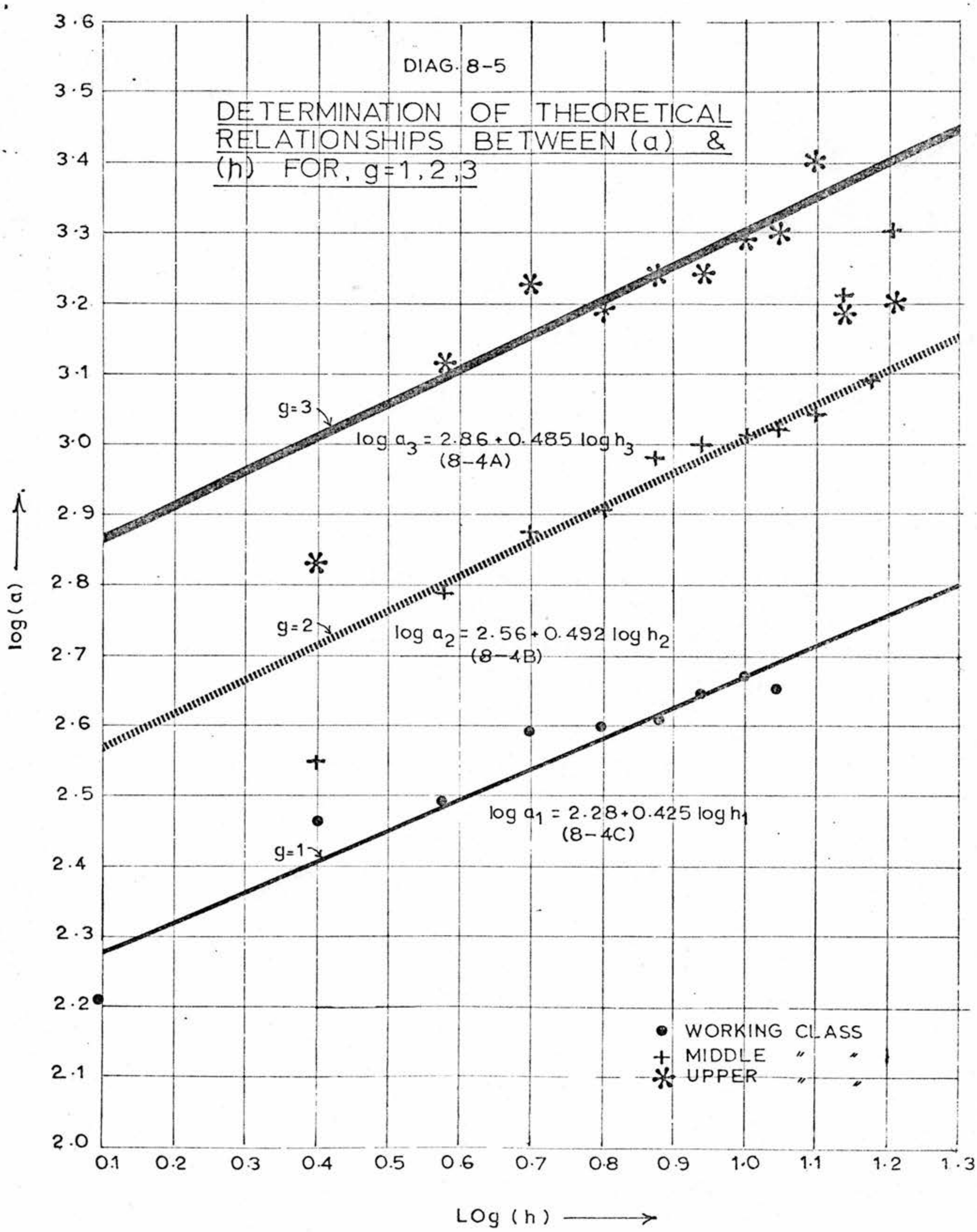
The question of satisfaction was treated in the same way as occupancy rate, i.e. those who felt the space was sufficient were the only ones considered.

No special tables were drawn up as the data is readily available from the data sheets in Appendix I.

Thus graphs were plotted of base area of house (a) in sq. ft. vs. size of household (h) for the different social groups. Diagrams (8-4A), (8 - 4B), and (8- 4C) refer.

It will be observed from the diagrams that there is a spread in the distribution of the points. This may be explained due to the variation in income for the same household size.

However, the average space consumed which is representative of a household of average income was calculated for households of different size by averaging the points plotted on the graphs. Note that these points follow the trend predicted in the theoretical model i.e. a consumption of space that increases with household size, but at a decreasing rate. Note further the increase in consumption with social class, which is partly due to rise in household income with class.


DIAG. 8-5
DETERMINATION OF THEORETICAL RELATIONSHIPS BETWEEN (a) & (h) FOR, g=1,2,3
g=3
log a3 = 2.86 + 0.485 log h3
(8-4A)
g=2
log a2 = 2.56 + 0.492 log h2
(8-4B)
g=1
log a1 = 2.28 + 0.425 log h1
(8-4C)
WORKING CLASS
MIDDLE " "
UPPER " "
log (a)
LOg (h)
3.6
3.5
3.4
3.3
3.2
3.1
3.0
2.9
2.8
2.7
2.6
2.5
2.4
2.3
2.2
2.1
2.0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
1.1
1.2
1.3

8.3.1 Determination of space standards

In order to determine models governing space standards, the logarithm of average consumption with log household size for the three social groups was plotted. Refer diagram (8-5). Since the original equation was of the form

$$a = K\ h^{p_1},$$

$$\log\ a = \log\ K + p_1 \log\ h.$$

The graphs of log a vs. log h should be a straight line if the theoretical equation was correct. From diagram (8-5) it will be observed that the points lay in a straight line except for a few cases. It could thus be concluded that the models are correct and describe the situation fairly accurately.

The equations obtained for the three cases are:

$g = 1$, Blue collar $\quad a_1 = 190h^{0.425}$ . . . . . . (8 - 1a)

$g = 2$, White Collar, N.P. $\quad a_2 = 362h^{0.492}$ . . . . . (8 - 1b)

$g = 3$, White Collar, prof. $\quad a_3 = 725h^{0.485}$ . . . . . (8 - 1c)

These equations are plotted on the respective graphs. Note how closely they are representative of the real situation.

It will be observed how the initial consumption of space increases with social class from the equations. It will also be noted that the marginal rate of increase $\frac{d\,a}{d\,h}$ increases with social class. This is in keeping with the assumptions made in the theoretical model, Chapter 7.

When the curve representing the average middle class is plotted on the working class diagram (8 - 4A) note how it forms an envelope covering those who demand maximum space within the class. At the same time note how a minimum standard envelope could be constructed.

TABLE (8 - 3) Space Standards

(8-3a) Blue collar workers

Standards Sq. ft. (a)	Household size										
	1	2	3	4	5	6	7	8	9	10	11
1. Observed	160	290	310	390	395	400	440	460	450	-	-
2. Minimum	50	80	110	130	150	170	180	190	200	210	-
3. Average	200	250	300	350	400	400	450	450	500	500	-
4. Maximum	350	500	625	725	800	875	950	1000	1050	1100	1150

(8-3b) White collar non professional workers

Standards Sq. ft. (a)	Household size										
	1	2	3	4	5	6	7	8	9	10	11
1. Observed	-	350	600	750	800	950	1000	1025	1050	1100	1650
2. Minimum	200	250	300	350	400	400	450	450	500	500	-
3. Average	350	500	625	725	800	875	950	1000	1050	1100	1150
4. Maximum	725	1000	1200	1400	1550	1700	1800	1950	2050	2150	2250

(8-3c) White collar professional and managerial workers

Standards Sq. ft. (a)	Household size										
	1	2	3	4	5	6	7	8	9	10	11
1. Observed	-	650	1300	1750	1550	1700	1700	1950	2000	2500	1550
2. Minimum	350	500	625	725	800	875	950	1000	1050	1100	1150
3. Average	725	1000	1200	1400	1550	1700	1800	1950	2050	2150	2250
4. Maximum	2000 sq. ft.										

For the middle classes a similar situation occurs, diagram (8-4B), where the working class average becomes the middle class minimum, and the upper class average becomes the middle class maximum.

For the upper social classes diagram (8-4C), note how the middle class average becomes the minimum.

These observations form an interesting rule of thumb which states that with regard to the consumption of space the working class average equals the middle class minimum, while the middle class average is the upper class minimum. In regard to maximum, the upper class average is equal to the middle class maximum, while the middle class average is equal to the working class maximum.

What of upper class maximum? This theoretically and practically will have no limit, since as incomes increaseit can keep increasing. However, as mentioned earlier in the text Ceylon has imposed a limit of 2000 sq. ft. on a house. Refer to diagram (8-4C) and note that this is more than sufficient for a household of average size, i.e. 6 persons.

Tables (8-3a), (8-3b), and (8-3c), give the average space standards observed, and the proposed minimum, average, and maximum space standards for each social class.

8.4 Conclusion

In conclusion one basic fact emerges. It appears that throughout, the standards developed appear to be lower than what has been proposed in the past assuitable for housing. However, it will be observed that these standards have been developed on the principle of demand which works on social, economic and cultural satisfaction of the population and, therefore, tends towards a solution of the housing problem. Thus, the detrimental effects of lowering standards indiscriminately have been overcome.

In Chapter 3 a linear standard of (100 + 50h) was used to estimate the overall resources needed for housing in Ceylon. This resulted in a house of 400 sq.ft. for an average household of six persons. It will be observed that this is not far removed from the proposed standard of 400 sq. ft. average for the working classes and also 400 sq. ft. minimum for the middle classes for households of 6 persons. Thus for the purpose of overall estimates the linear model was sufficiently accurate, resulting in a fairly accurate estimate of resources required.

Finally, it must once again be stressed that the purpose of this chapter was to develop techniques for testing the theoretical model. The values proposed for the standards are only guides, and must therefore be verified using a larger sample before they are used for large scale housing programmes.

CHAPTER 9

The real cost of housing to the consumer (R).

9.0 Introduction

In section 7.5, Chapter 7, a theoretical model was developed for achieving the given standards at minimum real costs to the consumer (R).

The standards to be provided were developed using the city of Colombo as an example and were presented in Chapter 8. Briefly they were:

(1) The net residential density for all social classes should be about 170 p.p.a. The resulting gross density should be around 118 p.p.a., i.e. an allowance of about 2.5 acres/1000 population for support facilities.

(2) The occupancy rates should be 3, 2, and 1 respectively for the development of housing for the working class, middle class, and upper class respectively.

(3) The space standards to be provided should follow the following models:

$a = 190h^{0.425}$ for the working classes

$a = 362h^{0.492}$ for the middle classes

$a = 725h^{0.485}$ for the upper classes

where a is the area of the house in sq. ft. and h the number of persons in the household.

The purpose of this chapter is to verify the theoretical model developed in Chapter 7 and calibrate the detailed models therein. Once again it must be stressed that with the limited data available only the trends can be verified, and that the calibrations are therefore approximate. However, it will be appreciated that this approach sets the base for intensive study on the same basis, which is the purpose of this study.

9.0.1 Identities and design limitations

The definition of housing density in terms of shells(s), units/floor(n), and floors/shell(f), developed in section 7.5.2.2.1 is important, and is used exclusively in the following sections. From these definitions the following identities were evolved.

(1) $U = s.f.n.$ . . . . Equation (7-13)

where U is the net density in units/acre, and s the number of shells/acre.

(2) $B = n.a.$ . . . . Equation (7-14)

where B is the base area of a shell in sq. ft. and a the base area of a housing unit.

(3) $\rho = U.h$

where ρ is the residential density in persons per acre, U the density in units/acre, and h the average household size of the residential area under consideration.

Due to the limitations imposed on the designer by daylighting, ventilation, and privacy considerations, it was suggested that the number of shells per acre (S), would decrease with an increase in base area (B), and floors (f). This was given by:

$$S = K_3 \, B^{-p_3} \, f^{-p_4} \quad \ldots\ldots (7\text{-}15)$$

where p_3, and p_4 were interpreted as negative, and fractional.

In order to verify the existence of such a model and its validity the following study was carried out.

Fortysix recent residential developments in and around the city of Colombo were selected. Only recent developments were considered since these had been planned using the basic principles of residential area planning, and therefore took into consideration factors such as daylight, privacy, and ventilation. A further advantage was that these residential developments were surveyed and accurately mapped on completion.

Table (9 - 1) Observed values of shells/acre (S), base area of shell (B) sq. ft., and number of floors (f)

	S per acre	B sq. ft.	f		S per acre	B sq. ft.	f
1	7.95	908	1	24	13.00	650	1
2	5.23	1016	1	25	11.66	650	1
3	2.13	578	1	26	9.20	650	1
4	3.67	1058	1	27	6.08	1706	1
5	2.50	3137	4	28	10.00	650	1
6	1.72	3999	4	29	13.33	325	1
7	0.94	6330	4	30	4.00	2100	2
8	6.35	1878	4	31	2.22	2580	1
9	12.61	578	1	32	2.26	11696	4
10	9.84	1586	2	33	3.22	1700	5
11	2.73	3999	4	34	10.00	659	1
12	3.14	4093	4	35	3.10	294	1
13	0.63	9000	4	36	2.11	2847	4
14	1.48	7533	5	37	2.90	2875	4
15	3.63	1300	1	38	1.52	2943	4
16	1.05	1718	1	39	2.13	3136	4
17	1.55	7842	3	40	1.81	2276	4
18	2.48	5714	4	41	9.37	650	1
19	2.32	4326	4	42	2.02	2935	4
20	4.50	1700	1	43	1.98	2765	4
21	9.71	650	1	44	2.29	3026	4
22	4.71	1600	5	45	2.16	3031	4
23	16.96	750	1	46	2.53	2900	4

For each of these areas the following were then computed.

(1) The number of shells/acre (s)

(2) The number of floors/shell (f)

(3) The base area of a shell (B).

Where a mixture of types existed a weighted average for f and B were estimated. Table (9-1) gives the values of s, B, and f obtained.

Using the data obtained a multiple regression analysis of the form,

$$\log_{10} S = \log_{10} K_3 + p_3 \log_{10} B + p_4 \log_{10} f$$

was run using the computer. The results obtained gave:

$$\log_{10} K_3 = 2.63874$$
$$p_3 = -0.62829$$
$$p_4 = -0.08685$$

The explained variation was 59.5% at a 1% level of significance. This is sufficient for practical use. Note how the signs of p_3, and p_4 are negative and fractional conforming to the theory.

In the equation topographic conditions are assumed constant. This is practically not so, and can account for the variation not explained. This equation represents average conditions. A more detailed equation can be estimated if required using average gradient as another variable. However, from the point of view of this model considering the approximations that occur, this equation is sufficient.

The equation thus derived is

$$S = 435 \; B^{-0.628} \; f^{-0.087} \quad \ldots\ldots \quad (9-1)$$

using the identity $B = n.a.$

This is expressed as

$$S = 435 \; n^{-0.628} \,.\, a^{-0.628} \,.\, f^{-0.087} \quad \ldots\ldots \quad (9-1A)$$

This equation therefore governs broadly the relationship that must exist between floors (f), units per floor (n), and base area of a housing unit (a), for future residential development.

9.1 The basic controlling functions

The basic controlling functions are evolved from the following:

(1) The standards to be achieved, and

(2) The design limitation function derived. Equation (9 - 1A)

The basic stand to be achieved is a net residential density of 170 p.p.a. i.e.

$$\rho = 170 \ldots\ldots\ldots\ldots \quad (9 - 2)$$

This condition when introduced into equation (9- 1A), together with the identities stated in 9.0.1, give the following function:

$$n^{0.372} \cdot a^{-0.628} \cdot f^{0.913} = 0.3908 \ldots\ldots \quad (9 - 3)$$

This expression therefore becomes an overall controlling function for future residential development in the city of Colombo. It may be used for other urban areas as well as there is very little difference in climate, culture etc. which might permit a change. It is useful that one density standard was obtained, and thus simplifies the design process.

The other controlling functions are specified by class of population, and relate to the space standards, i.e. the relationship between a, and h. These are given by:

(1) For the blue collar workers, normally termed the working class:

$$a = 190\, h^{0.425} \ldots\ldots\ldots\ldots \quad (9 - 4)$$

(2) For the white collar non professionals termed the middle class,

$$a = 362\, h^{0.492} \ldots\ldots\ldots\ldots \quad (9 - 5)$$

(3) For the white collar professionals, normally termed the upper class,

$$a = 725\, h^{0.485} \ldots\ldots\ldots\ldots \quad (9 - 6)$$

Equations (9 - 3) to (9 - 6) are therefore functions that will control future residential development, and will therefore influence the future cost functions accordingly.

9.2 The cost of land per housing unit (C_1)

The discussion in section 7.5.2.1 showed that land cost per housing unit would depend on two factors. They are, the cost of land per acre, and the density in housing units per acre at which the houses are built.

In this section these two factors will be considered with reference to the city of Colombo, thus evolving an expression for the cost of land per housing unit at a distance (d) from the city centre.

9.2.1 Location and the overall cost of land

The model relating land cost per acre and price has been established. However, for the city of Colombo it is necessary to verify the validity of this model and determine the constants in the model.

It was seen from equation (7 - 10), that land costs/acre can be related to the distance from the city centre (radial, d) by the equation,

$$C_L = K_6 \cdot e^{-k_7 \cdot d} \quad \ldots\ldots\ldots \quad (7 - 10)$$

i.e. a negative exponential relationship.

To verify this model for the city of Colombo the following procedure was adopted. Diagram (9 - 1) is a map of the city of Colombo at a scale of 16 chains to one inch on which the land prices at 1972 have been indicated. The map reproduced here is a reduced photostat copy of the original map which was in colour.

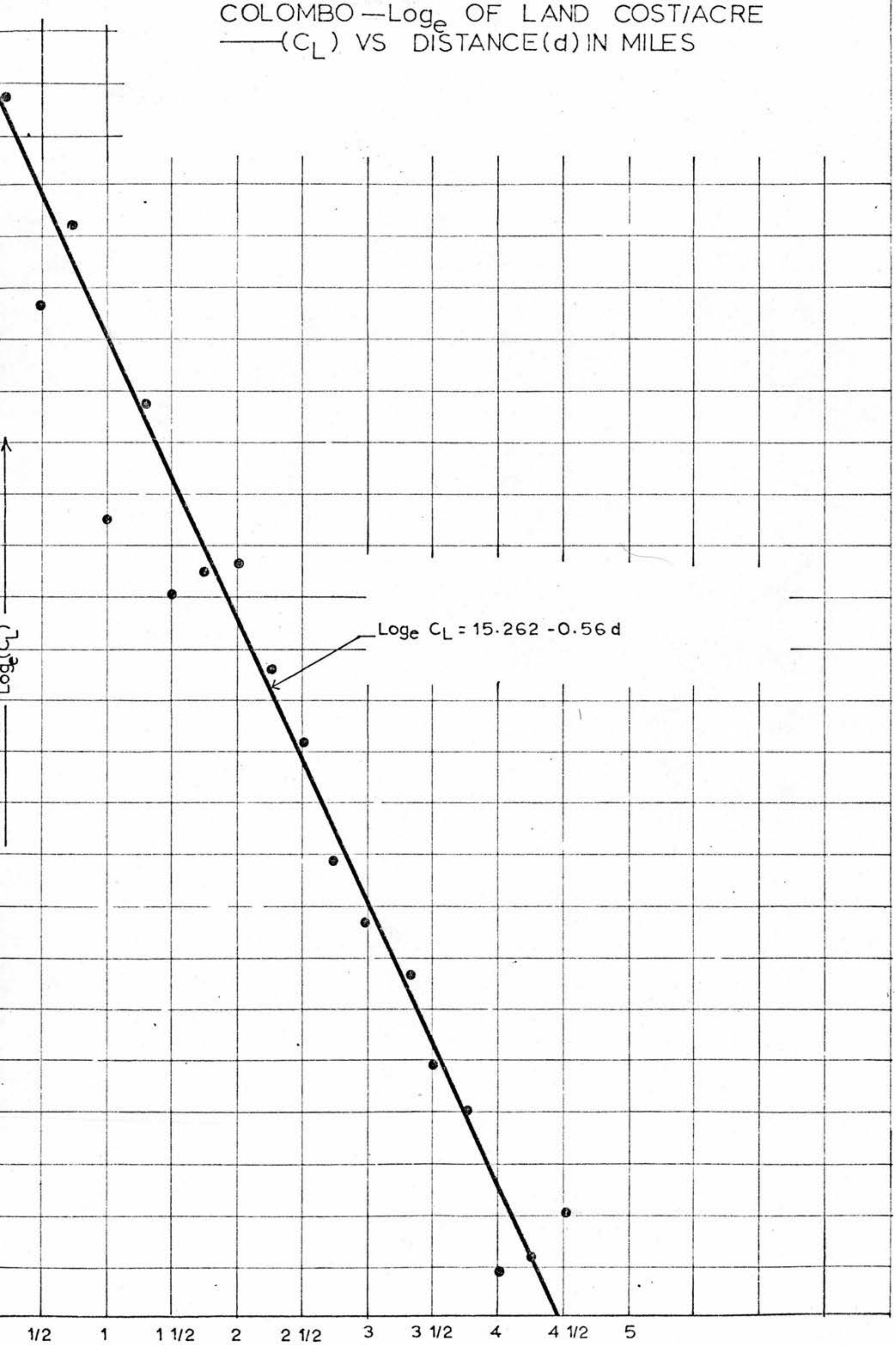
Using the city centre indicated, circles of ½ mile radius were drawn.

	VALUE IN '000s		
	rate per perch between	rate per acre between	rate per hectare between
1	0·4 - 0·5	64-80	158-198
2	0·5 - 0·75	80-120	198-297
3	0·75 - 1·00	120-160	297-395
4	1·00 - 1·25	160-200	395-494
5	1·25 - 1·50	200-240	494-593
6	1·50 - 1·75	240-280	593-691
7	1·75 - 2·0	280-320	691-790
8	2·0 - 2·5	320-400	790-987
9	2·5 - 3·0	400-480	987-1185
10	3·0 - 3·5	480-560	1185-1383
11	3·5 - 4·0	560-640	1383-1580
12	4·0 - 4·5	640-720	1580-1778
13	4·5 - 5·0	720-800	1778-1976
14	5·0 - 5·5	800-880	1976-2173
15	5·5 - 6·0	880-960	2173-2371
16	6·0 - 6·5	960-1040	2371-2569
17	6·5 - 7·0	1040-1120	2569-2767
18	7·0 - 7·5	1120-1200	2767-2964
19	7·5 - 8·0	1200-1280	2964-3161
20	8·0 - 8·5	1280-1360	3161-3360
21	8·5 - 9·0	1360-1440	3360-3557
22	9·0 - 9·5	1440-1520	3557-3755
23	9·5 - 10·0	1520-1600	3755-3953
24	10·0 - 11·0	1600-1760	3953-4349
25	11·0 - 12·0	1760-1920	4349-4744
26	12·0 - 14·0	1920-2240	4744-5535
27	14·0 - 16·0	2240-2560	5535-6326
28	16·0 - 20·0	2880-3200	7116-7907
29	20·0 - 25·0	3200-4000	7907-9885

Reprinted Oct. 1970.
Survey Dept., Ceylon

DIAG. 9-2

COLOMBO — $\log_e$ OF LAND COST/ACRE (C_L) VS DISTANCE (d) IN MILES



DIAG. 9-3

RELATIONSHIP BETWEEN (C_L) AVERAGE LAND COST/ACRE AND DISTANCE (d) IN MILES FROM CITY CENTRE COLOMBO 1972

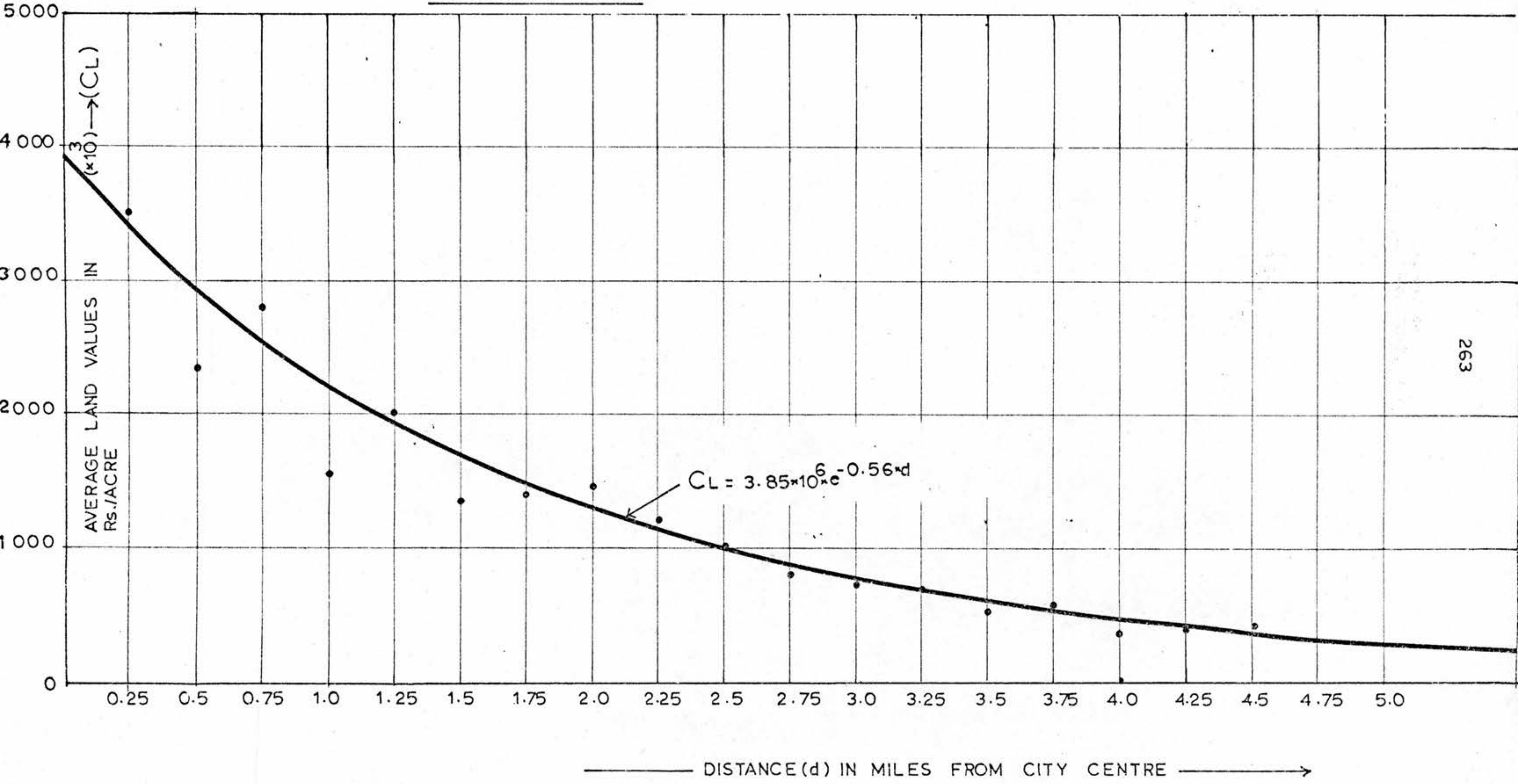


Table (9 - 2) Average Land Costs per acre in Rs. relative to distance from the centre of Colombo in miles.

Distance from City Centre Miles	Average Cost per acre in Rs. x 10^3
0.25	3500
0.50	2338
0.75	2800
1.00	1563
1.25	2000
1.50	1347
1.75	1400
2.00	1457
2.25	1200
2.50	1008
2.75	800
3.00	718
3.25	702
3.50	541
3.75	550
4.00	362
4.25	400
4.50	412

Source: Annexed map diagram (9 -1) obtained from the Colombo Municipality

Along each radii the average value of land per acre was estimated by evolving the following:

$$C_{L,r} = \frac{\sum_{x=1}^{x=N} C_{L,r,x} \cdot lx}{\sum_{x=1}^{x=N} lx}$$

i.e. the average weighted by circumferential length along the particular radius.

Land values of marsh land were excluded. This is because the intention was to establish the relationship for residential land, which when applied to marsh land will give its approximate value on preparation for the development of housing. Thus for example marsh land at Rs. 200/= per acre might show Rs. 1000/= per acre, allowing Rs. 800/= for filling and levelling. Further the average also consists of developed land which may be low in value due to the existing size and shape of holdings in certain areas. This occurs mainly in the overcrowded slum areas, which are suitable for redevelopment. Hence application of the model can include the costs of demolition in these areas.

Table (9 - 2) gives the radii and resulting average values of land obtained - land value in rupees/acre, and distance (d) in miles.

To verify the validity of the model equation (7-10) was converted into logarithmic form, i.e.

$$\log_e C_L = \log_e K_6 . - K_7 . d .$$

Plotting the points diagram (9 - 2) showed a linear relationship, thus confirming the validity of the model.

The constants for this equation were thus determined using this graph giving the equation:

$$\log_e C_L = 15.262 - 0.56d .$$

This converted to its normal form gave

$$C_L = 3.85 \; 10^6 . e^{-0.56d} \quad \ldots\ldots (9 - 7)$$

Diagram (9 - 3) indicates the observed values plotted, and the curve indicates the model obtained. The validity of the model for prediction will thus be appreciated.

9.2.2 Density and the cost of land per housing unit

From the identity in 9.0.1, the density (ρ) in persons/acre is related to the density (u) in units/acre, and average household size (h) by the expression:

$$\rho = u \cdot h.$$

but from section 9.1 the controlling condition indicates ρ = 170 p.p.a

$$\therefore \left(\frac{1}{u}\right) = \left(\frac{h}{\rho}\right) = \left(\frac{h}{170}\right) \text{ acres/housing unit}$$

at a household size h.

From equation (9 - 7) it was seen that cost per acre C_L is given by:

$$C_L = 3.85 \cdot 10^6 \; e^{-0.56d} \text{ rupees}$$

$\therefore$ Cost of land per housing unit at distance(d) miles from the city centre for a household of size (h), and at 170 p.p.a. is given by:

$$C_1 = C_L \left(\frac{h}{170}\right)$$

i.e.

$$C_1 = 22,600 \, h. \, e^{-0.56d} \quad \ldots\ldots (9 - 8)$$

This model therefore describes the cost of land for providing a housing unit for a household of size h, at distance d from the city centre, at 170 p.p.a.

It is useful to note that this model may also be used if ρ is changed, by changing it to its appropriate value.

It is also useful to note that this is the price of land at 1972, hence if a programme is planned after this date it is necessary to change the model to incorporate changes in price to the starting year of the programme. Further land prices should be frozen for the duration of the programme. The public sector has the power to do this. If on the other hand land prices are not frozen, then the necessary land must be acquired at the beginning of the programme. Again this is possible, since the financing model suggests that payment for land can be made using the system of bonds.

9.3 The initial cost of land development per housing unit (C_{dl})

In section 7.5.2.3 of Chapter 7, a theoretical model was developed which would

(1) describe the initial costs of land development per housing unt (C_{dl}) in terms of S, f, and n; and

(2) incorporate the controlling functions, thus describing the future costs of land development.

The form of housing described by (y) in the theoretical model has been for the complete house. The case of the core house, and the serviced block of land, was treated as an extension of the original model.

In this section it is proposed to verify the theoretical model, incorporate the controlling functions, and establish the model for describing the initial cost of land development per housing unit, for a complete house .

The model will then be applied to the case of the self help house and the core house.

9.3.1 The existing situation

The theoretical model developed in Chapter 7 indicated that the cost of land development in general could be given by

$$C_{dl} = K_5 . S^{-p_8} . f^{+p_9} . n^{-p_{10}} \quad \ldots\ldots (7-18)$$

where S represents the number of shells/acre, f the number of floors per shell, and n the number of units per floor.

The theoretical discussion indicated that p_8 and p_{10} will be negative and fractional and p_9 positive and fractional.

9.3.1.1 Verification of the validity of the model

In order to verify the validity of the model the following procedure was used.

Data from the past records of the department of National housing was compiled for housing developments in and around the city of Colombo. The process involved was tedious as data had to be extracted from old files, and this took over six months.

The data recorded was details of the development in terms of S, f, and n, which also involved the detailed study of layout plans.

The cost of roads, sewage disposal mains, electricity, and water supply was taken into account. No gas or telephone had been supplied, thus these could not be incorporated.

In each case the year at which construction began was noted. This was an important factor as change in prices in the construction industry had to be accounted for.

The actual data collected was for seventeen different developments. This was because of three reasons:

(1) The limited number of housing areas developed.

(2) The non-availability of data in certain cases, due to the loss of records.

(3) The availability of mixed data in certain cases, i.e. no specific data relating to land development.

It will be appreciated that the results of the analysis may not be as reliable as if a larger number of cases had been used. However, it is at the present moment impossible to cover a larger area in a study of this nature, and since the purpose of this analysis is to verify the general trend it can be considered sufficient. If the general trends are found to be correct this analysis will form the base for a useful large scale study.

Table (9 - 3) Area of house (a), floors in building (f), units per floor (n), and their relation to cost of developing land/unit (C_{dl})

Ser. No.	Cost of Land Dev. /Unit Rs.	Year of Const.	Corrected Cost/Unit at 1972 prices C_{dl} Rs.	Floors in Bldg. (f)	Units/floor (n)	Shells/acre S
1	2680	1962	4261	4	20	02.50
2	5000	1970	5450	4	04	01.72
3	2420	1966	3968	4	16	00.94
4	2226	1965	3650	4	10	00.60
5	1000	1971	1040	2	04	09.84
6	3211	1968	3950	4	04	02.73
7	3000	1971	3120	1	06	01.05
8	2500	1971	2600	1	06	04.50
9	1430	1971	1487	1	02	09.71
10	1800	1972	1800	5	06	04.70
11	1200	1972	1200	1	03	16.96
12	2500	1972	2500	1	02	13.00
13	1600	1972	1600	1	02	11.66
14	2900	1972	2900	1	02	09.20
15	1100	1972	1100	1	02	10.00
16	1400	1972	1400	1	08	02.22
17	2000	1972	2000	1	01	03.10

Table (9 - 4) Index of inflation for the cost of housing $(C_c + C_{dl})$

Year	Average cost/sq. ft. of a complete house approx. 1000 sq. ft. Rs.	Index of Deflation 1972=100	Correction factor
1955	19.75	82	1.23
1956	18.52	72	1.38
1957	17.63	73	1.37
1958	18.60	78	1.28
1959	17.09	71	1.40
1960	17.00	70	1.42
1961	16.27	68	1.47
1962	15.00	63	1.59
1963	19.31	81	1.23
1964	15.26	64	1.56
1965	14.39	61	1.64
1966	14.58	61	1.64
1967	14.50	60	1.67
1968	19.50	81	1.23
1969	21.00	88	1.14
1970	22.00	92	1.09
1971	23.00	96	1.04
1972	24.00	100	1.00

Table (9 - 3) indicates the abstract of the data giving: cost of land development per unit in rupees, year of construction, average number of floors in the building, units per floor, and shells per acre.

As mentioned earlier the relationship proposed was for fixed prices. This meant inflating or deflating the costs to a base year.

In order to inflate or deflate the prices an index of construction costs in the housing industry was needed.

Ceylon up to now has not compiled a construction index, and this presented a major problem.

The question was how to arrive at a suitable index. This problem was overcome as follows.

The department of housing in Ceylon has given loans for housing from 1955. In order to obtain a loan the applicant must submit an approved plan and estimate. These details have fortunately been stored in a large record room.

Approximately one hundred cases for each year were selected at random from the records. Since the total cost and area was known it was possible to estimate the average cost per unit area for the particular year. The process was tedious and long, but there was no other alternative. Hence it was possible to have a fair approximation of the cost of constructing houses including land development per unit area of house from 1955 to 1972. The results only are presented in table (9 - 4). Using 1972 as a base year it was possible to calculate a deflation index, and therefore a correction factor for bringing prices up to 1972 levels.

These correction factors were then applied to the original data in table (9 - 3), and the values of C_{dl} converted to 1972 levels.

Thus the new data was ready for verifying the theoretical model.

To verify the model the form of equation (7 - 18) was converted to:

$$\log_{10} C_{dl} = \log_{10} K_5 + p_8 \log_{10} S + p_9 \log_{10} f + p_{10} \log_{10} n.$$

A multiple regression analysis was then carried out using the computer.

The results of the analysis were as follows:

$$\log_{10} K_5 = 3.53484$$
$$p_8 = -0.29771$$
$$p_9 = 0.25196$$
$$p_{10} = -0.08636$$

The explained variation was 52.76% at a 2.5% level of significance.

The interesting point of the analysis is the sign of p_8, p_9, and p_{10}. The signs tally with those predicted under the theoretical discussion. Further the explained variation is good. All developments are not exactly the same in quality of materials used, and topography, which is fairly important in the laying of water and sewage disposal mains. The need in certain cases for the construction of water towers would have distorted the figures. However, overall the model gives an average picture of what could be expected, and also verifies the validity of the theoretical model.

The model describing existing conditions could thus be given by:

$$C_{dl} = 3426.\ S^{-0.298} \, . \, f^{0.252} \, . \, n^{-0.086} \quad \ldots . (9 - 9)$$

It is useful to note the influence of developing high rise building by increasing f. This results in an increase in costs. On the other hand increasing S has the effect of reducing costs, while increasing n has a relatively small effect on reducing costs.

9.3.2 <u>The effect of introducing the controlling functions</u>

In order to achieve the objectives for solving the housing problem on a practical basis the controlling functions must now be introduced. These functions are given in section 9.1 .

Introducing the controlling functions into equation (9 - 9), gives

$$C_{dl} = 422.\ a^{0.378} . n^{-0.012} . h^{-0.304} \quad \ldots\ldots\ldots (9-10)$$

for all social groups. This is important since a is a separate function of (h) for each social group.

Introducing further the models relating space standards to household size for each group, given by equations (9 - 4), (9 - 5), and (9 - 6) for g = 1, 2 and 3 respectively, the following functions are evolved, in rupees at 1972 prices.

(1) For blue collar workers housing:

$$C_{dl} = 3066\ h^{-0.152}\ n^{-0.012} \quad \ldots\ldots\ldots\ldots (9-11)$$

(2) For white collar non professional workers housing:

$$C_{dl} = 3908\ h^{-0.118}\ n^{-0.012} \quad \ldots\ldots\ldots\ldots (9-12)$$

(3) For white collar professional workers housing:

$$C_{dl} = 5018\ h^{-0.121}\ n^{-0.012} \quad \ldots\ldots\ldots\ldots (9-13)$$

Examining in general the three models governing land development costs, note that costs decrease with increase in household size and units per floor.

The decrease with increase in household size may be explained as follows.

(1) Densities are fixed.

(2) Therefore - increase in household size will result in a lesser number of units, the size of which is not directly proportional to the size of the household, since consumption of space has a decreasing rate of marginal increase. In other words, the total housing space provided per acre will decrease.

(3) This therefore leads to decrease in the number of floors, which has a -ve effect on C_{dl}, and an increase in (S), which also has a -ve effect on C_{dl}.

The overall result is therefore a reduction in C_{dl} as h increases.

This is a most useful conclusion, and this supports the argument for providing housing for the extended household and not the nuclear family.

The reduction in C_{dl} with n is as expected, and verified in the basic model.

The next point comes from examining each of the models separately. Note that as social class increases so does the cost of developing land per housing unit. This is explained once again with reference to the earlier arguments. First the initial consumption of space of the working classes is much less than the middle and upper classes. Therefore the developments can occur at less number of floors. Further note that the marginal rate of increase of consumption of space is much lower in the working classes, than in the middle and upper classes. Hence, the net result - it is cheapest to develop land per housing unit for the blue collar workers, and it is still cheaper to cater for larger households than smaller ones.

The models developed in (9 - 11), (9 - 12), and (9 - 13), therefore describe the cost of developing land, for housing for the three classes to the prescribed standards. These are at 1972 prices, and need adjustment if used at future dates.

9.3.3 The effect of form on the cost of land development

The discussion so far has allowed f, n, and S to move within the limits of the controlling functions.
The question of form raises further limitations.

The three basic types of form discussed in the theoretical model were the complete house at $(y = 1)$, the core house at $(y = 2)$, and the developed block of land at $(y = 3)$.
The discussion section 7.5.4 stated that for core housing $f \doteq 1$, and for self help housing $f = 1$, and $n = 1$.

(1) Core housing.

The extra limitation set by the use of core housing is to limit the number of floors in the development (f) to 1. Applying this condition to the controlling function, the identities, and the model describing C_{dl} in general, the particular model obtained for working class housing is:

$$C_{dl} = 1984\, h^{0.106} \quad \ldots\ldots\ldots (9-14)$$

This particular type of housing is not suitable for the middle and upper income groups, from a social point of view (section 7.5.4). This was confirmed in the survey - annexure 5, Appendix I, where it is seen that of the 2% sample selected, not a single case was recorded where the middle and upper groups lived in semi-permanent or temporary houses.

The value of n to be used in this case is estimated using f = 1, in the controlling function given in equation (9 - 3), for a given h, where a is related to h by equation (9 - 4).

(2) Self help housing

In this case where developed blocks of land are provided for the construction of houses on a self help basis, both f and n are limited to 1, since each household builds its own house. This sets an extra limit condition, i. e, n = 1. Applying therefore the limits to the original equations, and as before for working class housing, the following model is obtained for C_{dl}, in rupees at 1972 prices.

$$C_{dl} = 3787\, h^{0.0795} \quad \ldots\ldots\ldots (9-14A)$$

In applying this case a practical difficulty will arise. Consider equation (9 - 1A). This gives the maximum shells per acre for given a, n, and f. If f and n are limited to 1, then

$$S \leqslant 435 \quad a^{-0.628}$$

Further, for the working class ($g = 1$) a is governed by

$$a = 190\ h^{0.425}.$$

$$\therefore \text{ since } \rho = S.n.f.h., \text{ and } n = f = 1,$$

$$S = \left(\frac{\rho}{h}\right), \quad \rho = 170$$

$$\therefore \left(\frac{170}{h}\right) \leqslant 435 / \left(190\ h^{0.425}\right)^{0.628}$$

$$\text{i.e. } h \geqslant 2.851$$

Practically households over 3 persons are most suitable for self help, achieving about 56 houses to the acre at a maximum.

The models developed for core housing and self help housing exhibit a typically expected feature, i.e. an increase of C_{dl} with h, at a decreasing marginal rate. This is understandable, since once f was limited to 1, the effects it had on the variation of C_{dl} were halved. Thus, the equations represent the case of typical detached housing development, and reflect the well known fact that the cost of infrastructure development increases as density in units per acre is reduced.

Comparing the models for core housing and self help housing it is observed that the costs are more for self help housing than for core housing, at a given household size. This is due to the fact that in self help housing n has been fixed at its minimum value 1, and thus the advantages of economies of scale are lost. Hence the obvious increase in this case compared to the case of core housing.

9.4 The initial cost of constructing a housing unit (C_c)

Similar to the analysis of the cost of land development a theoretical model describing the cost of construction of a housing unit was developed in section 7.5.2.4.

Table (9 - 5). Area of house, floors in building(f), and units per floor(n) and their relation to the initial cost of construction of a housing unit (C_c)

Ser. No.	Cost of Const. per Unit. Rs.	Year of Const.	Inflation Index	Cost at 1972 prices Rs.	Area(a) sq. ft.	(f)	(n)
1	17,890	1962	1.59	28,445	0165	4	16
2	16,920	1962	1.59	26,902	0155	4	24
3	32,500	1970	1.09	34,425	1000	4	04
4	11,700	1965	1.64	19,188	0390	4	16
5	11,200	1960	1.42	15,904	0470	4	04
6	2,800	1972	-	02,800	0396	2	04
7	24,800	1968	1.47	36,456	1000	4	04
8	11,000	1960	1.42	15,620	0580	4	07
9	22,000	1965	1.64	36,080	0900	4	10
10	9,700	1972	-	09,700	350	1	04
11	12,900	1972	-	12,900	0286	1	06
12	15,200	1966	1.64	24,928	0565	4	16
13	18,128	1955	1.23	22,297	0840	4	10
14	22,198	1955	1.23	27,303	1110	3	06
15	18,128	1955	1.23	22,297	0830	4	12
16	22,198	1955	1.23	27,303	1106	3	08
17	12,122	1955	1.23	14,910	0460	2	16
18	10,000	1960	1.42	14,200	0635	4	09
19	5,500	1956	1.38	07,590	0420	4	09
20	7,900	1956	1.38	10,902	0607	4	08
21	10,000	1956	1.38	13,800	0725	4	06
22	11,540	1972	-	11,540	0266	5	06
23	7,000	1972	-	07,000	0250	1	06
24	7,900	1972	-	07,900	0325	1	02
25	6,800	1972	-	06,800	0250	1	03
26	8,250	1972	-	08,250	0325	1	02
27	7,300	1972	-	07,300	0325	1	02
28	10,600	1972	-	10,600	0325	1	02
29	9,000	1972	-	09,000	0284	1	06
30	6,500	1972	-	06,500	0325	1	01
31	2,400	1972	-	07,400	0250	2	18
32	5,840	1972	-	05,840	0360	1	17
33	11,000	1960	1.42	15,620	0725	4	16
34	6,000	1972	-	06,000	0300	1	01
35	15,400	1966	1.64	25,256	0350	4	10
36	23,844	1966	1.64	39,104	0570	4	04
37	27,700	1966	1.64	45,428	0784	4	04
38	39,300	1966	1.64	64,452	1254	4	02

This model described the cost of construction in terms of a, f, and n, i.e. the area of the house, the number of floors in the shell, and the number of units per floor in each shell.

This section is devoted to verifying the validity of this model under existing conditions, and then applying the controlling function to it, in order to develop a model for estimating the future costs of construction per unit. This model is then applied to the two other forms under consideration, i.e. the core house and the self help house.

9.4.1 The existing situation

The theoretical model developed in section 7.5.2.4 described the cost of construction of a housing unit C_c by:

$$C_c = K_4 \cdot a^{p_5} \cdot f^{p_6} \cdot n^{-p_7}$$

where p_5 and p_6 are positive fractional indices, and p_7 was expected to be a negative fractional index.

9.4.1.1 Verification of the validity of the theoretical model

To verify the validity of the theoretical model, the data was collected in a manner similar to that described in section 9.3.1.1. In this case, however, it was possible to get data for 38 cases.

Table (9 - 5) gives the resulting data. This table also gives the values adjusted to 1972 prices rising the conversion factors given in table (9 - 4).

This data was now suitable for verifying the validity of the model.

For verification by regression analysis, using the computer, the model was converted to the logarithmic form.

The results of the regression gave:

$$\log_{10} K_4 = 2.8313$$
$$p_5 = 0.42573$$
$$p_6 = 0.5530$$
$$p_7 = -0.03182$$

resulting in the equation

$$C_c = 678\ a^{0.426} \,.\, f^{0.553} \,.\, n^{-0.032} \quad \ldots\ldots \ (9-15)$$

The variation explained was 57.05% at a 0.1% level of significance, i.e. a chance of less than 1 in 1000 of the cases selected being a typical.

The result thus proves the validity of the theoretical model. It will be observed what a strong influence multistoried construction has in increasing costs in Colombo. It appears that 2 storeys increase the cost by about 50%, while 3 storeys increase the cost by about 75%, and 4 floors more than doubles the cost. It is also useful to note that the marginal rate of increase of costs with respect to area is quite low, confirming the fact that it is cheaper per capita to house larger households than small ones.

9.4.2 <u>The effect of introducing the controlling functions</u>

In a manner similar to that described in section 9.3.2, the general controlling function given in equation (9 - 3) when introduced produces the following model.

$$C_c = 348\ a^{0.806}\ h^{-0.605}\ n^{-0.257} \quad \ldots\ldots \ (9-16)$$

and is valid for all social groups.

Introducing further the models relating (a) to (h) given in equations (9 - 4), (9 - 5) and (9 - 6), the following models are obtained.

(1) for blue collar workers housing:

$$C_c = 26{,}300\ h^{-0.263} \,.\, n^{-0.257} \quad \ldots\ldots \ (9-17)$$

(2) for white collar non professional workers housing:

$$C_c = 44{,}260\ h^{-0.208}\ n^{-0.257} \quad \ldots\ldots \ (9-18)$$

(3) for white collar professional workers housing:

$$C_c = 77{,}450\ h^{-0.214} \,.\, n^{-0.257} \quad \ldots\ldots \ (9-19)$$

These are expressed in rupees at 1972 prices.

A general examination of the three models reveals a startling fact. The cost of a house appears to reduce as household size increases. This may be explained by the following.

(1) For a fixed density an increase in household size will result in a total drop in the space consumed, since the marginal rate of increase in space consumption decreases as h increases.

(2) The above fact results in housing the same population with a fewer number of floors. From the original equation it was seen that this virtually halves the price of a house. The net result is that an increase in h results in a slight decrease in C_c rather than an increase.

In short the cost of increasing the area of a unit is offset by the tremendous reduction that occurs due to lessening the number of units, and thus the number of floors.

The reduction of construction costs with increasing n is slight and is as expected.

Examining each model separately, the constant term increases with class due to the increased initial space requirement, which also increases f. The rate of decrease of C_c with h is higher for the lower social classes and is due to their lower marginal rate of space consumption.

Overall the facts presented reinforce the use of the concept of "demand" which suggests the use of the extended family as the household and not the nuclear family as suggested by the concept of "need".

Models given in equations (9 - 17), (9 - 18), and (9 - 19), are thus suitable for guiding the formulation of a housing programme for the city of Colombo. Application to other areas needs recalibration, due to regional variation in costs.

9.4.3 The effect of form on the cost of construction

Similar to the case of land development, the models must be modified for use in core housing, and self help housing using the developed block of land.

(1) Core housing

Similar to the method used in section 9.3.3, the case of the cost of construction per unit for core housing can be analysed by putting $f = 1$ in the original equations governing the model and the controlling functions. This yields the following model.

$$C_c = 7225\, h^{0.190} \qquad \ldots\ldots\ldots\ldots (9 - 20)$$

The effect of limiting $f = 1$ is indicated in the model by the change of sign of the power governing h. This change is drastic due to the strong influence f has on the cost of construction per unit.

It will be observed that the model is for working class housing, as only this class will tend to accept this form of housing. The model, however, indicates the trends to be expected in the cost of terraced housing for the working classes.

(2) The self help house

The self help house as analysed before has both f and n limited to 1. These results incorporated in the controlling functions, and the basic cost equation, yield the following model for the working classes, in rupees at 1972 prices.

$$C_c = 6327\, h^{0.181} \qquad \ldots\ldots\ldots\ldots (9 - 20A)$$

This model is also governed by the condition that the household size should be greater than three persons, section 9.3.3(2).

It is relevant to mention here that the models for core housing, and self help housing, describe the total costs, i.e. the costs include the materials and labour provided by the prospective tenant. The main consideration here was form and its effect on costs. The real proportion of these costs to be met by the tenant are developed later in this chapter, using these models derived as the basis.

9.5 Minimising the cost of land development and construction per housing unit at a given location

In section 7.5.3 of Chapter 7, a method was developed for selecting n, and then f and S, which would minimise the sum of land development costs, and construction costs, at a given point, irrespective of land costs.

Each form of house is considered separately, and the expression for C_l must be added in each case to obtain the total minimum cost.

9.5.11 The complete house $y = 1$

In this case it will be observed that for all social classes the cost of land development C_{dl}, and construction costs per unit C_c tend to decrease as n increases. Equations (9-11), (9 - 12), (9 - 13), refer to C_{dl} for $g = 1, 2, 3$, and equations (9-17), (9 - 18) and (9 - 19) refer to C_c for $g = 1, 2, 3$ respectively.

This is similar to the theoretical case described in section 7.5.3(2), wherein the value of n selected should be the maximum possible. This will depend on two factors

(1) the area and shape of land available for development

and (2) the ability of the architect to achieve the maximum value of n possible in the design.

From the point of formulating broad policy for Colombo the average values of n obtained to date should be a sufficient guide. The values are:

for the working class $n = 16$ (terraced houses)
for the middle class $n = 10$ (double wing flats)
for the upper classes $n = 5$ (flats)

No doubt other forms of design can increase n, but as an overall guide the figures are reasonable, as they have been achieved practically and do not need extraordinary large areas of land.

These values substituted in the above mentioned equations give, for Colombo, in rupees at 1972 prices the following policy decision-making models.

(1) For the working class, complete house $(n = 16)$

$$(C_{dl} + C_c) = 2965\, h^{-0.152} + 13{,}120\, h^{-0.263} \quad \ldots (9 - 21)$$

(2) For the middle class, complete house $(n = 10)$

$$(C_{dl} + C_c) = 3802\, h^{-0.118} + 24{,}490 h^{-0.208} \quad \ldots (9 - 22)$$

(3) For the upper class, complete house $(n = 5)$

$$(C_{dl} + C_c) = 4921\, h^{-0.121} + 51{,}170\, h^{-0.214} \quad \ldots (9 - 23)$$

Overall the cost of providing complete houses decreases with an increase in household size, and increases with class as expected. The values of f, and S, for a particular h are estimated using equation (9 - 3).

9.5.2 The core house $y = 2$

In this case the equations developed suffice, since $f = 1$, and n can then be calculated using equation (9 - 3) for a defined (h).

The cost equations are for the working class only and are given by equations (9 - 14) and (9 - 20).

$$(C_{dl} + C_c) = 1984\, h^{0.106} + 7225\, h^{0.190} \quad \ldots . (9 - 24)$$

The total cost per unit excluding land costs will therefore increase with household size, but the per capita costs of core housing will decrease with increasing household size.

9.5.3 The self help house $y = 3$

Finally the case of self help housing which uses $f = 1$ and $n = 1$ can be described by the sum of C_c, and C_{dl} as described by equations (9 - 14A) and (9 - 20A). In this particular case the household size must be greater than three if the desired density is to be achieved. This is also true for any form of housing development consisting of single storied detached houses.

The minimum costs of a self help house, for a household of size h, at 1972 prices is:

$$(C_{dl} + C_c) = (3787\, h^{0.0795} + 6327\, h^{0.181}) \quad \ldots (9 - 25)$$

As in the case of the core house the total costs will increase with an increase in household size, but the per capita costs will decrease with increasing h.

9.5.4 <u>The locational aspect</u>

The models describing the probable minimum cost of land development and construction for the three forms considered will be true on the average for all locations. However, site conditions may tend to increase or decrease these costs. But from the point of view of developing a broad policy for Colombo these models will suffice.

The total cost also includes the cost of land suitable for housing development. This cost was developed in section 9.2 and is given by:

$$C_1 = 22,600\, h\, e^{-0.56d}. \quad \ldots\ldots\ldots\ldots (9 - 8)$$

This model is true for a development having a density of 170 p.p.a. or thereabouts, and an average household size (h). The development is situated at a radial distance (d) from the centre of Colombo.

Hence, the total minimum cost for a particular form of house, at the optimum density of 120 p.p.a. at a distance (d) from the centre of Colombo (the clock tower) can be estimated using the given models. It must be noted that this model describes the average situation. There will be variations on either side, which must be treated as special cases. This means using the values of the variable (n), other than average if the situation so demands.

9.6 The cost of maintenance

Section 7.5.9 of Chapter 7 was devoted to the theoretical analysis of maintenance costs.

The main conclusion reached showed that the annual recovery for maintenance is a function of the initial cost and the period over which the building was to be maintained. It was shown that if costs are recovered without including the probable increases due to inflation, little or no loss would occur, since the expenditure on maintemance is sporadic. This releases the capital for expenditure on new housing during the interim period, which thus generates interest, which accounts for increases due to inflation. This system as seen would ensure the maintenance of public sector housing at minimum costs to the consumer, and at little or no loss to the public sector.

In this section the theoretical model developed is verified and calibrated for use in determining the real costs of housing to the consumer. The calibration refers to the city of Colombo, but may be used as a useful indicator in predicting the probable costs of maintenance in other urban areas of Ceylon.

9.6.1 Calibration of the theoretical model

The theoretical model suitable for calibration is given in section 7.5.9.2, which is:

$$M_t = (C_c + C_{dl}) \cdot k_8 \cdot t. \quad \ldots\ldots\ldots\ldots (7 - 33a)$$

This describes the cost of maintenance of a housing development in the t^{th} year of its life, adjusted to a base year, so that the effects of inflation have been accounted for. The value of $(C_c + C_{dl})$ covers the cost of infrastructure development, and the average cost of a housing unit within the net residential area.

This equation may be represented as

$$\frac{Mt}{(C_c + C_{dl})} \times 100 = 100. k_8. t. \quad \ldots\ldots (9 - 26)$$

which expresses the maintenance as a percentage of initial cost, at the base year prices, during the t^{th} year of life.

9.6.1.1 The data for calibration

The data for calibrating this model was obtained from the records of the department of national housing in Ceylon.

As mentioned by Stone, data on maintenance is the most difficult to obtain. Ceylon is no exception, and is far worse since no systematic records of maintenance costs have been maintained.

The system adopted for administering a housing development in Ceylon includes keeping a file which records the problems, and resulting maintenance over the years.

Hence this meant reading through all the files relating to maintenance over the life of different housing schemes, and recording the costs spent on maintenance each year.

The data was thus obtained for about fifteen housing areas developed and maintained by the department of national housing, in and around the city of Colombo.

The reliability of the data thus obtained was then examined. It was found that of the schemes studied certain schemes included additional development at later periods, and the maintenance recorded thereafter included both the original as well as later additions. This presented a problem, since the cost of maintenance recorded involved buildings of different initial costs, and different age, mixed together. These schemes had thus to be rejected, and of the balance 9 were considered to give suitable data for analysis.

These costs were then adjusted together with the initial costs to represent the equivalent at 1972 prices, using table (9 - 4). The percentage spent on maintenance of the initial cost was then estimated, for the years for which the data was available.

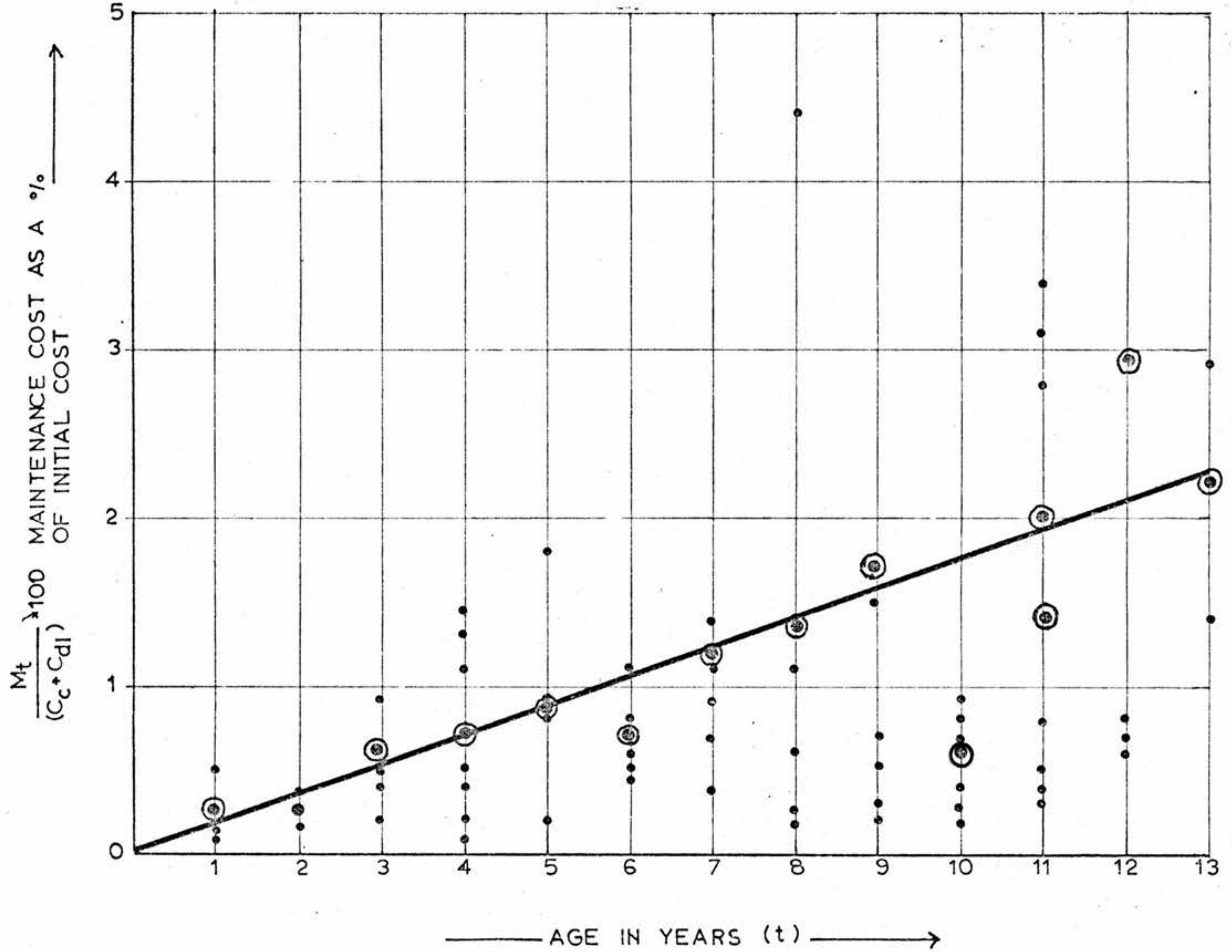
Table (9 - 6) gives an abstract of the resulting data obtained.

Table (9 - 6) The annual cost of maintenance at 1972 prices expressed as a percentage of initial costs at 1972 prices vs. age in years

Ann. main. costs (1972) as % (PRICES). / Age in years (t)	1	2	3	4	5	6	7	8	9	10	11	12	13
(1)	0.51	0.36	0.46	0.41	0.20	0.45	0.67	0.58	0.21	0.41	-	0.69	2.9
(2)	0.15	0.17	0.40	1.45	0.84	0.79	0.42	0.26	0.51	0.90	1.93	0.62	1.4
(3)	0.13	-	0.19	0.21	-	1.06	1.42	0.24	1.55	0.72	0.33	0.74	-
(4)	-	-	-	0.12	0.87	0.52	-	-	-	0.81	2.83	9.66	-
(5)	-	-	0.87	0.48	1.82	0.59	-	1.16	10.09	0.37	0.41	-	-
(6)	-	-	-	1.07	-	-	0.94	-	-	0.23	0.72	-	-
(7)	-	-	-	1.29	-	-	1.15	4.44	0.39	-	3.10	-	-
(8)	-	-	-	-	-	-	-	-	0.69	-	3.44	-	-
(9)	-	-	-	-	-	-	-	-	-	-	-	-	-
Average	0.26	0.27	0.48	0.72	0.93	0.68	0.92	1.34	2.24	0.57	1.54	2.92	2.1

ANNUAL MAINTENANCE COSTS AS A % OF INITIAL COSTS VS AGE OF HOUSES
PRICES INFLATED TO 1972 LEVEL

$100\,M_t = (C_c + C_{dl}) \times 0.172 \times t$



9.6.1.2 Calibration of the model

To calibrate the model, the percentage spent on maintenance was plotted against age, graph diagram (9-4) refers.
It will be observed that though there was a spread of points on the graph, it followed an expected trend.
The average values for each year were then estimated, and from the graph it is observed that the theoretical model appears to describe the situation fairly accurately.

The spread may be explained due to variations in initial costs due to site conditions. Areas where the bearing pressure is low would require heavier foundations which result in an increase in initial costs, but which do not affect the future costs of maintenance.
On the other hand the reverse can occur for housing built on ground where the bearing pressure may be high.

There will also be variations due to the type of materials used for water supply and sewage disposal systems. The recent trend in Ceylon is to use P.V.S. piping for these, and therefore cut down on the initial costs, as well as the future costs of maintenance.
The proportionate reduction in comparison to the use of galvanised piping and E.W. piping is quite large.
Overall the model obtained was found to describe the situation fairly accurately, and is given as a percentage by:

$$\frac{M_t}{(C_c + C_{dl})} \times 100 = 0.172.t. \; . \; . \; . \; . \; . \; . \; . \quad (9 - 26a)$$

or in the original form as

$$M_t = 0.000172. \; (C_c + C_{dl}). \; t.$$

i.e. the maintenance cost per rupee of initial cost spent at 1972 prices is 0.00172.t rupees in the t^{th} year at 1972 prices.

9.6.2 <u>The annual cost of maintenance to the consumer</u>

Suppose maintenance is to be carried out over a period of T years the annual average will be given by

$$M \doteq \frac{M_T}{T}$$, where M_T represents the total expenditure over the T years at fixed prices, and is given by

$$M_T = (C_c + C_{dl}) \cdot Kg. \frac{T^2}{2} \; \ldots\ldots \; (7 - 35)$$

Therefore for the city of Colombo, and possibly the majority of urban areas in Ceylon the average cost of maintenance, over a period of T years is given by

$$M = (C_c + C_{dl}) \cdot 0.00172 \; \frac{T^2}{2} \cdot \frac{1}{T}$$

$$= (C_c + C_{dl}) \cdot \cdot 0.00086\,T$$

at 1972 prices.

Hence the annual average cost of maintenance per rupee spent on housing at 1972 prices over a period of T years will be:

$$M = \frac{M}{(C_c + C_{dl})} = 0.00086\,T \; \ldots\ldots \; (9 - 27)$$

Equation (9 - 27) therefore becomes the basis on which the costs of maintenance to be recovered from the tenant are calculated, as given in the following example.

Suppose the cost of construction of a housing unit and infrastructure of 400 sq. ft. area is Rs. 25/= per sq. ft. at 1972 prices. If the expected life of the house is 50 years, what should be the monthly component of maintenance M of the total real costs(R).

Initial cost of unit = 400 x 25 = Rs 10,000

Expected life T(yrs) = 50.

∴ Annual costs of maintenance M at 1972 prices are:

$$M = 10{,}000 \times 0.00086 \times 50 \quad (Rs)$$

$$= 430 \; (Rs.)$$

∴ Component of rent accounting for maintenance per annum = Rs. 35/83 i.e. just over Rs 1/= per sq. ft. per annum.

Experience in Ceylon has shown that this average is correct. The figures used in the example are a real representation of the existing situation in Ceylon.

For reasons given earlier this represents the costs that must be recovered at 1972 prices. The equation is also valid for application in later years since $M/(C_c + C_{dl})$ is a ratio which will not change drastically. Change will occur when there is a considerable change in the materials used for construction.

9.7.0 The amortization of initial costs

Where costs are to be recovered over a period of time with interest, the annual or monthly recovery represents the costs to the consumer.

In section 7.5.6 the theoretical expression for amortizing costs at a fixed rate of interest, and interest calculated on a depreciating capital was given.

The expression for recovery of a unit of cost, in this case one rupee, annually is:

$$I = \frac{i}{100} \left[\frac{\left(1 + \frac{i}{100}\right)^T}{\left(1 + \frac{i}{100}\right)^T - 1} \right] \quad \ldots\ldots (9 - 28)$$

where i is the rate of interest to be charged, and T the total number of years over which the cost is to be amortised. The first instalment is paid one year after the date at which the cost is incurred.

9.7.1 The rate of interest (i)

The rate of interest charged for housing in Ceylon is 11%. This rate has been stipulated by the Central Bank of Ceylon, and is the rate charged even by most private banks. Private financing institutions do not generally finance the purchase or construction of houses in Ceylon. It may probably be due to the fact that the investors have looked for a quick turnover at a high rate of interest. Hence interest rates charged by these institutions, which finance the purchase of cars etc. charge up to 35%.

An arbitrary cut in interest rates is meaningless, as this constitutes a hidden subsidy.

The financing model in Chapter 3 promoted the use of private savings, which are in the form of compulsory savings, and pension and provident funds.

These funds are to pay an interest of about 5% per annum. Hence allowing for overheads in the use of these funds for housing the rate of 11% is not far wrong.

A reasonable rate would be 10%. This has been already done whereby interest rates have been brought down this year (1973), via cabinet approval.

Hence for the financing of urban housing for the present calibration of the model a rate of 10% is considered to be in force.

It will be appreciated that any serious fluctuation in these rates will alter the final result of this model. It will also be appreciated that in the practical use of this model at a future date the appropriate value of (i) must be used.

9.7.2 An expression for the amortization of unit cost over a period T years

Equation (9-28) gives the general expression for amortizing one rupee at i% interest. Using the value of $i = 10\%$ the final expression is:

$$I = 0.1 \left[\frac{(1.1)^T}{(1.1)^T - 1} \right] \quad \ldots\ldots\ldots (9 - 28a)$$

which therefore indicates the annual cost of amortizing one rupee worth of housing to the consumer.

9.7.3 Form and its effect the rate of amortization

The models describing the minimum initial cost of developing housing at a given location, section 9.5, are for the three forms denoted by y, where

$y = 1$ denotes a complete house
$y = 2$ denotes a core house
and $y = 3$ denotes a self help house.

It was stated that these models describe the entire cost in the case of $y = 2$, and $y = 3$, i.e. the models are equivalent to complete houses with the limitations of $f = 1$ for $y = 2$, and $f=$ and $n= 1$, for $y = 3$. These models therefore include the cost of self help labour to complete the core house, and the cost of labour to build a self help house.

In amortizing the costs and therefore estimating the real cost to the consumer, that part of the labour content provided must be deducted from the models described in section 9.5.0, for the core house and the self help house. This aspect has been discussed theoretically in section 7.5.11.

In this section coefficients will be estimated by which the cost of a complete house for $y = 1$, and $y = 2$, must be multiplied before equation (9 - 28a) can be applied. Each case is treated separately as follows.

9.7.3.1 <u>The complete house ($y = 1$)</u>

In this case all expenditure has been borne by the public authority, therefore the coefficient $F_1 = 1$. Equation (9 - 28a) can be applied to $(C_c + C_{dl})$ directly.

Land costs must be treated separately depending on the form of tenure.

9.7.3.2 <u>The core house ($y = 2$)</u>

In this case the costs of land development are met by the public authority.

The costs of the house are on the other hand met partly by the public authority and partly by the prospective tenant in the form of self help labour.

From equation (9 - 24) it is seen that the ratio $C_c/(C_{dl} + C_c)$ is equal to about 80% for an average household of 6 persons.

Therefore, for a rupee spent on land development, and construction of the house, 20% will be borne by the public authority while part of the balance will be borne by the prospective tenant.

Of the balance 80%, the following division occurs:

65% on materials and 35% on labour[1]

Of the 35% spent on labour about one quarter will be spent on building the core.

If the system is operated on a basis where either the balance materials required are supplied or a loan is given for the purchase of the balance materials, the public authority must base in addition to the 20% for land development, an addition $(64 + \frac{35}{4})$% of the balance 80%

i.e. $(20 + 0.73 \times 80) = 78\%$ of $(C_{dl} + C_c)$.

Hence in the case of core housing of a total rupee spent, only 78 cents have been spent by thepublic authority, and therefore need to be amortized. Equation (9 - 28a) in this case becomes:

$$I_2 = 0.078 \left[\frac{(1.1)^T}{(1.1)^T - 1} \right] \quad . \; . \; . \; . \; . \; (9 - 29)$$

Land costs as before must be treated separately.

9.7.3.3 The self help house

In this case the public authority meets the total cost of infrastructure development, and the cost of materials for the housing unit via a loan, or the supply of materials.

Once again, the ration $C_c/(C_c + C_{dl})$ estimated from equation (9 - 25) for an average household of 6 persons, is about 0.65, or 65% of the total cost.

The public authority must therefore meet:

$$(35 + 65 \times \frac{65}{100}) = 77\%$$

which is nearly the same as for core housing. This preliminary analysis suggests that self help housing does not seem to cut down the initial costs as much as expected.

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[1] See Chapter 2 - for source, and its use.

Hence in the case of self help housing the equation (9 - 28) becomes

$$I_3 = 0.077 \left[(1.1)^T / (1.1)^T - 1\right] \quad \ldots\ldots \quad (9 - 30)$$

If the system adopted is only to provide a serviced block of land and no materials for constructing the house then

$$I_3 = 0.035 \left[(1.1)^T / (1.1)^T - 1\right]$$

Land costs must be included separately depending on the form of tenure, as in the case of the complete house and core house. This is treated in section 9.8.

9.7.4 The optimum period of amortization, and resulting costs to the consumer.

The real cost to the consumer has been defined in Chapter 6, section 6.2.1, as

$$R = I + M \quad \ldots\ldots\ldots \quad (6 - 3)$$

where I is the annual equivalent for amortizing the total initial costs and M the annual cost of maintenance.

Expressions were developed for I excluding land costs, and M, in sections 9.7.3 and 9.6.2 respectively.

It will be noticed that both these functions are dependent on the initial value of $(C_c + C_{dl})$, and the time T where T represents the period of amortization, over which the houses and related infrastructure must also be maintained.

Hence, considering the case of a complete house for a rupee spent on infrastructure development, and house construction, the annual equivalent of amortizing the cost is given by

$$I = (0.1) \left[(1.1)^T/(1.1)^T - 1\right] \quad \ldots\ldots \quad (9 - 28a)$$

and the annual cost of maintenance is given by

$$M = 0.00086\, T \quad \ldots\ldots\ldots\ldots\ldots \quad (9 - 27)$$

Hence the consumer must meet the total of (I + M) over the period T, after which if the house is being purchased he meets a new cost of maintenance M_1 only and may therefore be less than the present value of $(M + I)$. If the house is being rented since the initial cost has been amortized, only the maintenance costs must be met. If the rent is kept at its original value of $(I + M)$, the house will continue to have a further useful life of say x years till such time $M_{(T + x)}$ is greater than or equal to $(I_T + M_T)$.

The economic life of the house x may then be estimated by using the condition

$$M_{(T + x)} \leqslant (I_T + M_T).$$

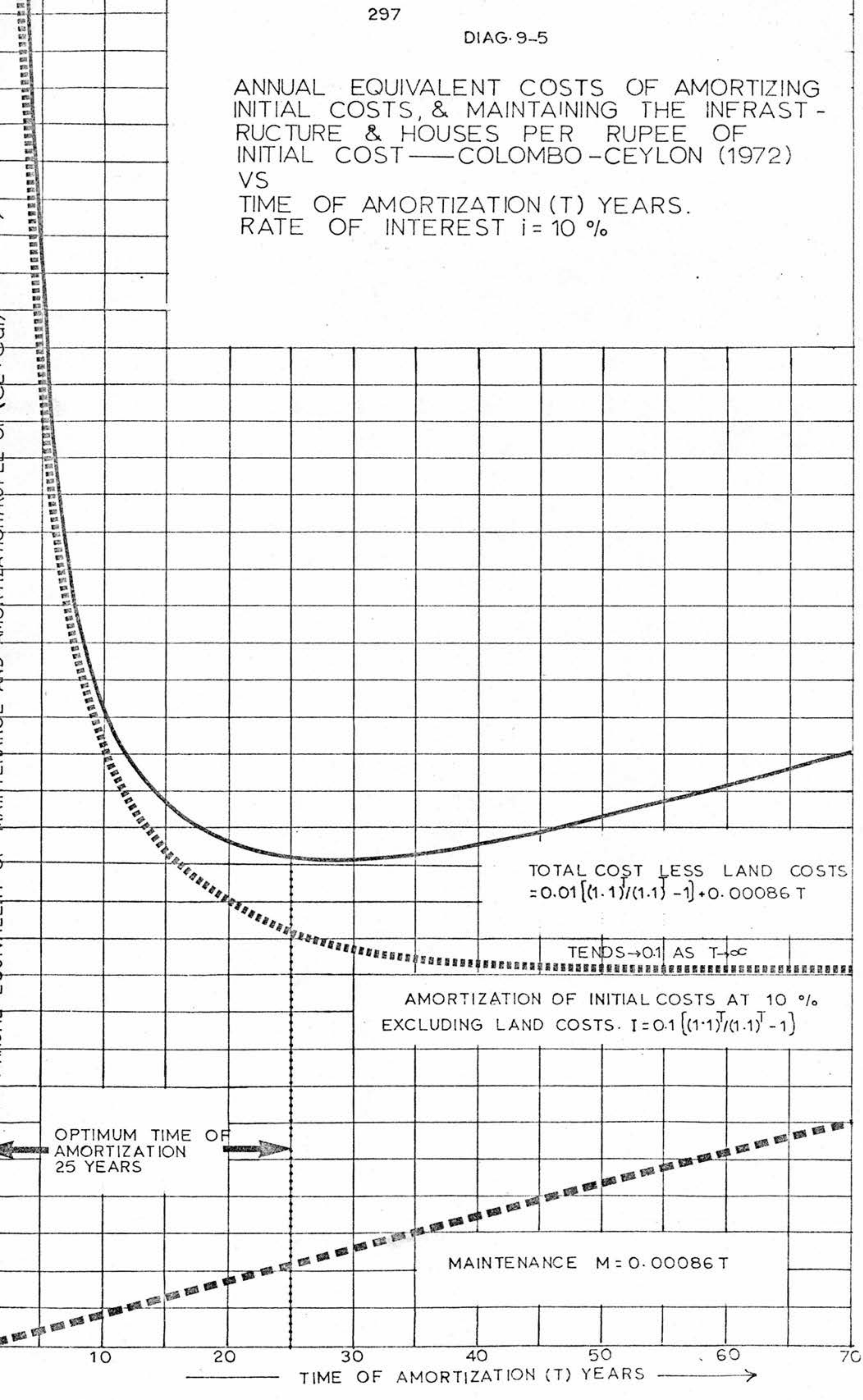
Note that the land rent has been excluded. Thus if the land is on rent, this will remain a constant addition throughout, or if it is on rent purchase this will be amortized using equation (9 - 28a) over the same period T.

If the house is being bought on a rent purchase basis the cost to be met by the consumer will be only the new cost of maintenance $M_{(T + x)}$ over the useful life of the house. Land cost will be a constant if it is being rented, or will be amortized over the same period T if it is being purchased.

Of interest now is the behaviour of the two functions, i.e. amortization of the costs of $(C_c + C_{dl})$ and maintenance costs. Section 7.5.10 was devoted to a theoretical discussion whereby it was shown that I decreases with T, while M increases with T. Hence, the total decreases to a minimum and increases again. The objective now is to estimate the optimum value of T, that produces the minimum $(I + M)$ and therefore the minimum cost to the consumer, to which land costs are added, resulting in the minimum real cost of housing to the consumer.

From the discussion it was seen that a graphical solution is the simplest. Diagram (9 - 5) gives the solution for the case of Colombo, which may be generally true for all urban areas in Ceylon, since land costs are not included.

DIAG. 9-5


ANNUAL EQUIVALENT COSTS OF AMORTIZING INITIAL COSTS, & MAINTAINING THE INFRASTRUCTURE & HOUSES PER RUPEE OF INITIAL COST —— COLOMBO - CEYLON (1972)
VS
TIME OF AMORTIZATION (T) YEARS.
RATE OF INTEREST i = 10 %
TOTAL COST LESS LAND COSTS
= 0.01 [(1.1)^T/(1.1)^T - 1] + 0.00086 T
TENDS → 0.1 AS T → ∞
AMORTIZATION OF INITIAL COSTS AT 10 %
EXCLUDING LAND COSTS. I = 0.1 [(1.1)^T/(1.1)^T - 1]
OPTIMUM TIME OF AMORTIZATION 25 YEARS
MAINTENANCE M = 0.00086 T
10
20
30
40
50
60
70
TIME OF AMORTIZATION (T) YEARS

From the diagram it will be observed how the annual equivalent of amortization drops sharply and then eases off to a limiting value of 0.1 Rs at $T \to \infty$ If the interest rates were higher the limit would be higher and if they were lower the limit would be lower.

Again from the diagram it will be observed how the annual maintenance cost to be recovered increases with (T).

The total cost as seen decreases sharply and reaches a minimum value of Rs 0.13 per rupee at T = 25 years and then increases again due to the influence of increasing maintenance costs.

Hence, in order to minimise the annual equivalent of amortizing the initial costs of land development and construction of the house, either for rent or rent purchase, the time of amortization should be twentyfive years.

The discussion so far has centred around the case of the complete house. Considering now the other forms, namely, the core house and the self help house, the question that arises is whether there will be a change in the value of T obtained for the complete house.

If the same system is used for maintenance as for the original construction both components will be multiplied by the same coefficient, thus reducing proportionately the annual value of amortization as well as annual maintenance costs. Hence, there will be no alteration in the time, but only in the total to be paid. These new totals are obtained by multiplying the minimum value obtained for the total house by the respective coefficients.

(1) In the case of the core house the minimum will be

Rs (0.13 x 0.78) = Rs 0.104 per total initial rupee spent.

(2) In the case of the aided self help house it will be

Rs (0.13 x 0.77) = Rs 0.10 per total initial rupee spent on land development and construction of the housing unit.

(3) In the case of the developed block of land, with no other aid, it will be

Rs. (0.13 x 0.35) = Rs 0.046 per initial rupee spent.

These then are the factors for estimating the annual equivalent costs to the consumer for the provision of a house of specified form, and standards, over a period of twentyfive years. These are the minimum possible.

To each of these cases must now be added the land costs depending on the type of tenure specified.

9.8 The minimum total cost of housing to the consumer (R)

The analysis of the preceding sections can now be used to develop a set of expressions for determining the real cost a household of a specified size, and specific social group will have to pay for the type of house it demands from a socio economic point of view.
The expressions will be at 1972 prices, and will contain two objective variables, namely the location of the house in terms of its radial distance from the city of Colombo (d) and the size of the household(h). Two types of tenure will be considered. They are pure rent and rent purchase. The rent given is annual.

The expressions will be classified by social group, type of house, and tenure of house.

In the case of renting land, rent will be calculted using the expression developed in Chapter 7, section 7.5.6, which gave,

$$I_{1,g,1} = 0.04\, C_{1,g} \quad \ldots\ldots \quad (7-29)$$

In the case of land being purchased the expression given by equation (9 - 28a) will be used, using T - 25, i.e.

$$I_{1,g,2} = 0.11.\ C_{1,g} \quad \ldots\ldots \quad (9-31)$$

The expression for $C_{1,g}$ is given in section 9.2.2

$$C_{1,g} = 22{,}600\ h\ e^{-0.56d.} \quad \ldots\ldots \quad (9-8)$$

The minimum annual equivalent of amortizing the initial costs of land development and annual recovery for maintenance were given in section 9.7.4. (1), (2) and (3).

Consider each case in turn, as given in section 7.5.11.

(1) Blue collar workers in complete houses for rent (g=1, y=1, x=1)

(a) Use equation (9 - 21) for $(C_{dl} + C_c)$ - section 9.5.

(b) Use a conversion factor of 0.13 to convert $(C_{dl} + C_c)$ into its minimum annual equivalent including maintenance - section 9.7.4.

(c) Use equations (7 - 29) and (9 - 8) to estimate the land rent.

Then annual real cost $(R_{1,1,1})$ is given by

$$R_{1,1,1} = (385\, h^{-0.152} + 1700\, h^{-0.263} + 904.\, h.\, e.^{-0.56\, d}) \qquad \ldots\ldots (9 - 32)$$

(2) Blue collar workers in complete houses for rent purchase (g = 1, y = 1, x = 2)

(a) and (b) are as before, but (c) changes wherein (9 - 31) is used for conversion.

Then

$$R_{1,1,2} = 385h^{-0.152} + 1700\, h^{-0.263} + 2486\; h.\, e.^{-0.56d} \qquad \ldots\ldots (9 - 33)$$

(3) Blue collar workers in core houses for rent purchase (g = 1, y = 2, x = 2)

The case of renting the land in this case is possible under special circumstances, while at the same time purchasing the house. The condition is that the land must belong to the state. Hence in this case two cases will be treated (1) the normal case where the house and land are both purchased; (2) the case where the house is purchased but the land rented. Items (a) and (b) will be the same for both cases but item (c) will differ accordingly.

Case 1 (Land and house both purchased)

(q) Use equation (9-24) to determine $(C_{dl} + C_c)$

(b) Use a conversion factor of 0.104. Section 9.7.4. (1)

(c) Use the same value as for (y = 1, y = 1, x = 2).

Then

$$R_{1,2,2} = (203\, h^{0.106} + 750\, h^{0.190} + 2486.\, h.\, e^{-0.56d}) \qquad \ldots\ldots (9 - 33a)$$

<u>Case 2</u> (Land on rent, house on rent purchase).

(a) and (b) are as before but (c) is as (1,1,1)

$$R_{1,2,2} - 203\,h^{0.106} + 750h^{0.190} + 904h^{-0.56} \quad \ldots (9 - 33b)$$

(4) **Blue collar workers in aided self help houses for rent purchase**
($g = 1,\ y = 3,\ x = 2$)

In this case also two sub cases arise. They are (1) the land being purchased and (2) the land being rented. A further limit is imposed on this model, i.e. h must be greater than or equal to 3.

In both cases items (a) and (b) will be the same and item (c) will differ accordingly.

<u>Case (1)</u> (Land and house both on rent purchase)

(a) use equation (9 - 25) to estimate the minimum value of $(C_c + C_{dl})$

(b) use a conversion factor of 0.10. Section 9.7.4(2)

(c) use the same value as for ($g = 1,\ y = 1,\ x = 2$)

$$R_{1,3,2} = (378\,h^{0.0795} + 633\,h^{0.181} + 2486\,h\,e^{-0.56d}) \quad .. (9 - 34a)$$

<u>Case (2)</u> (Land on rent and house on rent purchase)

In this case (a) and (b) are the same and (c) changes to that as in (1.1.1)

$$R_{1,3,2} = (378\,h^{0.0795} + 633\,h^{0.181} + 904\,h^{-0.56d}) \quad .. (9 - 34b)$$

These two equations may also be applied to the case of the developed block of land, for construction of the house using both materials and labour provided by the tenant. In this case the middle term which is the cost of constructing a self help house is excluded, since the total cost is borne by the tenant. The conversion factor is as in Section 9.7.4.(3) i.e. 0.046. Thus the two equations can be written as -

Case (1)

$$R_{1,4,2} = (173h^{0.0795} + 2486\ he^{-0.56d}) \ldots (9 - 35a)$$

for the purchased block of developed land.

Case (2)

for the rented block of developed land:

$$R_{1,4,2} = (440h^{0.0795} + 904\ h^{-0.56\ d}) \ldots (9 - 35b)$$

(5) White collar non professional worker in complete houses for rent ($g = 2,\ y = 1,\ x = 1$)

(a) Use equation (9-22) to estimate the minimum value of $(C_c + C_{dl})$

(b) Use a conversion factor of 0.13 to convert $(C_c + C_{dl})$ into the annual equivalent, together with maintenance costs.

(c) Use the same as for (1,1,1).

Then

$$R_{2,1,1} = (493h^{-0.118} + 3180\ h^{-0.208} + 904\ h.^{0.56\ d}) \ldots . (9 - 36a)$$

(6) White collar non professional workers in complete houses for rent purchase. ($g = 2,\ y = 1,\ x = 2$).

In this case (a) and (b) are the same, but (c) is as for (1,1,2).

Then

$$R_{2,1,2} = (493h^{-0.118} + 3180\ h^{-0.208} + 2486\ h^{0.56d}) \ldots . (9 - 36b)$$

(7) White collar professional workers in complete houses for rent ($g = 3,\ y = 1,\ x = 1$)

(a) Use equation (9-23) to estimate the minimum value of $(C_c + C_{dl})$

(b) Use a conversion factor of 0.13 to convert $(C_c + C_{dl})$ into the annual equivalent together with maintenance costs.

(c) Use the same as for (1,1,1).

Then

$$R_{3,1,1} = (640h^{-0.121} + 6650\ h^{-0.214} + 904^{-0.56d}) \ldots . (9 - 37a)$$

(8) White collar professional workers in complete houses for rent purchase $(g = 3,\ y = 1,\ x = 2)$

In this case (a) and (b) are the same but (c) is as for (1, 1, 2)

$$R_{3,1,2} = (640\,h^{-0.121} + 6650h^{-0.214} + 2486h^{\theta 0.56d}) \quad \ldots\ldots (9-37b)$$

9.9 Conclusion

As mentioned in the introduction the purpose of this chapter was mainly to verify the basic models that govern, development limitations, land costs, infrastructure development, housing construction, and maintenance costs.

The data obtained and used for calibrating these models though not large in quantity, has shown that the models are basically correct; and confirm the theoretical trends expected.

These models were then used to develop a set of models which describe the real costs of housing to the consumer. These models are for the three social groups, subdivided by four basic forms of housing ranging from the complete house to the unaided self help house. They also contain variations in tenure. Thus these models describe completely the various possibilities of providing housing within and around the city of Colombo, and thus form a base on which a housing programme could be formulated, that meets the demands of the population.

Some general conclusions of unusual interest were reached with regard to the variation in the cost of construction and infrastructure development.

In both these cases it appears that the cost is affected tremendously by increasing the number of floors in a building. The increase is so great that it appears that the cost of housing a larger household becomes cheaper than housing a smaller one. This conclusion is of utmost importance since it confirms the fact that multistoried flats are far too costly for a developing country like Ceylon. The trend though verified for Colombo may be generally true for the whole country.

Since the density is fixed at the maximum possible the land cost/capita does not vary, so that overall it is cheapest to build single storied terraced housing which can achieve the specified density of 170 p.p.a. net and the resulting maximum gross density of 118 p.p.a. allowing $2\frac{1}{2}$ acres per thousand population for the provision of support facilities.

The effect of this is seen when the number of floors are reduced to one, as in the case of the core house and self help house.

The conclusions and detailed models developed in this chapter form the basis on which a locational policy can be developed in the next chapter, so that a solution to the housing problem may be achieved at the minimum physical costs.

CHAPTER 10

Real expenditure on housing and its use in defining the housing threshold

10.0 Introduction

An important part of the theoretical model developed in Chapter 7 was the development of a model governing the household's expenditure on housing (section 7.6), and using it to define the housing threshold.

The housing threshold is then used for defining areas of residential location, so that the subsidy factor is minimised and thus the total physical costs.

The purpose of this chapter is to test the validity of the theoretical model proposed with reference to the city of Colombo, and propose modifications necessary for refining it.

This modified model is then used in conjunction with the standards developed in Chapter 8, and the models governing real costs developed in Chapter 9 to define the housing thresholds.

The use of these thresholds in aiding broad policy formulation is explained in Chapter 11.

10.1 Testing the original model governing the expenditure on housing

In this section the original model proposed is tested using data obtained via the survey described in Appendix I and modifications proposed for inclusion in a refined model.

10.1.1 The original model

The original model was based on developing two models, one which governed consumption of space, and the other which governed expenditure per unit of space. These models in a combined form gave the expression

$$A_{g,y,x} = K_{11,g,y,x} \; E^{\delta_{g,y,x}} . \; h^{-\beta_{g,y,x}} \; d.^{-\gamma_{g,y,x}} \qquad \ldots\ldots (7-46)$$

Hence the benefits or real expenditure on housing appeared to be dependent on social class, type of house, and type of tenure. Within each of these it was theorised that A would increase with income E where $\delta > 1$, decrease with household size h, and decrease with distance.

10.1.1.1 Data for testing the model

The basic data required for testing this model was household size(h), normal income of household(E), expenditure on housing(A), and location of house(d) with respect to the city centre. Further the household had to be classified by social group, and the house by type and tenure.

In the survey questionnaire, questions (1,12), (4,1) indicated the social class of the household, and the type of house. The type of house is classified into three types:

(1) permanent, i.e. uses permanent materials

(2) semipermanent, i.e. uses a mixture of permanent materials and semipermanent materials such as old packing cases etc.

(3) Temporary which uses purely scrap materials.

Tenure was marked separately on the side of the remarks column of the questionnaire with a full bar indicating an owner occupied house, a half bar for a rent purchase house, and left blank in the case of a rented house.

Using this information the data as presented is given by tenure, social class, and type of house. Annexure (A-5) of the Appendix gives the percentage breakdown by these major groupings. Tables (A1-1) etc. refer to the major groupings.

Within each of these groups, question (1,2) gave the household size(h) and is recorded in columns (6 - 7).

As explained in Chapter 8, a direct question on incomes would have yielded a very high percentage of no response cases. Hence the normal or long run income was approximated to total monthly expenditure. This was obtained via answers to questions (2,1) to (2,10) and are recorded on columns (21-24) to (49-51). The sum of these gives the approximate monthly income of the household (E).

The location of the house was defined as described in Chapter 8 by plotting the position of the house on a map of scale 1" = 8 chains, and measuring the distance from the city centre (d). The city centre is the clock tower and can be seen in the map in Appendix I, diagram (A1-1), at roughly towards the middle of the western sea coast. This data is recorded in miles in columns (76-78). The decimal point must be read after column (76).

10.1.2 Testing the model

To test the model the original form was expressed in the logarithmic form, to the base 10 as,

$$\log A = \log (K_{11}) + \delta \log E + \beta \log h + \gamma \log d.$$

During the survey it was found, as can be seen in annexure (A1-5) that no middle and upper classes lived in semipermanent or temporary houses. Therefore this class was excluded, and also acted as an indication as to what type of housing these classes demanded. Further it was found that within the city there were no cases recorded of rent purchase housing. This is understandable, since most loans for housing have been used for development beyond the city limits. Hence this case was also excluded.

The data was thus available for renters in the three groups, since owner occupiers did not pay any rent. In the blue collar group data was available for the three types of housing.

Using this data, regressions were run using the computer. The results are presented in table (10 - 1).

An examination of these equations revealed that there was a change in the expected signs of the regression constants and the overall explained variation was quite low.

Table (10 - 1). Regression coefficients for $\log_{10} A = \log_{10} (K_{11}) + \delta \log_{10} E + \beta \log_{10} h + \gamma \log_{10} d$

Social class (g)	Type of house (y)	Tenure (x)	$\log_{10}$ (K_{11})	δ	β	γ	% Exp. Var. (R^2)	Significance F	F at given level of significance	Sample size
1	1	1	-0.09684	0.03386	0.52018	0.00485	17.8	26.1354	$F_{0.001} = 5.42$	366
1	2	1	0.05207	0.17935	0.33214	0.23504	12.37	2.30592	$F_{0.05} = 2.76$	53
1	3	1	0.08245	0.15592	0.46503	-0.64239	27.7	2.6827	$F_{0.05} = 3.10$	25
2	1	1	-1.15296	-0.35273	1.02959	0.77880	43.7	41.9191	$F_{0.001} = 4.62$	166
3	1	1	-0.28625	-0.72955	0.83474	1.12046	37.39	15.7318	$F_{0.001} = 6.17$	83

Thus before any detailed analysis of the constants was carried out, it was decided to re-examine the theoretical model, and propose a modified version which may increase the explained variation.

10.1.3 Modifications to the original model

Going back to the theoretical model, it will be observed that the model suggested that the consumption of space would increase with household size. This fact was seen to be true only for a limited number, in Chapter 8, when the space standards were developed. Thus the theoretical model assumed that houses were freely available for households to move into, as household size changed. But this is not the true situation where there exists a shortage of houses in Colombo. Hence, if only those satisfied were used the theoretical model would have sufficed. However, to make allowance for the shortage, and area (a) of the house had to be included to improve the model, since the majority of cases recorded showed no relationship between area and household size.

10.2 A restatement of the theoretical model governing expenditure on housing

Taking into consideration the conclusion reached in 10.1.3, the model was restated as

$$A = K_{11} \cdot h^{-\delta} \cdot E^{\beta} \cdot d^{-\gamma} \cdot a^{\theta}$$

where a is the area of the house in sq. ft.

This model thus considered the effect of area of the house on a household's expenditure on housing. θ was expected to be > 0 but < 1 due to economies of scale.

10.2.1 Testing the model

To test this model, the extra data needed was the area of the house. This information had been obtained via question (4, 2) of the questionnaire, and is recorded in columns (57-60) of the tables in Appendix I.

Table (10 - 2) Regression Coefficients for $\log_{10} A = \log_{10}(K_{11}) + \delta \log_{10} E + \beta \log_{10} h + \gamma \log_{10} d + \theta \log_{10} a.$

Social class (g)	Type of house (y)	Tenure (x)	Average monthly income (Rs)	$\log_{10}(K_{11})$	δ	β	γ	θ	% Exp. Var. (R^2)	Significance F	F at given level of significance	Sample size
1	1	1	283	-0.58571	0.03659	0.40326	-0.03136	0.31674	28.73	36.09134	$F_{0.001} = 4.62$	363
1	2	1	250	-0.26178	0.16942	0.29196	0.20726	0.18994	14.81	2.0864	$F_{0.05} = 2.53$	53
1	3	1	207	-0.58767	0.08821	0.48322	-0.66099	0.33283	33.11	2.47596	$F_{0.05} = 2.87$	25
2	1	1	483	-1.61111	-0.34072	0.80908	0.45229	0.41910	59.15	56.12843	$F_{0.001} = 4.95$	160
3	1	1	863	-1.82834	-0.30694	1.19764	0.75571	0.11422	56.03	2w.89917	$F_{0.001} = 5.31$	80

Notes

(1) g = 1 blue collar, g = 2 white collar non prof. g = 3 white collar prof.
(2) y = 1 permanent house y = 2 semipermanent house y = 3 temporary structure
(3) x = 1 rented
(4) Significance calculated using Table 9 - Statistical Tables. J. Murdoch and J.A. Barnes.

For regression the model was expressed in logarithmic form to the base 10, where

$$\log A = \log K_{11} + \alpha \log h + \beta \log E + \gamma \log d + \theta \log a$$

Regression analysis was carried out using the computer, and the results are presented in table (10 - 2).

Note that in both cases the data stored on cards was used directly, conversion of the data into the required form being carried out within the programme. The programme used was an SPSS, and the computer one belonging to the ERCC of type 370/155.

This model gave a vastly improved explained variation, excepting for one case. Hence, themodel was considered valid as the level of significance was reasonably high, i.e. 0.01% to 0.5%.

10.2.2 A discussion of variations from the theoretical model

From table (10-2) it will be observed that none of the cases adhered strictly to the theoretical model and thus need explanation. These variations are also useful in making broad judgments on the behaviour patterns of each class regarding expenditure on housing. Consider each case separately.

10.2.2.1 Blue collar workers living in rented permanent houses

(1) In this case it will be observed that there is an increase in rent paid with increase in household size, rather than a decrease.

This may be explained due to the fact that an increase in household size tends to indicate an increase in household income within this class[1], and that the net increase on food, clothes etc. is negligible with an increase in household size[2], which results in a slight increase in expenditure on housing.

---

[1] Table 31 of the socio-economic survey of Ceylon for 1969-70 shows a positive correlation between household size and number of income receivers. A simple regression of household size vs. household income using the survey data confirmed the existence of a positive correlation.

[2] A regression of the survey data confirmed a decreasing rate of marginal increase in the expenditure on food, clothes etc. with increasing household size.

(2) The increase due to increased incomes is very low. This is due to the fact that most of these houses come under the rent control act. They are old and the rents have been fixed at 1940 levels. Thus the real rents charged do not reflect the real capacity of the household to pay for housing.

(3) There appears to be a decrease with distance. This may be due to the fact that most of the householders work in the port which is near the city centre. Thus moving away from the centre reflects a decrease in rent paid.

Overall this model gives an idea of the behaviour patterns but is not representative of behaviour in free market conditions.

10.2.2.2 Blue collar workers living in rented semipermanent houses

This class appears to be similar in behaviour to the case of those living in permanent houses. Once again the restriction of rent control applies to this case and is therefore not really representative of the situation.

10.2.2.3 Blue collar workers living in rented temporary houses

This situation is real and useful since it does not come under the category of rent control. Therefore it will represent the real behaviour patterns of the working class.

(1) The power to which household size is affected is only 0.01821. This is more realistic as it shows that increase in household size though it probably results in a higher household income, results only in a slight increase in the rent paid. This is because the rents are already high, and the household cannot afford more on rent.

(2) The income elasticity is greatest for this type of housing within the class i.e. 0.4832. Though this is still less than 1, it represents the real situation. It also confirms that probably the working class aspirations are less than the middle and upper classes, and they are therefore able to achieve their aspirations at a lower income thus the tendency to follow Schwabe's law, rather than that proposed by Reid (see Chapter 6).

(3) Distance plays an important part as can be seen from the constant where $\gamma = -0.66099$. This confirms the fact that to this class travel cost and time means a lot, especially since most of these people work in the city centre. It thus confirms the ideal case that occurs theoretically.

(4) In all three cases rent has been affected by area to the power of approximately 0.3. This is as expected, i.e. due to economies of scale, the marginal rate of increase decreases with increase in area.

Overall this model, which explains about 33% of the variation, is the most suitable to be adapted for estimating the probable expenditure on housing by the working class for different types of tenure, and form. This basic model is thus used in section 10.3 to develop a set of models for various combinations of tenure and type for the working class population.

10.2.2.4 White collar non professionals living in rented permanent houses

This class of population begins to depict the effects of class increase.

(1) The decrease of the constant δ to -0.34072 shows clearly the validity of the theoretical model. In this case the middle class attitudes tend to reflect greater expenditure on items like food, clothes, education of children, entertainment etc. whereby an increase in h reflects a decrease in the expenditure on housing.

(2) The income elasticity β jumps to the value of 0.80908 showing that increase in social class has set higher standards which requires a greater proportion of income for housing. Still the standards do not appear to be beyond their reach as β is less than 1.

(3) The constant γ which controls distance has reversed in sign to $+0.45229$. This is very interesting as it goes against the theoretical model, and is opposed to the behaviour of the working class population.

This may be explained by considering the basis on which the theoretical model was built.

The theoretical model assumed that movement away from the city centre would result in increased travel costs, and inconvenience. However, it also contained the inbuilt assumption that the entire urban area was environmentally similar. This situation is far from real, since the city centre is old, delapidated, and overcrowded. Moving away from the centre provides newer and better residential areas. Thus the all important fact that this class is beginning to move away to the suburbs, and is willing to pay more for a pleasant environment. Hence γ is positive for this class. This is an important conclusion in the location of future middle class housing.

(4) Size of house has a positive effect on rent paid. This, though considerable (given by $\delta = 0.4191$), is still less than 1. It shows that the middle classes are prepared to pay more for increased space than the other classes.

10.2.2.5 White collar professionals living in rented houses

(1) In this class of population, household size affects the rent paid in a manner similar to that of the middle classes and is in keeping with the theoretical model, i.e. a decrease in rent paid, with an increase in household size.

(2) The income elasticity achieves its typically predicted theoretical value, i.e. $\beta = 1.19764$. This explains the increase of the real cost, with reference to the standard of housing set by this class for themselves, and the increasing marginal rate of expenditure with income shows that households move at an increasing rate towards achieving their aim.

(3) The value of γ in this case increases still further to 0.75571 confirming the household's desire for an improved living environment. This class has also got the highest income levels, and the highest probability of car ownership. Thus distance means less to this class in terms of travel costs and time, than to the middle class and working class, who are progressively poorer, and use public transport to a greater extent.

(4) The value of (θ = 0.11422) which governs the relationship between area of house and rent paid, shows that the majority have probably more space than they need, but what they are looking for is improved qualitative standards, unlike the middle class who are looking for improved quantitative standards, as well.

10.2.2.6 Broad conclusions

From the foregoing discussion it is possible to draw some broad conclusions on the class preferences of housing.

(1) The blue collar workers

This class appears to prefer living towards the city centre. An increase in household size helps them in paying more rent, and confirms the usefulnessof the extended family which is proposed by the concept of "housing demand". Increased incomes, however, are not very effective in increasing rents as were expected. This is simply because the standards this class demand are relatively low and are achievable within their incomes. Increased areas reflect a normally expected increase in the rent paid, i.e. at a decreasing marginal rate. This class is probably in the stage of primary demand.

(2) The white collar non professional workers

This class appears to prefer an improved living environment and therefore moves away from the city centre. Household size increases result in a decrease in rent paid. Here, as explained in 10.2.2.4 other household expenditure appears to take priority over housing. Increased incomes play a more important part than the working classes on the rent paid. This class appears to be in a transition period, reflecting a demand for more space rather than improved quality. This class depicts the stage of need.

(3) White collar professional and managerial workers

It appears that this class appears to want houses further away from the city centre than even the middle classes. Household size is

Table (10 - 3) Probable percentage of income spent on rented housing by class for a household of 6 persons, at $2\frac{1}{2}$ miles from city centre, for various household income groups Colombo, Ceylon - 1972

INCOME GROUPS IN RUPEES											
0-500	100-150	150-200	200-300	300-400	400-500	500-600	600-700	700-900	900-1000	1000-1500	1500-2000
BLUE COLLAR OR WORKING CLASS[1] (Percentage)											
14.17	8.915	7.46	*6.2	5.16	4.60	4.10	-	-	-	-	-
WHITE COLLAR N.P. OR MIDDLE CLASS[2] (percentage)											
-	-	-	11.93	11.16	*10.63	10.21	9.90	9.89	9.22	-	-
WHITE COLLAR PROF. OR UPPER CLASS[3] (Percentage)											
-	-	-	-	12.76	13.45	13.98	14.50	*15.09	15.61	16.4	17.53

Notes :

1. Calculated as %A of E $= 107.9 \times E^{-0.517}$
2. Calculated as %A of E $= 34.1 \times E^{-0.191}$
3. Calculated as % A of E $= 4.02 \times E^{0.198}$

* Average income for class

4. Area of house as per standards table (8 - 3), i.e. g= 1, 400 sq. ft. g = 2, 875 sq. ft. g = 3 , 1700 sq. ft.

of the same importance as in the middle classes, i.e. increased household size results generally in less being paid as rent for housing. Increasing incomes reflect the typical attitude of the affluent society, i.e. a tremendous rate of increase in rent with income. The fact that increased areas do not reflect as great an increase in rent paid as in the middle classes shows that this class has more or less achieved its space requirements and is looking for improved quality. Overall this class reflects the stage of secondary demand (Chapter 6).

Hence, "need" as accepted to-day is a point along the line of "demand" and tends to reflect the middle class values of a population. The foregoing shows clearly why the concept of "demand" as put forward in Chapter 6 is a more realistic approach to solving the housing problem of the developing countries. In short, "need" assumes that the entire population will pay a fixed percentage of income under all conditions, while the analysis of "demand" has shown that this assumption is entirely false, and the closest case it may represent is the middle class population, while in the case of the working classes demand reflects a decrease in percentage of income devoted to housing with increasing incomes, and in the upper classes it reflects an increase in percentage income devoted to housing with increasing incomes. Table (10-3) indicates the probable percentages of income devoted to rented housing, for each class, for an average household of size 6 persons, living at an average distance of $2\frac{1}{2}$ miles from the city centre for different income groups. The areas used represent those given in table (8-3) for a household of 6 persons.

10.3.0 Models governing the probable expenditure on housing by tenure, class, house type, household size, location, and household income

From the analysis it is now possible to develop a set of models which will describe the probable expenditure on housing at 1972 prices. These models will then be used in defining housing thresholds in conjunction with the models developed in Chapter 10.

In developing the models for rent purchase certain assumptions will be made, since no data was available for developing an independent set of models for this type of tenure.

10.3.1 Rented housing (x = 1)

In dealing with this type of tenure the three classes are considered separately, and for the working class the four forms, namely, the complete house, core house, aided self help house, and developed block of land, are considered.

(1) Blue collar, permanent houses ($g = 1$, $y = 1$)

From the discussion in 10.2.2.3 it was seen that the model describing those living in rented temporary houses describe the situation best.

Therefore the model gives the rent paid per mensum i.e.

$$A_{1,1,1} = 0.2584 . h^{0.018} E.^{0.483} . a^{0.333} . d^{-0.661} \quad \ldots\ldots (10-1)$$

but the area a to be provided is governed by the standard developed in chapter 8:

$$a = 190\, h^{0.425} \quad \ldots\ldots\ (8-1a)$$

$$\therefore A_{1,1,1} = 1.486 . h^{0.159} . E^{0.483} . d^{-0.661} \quad \ldots (10-1a)$$

(2) Blue collar, semipermanent and temporary housing

Suppose the real cost of a house for this household of size h and location d is above the amount the household is prepared to pay, then for its income E the household will move to a point further away from the city centre, where the cost of providing the house is in line with A, or alternatively it will accept the next best, which is the core house. Applying the same arguments the type of house provided can move down the scale at a fixed location till the real cost is equal to A, or the location of the house can be decided such that the real cost is equal to A.

Hence in general the household will maintain the same paying capacity, but move its location and type of house till it is able to meet the real cost. This is what has happened among the working class population, though in a haphazard way.

Therefore for all types of house, the paying capacity of a household for rented housing will follow the same model given in equation (10-1a).

This system of renting, however, is difficult to apply to core housing and self help housing. These are best suited to a rent purchase system, where ultimate ownership is the incentive to self help methods.

(3) White collar, permanent houses (non professional)

This case is straight forward and is given by the model in 10. 2. 2. 4, where the monthly rental is given by:

$$A_{2,1,1,} = 0.02448\, h^{-0.341} . E^{0.809}\, a^{0.419} . d^{0.452} \quad \ldots (10-2)$$

but (a) in this case is governed by:

$$a = 362h^{0.492} \quad \ldots\ldots\ldots (8-1b) \quad \text{Chapter 8}$$

$$\therefore A_{2,1,1,} = 0.187\, h^{-0.135} .\ E^{0.809} .\ d^{0.452} \quad \ldots\ldots (10-2a)$$

The case of the semipermanent and temporary house does not arise.

(4) White collar professional, in permanent houses

This case is also straight forward and is given by the model in 10. 2. 2. 5, where the monthly rental fixed is given by :

$$A_{3,1,1,} = 0.01522\, h^{-0.307} .\ E^{1.198} . a^{0.114} . d^{0.755} \quad \ldots\ldots (10-3)$$

but (a) is given in chapter 8 by

$$a = 725\, h^{0.485} \quad \ldots\ldots\ldots\ldots (8-1c)$$

$$\therefore A_{3,1,1,} = 0.03166\, h^{-0.252} .\ E^{1.198} . d^{0.755} \quad \ldots (10-3a)$$

In this case also the form of house given as semipermanent and temporary does not arise.

10.3.2 Rent purchase housing (x = 2)

In the case of rent purchase housing no data was available for assessing individual models.
However, a safe approximation of the models used for rented housing can be made.

One of the basic objectives of a household in Ceylon is to try and own their own house. This is obvious from the vast numbers who are willing to pay up to a 11% rate of interest to obtain loans for putting up houses for their own occupation. Thus it may be concluded fairly safely that if the house provided is for purchase on a monthly basis, the rent the household is prepared to pay is greater than if the house was on a pure rental basis.

Hence it may be approximated that if the house is for rent purchase, the household will pay up to about $1\frac{1}{4}$ times the amount paid for pure rent. Therefore in this case the models derived for rent multiplied by 1.25 can be used to estimate the household's paying capacity.

10.4 The housing threshold

In section 7.7. of Chapter 7 it was seen that the housing threshold was defined as the household income at which the real cost of housing(R) to the consumer, was equal to the real expenditure on housing by the consumer. This was given by the condition

$$\phi_{g,y,x}\left[h,\ d\right] = \psi_{g,\ y,\ x}\left[h,\ d,\ E\right] \quad \ldots .\ (7-49)$$

On using the functions developed, ϕ and ψ, for various g, y, x, it is possible to estimate the household income E, for a given h and d, or alternatively for a given h, and E, it is possible to determine the most suitable location (d) which satisfies the above condition.
This ideal condition may be beyond the reach of certain categories of household, in which case (d) can be selected such that (R-A) is

Table (10 - 4) : Real expected maximum (E_{max}), and minimum $E_{(min)}$ expenditure on housing (A) of each social class, for households of average size (h_a) at distance (d) from city centre, Colombo, 1972 prices

Social class (g)	Max. income of household in E_{max} Rs per month	Min. income of household in E_{min} Rs per month	Average household size (h_a)	RENTED		RENT PURCHASED	
				Real annual expenditure on housing(A) for (h_a) and $E_{(max)}$	Real annual expenditure on housing(A) for (h_a) and $E_{(min)}$	Probable annual expenditure on housing(A) for (h_a) and $E_{(max)}$	Probable annual expenditure on housing(A) for (h_a) and $E_{(min)}$
1	750	87	6.7	$592.6d^{-0.661}$	$210.8d^{-0.661}$	$740d^{-0.661}$	$262d^{-0.661}$
2	1220	191	6.5	$845d^{0.452}$	$189d^{0.452}$	$1060d^{0.452}$	$236d^{0.452}$
3	2015	366	6.4	$2167d^{0.755}$	$285d^{0.755}$	$2720d^{0.755}$	$356d^{0.755}$

Note:
1. The maximum and minimum incomes are estimated as (mean $\pm$ 2 standard dev.) which gives a 95% probability of occurrence.
2. The average household size is the average for each social group.
3. The data is from the survey - Appendix 1.
4. These equations are for $d \geqslant 1$.

Table (10-5) : The Real cost of housing by class, type, form, and location, for a household of average size

		Blue Collar g = 1		White Collar N.P. g = 2		White collar prof. g = 3	
Type of house(y)	Tenure (x)	Average household size (h_a)	Real cost (R) per annum of house	Average household size (h_a)	Real cost (R) per annum of house	Average household size(h_a)	Real cost (R) per annum of house
1	1	6.7	$1340+6000e^{-0.56d}$	6.5	$2550+5900e^{-0.56d}$	6.4	$4975+5800e^{-0.56d}$
1	2	6.7	$1340+16,600e^{-0.56d}$	6.5	$2550+16,200e^{-0.56d}$	6.4	$4975+15,900e^{-0.56d}$
2	2	6.7	$1324+16,600e^{-0.56d}$	-	-	-	-
2	$C_{\ell}=1$ $(C_c+C_{dl})=2$	6.7	$1324+6,000e^{-0.56d}$	-	-	-	-
3	2	6.7	$1257+16,600e^{-0.56d}$	-	-	-	-
3	$C_{\ell}=1$ $(C_c+C_{dl})=2$	6.7	$1257+6,000e^{-0.56d}$	-	-	-	-
4	2	6.7	$440+16,600e^{-0.56d}$	-	-	-	-
4	1	6.7	$440+6,000e^{-0.56d}$	-	-	-	-

a minimum. Since (R-A) is the subsidy factor, this technique minimises the subsidy, and thus the total physical costs. It is also possible to reduce the standards to the minimum possible, as defined in Chapter 8, so that the subsidy may be reduced further.

Functions governing the real expenditure on housing by the different social groups were derived in section 10.3. These expressions are thus used to derive expressions for households of average size for each group, and who have a maximum or minimum income, thus covering the entire income range. The average household size (h_a) was obtained by averaging the household sizes within each group. The maximum and minimum incomes were derived as the mean for each group $\pm$ twice the standard deviation. This would account for about 95% of the distribution and is therefore quite accurate. The values obtained for each group were substituted in the equations in 10.3. giving models using distance (d) as the only independent variable. The details are given for each group in table (10-4).

Models expressing the real cost of housing by social group, type of house, tenure, household size, and location were derived in Chapter 10. Once again the average values of h for each group were substituted in these models, giving models of the real cost(R) as a function of distance(d) from the city centre. These models are given in table (10-5), using the standard notation to describe tenure and form, i.e. $y = 1$ the complete house, $y = 2$ the core house, $y = 3$ the aided self-help house, $y = 4$ the developed block of land with no aid to build the house. The tenure $x = 1$ gives pure rental, and $x = 2$ gives rent purchase. The same notation is used in the diagrams.

Using these two sets of models, it is possible to determine if housing thresholds exist and if so their locations.

It must be noted that both real costs as well as expenditure is given at 1972 prices. Thus, there will be no discrepancy in equating one to the other.

Will the results obtained be valid in the future? Using a safe assumption that as prices rise due to inflation so will wages, and since the net result estimates the location (d), the results should be valid unless there is an unusual rise in costs or increase in wages.

Each social group will be treated separately, as in the following discussions.

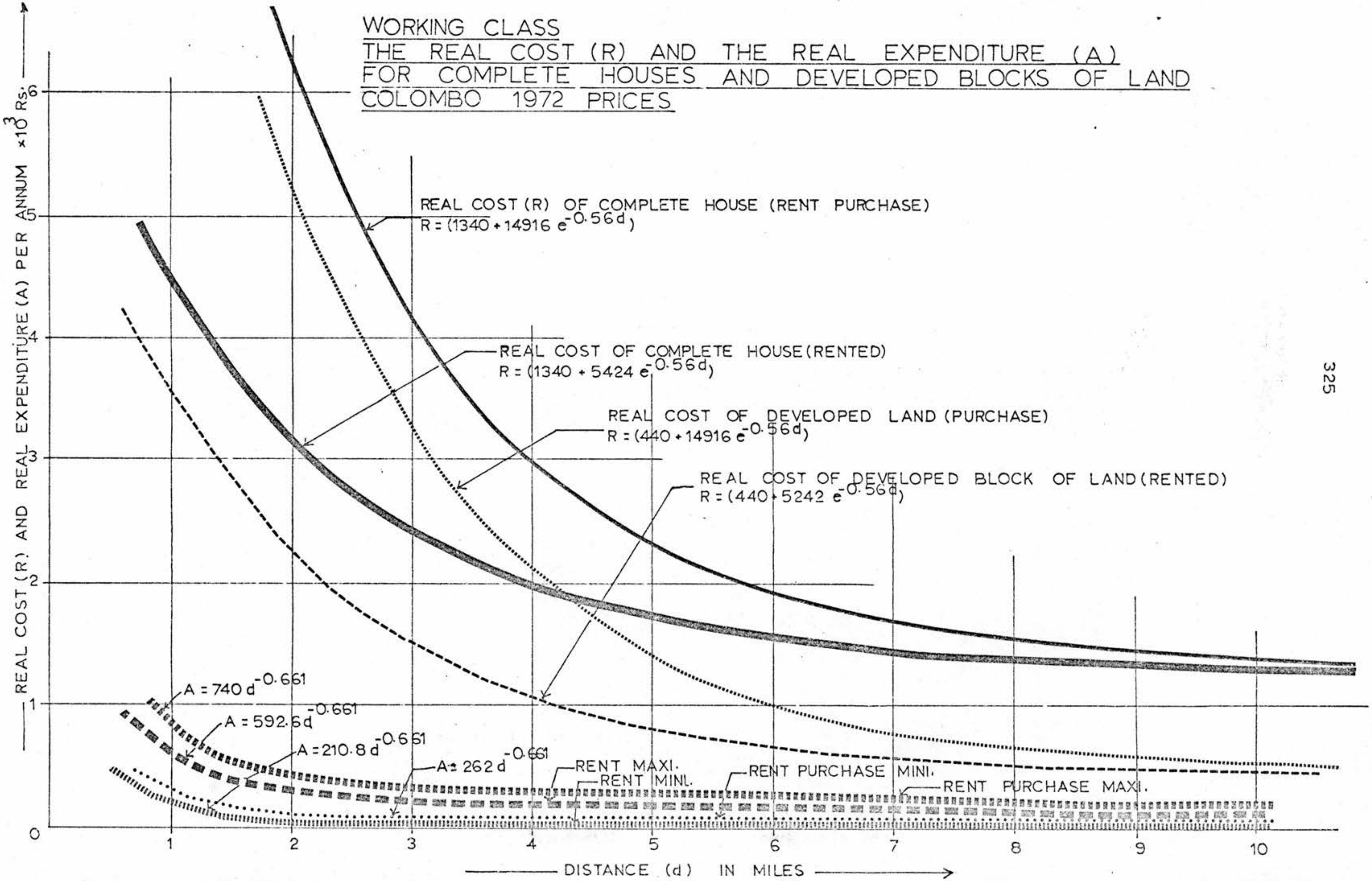
10.4.1 The working class thresholds

The models governing the real expenditure (A), and the real costs (R) per annum of a complete house and a developed block of land are plotted in diagram (10-1). These are the two extreme cases. (R) is given both for pure rental as for rent purchase, while (A) is for the maximum and minimum incomes both for pure rental, and for rent purchase.

The case of the core house and the aided self help house fall between these two extreme cases of R. They have not been plotted.

Referring to table (10-5) it will be observed that core housing and aided self help housing do not reduce the overall cost to the consumer to a very great extent. The reason for this is that materials account for 65% and labour only for 35%. Further, the full cost of land development has to be borne by the tenant, since this is a skilled job. Only the labour content in housing is saved. Between the core house and the self help house there is an increase in the costs of land development because in the latter case n has been limited to 1. Overall it appears that the developed block of land for unaided self help is the cheapest.

WORKING CLASS
THE REAL COST (R) AND THE REAL EXPENDITURE (A)
FOR COMPLETE HOUSES AND DEVELOPED BLOCKS OF LAND
COLOMBO 1972 PRICES



COLOMBO REGION BELT FOR WORKING-CLASS SELF-HELP HOUSING

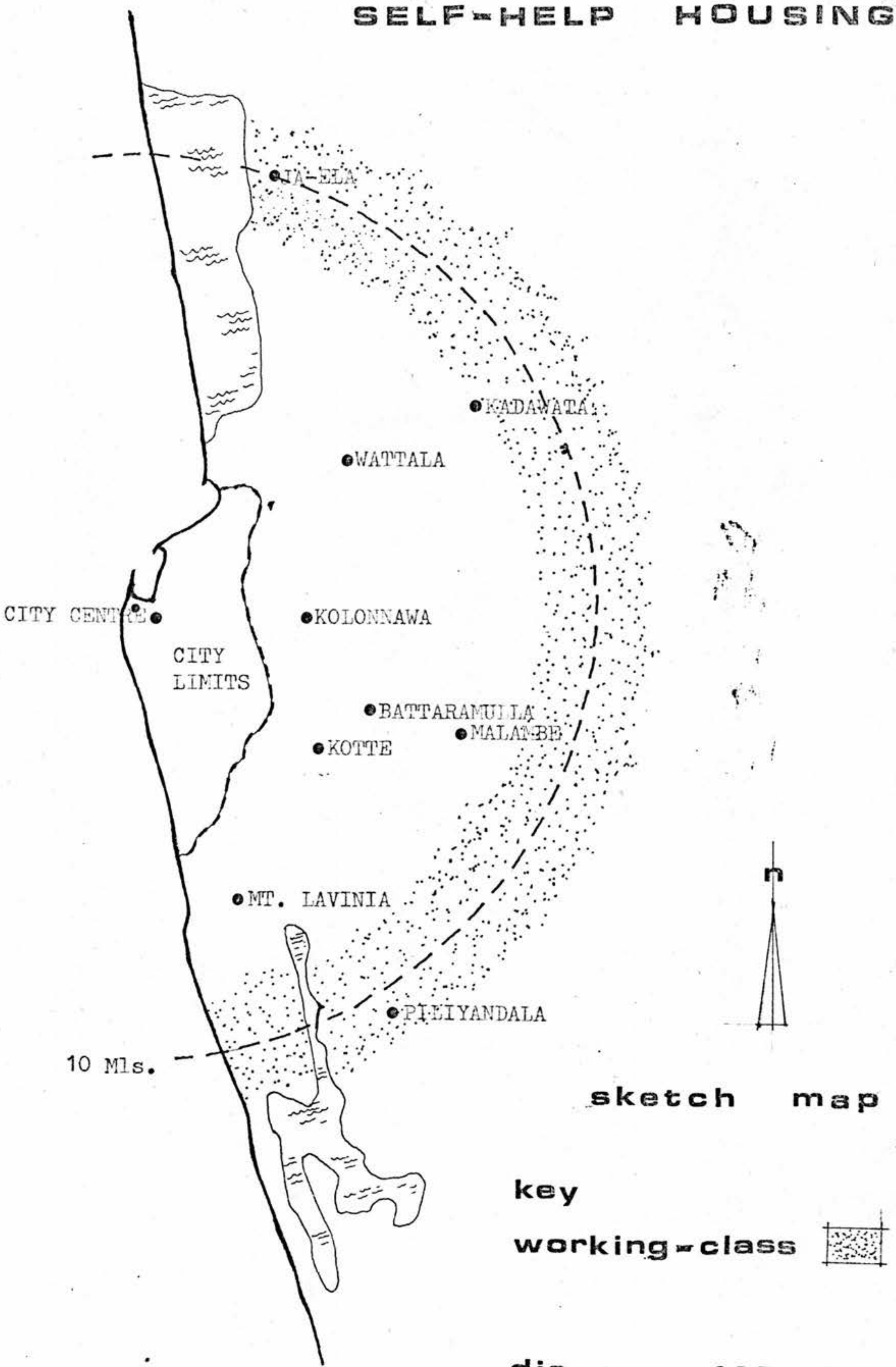


diagram (10-2)

Referring to diagram (10-1) it will be observed that as distance increases so does the real cost (R). The actual expenditure also decreases.

It appears from the diagram any form of housing for the working classes is beyond their reach. But it will be observed that the subsidy is least at a point for the case where a developed block of land has been provided. The variation between the case of rent and rent purchases vanishes at about 10 miles from the city centre.

Overall the broad conclusion that can be reached regarding the blue collar workers in Colombo is as follows:

(1) Any form of housing appears to be beyond their ability to pay.

(2) In view of (1) above it appears that public sector investment in the direct development of housing for the working classes in Colombo should be concerned with providing developed blocks of land around the periphery of the city and beyond. This results in minimising the subsidy factor necessary.

(3) The land can be given on a rent purchase basis. This will help in reducing the subsidy further, and be an incentive for the owner to develop his house with time.

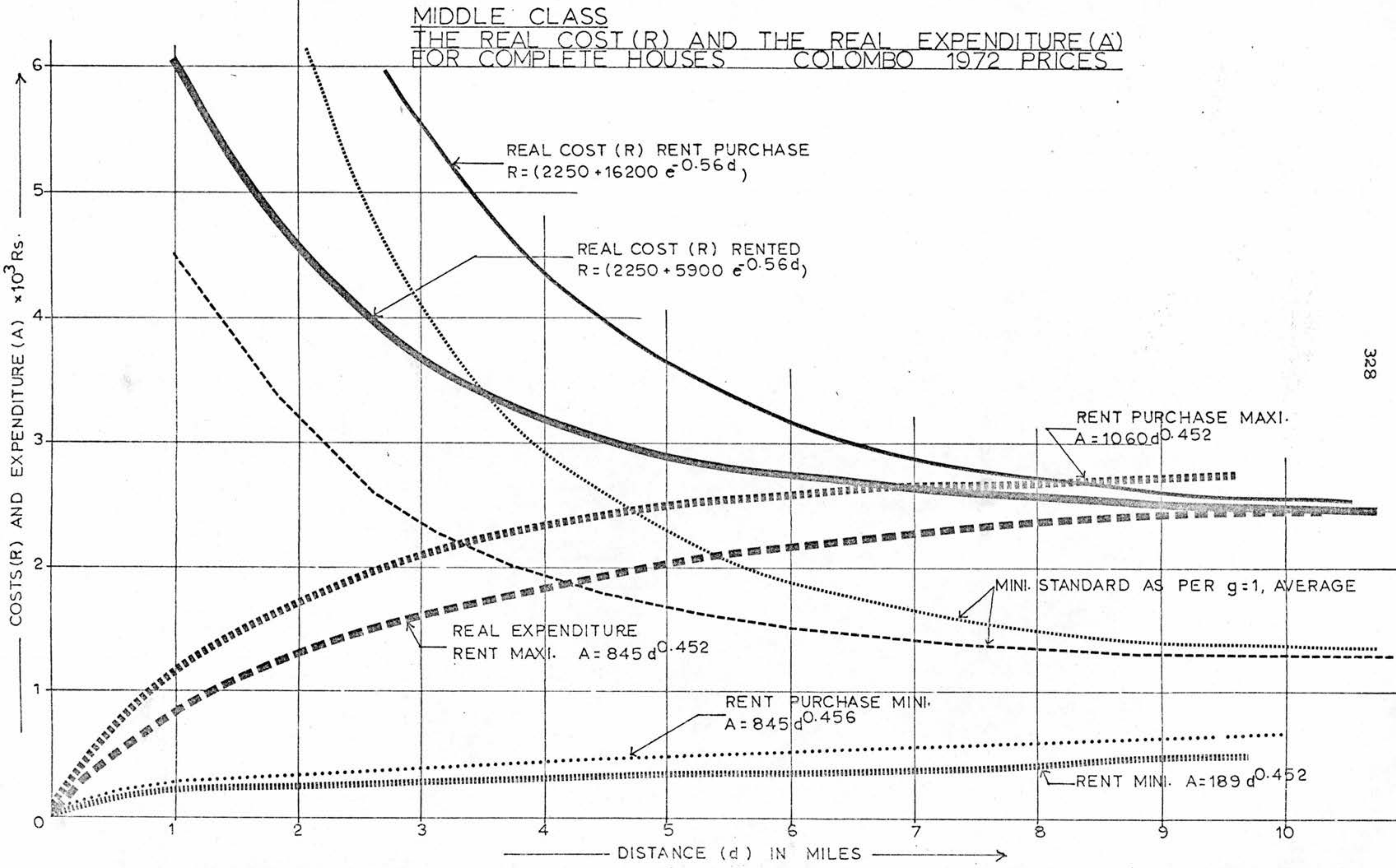
(4) Increase in household size will have a slight effect in reducing the subsidy.

This broad information can be transferred on to a map which is called a threshold map. Diagram (10 - 2) gives an outline of the Colombo region and indicates the area where blocks of land should be developed for self help housing. The map is a sketch and does not include other land uses which may be proposed. It only gives the broad possibilities.

10.4.2 Middle class thresholds

Similar to the case of the working class, the real cost of middle class housing (R) and the real rent paid (A) are plotted on diagram (10-3).

DIAG. 10—3


MIDDLE CLASS
THE REAL COST (R) AND THE REAL EXPENDITURE (A)
FOR COMPLETE HOUSES COLOMBO 1972 PRICES
REAL COST (R) RENT PURCHASE
R=(2250+16200 e^-0.56d)
REAL COST (R) RENTED
R=(2250+5900 e^-0.56d)
RENT PURCHASE MAXI.
A=1060d^0.452
MINI. STANDARD AS PER g=1, AVERAGE
REAL EXPENDITURE
RENT MAXI. A=845d^0.452
RENT PURCHASE MINI.
A=845d^0.456
RENT MINI. A=189d^0.452
COSTS (R) AND EXPENDITURE (A) ×10^3 Rs.
DISTANCE (d) IN MILES
0
1
2
3
4
5
6
7
8
9
10

COLOMBO REGION BELT FOR MIDDLE-CLASS HOUSING

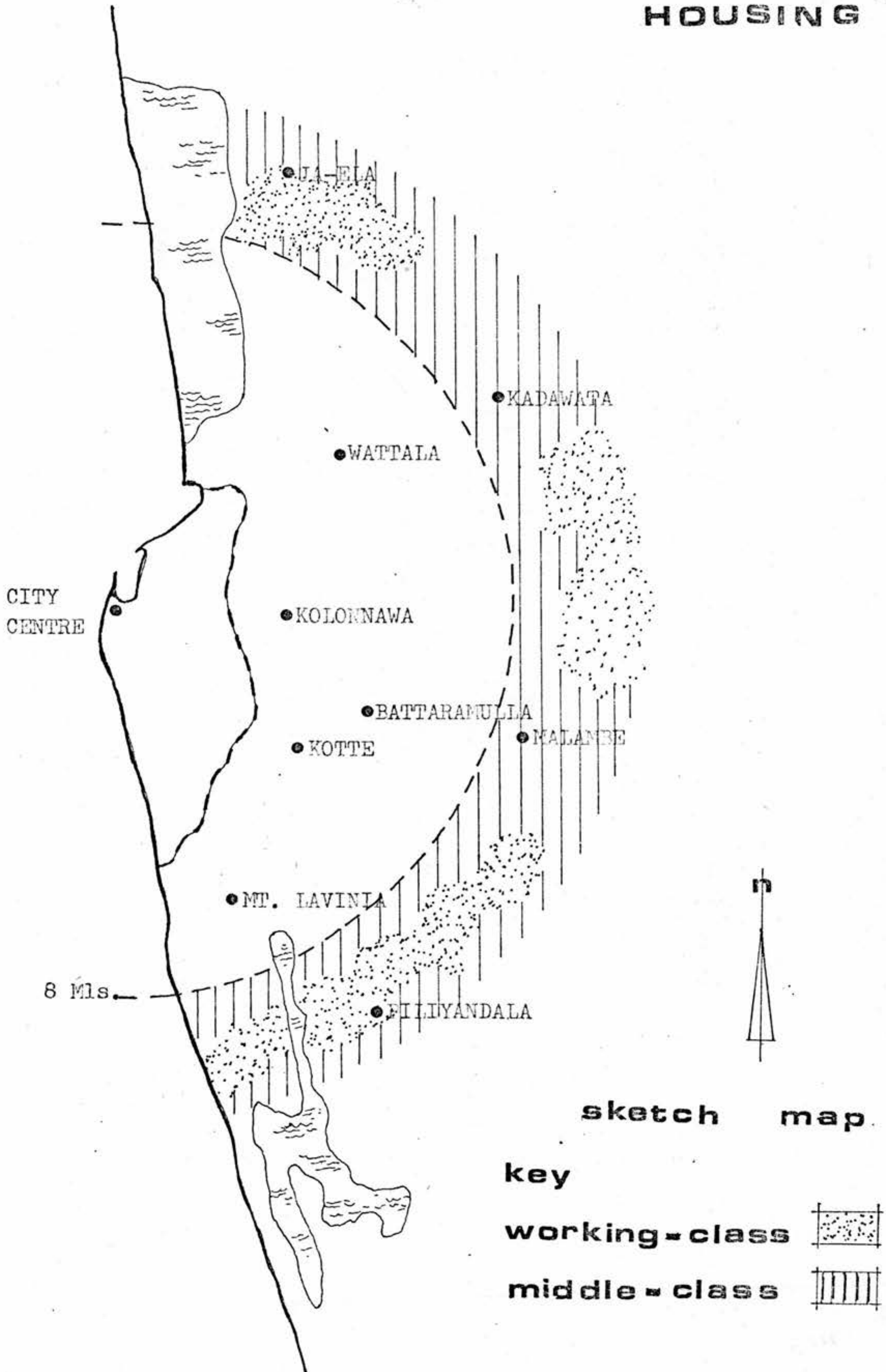


diagram (10-4)

In this case note how the upper income group of this class is able to meet its real costs at the point A, at about 8 miles from the city centre for purchasing, and at point B about 10 miles from the city centre for renting.

The lower income groups fall below the average standards. In Chapter 8 the space standards given showed (table 8-3b) that the minimum for this group was the average of the working class group. Hence, the curves representing the real cost of providing average working class housing is included. This brings the cost closer to the probable expenditure. The need for a range of standards can nowbe seen very clearly. At about 12 miles the subsidy is minimised. Beyond this, prediction is difficult as the equation may not be valid.

Thus broadly the middle class threshold moves from about 8 miles beyond the city centre to about 12 miles or more, thus overlapping with the working class belt, and avoiding segregation.

Diagram (10 - 4) is a sketch map of the region showing the residential belt that minimises subsidy and thus total physical costs.

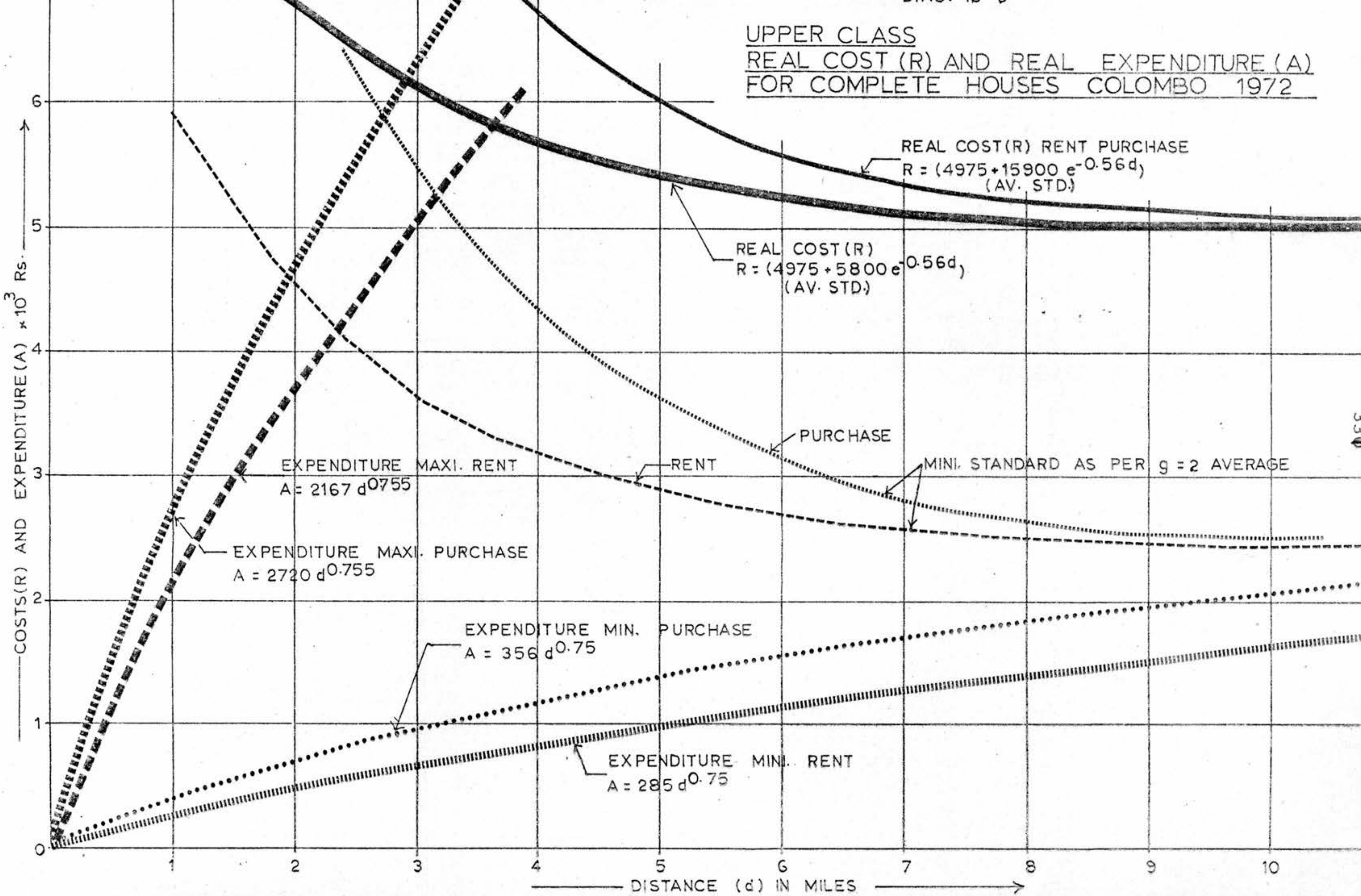
The fact of smaller or larger households will not affect the location decided on by using the average to a great extent. Smaller and larger households will spread on either side of the average.

10.4.3 <u>The upper class thresholds</u>

Using the same technique described in the earlier sections, the real costs, average as well as minimum represented by the middle class average, are plotted in diagram (10 - 5). The expenditure (A) is also plotted on the diagram.

It will be observed that the upper income group of this class meets its costs at about 3½ miles from the city centre, while the lowest income of this group meet their thresholds at about the 12 mile point. Both renters and rent purchasers appear to be between the same limits.

UPPER CLASS
REAL COST (R) AND REAL EXPENDITURE (A) FOR COMPLETE HOUSES COLOMBO 1972



COLOMBO REGION BELT FOR UPPER-CLASS HOUSING.

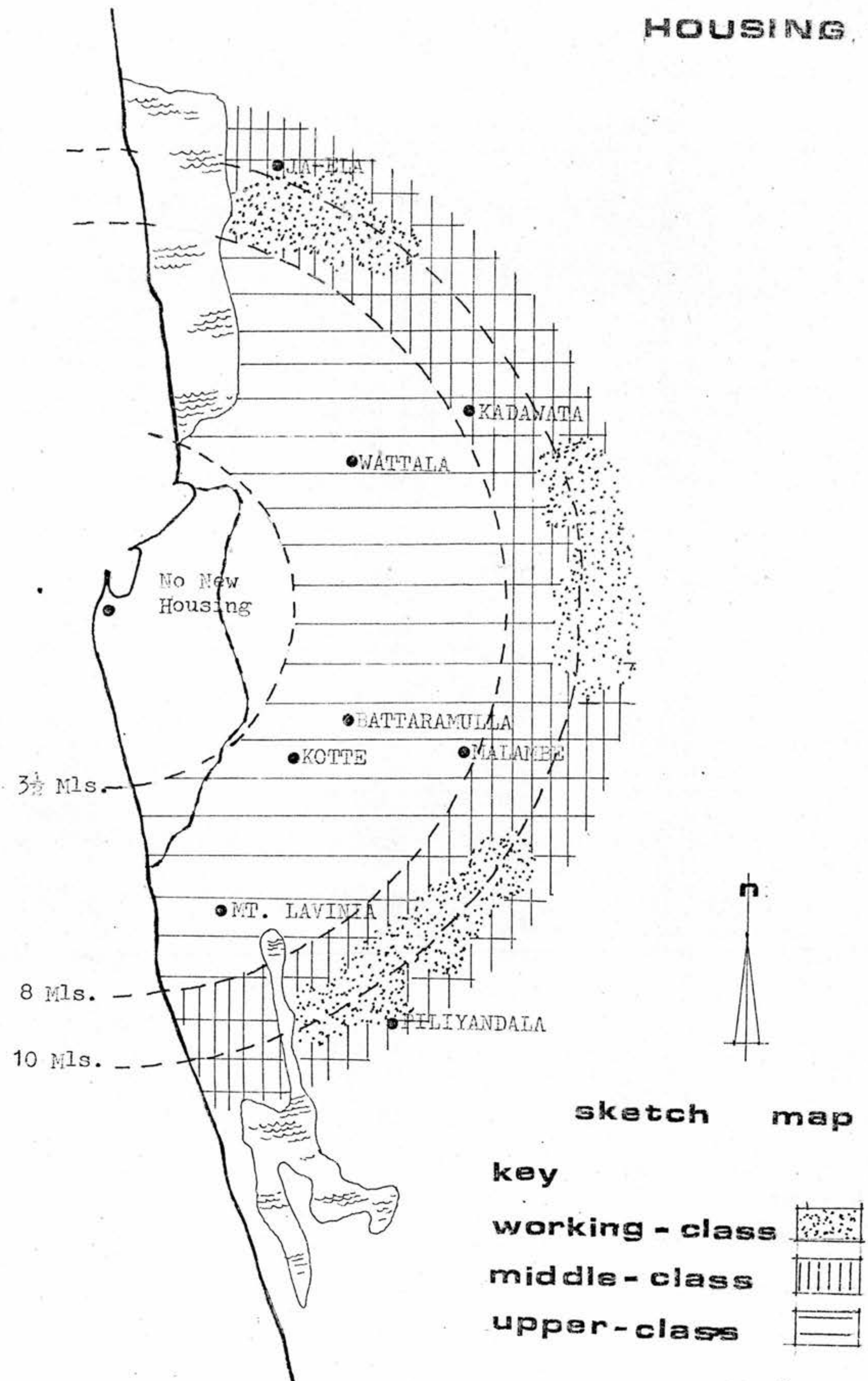


diagram (10-6)

Overall it appears that this group is able to cover a wider range and thus achieve its objectives.

Diagram (10 - 6) is a sketch representing the belt on which housing for this group should be constructed.

10.5 Conclusion

The conclusions reached in this chapter have indicated the importance of social class in analysing the patterns of expenditure on housing. This confirms the validity of the concept of "housing demand" as proposed via this thesis.

The analysis of expenditure on housing has also confirmed the importance of household size, and location, in estimating the ability of a household to pay for a house that it must have if the housing problem is to be solved. Hence, the fallacy in using a fixed percentage of income for all classes, all household sizes, all locations, and all types of tenure.

In combining the real expenditure on housing with the real costs it was possible to vary location, standards, type, and tenure, to arrive at a situation which minimises the subsidy content in the development of housing. The case of Colombo has been analysed and threshold maps presented. These maps are important base maps for the preparation of an overall development plan for the city.

The technique is of importance, since it is universally applicable to any city, anywhere in the developing countries, using the relevant data for the area under consideration.

CHAPTER 11

A brief description of the practical use of the model

11.1 Introduction

To conclude this section of the study, and the study as a whole, it would be appropriate to consider very briefly how this model

(1) fits into the long term urban planning process,

and (2) can be used to guide ongoing public sector investment in the direct development of urban housing, so that the resulting development fits into the long term plan.

In this chapter, or it may be more appropriate to term it an appendix, no calculations are given. It is of a purely descriptive nature, and makes reference to the city of Colombo, for which the model was calibrated and tested.

11.2 The place of the model in the preparation of a long term urban development plan

In the long term, housing can not be considered in isolation - It is a major part of the urban planning process. Hence, the model developed here has considered broadly the possibilities of solving the housing problem of an urban area, in this case the city of Colombo. Basic information for operating this model in the long term, stems from the overall development proposals for the city. The overall development will also impose limitations on this model, hence this model becomes one of the many models that go into the formulation of the urban plan.

11.2.1 Quantitative estimates

The basic information required for this model is the existing and proposed population for the proposed development area, with a break down by age and sex. The projections of the future population depend on

(1) The proposed employment to be generated; and is therefore tied up to the proposed economic development of the area.

(2) The proposed limits of the area, which is once again tied up to overall economic development.

This information must thus flow from an independent analysis, and feed the model for estimating the quantitative demand given in section (7.3). The use of this model has been explained in the relevant section. A detailed explanation of the use of the model is given in the author's dissertation "a model for estimating and projecting the housing requirements of an urban area in Ceylon"[1].

11.2.1.1 <u>Breakdown by social class, and income</u>

An important requirement of the model is a breakdown of the population by social class, classfied by occupation of head of household. The existing situation can be estimated by means of a survey, as was done in this study. The future, however, needs careful projections.

Projections of the future will once again be related to the proposed economic development plan for the area, which will indicate the proportion of workers by blue collar, white collar non professionals, and professional and managerial workers. These projections may not be very reliable, but they will be an important guide.

Another important factor is the probable income distribution of the households by household size. This information can only be obtained by means of special surveys such as the socio-economic survey of Ceylon carried out in 1969-1970, and the survey carried out for this study.

Using this information it is possible to estimate the immediate and future demand for housing distributed by social class, and subdivided by household size and income groups.

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[1] Dissertation presented for the diploma in planning and housing in the developing countries. University of Edinburgh, June 1970.

Using the models of occupancy rate and space standards developed in Chapter 8 it will be possible to distribute this housing demand by size of houses, and number of rooms for the different sizes.

The distribution by size will assure that households below average income are provided with the lower range of space standards proposed for the group, and households above average income the average space standards for the group.

In the case of the working classes the minimum will be the minimum proposed in table (8 - 3a), and in the case of the upper classes the maximum will be 2000 sq. ft. These standards refer to the city of Colombo, but form a useful guide for the other urban areas as well. It will also be appreciated that a large scale study on the same basis of all urban areas may produce a set of space standards applicable to all the urban areas of Ceylon in general.

This information would thus produce a complete picture of the present requirements, and the future requirements, at a date for which the plan is to be operative.

11.2.1.2 Estimation of the backlog

Estimation of the backlog will depend on a survey which describes the existing stock by type and size. Obsolete areas of housing must be excluded if the long term plan is to achieve its objectives. This is a delicate operation, and as far as possible must be left to the very last stages of the plan. This point is made since in the long run demolition results in depleting the stock, and thus as far as possible the programme should aim at upgrading the existing stock rather than removing it. This is of vital importance in the developing countries where the lack of resrouces is the main setback to development.

As a result of this exercise it will be possible to prepare a quantitative development programme for the time period fixed, i.e. covering the increase in population, and meeting the backlog.

This less the probable private sector construction, will indicate the minimum public sector investment programme in the direct development of housing for the area.

11.2.2 The location of housing

On preparing the quantitative programme as described in (11.2.1) the next stage is the break down of the programme into location and type.

Chapter 10 has been devoted to developing a technique for the preparation of threshold maps which indicate broadly the type and location of housing, if a programme is to achieve the objective of solving the housing problem at minimum physical costs.

As mentioned earlier these maps are broad, and will thus be subject to the limitations of

(1) the physical characteristics of the areas, as to the suitability for housing;

(2) the existing land use

and (3) proposed industrial and commercial developments.

Hence the housing threshold maps become basic information for the urban planning process.

These maps used in conjunction with the propsals for overall development of the area can thus be used for locating the proposed new housing.

There are a few practical details worthwhile mentioning. They are:

(1) Land owned by the state should be used first, as this reduces the costs of acquisition and is most suitable for rented housing. It will also create a return to the State if used for rent purchase housing.

(2) Areas where broad infrastructure exists, i.e. roads, water supply, etc. should be used first. This will prevent the extra expenditure on overall infrastructure development.

This exercise will lead to the preparation of detailed location maps, which will indicate the following:

(1) Gross area of development

(2) Proposed population distributed by class and household size

(3) Proposed distribution of houses by type and size and form.

(4) Net density of development derived by using the standard of density derived in Chapter 8.

This information therefore forms the brief within which the architect is free to design the detailed residential area.

It is useful to note that the architect's brief has now been qualified in detail. The quantification was necessary to achieve the objectives of public sector investment, i. e. to solve the housing problem at minimum physical costs. Architects may find this approach too restrictive, but this is necessary in the developing countries where the lack of resources both domestic and foreign are of prime importance.

It is useful to note that at the moment a regional plan is being prepared for Colombo under the auspices of the United Nations. The author on his return to Ceylon hopes to work with this team and incorporate this model into the preparation of the overall urban development plan for the Colombo region.

11.3 The use of the model in guiding ongoing public sector investment in the direct development of urban housing

It is a well known fact that the preparation of detailed plans as described in 11. 2 require a wealth of information, and take a long time for preparation. Invariably the plan is outdated by the time it comes into operation. This problem is very great in the developing countries where urban growth has reached unprecedented levels. What is required then is a quick guiding policy that will not conflict with the ultimate goals of the plan, but be compatible with them.

The model developed in this study has this advantage, as it is capable of guiding residential development while the overall urban development plan is in preparation.

Two simple rules must be followed. They are:

(1) New residential development within the city limits must be limited to areas where the gross density is less than the optimum specified, using the method described in Chapter 8, section 8.1. The method may be applied to any urban area and the results found in a couple of months. This requires an elementary survey of about 2% of the population.
In the case of Colombo, the proposed gross residential density was 118 p.p.a. Thus the catchment areas which have densities greater than this must await the overall plan before any development can take place. Areas where the gross residential densities are less than 118 p.p.a. can accommodate new housing till this limit is reached. Of course, any areas reserved for other specific purposes must be taken into consideration.

(2) The second rule is that new residential development must be guided by the threshold maps. These once again may take a few months for preparation, since the method as described in the model is now known.

The maps for Colombo are given in Chapter 10, diagrams (10-2), (10-4) and (10-6).

The type and form of housing is also specified, and result in ongoing public sector investment achieving its objectives at the minimum physical costs.

In the course of preparing these maps many details are derived, which form part of the detailed national housing policy essential for achieving the objectives set out.

11.4 Conclusion

This chapter has described briefly how the theoretical model developed and calibrated can be used in practice in aiding the formulation of long term development plans, and guiding ongoing public sector investment in the direct development of urban housing with reference to the city of Colombo in Ceylon.

Overall it is hoped that further research will be devoted to refining this model, thus enabling the formulation of a standard practical technique whereby the developing countries can hope to solve their urban housing problem with the limited resources at their disposal.

SELECTED BIBLIOGRAPHY

(1) ABEYSINGHE, D.E. Review of co-operative housing in Ceylon. Paper presented to the seminar on co-operative housing in Ceylon. Colombo (1971)

(2) ABRAHAM, CHARLES. Housing in the modern world. Faber and Faber (1966).

(3) ALLEN, R.G.D. and BOWLEY, A.L. Family expenditures. P.S. King & Son. London (1935).

(4) ANTHONY, JUDITH. Urban systems: data on household income and socio-economic group. Land use and built form studies. W.P. 37. University of Cambridge School of Architecture. (1970)

(5) BAUER, C. Social questions in housing and town planning (1952).

(6) BLECHER, EARL M. Advocacy planning for Urban development. Praeger Publishers. New York. (1971)

(7) BRETT, G.E. and BENJAMIN B. Housing and tuberculosis in a mass radiographic survey. British Journal of Social and Preventative Medicine. XI (1957) 7 - 9.

(8) BURTON, T.L. and CHERRY, G.E. Social research techniques for planners. Allan and Unwin. (1970)

(9) BURNS, LELAND S. Cost Benefit analysis of improved housing. A case study. University of California, Los Angeles. (1965)

(10) BURNS, L.S. Housing as social overhead capital. Essays in urban land economics. University of California, Los Angeles. (1966)

(11) BUILDING RESEARCH STATION. Standards of accommodation for low cost housing in tropical countries. B.R.S. (U.K.) No. E 1307. Amended. 1963.

(12) CENTRAL BANK OF CEYLON. Annual report of the monetary board to the Minister of Finance for the year 1971. Colombo. (1972)

(13) CLAPP, M.A. Cost comparisons in housing maintenance. Local Government Finance Vol. 67. Oct. 1963.

(14) Co-ownership Housing. What is it? Pamphlet published by the Housing Corporation, Sloane Square House, London, S.W.1.

(15) COTTAM, GUY. Inflation. Why costs will soar to new peaks. I.C.E. Journal. (1972)

(16) DAVID, M.H. Family composition and consumption. North Holland Publishing Company. Amsterdam. (1962)

(17) DEVANATHAM, M.A.V. and FERNANDO, M.J. A proposal for low cost housing based on tubular modules. Paper presented to the special committee on housing. Colombo. (1970)

(18) EVERSLEY, JACKSON, AND LOMAS. Population growth and planning policy. Frank Cass & Co. (1965)

(19) EZEKIEL, M. Methods of correlation analysis. John Wiley & Sons, Inc. New York. (1930)

(20) FEIN, A. E. A mathematical aid in optimizing engineering designs. Proceedings of the National Academy of Science, U. S. A., Vol. 47, 1961, page 705.

(21) FERNANDO, I. A. C. The financing of housing and urban development in Sri-Lanka (Ceylon). Paper presented at the seminar on financing of housing in the E. C. A. F. E. countries, Copenhagen, 1972. Department of National Housing, Colombo (1972).

(22) FONSEKA, JOSE. Housing finance in the developing countries. Paper presented to the 30th world congress of IFHP. IFHP. The Netherlands (1971)

(23) FRANKLIN, GEORGE. The place of housing in the national plans of developing countries. Paper presented to the IHFP Congress, Dublin, May 1969.

(24) FRIDEN, B. J. and MORRIS, R. (Editors). Urban planning and social policy. Basic Books, Inc. New York (1968)

(25) GANESAN, S. Fundamental considerations towards formulating a national housing policy and a long term housing programme. Paper presented at the annual conference of the Institution of Engineers, Ceylon (1971)

(26) GOVERNMENT OF CEYLON. Legislative Enactments. National Housing Act. 1956 revision, 1958 amendment, and 1966 amendment. Government Publication Bureau, Colombo.

(27) GOVERNMENT OF CEYLON. Housing and town improvement Ordinance. Legislative enactments (1956 revision). Government Publication Bureau. Colombo (1960).

(28) GOVERNMENT OF CEYLON. Preliminary report on the socio-economic survey of Ceylon (1969-70). Dept. of Census and Statistics. Colombo. October 1971.

(29) GOVERNMENT OF CEYLON. Report of the special committee on housing. Sessional Paper XXIII 1963. Government Publications Bureau (1963).

(30) GOVERNMENT OF SRI-LANKA. The five year plan (1971-1976). Goverment Publications Bureau (1971).

(31) GOVERNMENT OF CEYLON. Supplementary report on housing. Census of population and housing Ceylon 1963. Dept. of Census and Statistics. Colombo.

(32) GOVERNMENT OF CEYLON. Special committee on housing (1970). Interim report No. 1. Rental housing. Sessional paper No. V - 1971. Government Publications Bureau. (1971)

(33) GOVERNMENT OF SRI-LANKA. Ceiling on housing property law. No.1 of 1973 of the National State Assembly. Government Publications Bureau, Colombo. (1973)

(34) GOVERNMENT OF SRI-LANKA. Apartment ownership. A Bill. The Gazette of the Republic of Sri-Lanka, Part II of 2-2-1973.

(35) GOVERNMENT OF CEYLON. Report of the planning committee on Education, Health, Housing, and Manpower. Ministry of planning and economic affairs, Government of Ceylon (1967).

(36) GOVERNMENT OF SRI-LANKA. Common amenities board. A Bill. The Gazette of the Republic of Sri-Lanka. Part II of 2-2-1973.

(37) GOVERNMENT OF CEYLON. Rent Act, No. 7 of 1972. Government Publications Bureau. Colombo (1972)

(38) HANSEN, A. H. A Guide to Keynes. McGraw-Hill Book Co. Inc., New York. (1953)

(39) HANSON, D. R. Report on the financing of housing and low cost housing in Ceylon. United Nations. New York (1967)

(40) HANSON, D. R. An experiment in housing policy and programming. Human settlements, October 1971. Centre for housing, building and planning, New York.

(41) HERBERT, JOHN D., and VAN HUYCK, A. P. Urban planning in the developing countries. Fredrick A. Praeger, New York.

(42) HOSSE, H. A. Review of the Colombo regional plan, and aspects of physical planning organisations and regional development in Ceylon. U. N. ECAFE. Bangkok, Thailand (1965).

(43) I. L. O. Matching employment opportunities and expectations. Vol. I The Report and Vol. 2 Technical Papers. A programme of action for Ceylon. International Labour Office, Geneva. (1971)

(44) JEPHCOTT, PEARL. Homes in high flats. Oliver and Boyd, Edinburgh. (1971)

(45)* JOACHIM, M. E. A model for estimating and projecting the housing demand of an urban area in Ceylon. Unpublished dissertation presented for the diploma in planning and housing in developing countries. June 1970.

(46) KEBLE-LEWIS. Principles and practice of town and country planning. The Estates Gazette Ltd. (1967)

(47) KEUNEMAN, PIETER. -Ministry of housing and construction. Policy statement on housing and construction. Speech made during the budget debate in 1970.

(48) KEYNES, J.M. The general theory of employment, interest and money. Harcourt, Brace & Co. Ltd. (1936).

(49) KLASSEN, L. H. Considerations on the structure of the housing market. Essays in honour of Leo Grebler. Los Angeles (1966)

(50) KLASSEN, L. H. Social amenities in area economic growth. O. E. C. D. Paris. (1968)

(51) KLASSEN, L. H. and BURNS, L. S. Capital formation for housing in Latin America. Pan American Union. Washington, D. C. (1963)

(52) KOENIGSBERGER, OTTO. Investment in housing. A report submitted to the Government of Ceylon (1966).

(53) KOSLOWSKIE, J. Some aspects of planning theories and techniques. Planning Research Unit, University of Edinburgh (1970)

(54) LITTLE, I.M.D., and MIRRLEES, J.A. Manual of industrial project analysis in developing countries. Vol. II. Social cost benefit analysis. O. E. C. D. publications. Paris (1969).

(55) LUBEGA, ANTHONY. The financing and production of private houses in urban districts of Kampala (Uganda). Unpublished Ph. D. Dissertation, University College, London. (1970)

(56) MARCH, L. A statistical theory of simple spatial distributions. Land use and built form studies. W. P. No. 5. University of Cambridge, School of Architecture.

(57) MARTIN, L. and MARCH, L. Land use and built forms.

(58) MENDIS, W.W.J. and RAJARATNAM R. Country paper for Ceylon presented at the Regional Seminar on the development of housing co-operatives in S. E. Asia and Malaysia. (1970).

(59) MERRIL, R. and GRINDLAY, W. Sites and Services. The experience and potential. E. C. A. F. E. seminar on the financing of housing and urban development. Working Paper No. 7 Copenhagen (1972).

(60) MOYNIHAM, DANIEL, P. (Editor) Towards a national urban policy. Basic Books Inc. Publishers. New York (1970)

(61) OVERSEAS TECHNICAL CO-OPERATION AGENCY, GOVERNMENT OF JAPAN. Reclamation of marshes in and around the city of Colombo. Vol. 1. Land Reclamation: Vol. II Town planning. March (1971)

(62) PRAIS, S. J. and HOUTHALEKEV, H. S. The analysis of family budgets. Cambridge University Press (1971).

(63) PERERA, N. M. Minister of Finance, Republic of Sri-Lanka. The first Budget of the Free, Independent and Sovereign Republic of Sri-Lanka (1973)

(64) Planning Research Unit, UNIVERSITY OF EDINBURGH. Threshold Analysis Optimization. May 1970.

(65) RAIN WATER, LEE. Fear and the house as Levan in the lower classes. Page 85 of Urban Planning and Social Policy. op. cit. (24)

(66) RAO. P. PRABHAKAR. Housing and urban development in national development planning. E.C.A.F.E. seminar on the financing of housing and urban development. Working Paper No. 1 Copenhagen (1972)

(67) REID, MARGARET G. Housing and income. Chicago University Press (1962).

(68) Research Techniques and Structure Planning of South Hampshire. T.P.I. Journal, June 1970.

(69) RICHARDSON, H.W. Urban economics. Penguin Books (1971)

(70) SAMUELSON, P.A. Economics. An introductory analysis. McGraw-Hill Book Co. New York. (1964)

(71) SMITH, WALLACE F. Housing Chapters I and II.

(72) SPIEGEL, M.R. Statistics. McGraw-Hill Book Co. (1961)

(73) STONE, RICHARD. Mathematics in the social sciences and other essays. Chapman and Hall Ltd., London. (1966)

(74) STONE, P.A. Housing, Town Development and Land Costs Estates Gazettes Ltd., London 1963.

(75) STONE, P.A. Building design evaluation costs in use. Appendix B. Statistical treatment of desirability and maintenance data. Spon, London

(76) STONE, P.A. The prices of sites for residential building, The Property Developer, Estates Gazettes Ltd., London. (1964)

(77) STONE, P.A. Urban development in Britain; Standards, Costs and Resources, 1964-2004. Cambridge Univdrsity Press (1970).

(78) STIGLER, GEORGE. The early history of empirical studies of consumer behaviour. Journal of Political Economy. April, 1954, page 98.

(79) TORRES, HORACIO. Accessibilities and residential location. Land use and built form studies. W.P. No. 37. University of Cambridge, School of Architecture (1970)

(80) TURNER, J.C. Housing priorities, settlement patterns, and urban development in modernizing countries. A.I.P. Journal, November 1968.

(81) UNITED NATIONS. Report of the inter-regional seminar on the financing of housing and urban development. Copenhagen 1970. Sales No. E.72.IV.5 New York 1972.

(82) UNITED NATIONS. Housing in Africa. No. E/CN/14/HOU/7/REV (1965)

(83) UNITED NATIONS. Finance for housing and community facilities in developing countries. Sales No. E. 68. IV. 4. New York (1968)

(84) WINGO, Jr. LOWDON. Cities and space. The future use of urban land. John Hopkins Press, Baltimore (1963)

(85) WILDE AND BEIGHTLER. Foundations of optimization. Prentice-Hall, Inc.

(86) WOOD, ELIZABETH. Social aspects of housing and urban development. U. N. Sales No. 67. IV. 12.

(87) ZENER, CLARENCE. A mathematical aid in optimising engineering designs. Proceedings of the National Academy of Science, U. S. A. Vol. 47 - 1961. page 537.

(88) NEVILL, A. A. (Editor) The economic problems of housing. Macmillan, New York (1967)

*Note : Reference (45) is an original study by the author. Since only what is relevant to this study has been quoted from reference (45), if a full reference for that study is required, the original must be referred. Available in the Library of the Department of Urban Design and Regional Planning, University of Edinburgh.

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APPENDIX I

Survey and data for calibration of the theoretical model at the urban scale

1. Introduction

In order to test and calibrate the theoretical model, developed in Chapter 7, it was necessary to obtain data that was not readily available. This situation necessitated an original survey.

Thus during the period 1-7-71 to 1-10-72, while on leave of absence from the University, I developed a questionnaire, and with the help of the staff of the department of national housing in Ceylon carried out a survey of the city of Colombo in Ceylon.

The main features of the survey are described in this appendix. Annexure 1 is a copy of the survey questionnaire used. The annexed tables give the original data obtained via the above mentioned survey.

It must be noted that this is the first time such a survey relating the various data has been done in Ceylon, and thus the data is original in all respects.

The data collected referred mainly to data that was not readily available. Other data required for calibrating the model, but not obtainable via this particular survey, is given in the relevant chapters. The methods of obtaining the data is also described in the relevant chapters.

2. Development of the survey questionnaire

The main purpose of the survey was to obtain data relevant to testing and calibrating the theoretical model developed in Chapter 7.

Hence broadly the survey was aimed at:

(1) Determining information on the demographic, social and economic characteristics of households within an urban area.

(2) Determining information on the houses occupied by the above households.

(3) Determining the level of satisfaction that existed between the

households and the houses they occupied. The net area.

(4) Determining the level of satisfaction that existed between the households and their residential environment. The gross area.

The development of each of the detailed questions given in the annexure A.1 are explained in the relevant chapters within the relevant context.

It may appear that the data collected may be used for other studies related to overall urban planning in Ceylon. This was the purpose envisaged in the original survey, as it would form a useful base for further research in the future .

3. Selection of the urban area

The urban area selected for the survey was the city of Colombo in Ceylon.

Colombo is the capital of Ceylon, having a population of about half a million within the boundaries of the city, and about two million within the greater Colombo area. The annexed map, diagram (A1-1), shows the greater Colombo area, and also the city with the ward boundaries indicated.

The reasons for selecting Colombo are as follows:

(1) Colombo is the only urban area which has all aspects of a city in a developing country, i.e.

(a) high rate of population growth.
(b) the existence of squatter settlements.
(c) the existence of slums.
(d) a wide variation in socio-economic groups within the population.

(2) The Colombo municipality is the only municipality which has information on:

(a) land values
(b) house sizes identified by street and assessment number.
(c) land use maps
(d) service distribution maps
(e) traffic surveys
(f) other studies done for the purpose.of detailed planning.

Most of this information was collected recently in view of the proposed Colombo regional development study - sponsored by the U. N., which is now in progress.

(3) Since no special finance was available for carrying out this survey, it had to be done with the available resources.

The department of national housing is situated in Colombo. Thus with the co-operation of the sub-technical staff of the department it was possible to carry out this survey at no cost. Further, since the information is also of official use, the survey was treated as part of the official work of the department.

4. Proposed size and selection of sample

Colombo has approximately sixty thousand housing units. This is about eighty thousand households at approximately 1.33 households per housing unit.

It was thus decided to carry out two approximately 1% sample surveys. This is about six hundred housing units for each survey. The purpose of using two samples was in order to verify that each sample reflected the same average tendencies, thus assuming to a greater extent the validity of the combined sample, which is used for testing the model.

There was one obvious way of selecting the samples. This was by moving throughout the city and picking out every 100th house for the first sample, and every 50th house for the second sample. A pilot survey carried out on this basis showed that the error in using this method would be very great due to the fact that it was virtually impossible to conduct a systematic count. This occurred due to the haphazard arrangement of houses in the squatter and slum areas. Hence this method was rejected.

As mentioned, Colombo is one of the few cities with a complete record of houses in the city. This also includes squatter settlementswho have been given a number for the purpose of the last 1971 census. Thus the approach used for selecting the sample was as follows.

Sample (1) was selected as every 100th house in the official registers of the municipality, and sample (2) was selected as every 50th house in the register.

This method had tremendous advantages. They were:

(1) It was possible to divide the sample within the wards of the area. This made the carrying out of the survey relatively easy.

(2) It was possible to first locate the house on a map, thus making it possible to measure the radial distance(d) from the city centre, and also make it relatively easy for the interviewer to locate the house.

(3) It was possible to get the area of house in sq. ft. from the municipal register by referring to the street and assessment number of the individual houses selected.

Hence on this basis two samples each consisting of 595 houses were selected for the survey.

A random selection would not have given sufficient data on certain social classes which comprise a minute portion of the population. The worst affected would have been the upper classes which constitute only about 18% of the population.

Thus overall the method of selection appears to have been the best possible at the time.

5. The survey

The survey was carried out using three teams, consisting of sub-technical staff of the department of national housing in Ceylon.

The interviewers were trained by me. During this training, I explained to them the method of filling in the answers to the questions which were in numerical form, and therefore did away with a large amount of the written work.

During the period of training it was impressed upon the interviewers that in no way must they influence the answer to the questions by prompting possible answers. They were requested to maintain a strict consistency in the method and sequence of asking the questions.

After a training period of about a week we tried out a few houses for the purpose of testing the questionnaire, and training the interviewers. The result of this pilot survey did not suggest any serious changes to the original questionnaire or any marked differences to the type of answer obtained by the various teams.

The teams were then requested to go ahead with the survey. Of the 47 wards in the city each team was responsible for about a third, during which time weekly discussions were held on the progress.

Each team provided a brief report indicating any difficulties or unusual problems they might encounter, which would affect the reliability of the results. Summary reports presented by each team at the end of the survey are given in Annexures A2, A3 and A4.

At the end of the field survey the degree of response to the survey was analysed.

There were five possible conditions under which the survey would not be successful for a particular household. They are as listed in question 6 of the annexed questionnaire. Briefly the reasons were:

(1) House not occupied.

(2) The use of the house for purposes other than residential use, not lodging houses.

(3) No response from the household.

(4) The use of the house as a lodging house.

(5) The house being non existent.

For the reasons given above it was observed that in sample (1) out of 595 houses visited only 457 fell outside one of the above categories, thus recording a success of 77.3%. In sample (2) the success recorded was 442 out of 595, i.e. 74.3%. On the average there was a success rate of 75.6%.

From the reports handed in by the teams in Annexures A2, A3 and A4 it will be noted that the greatest degree of failure was recorded by houses being demolished and the records not being corrected. Further it was observed that the actual refusal to co-operate with the survey was highest among the so-called educated, professional and managerial class. The reason is obvious where the survey shows that on the average over 97% of this class are satisfied with the housing they have. The highest degree of co-operation was obtained from the working class population who really experience the housing problem.

6. <u>The data and its reliability</u>

The data collected from the survey was in numerical form. The annexed questionnaire, Annexure (A.1), indicates all the details.

The data from each household was then punched on to a computer card, in a form suitable for analysis. These cards listed produced the basic data in the form of a print out which is given in tables (A1-1), (A1-2) etc. The print out gives the basic data for each sample, subdivided by social class, house type, and tenure. This division is the same as the subjective variables used for objective analysis.

It is useful to consider in this appendix the broad reliability of the data. Reliability of individual components of the data is considered in the relevant chapters in which it is used.

Possible sources of error may arise due to the following.

(1) Under section 1, which concentrates on the composition of the household. Most of the questions are straightforward. However, error may arise due to the fact that many of the working classes do not know their exact ages.

(2) Under consumption patterns, section 2. The data obtained tends to overstate slightly the expenditure patterns of the

working class households. This, as explained in the annexed survey reports,may be due to the household wanting to create an impression which indicates conditions better than they really are.

On the other hand, the upper classes tend to underestimate their expenditure. This is created by a fear that the data obtained will be used to check income tax returns etc.

However, overall this approximation of income is far more accurate than asking people what their incomes are. This direct question as is well known generally produces no answer or a highly inaccurate one.

Hence for the purpose of this study the approximation of total expenditure to normal or long run income is sufficient.

(3) Questions 3 and 4 are straightforward and should not lead to any erroneous data. The one question that may be erroneous is 4(10). In this case answers from the working class and middle class will be reliable. In the case of the upper class, even though the area of the house may be too much for the household, the answer given tends to say it is just sufficient. This again is due to the fear that under the socialist system of government in the country at present, these large houses may be subdivided by law. Hence, for this group discretion must be used when using the data.

(4) Under section 5, the answers may be considered accurate, as this affects the overall area and not the individual house. This was a good chance for many to air their grievances.

Overall since the main aim of this survey is to check the trends proposed in the theoretical model, the degree of accuracy of the data obtained may be considered as sufficient.

For wider use and application of the model in practice, it is necessary to carry out a survey on the same basis, but using a much larger sample, say 10-15%, preferably as part of the next national census.

ANNEXURE A.1

DEPARTMENT OF NATIONAL HOUSING
SOCIO-ECONOMIC RESEARCH SURVEY 1972
(HOUSEHOLDS AND HOUSING)

1. **Information about households**

    1. How many households share this house?
       (Select (Family) the main household for the following questions)
    2. How many people are there in your household (including servants, lodgers, etc.)?
    3. How many lodgers do you have if any?
    4. How many servants do you have if any?
    5. How many males are below 25?)
    6. How many males are between 25 and 55?)
    7. How many males are over 55?)
    8. How many females are below 20?)
    9. How many females are between 20 - 50?)
    10. How many females are over 50?)
    11. How many people within your household go out to work?
        (this includes lodgers who go out to work)
    12. What is the job of the head of the household?
        (B.C.=1, W.C.N.P. = 2), W.C.P. = 3)
    13. What area does he/she work in? (see code)
    14. How does he/she travel to work?
        (Walk= 1, Cycle = 2, Bus = 3, Car = 4, Train = 5)

2. **Consumption pattern of household**

    How much do you spend in an average month on the following:-

    1. Food, dhoby
    2. Electricity, gas, water
    3. Clothes for household
    4. School fees, tuition fees, etc.
    5. House rent if rented, or rent purchase, rates if owned.
    6. Telephone including rental.
    7. Travelling for the household (bus fare, train fare, cost of running car including insurance, licence etc.)

8. Cost of domestic help if any.

9. Sundries including smokes, drinks, pictures, club bills, other entertainments.

10. Savings, including loan repayment, insurance premium, savings bank deposits.

3. Determination of Nodal points

1. Where do you normally shop for your food and other consumable articles?

2. Where do you do your occasional shopping (i.e. for clothes etc. (regional shopping) (see code) ?

4. Information about the house

To be filled in by interviewer.

1. Type of house (P,SP,T) P = 1, SP = 2, T = 3.

2. Area of house

3. Do you have the following services?
Water supply on (a) Tap (b) stand post (c) wall.
Tap = 1, Standpost = 2, Well = 3.

4. Is the system convenient (Yes = 1, No = 2)

5. Sewerage disposal (a) Drainage (b) Bucket (c) Pit
1 2 3

6. Is the system convenient. Yes = 1, No = 2.

7. Electricity: Yes = 1, No = 2.

8. Gas: Yes = 1, No = 2.

9. How many rooms are there in your house (excluding bathrooms, kitchen)?

10. For your household do you feel your house has (a) sufficient space "1", (b) Insufficient space "2", (c) too much space "3" ?

5. Assessment of the environment

In your area do you feel the following are 1. Sufficient "1"
2. Insufficient "2" 3. Too much "3"

1. Shopping facilities.

2. Public parks and playgrounds

3. Schools

4. Entertainment facilities (cinemas, clubs for games, tennis etc.)

5. Garden space in houses.

6. Remarks

Under this column we enter the following conditions due to which the Survey could not be carried out, or would be of no use.

1. House not occupied - 1
2. Use other than for housing - 2
3. No response - 3
4. Lodging house - 4
5. House demolished - 5

7.

Ser. No.	Node	No.	Node	No.	Node
1.	Mattakuliya	16.	Wekanda (Union Place)	29.	Pamankade West (High St. junction)
2.	Aluthmawatta	17.	Suduwella (Ibankwella, Town Hall etc.)	30.	Wellawatte North (High St. junction)
3.	Mahawatta(Thettalanka)	18.	Borella South	31.	Wattala Peliyagoda area
4.	Ketahena East	19.	Kellupitiya	32.	Kelaniya area (Pattiya Junction)
5.	Grandpass North	20.	Cinnamon Gardens (University area)	33.	Seithawallai
6.	Ketahena West (Kechchikade)	21.	Narahenpita (manning town)	34.	Wellampitiya
7.	Fort (Pettah)	22.	Cinnamon Gardens (Terrington)	35.	Kolonnawa
8.	Fort (Chatham Street)	23.	Milagiriya (Bambalapitiya Junction)	36.	Welikade (Rajagiriya)
9.	Kehelwatta (Hulsdorf)	24.	Kirula (Labour Secretariat & Milk Board.)	37.	Nawala Junction;
10.	Panchikawatte	25.	Milagiriya (Flats area)	38.	Nugegoda Junction
11.	Dematageda	26.	Thimbirigasyaya Junction	39.	Kobuwella Junction
12.	Kuppiyawatte (Maligakanda)	27.	Pamankade (Kirillapenne Junction)		
13.	Maradana	28.	Kirillapenne (Seibel Avenue)		
14.	Kampannaweediya				
15.	Kuppiyawatte West (Punchi Berella)				

ANNEXURE A.2

REPORT ON THE SOCIO-ECONOMIC RESEARCH SURVEY ON HOUSING, THE CITY OF COLOMBO GROUP 1

One of the teams that took part in the above survey comprised Mr S.Weerasingham and myself. This survey involving 11 municipal wards of the city was completed in approximately 31 days, within which period, however, other urgent departmental work also had to be attended to when necessary.

As the weather conditions that prevailed during this period were far from ideal, a considerable time had to be used up unnecessarily.

The wards in which the survey was conducted by us are:

1. Kellupitiya Ward No. 37
2. Bambalapitiyn Ward No. 38
3. Milagiriya Ward No. 39
4. Thimbirigasyaya Ward No. 40
5. Kirula Ward No. 41
6. Havelock Town Ward No. 42
7. Wellawatte North Ward No. 43
8. Kirillapone Ward No. 44
9. Pamankade East Ward No. 45
10. Pamankade West Ward No. 46
11. Wellawatte South Ward No. 47

The response on the part of the residents for this survey could be considered as generally 'good', although in somewhat affluent areas, viz. Kellupitiya and Bambalapitiya Wards, there were a fair incidence of 'no response' cases. This, in my opinion, is due to the fact that the respective residents are well housed and acoommodated and did not want to be bothered.

On the other hand, the class of residents, well-to-do and otherwise, who apparently have problems of housing and accommodation, were very eager to respond with all the information. In certain instances it was indicate that due to their ever eagerness figures and statements given by them were somewhat exaggerated.

From the reports it is evident that some assessment numbers could not be traced. The number of such cases is rather high. Also there were several instances where houses were demolished, or non existent. In every such instance it was found that the demolitions were done to accommodate new buildings coming up in their place.

It is observed that the residents' main expenditure item is food. Due to the prevailing high cost of this item, the residents find it barely possible to spend for other less essential items. Savings appear to be "taboo" with almost all.

Expenditure on clothing and entertainment is reduced to a minimum to accommodate other essential items like medicine, medical care etc.

During the survey, it was observed that slum conditions prevailed mostly in the highly congested areas of wards like Kellupitiya and Bambalapitiya. Slum conditions where they existed were unsightly and pathetic as accommodation and basic amenities like lavatories, water service etc. were poor if not altogether absent. The rentals, however, cannot be considered too high for these slum dwellings.

Approximately 30% of the residents live in houses of their own.

K.H. Perera,
I.W.

ANNEXURE A3.

Report on the Socio-economic research survey on housing
The City of Colombo - Group 2.

This Survey was carried out by me assisted by Mr M.S.M. Suhaib. It was started on 5.9.72 and was concluded on 21.10.72, the delay being due to Mr Suhaib falling sick for one week and also rainy weather. The wards tackled by me are Kochchikado South(19), Fort (20), Kompanna weediyn (21), Wekanda (22), Hunupitiya(23),Suduwella(24), Panchikawatte(25), Maradana(26), Maligakande(27), Wanathamulla(3), Kuppiyawatte East(31), Kuppiyawatte West(32), Berella North(33), Narahenpita(34), Berella South(35), Cinnamon Gardens(36).

Of the above wards, excepting Berella North & South and Cinnamon Gardens, the others consisted mainly of Tenement Gardens. The response was almost 100% in the wards where the Tenement Gardens and slums exist, while, in the other three wards it was about 95%. Although I have marked several cases in each of the above wards as no response cases, the great majority of them are cases where the houses were closed or the occupants at the time of inspection could not give the information we required. The actual number of no response cases were therefore very few. I also have to state that at no house was our identity or our authority to carry out the survey challenged. The presentation of the letter of authority at several cases was purely voluntary on our part. It was also found that the women folk were more co-operative in giving the information than the men, probably because the impression created in their minds was that, this is an investigation on the cost of living, as the first few questions asked were on the consumer patterns.

It has to be noted that in the case of the questions on food and other things only a few gave accurate answers. In the Tenement Gardens, the figures given were in the range of Rs. 250/= to Rs. 300/= per month for food. Judging from the living conditions and the nature of the occupation of the Chief Occupant, we could infer that these are not very correct. The same has to be said on the question on clothes also. The cause may be attributed to the fact that especially the women would want to impress.

In the case of Fort Ward No. 20, it was found that all the cases excepting one were lodging houses, where no families lived. This is because Fort is the business centre of Colombo, and all the traders only lodged there and have their houses elsewhere. In the other wards also a few cases of lodging houses were found. We also came across some houses which had been demolished for purposes of road widening and fire gaps. The majority of these were in the Kochchikade South ward. In the Panchikawatte, Kompanna weediya, Hunupitiya, Suduwella and Maradana Wards, a few cases of houses which have been converted to business places were met with. In some wards, especially in the Hunupitiya and Dematageda wards, we found that some houses were not existing. There were no traces of these being demolished.

During the survey, for convenience some abbreviations and symbols have been used. A full bar for owner occupied houses has been used in the house rent column. The figure indicates the rates per month which is indicated by the latter Ra written on top of the figure. A half bar has been used to indicate a rent purchase house with the monthly instalment written. Where the Chief Occupant is a retired man, the letter R is written above the figure in the appropriate column. All three parties have used the figure 40 to indicate a person working outstations in column I(13). Where any special circumstances are to be explained these have been done in the Remarks column.

M.S.M. Suhaib
Draughtsman/D. N. H.

N.B. Cooray,
I.W/D. N. H.

ANNEXURE A.4

REPORT ON THE SOCIO-ECONOMIC RESEARCH SURVEY ON HOUSING, THE CITY OF COLOMBO GROUP 3

I carried out the above Survey assisted by Mr Wimal Weerasinghe from 5.9.72 to 26.10.72. The following Wards were surveyed.

1. Mattakkuliya Ward
2. Modera "
3. Mahawatte "
4. Aluthmawata "
5. Lunupokuna "
6. Bloemendhal "
7. Kotahena East "
8. Kotahena West "
9. Kochchikade "
10. Gintupitiya "
11. Masangasweediya "
12. New Bazaar "
13. Grandpass North "
14. Grandpass South "
15. Maligawatte West "
16. Aluthkade East "
17. Aluthkade West "
18. Kehelwatta "

Generally the response was good (99%).

The area I surveyed consisted of slums (working class) and Low Middle Income Group.

The response was 100% from women; most of them were expecting to get better houses from the Department. Only two ladies refused to give any information (which is negligible).

About 90% were unable to give their exact expenditure on food, clothes and sundries, and none of them had any savings.

About 99% said that they were in debt almost at the end of the month.

About 5 households did not have any income other than Charitable Allowance (of about 14/= to 28/=) they received from the Government.

Reg. Remarks

1. Where 5 is marked in the remarks column about 75% of the houses were demolished and 25% not traceable.

2. Where 3 is marked in the remarks column 75% were closed even on the second inspection and 25% were non-responsive.

(Signed)

Chief Inspector.

APPENDIX I
ANNEXURE - 5

Statistical abstract of Survey. (Total sample)

Description	No. of household	Percentage	Table No.	Remarks
(1) Size of original sample	1199	100	-	-
(2) Rejects: Total	291	24.5	-	% of (1)
(a) House not occupied	13	4.4	-	
(b) Use other than for hsg.	33	11.3	-	
(c) No response	53	18.2	-	% of (2)
(d) Lodging house	32	11.0	-	
(e) House demolished - non existent	160	55	-	
(3) Size of successful sample total	898	75.5	-	% of (1)
(a) Rented x = 1	706	78.6	-	% of (3)
(b) Owner occupied x = 2	192	21.4	-	% of (3)
(4) Rented. total	706	100	-	
(a) Class I g = 1	451	63.8	-	% of (4)
(b) Class II g = 2	171	24.2	-	"
(c) Class III g = 3	84	11.9	-	"
(5) Rented Class I. total	451	100	-	
(a) Permanent hse. y = 1	371	82.3	(A1 - 1)	% of (5)
(b) Semi-permanent y = 2	54	12.0	(A1 - 2)	"
(c) Temporary y = 3	26	5.7	(A1 - 3)	"
(6) Rented Class II total	171	100		
(a) Permanent y = 1	170	99.5	(A1 - 4)	% of (6)
(b) Semi-permanent y = 2	1	0.5	(A1 - 4)	"
(c) Temporary y = 3	0	0.0		"
(7) Rented Class III total	84	100	-	
(a) Permanent y = 1	84	100	(A1 - 5)	% of (7)
(b) Semi-permanent y = 2	0	0		"
(c) Temporary y = 3	0	0		"
(8) Owner occupied total	192	100	-	
(a) Class I g = 1	52	27		% of (8)
(b) Class II g = 2	63	33		"
(c) Class III g = 3	77	40		"
(9) Owner occupied Class I total	52	100	-	
(a) Permanent y = 1	48	92	(A1 - 6)	% of (9)
(b) Semi-permanent y = 2	1	2.3	(A1 - 6)	"
(c) Temporary y = 3	3	5.7	(A1 - 6)	"
(10) Owner occupied Cl. II total	63	100	-	
(a) Permanent y = 1	63	100	(A1 - 7)	% of (10)
(b) Semi-permanent y = 2	0	0		"
(c) Temporary y = 3	0	0		"
(11) Owner occupied. Cl. III total	77	100	-	
(a) Permanent y = 1	77	100	(A1 - 8)	
(b) Semi-permanent y = 2	0	0		
(c) Temporary y = 3	0	0		

ANNEXURE 6. Reference Diagram for interpretation of tables.

To be read in conjunction with Annexure 1 - Survey Questionnaire
(Column Number in Brackets)

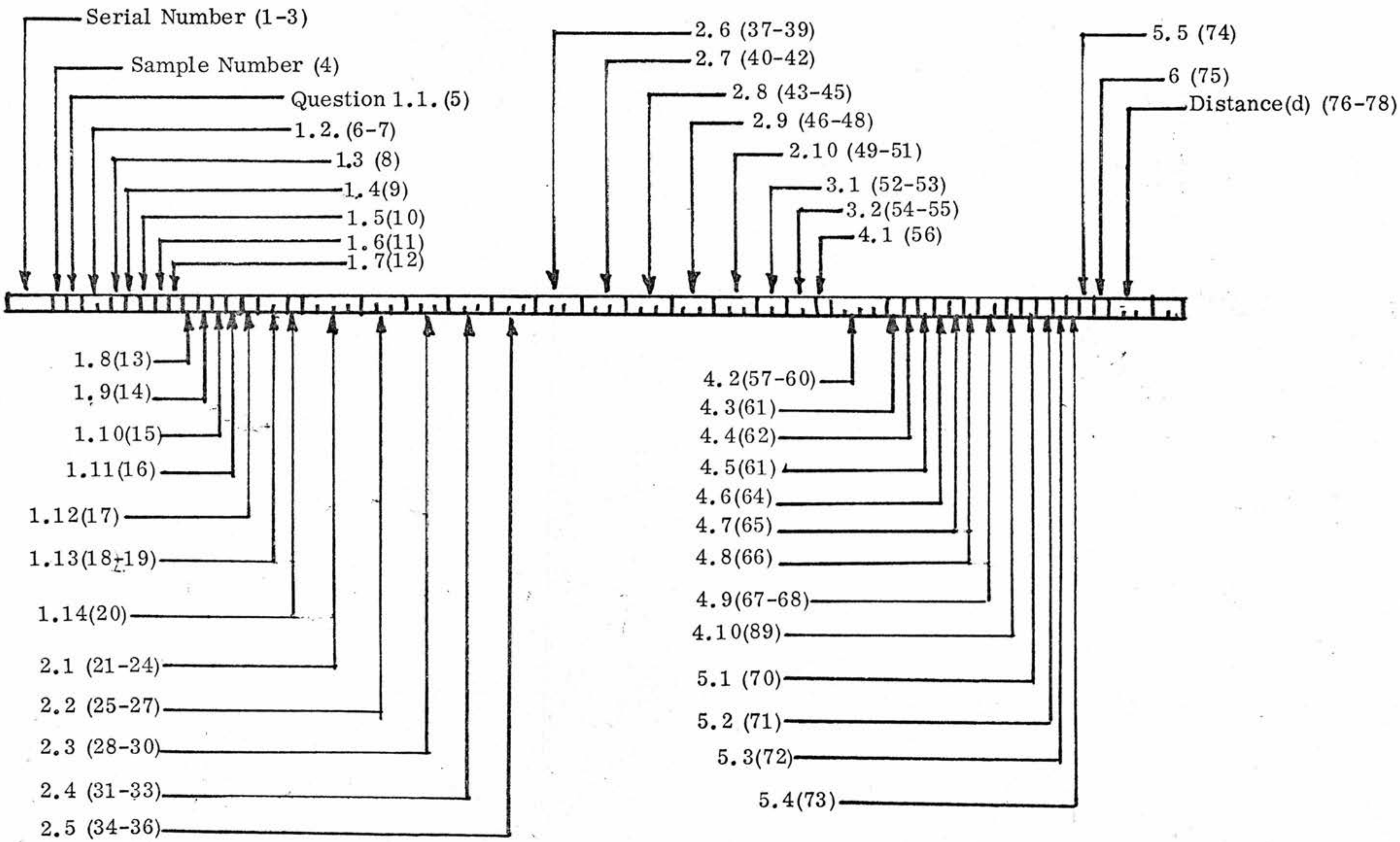

TABLE (A1-1) BLUE COLLAR - PERMANENT - RENTED.

(1)

```
00211 40011011011 53015000002000001700001000011000 3 71 168222222 12111120330
00511 50021011011 73015000001500003500001000015000 3 71 173221222 21111120350
00711 90041031011163020000001000302000000070001000 0 3 71 273221222 22111120316
01111 30010011011 11016000001000002000000000010000 3 71 492222222 31111120348
01711 90020151021 73030000002500202500001000015000 3 71 306222222 32111120290
01811 50011012021 11015000002000002500000000015000 3 71 290222222 32111120318
02111 50112110011 53030000050250100450000150200200 00 3 71 345111112 31111110277
02311 50021100111 43016000702000005800001500000000 3 71 865221212 31111120300
02711100061012021183022500802003603000002000000000 3 71 514111112 32111120285
03711 90021131111 83015000002500001800001500010000 3 71 537222222 12111120265
04311 70021111111 23024000002500001200001500020000 2 71 245222222 22111110240
04511 70011023021 730200004030000016000010000250000 0001 260111212 22111110215
04711 51002011021 710400005050000016000020000300000 0001 240111212 22111110218
04811 60021011111 71012000002000002500000000016000 3 71 425222222 32111110245
05011 70021031011173015000002500001200001000020000 0001 136222222 12111110270
05111 40011011011 53014000002000101200001500020000 3 71 227221222 22111110255
05411 90042012021 73024000002500702500001500025000 3 71 400222222 22111110258
05511 50003002021 93020000003000002500002000025000 3 71 499221222 31111110225
05611160054061021 71025000002500002500000000000000 3 71 325221222 22111110220
05811120022061121 11030000003000000900000500025000 1 71 231222222 22111110225
06111 60011111111 73012000002500001500001000010000 3 71 292222222 22111110227
06311 50021011011403018000503000100500001500020000 3 71 335112212 31111110202
06611 40010102011 73012000602501502500001000015000 3 71 522111112 22111110173
06711 70001041111 83 1250000150000300000100000000000 3 71 325222222 31111110202
06811100021151021 73020000502500003000001500020000 3 71 309112212 32111110201
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08413110033023031 73060001305000630000002500060000 5 71 927111112 52111110180
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08711 80021041021 72017500002501502200001000020000 4 71 632221222 32111120154
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08911 60021111011 73012000301500003400001000010000 4 71 347111112 12111120163
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09111 40000012100000018001202501001800001000020000 4 71 934222212 31111120188
09211 80023021011403017500002000300500002500020000 4 71 357222222 21111120190
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TABLE (AI-1) (2)

```
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11411 6002110111118301600000300000270000100000010000 4 71 403221222 32111120152
11611160043144031113040000803003506000005000025000 4 71 811111112 42111120147
11811 3001100101117301200000150000160000100000000000 4 71 193222222 12111120166
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12011130051051111 7102000000200000100000050000010000 7 71 137221222 12111120110
12211 30001001111 7101500040200000100000050000015000 7 71 309221212 21111120128
12311 40011011011 7101750030250000100000100000015000 7 71 321221212 22111120125
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14011100023121131 8102400000300000140000050000010000 7 71 206221222 12111120107
14511 50011012011 6101300090250020140000050000020000 7 710669 21212 32111120146
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14911140042062021 7102800080350000130000100000025000 7 710241 21212 22111120127
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15411 9004300205113305000000750150120000300000040000 7 51 510221222 32111120142
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```

TABLE (AI-1)(3)

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16521190035173031217303250250250150600000400000150000 7 71 546121212 3211111183

155211100411 31111 9301750000200000260000100000000000 7 703340221222 32111120146

TABLE (AI-2). BLUE COLLAR.-SEMIPERMANENT-RENTED

(1)

00111 70010141011 63015000002000000000001000001 3000 3 72 269222222 22111120320

03011 70012021111 830150000020000007000010000010000 3 72 107221222 12111120300

03111 70041011011 730110000015000008000010000015000 3 72 103221222 12111120298

03311 70041011011 530200000030000015000030000020000 3 72 115221222 12111120275

03811 90030051011 810100000010000035000000000005000 3 72 127221222 12111120268

039111100901010 11 730175000025000025000015000015000 3 72 187221222 12111120280

05211 20000100111183010000002000001300001000025000 3 72 158222222 12111110257

07411100051021121 530180000025000022000015000010000 5 72 231222222 32111120255

07811 10010000011 830060000010000003000005000020000 5 72 158221222 21111120235

0801110003204101117301200000150000150000100000 15000 5 72 207122222 22111120218

TABLE (A1-2) (2)

```
1131110003204102I 730180000025000003000020000030000 4 72  48221222 22111120152
11711 80021041011 830120000000000020000010000000000 4 72 195221222 12111120162
1431116008403101I 730175000015000013000010000012000 7 72 190221222 22111120132
1731107003121001107302100000250060200000300000200000507202752202220221111 20220
174110800310310210830175000020000012000010000015000050720119220222012111120165
211111200520230310730350000030070150000200000250000707202462212220221111120140
265111000610210112330200000010024012000030000025000140720198221222022111120096
266110800110420311930300006000000000900000500001500014072021023121201211 1120096
267110900330012411430300000002000001400004000000000001407201352212220221221 20106
290110800320111210930150000010000160000150000150001414201672212220211111120123
349111000510310111430300000001000000500001000000000013132 261121222 12111120205
41211 600210111110030250000010000020000005000010000181B2 225222222 12221120287
44111 80041021011 730300000020     015000000000000000013132 183222222 22121120225
50211 800320210111830180000020000010000035000040000262620222 22222 32111120305
50411 500120110112130175000015000010000030000025000262620180 22222 22111120353
53711 800310211111930180000000000000800004500005000026262016B 22222 22111110340
55711 80021013111 450150000015002030000010000015000282820409 21222 22121220450
00121 40011011011 110150000015010015000010000015000 3 72 132222222 12111120325
00423 80012022131 110350000030010035000000000025000 3 72 238222222 42111120335
03021 50021011011 730120000015000007000010000010000 3 72 105222222 12111120297
03121 20002000011 730180000025000019000015000025000 3 72 319222222 21111120350
03521 80002131121183302000000150000150000200000000000 3 72 105221222 22111120355
03821 60021002121 530180000020000025000015000020000 3 72 165221222 12111120270
03921 50021011011 730120000015001015000010000015000 3 72  81221222 12111120280
05621 60003012021 710400000060000015000010000030000 3 72  98221222 22111110225
05821 40002011011 210120000015000010000000000015000 1 72 212222222 22111110210
06421 70021031011 710120000015000012000000000010000 3 72 335222222 12111110202
0662112003107101I 430175000025000010000010000010000 3 72 235221222 12111110170
09221 80021131011 410120000010002005000005000015000 4 72 415221222 22111120182
101211000330220211330225000030000010000025000025000 4 72 178221222 12111120160
173210500110210113530200000250000200000100000200000507200942222220311111120242
179210900420210210730180000025000010000015000020000050720284221222022111120232
264210600211110110110100000010005010000010000025000140720141221222022111120101
265210600110310110030090000010000007000010000030000140720112221222012111120098
266211000321301210730450000050040140001250000900001407202302212220221111 20094
267211100410411111410400000010012015000015000040000140720254221222022111120098
39121 900410310211330300000020003013000030000030000011132 151222222 22111120222
50621 500110210212120200000015000004000025000040000212120152 22222 21111110355
51421 600020211111330200000010000015000035000005000132120228 22222 31111110350
54721 800311210113030120000005000008000015000020000303020259 21122 22111110410
55221 500210110111430250000010020015000045000015027282820654 22222 22121110410
55421 600220020112810125000005000009000000500001000028282 0150 22222 22111120447
56221 600122111111430200000015030010000045000020000141420177 22222 22111110420
569211100310610 21 730300000020010013000015000015000292920242 22222 22111110445
```

TABLE (A1-3) BLUE COLLAR - TEMPERORARY - RENTED.

```
03411 60011031011 5301750000200000000000100000010000 3 73 120221222 12111120285
03411 60011031011 5301750000200000000000100000010000 3 73 120221222 12111120285
05311 90031041011 7301250000150000200000100000010000 3 73 355222222 22111110257
06211 40011011011 7301200000200030250000100000025000 3 73  90222222 12111110226
1781112007103102105301750000150020100000100000100000507301502212220121111120228
1851105002101101117301500000150000150000100000150000507302262222220221111120236
2011110002303113107302500000250000120000600003000007133017722122202211111120197
2021114004206200134301500000100000100000100000000000713302862212220221111120202
34411 80032021011 830400000020000015000030000000000011113 240221222 12111120242
35411 40001021011 7301500000080000100000180001000000 7 83  74221222 12111120203
39211 300100200111110180000010000010000005000000000011133 120221222 12111120225
50011 900321111114030200000010000015000025000045000262630198 22222 12111110337
50111 6002101201126 0150000015000005000020000040000262630096 22222 12111120320
54311 200010010112530100000005000010000015000010000303030183 21122 22111120417
54811 90022221011 720175000010000011000015000010000303030348 21122 22111120415
55011 40011011011 730120000005000010000020000010000303030131 21122 21111120415
57511 3001100101129101000000050000010000000000010000292930103 22222 22111120440
00221 3002000101140301000000200000070000100000015000 3 73 102222222 11111120330
07021 80021041021 7301500000200000100000050000000000 3 73 142222222 12111110185
15821 60011031011 5101000000220020130000100000010000 7 73 189221222 22111110156
1772105001102101105101200000200020130000050000150000507302212212220121111120225
2012103000100101108201000000150000120000050000150001307300872212220221111120197
3002102000100101140301500000050000080000150000000001313301902212220112221120170
37521 4001000211111103000000180000100000000000000000011 73 242221222 22111120247
41521 80041021021113015000001200001000001800001000021183 294221222 12121210322
50121 60031011011 730125000010000010000030000065000262630092 22222 22111110345
54221 8003103101130101500000100200009000010000015000303030181 22222 22111120397
```

TABLE (AI – 4) WHITE COLLAR. N.P. - PERM. - RENTED.

(1)

```
07211 40001002112 73022000702500003100001000015000 5 71 435111112 1211112019
07511 40021001012 72017500903000402200002500025000 5 71 559221212 3111112020
07611 30002001122 71036001005000005000003000050000 5 711310111112 8111111019
09411 80003022122173 60001705002308000003000035000 4 711152111112 5211112019
0951110003113 2012 73030001503003507400002000040000 4 711217111112 4211111013
09811 70130111012 42050003005010002100006001503000 7 71 921111112 3111112015
09911 30000111012 73030000404003003000001000020000 7 71 386111112 2111112013
10211 60021021012 73030001202500001600001500030000 4 71 738111112 3111112017
11211120031133112173023002504008007500001500001000 4 711421112212 5111111017
12411 90051021012 61045000305000001000001000050000 7 71 321221212 2211112012
12811130023044032 73060002007500010800008000050000 7 712226111112 6111112010
13511 70022101112 81015000002000001500000500001000 7 71 156221222 1211112012
14211110003035112403030000003002502000001500001000 7 71 429221222 3211112012
15411 60031011012 73030000907502001800001500040000 7 710419221212 2211112014
15511 60031011012 73015000003002501200001000020000 7 710227221222 1211112014
15611130054022032 93045002004000805000003000025000 7 710000111112 6211112012
15711 70022021012 73035001505001003100002500015000 7 71 435111112 3111112016
15811140041134132 73045000005001001100001500025000 7 71 229121222 2211112017
16611100032022122 910350008025005049000050000010000 25 71 445111112 2211112015
170110600012121217301800120150050170000150000100000507104601112120521111 2022
19211060004010132073040000905000001200003000025000070710378111212022111112018
20911080051011012073014002002000505200003000010000070710816111112041111 12014
22011050021011012073020001402500014500002000030000070710727111112031111 12016
22411110051041012073037503504000406000003000025000070710982111212032111112012
24311030001011012073015001001000001500000500001000007071030022121202211 112013
25013160065113012071030001200000001500001000000000070710072212220221 1212011
25511060031020612071045001501200006500001000015000070710277221212022121 12009
25711040021001012071030001001505007500001500002500007071043611111202212122009
25811090031041012082015001000800001400000500001000007071026021111202212112011
26811050002101112143030000001002501000000500000000014071037822122203111112008
27411080021112132083045000002000002200000700002000014081038422222202112122007
27611100021051122172030000002000702500003000000800020081053911112203111112004
28011100041031112013030000001200001600002000000000014141016322122203211212016
28111030001011012221030000001000001200000000001500014071013121222012111112010
28411030011001012073020000001300001000001500002000014071023522122201211112011
28711060011111112193030000501500004400001200001500014071089511111202111112012
30111100131041012131045000002000002500001503002505013131033022122202212132015
30511060011022012053030001001800003700001500001000013131018811121203212122016
31211 500110111122510350008020000010000010000000000013 71 236221212 3121122013
31311 60022011012 73040000001500002000002000002000013 71 408221222 2222112014
33011 40021001012131020000801501501600001500003000013131 240211110 2212112016
33411 80022021112213030001002506001800004000002500013131 260111212 2211112018
34511 50011011112 73018000002500001500001500001500011131 228121222 2211112021
35711 30000111012 73030001000605503000001500000300013 71 684221212 3121112021
35911 70020032012 43030000002504502000002500000000011 71 676112122 2211112024
```

TABLE (A1-4) (2)

```
36911 90021032112 73030000002000001400003000002500011111 223211122 22111120256
37611 50110111102 730300020020037050000030030030000111311620111112 61111120242
37911 90041031012 83048000001000001600006000000000011111 216221222 22121120260
38511 80020042012 730300000020008035000012000010000111310000221222 31111120210
39311 50012011012 7303000120100000250000200000000000 7 71 933111122 41211120220
39811 90031113012173030000002502001000002500006000013131 171221222 22111120186
40311100052012022133030001203001003500000500001500013131 611112112 41111110182
405111011530000322130450015050260106000030050010000181811920111112 71211120185
41111 70031012022202030000903500200500002500003000018181 511111112 31222210290
41711 70022011112 830400015015025000000025000020000 7 711200111112 61222210343
42311120242003122 840700060150100085038100070030000181812555111112 41121110360
2072106014100101219303500100500010400000300200000000130710408111212022111120200
2042104002100101213103000100500300750000120000300001307102531222120221111120197
1992106023101011208304000100300051370000300400400000707107801111120511111120163
1952112012512204217304500350500300400000300200250001113109341111120321111120191
1692108001012401205102000080000250110000090000200000507102101212120221111120218
15321120041042112 73050001707504002200005000050000 7 71055221212 32111120145
12522170073052032 730450005050040010000030000040000 7 71 309221212 32111120125
11421 70122101022133050001305000004300003003005000 0 4 71 984111112 42111120165
09921 40001021012 930200005030015010000035000030000 7 71 246221212 12111120128
097211331122134221930600030070050033000025025020000 4 711669111112 91111120160
09421 90112032132 130450025075055030000040025060000 4 71 875111112 81111120162
08922130013072032 430450025050105039000015000040000 4 71 347111112 12111120163
08721 50001031022 420300010050045054000050000035000 4 71 546111112 21111120162
08621120041034022 730300008035065049000050000020000 4 71 347111112 12111120163
08521 40211002032 440600030075000036000300075050000 5 713471111112 61111110193
08321 80033011032 730400021075020025000040000050000 5 71 541221212 32111120190
08121 20001001012 710160000040000012000015000030000 5 71 254121222 21111120195
08021 20001001012 910110000010000007000005000010000 4 71 178221222 22111120150
07621 40011002022 730240010030000100000010000020000 5 71 306111112 22111120222
072211100421220324030450000050045030000060000075000 5 71 449222222 12111120205
042211000322310221030300000050000017000020000040000 2 71 181222222 32111110230
03621110121032222 730750028050040043000030025050000 7 712046111112 51111120260
03321 60021021012 630350000040025034000020000030000 3 71 695222222 22111120283
02621 62102100022 730500010050055025000060030040000 3 71 893111112 42111120290
02521 60031011012 730200008030012040000010000000000 3 71 158111212 22111120288
02221 700210310127 30210000025030015000020000015000 3 71 264222222 22111120295
211210900230121320730250035030000017000025000025000070710318221212022111120137
35521 90011043012133050001003503403700001800000000011131 360111112 32111110204
35022 90023013032 51030000002000201300000500001000011111 256122222 22111210211
34522140031062222 73045001500500003000001500001000011 71 470121212 41111210210
33921 40021000112 73020000601500001100001800002000013131 202111222 22121120190
33321 30001010112131010000000100000080000000000000013131 70211222 22121120177
33121 600120111122130300015250009075000025000030040131311351111112 51121110250
32321 51011001112131015000001000003000000000000000013131 401221222 42111120172
```

TABLE (A1-4) (3)

```
31921 80032021032 720300000012000028000015000010000013 71 360221222 12121120160
31221 90021033022405030000001001001000000000000000000 7 71 159221222 22121120145
309210400110110120730300015010000029000030000025000070710440111112021111120168
304210700050020422230350000000000000000000000025000130711030121112021122110165
302210700310111121310300015025040020000015000030000131310378211212022122120160
301210900310311124050300000018020020000015000020000131310272221222022121220154
299211400320711122310600000012000010000010000000000070710198221222012212120125
287210700040021320730400000018000024000020000060000141410499221222041111120114
283211300431221221330400000018000034000020000020000140711206211122041111110110
282211300431230120710350015008025026000010000020000140710225221212032111120110
271210600210210121410175007012005014000000000000000140710237211112022111120090
270210600110310120730200007007005040000010000075000140710709111112041112110094
268210800212210020000200007012000020000020000000000140710583111112021111120105
256210300101010120710300000801200004000000800001000007071045211111203112112 0110
248210600110211121910120010000000020000000000000000007071023522122202211212 0103
237210500210110120730175000030010015000010000010000070710192221222012111120105
219210300010011120730180008025000026000010000015000070710560111212031111120150
216210610220011220730250015050010013000040000030000070710212221212022111120153
38121 500010310121320200004015000    0000000000000000011131 283121210 21221210277
38221 80032021022111045001502504501500001200003000011131 305111112 22211120205
39521 80121031112133035000803002517500003503001500013131 797111112 41111120195
39724 30000111012 7302000100100000500000150000000013131 999111212 42111120182
39821 80051011012131030000001500901000000000000300013131 166211122 22111120168
213210200010010120730175000050000025000030000050000070710448221222021111120143
37321 700120121321730300006020000    000300000030000011131 360111112 22121220275
00921 700301300223530400010025030085000015000020000 3 712678112212 52111110338
58513 50101031012 7 040001002007517500004001503006030301 1920 11112 22111120450
58111 90041130012 7 0300020020035200000040000050000292911048 11112 41111110434
57611 5003100101214 0200017015020250000030000025000303010691 11112 41111110457
57411 50021011012 7 0300007020060100000045000030000303010896 11112 41111110440
56811170044062142 730900015045018100000075000015000293010830 12212 42111110448
56511 40011011012 730250008020000075000040000055000282610763 11112 41111220420
56111 601010131121330300015020000040000030030020000282812648 11112 71211210460
56011 40021001012 230180000100060350000350000500402828810354 12222 22121210464
53011 600210120121930325008045115035000060000075000262610585 11112 32111120343
52511 700210310121330325011025005130000070000000000232310820 11112 31111120365
52212 902220320121930525015060110275000075000040000272712038 11112 61111120420
52111 601210120122330350010025055225000060045050000272711082 11112 51111110413
51811 500210110122330400012040056265000065000045000272711200 11112 71111110426
51311 50001021112 730275015020040165000040000050000262610770 11112 41111110342
51211 60012021012 740425018030055180000165000060000262612200 11112 61111110350
51011 50011021012 730325015025000150000045000025000262611380 11112 51111110348
50811 400210010121430300020025050100015050000040000261411726 11112 41111110356
49011 80121121112 730450020030035065000050035100000232312488 11112 61111110332
48711 500121010120000250012015070040000045000050000232312216 11112 51111120325
```

TABLE (AI-4) (4)


```
05921100021061012 7302400090250040250000150000200000 1 72 208112212 32111110230
59421 60012021012 730250012020062175000065000025000303011087 11112 51111120480
59021 80121032012 7 037501502506020000018502507500030301271 7 11112 71111110447
58821 40011100122 750400010020000085000045000010000303010975 11112 51111110498
58721 40011011012 730250010015045075000060000045000303010651 11112 31111120485
5812112006112111214303000100250240300000300000500002929108 67 11112 42111120436
57221 50111012012 7 03500120150451500001750400250003030113 93 11112 51111110450
55521 50021011012 720200015015002040000020000000000028281065 1 22212 41122120433
52821 50012011012 730300008065080300000070000080000232310879 11112 51111120345
52721 701210220122340400035075120275025225045125025262612901 11111 71111120378
52621 60001014032 730400030050000096035065000100000232310876 11111 32111120365
51921 600111120123030300006020000045000030000250002727105 19 11112 41111110420
51721 50021011012 730325010020075250000045000000000262610722 11112 31111120380
51021 902510120221830450025030020200000050030045000262611182 11112 41111110370
49821 500010310122030180011025000030000060000125000181810946 12212 51111110340
49721 50121011012 730200012025022200000050025020000262610905 11112 41111120340
49621 60021012012 730250012020040150000045000020000262610401 11112 31111110330
48921 701210130121940425018025120250000175040085000232311386 11112 61111110325
48421 400110110121930200012025000200000035000050000232310684 11112 31111120290
48321 60021111012 730350022025070250000065000080000232311757 11112 51111120342
45321 400110110221330600015050200032000125000100000191910830 11112 42121120151
45121150025025132193030000002000502300003000004000019191031 3 21222 22121120169
43121 70011041012 7404000020200100180000100000450001818100002 21222 32121120295
41621 600210111121330450012015000000000200000150001313115691111 2 51222210340
40921 6001102111220302500080100000050000160000000000018181 529111112 41111110295
48411 420300001122330250015025000040015025000010000232310981 11112 41111120310
44811 50001013012 730300000015050032000060000045010191910413 11122 21121120154
44713 90141021112 83036000002008001800008001000 0 191910315 21122 22121120173
44312 60122001032 7403000000250000300000350000000000013 71 509221222 42211110212
43711 502010220122040700025040000500050200100200250 20 711913111112111111110240
42911100222002262193070003504000038004510006515000018 710000111112 81111120268
```

TABLE (AI-5) - WHITE COLLAR. PROF.- PERM - RENTED.

(1)

```
00611 60012021023 13035003002500420000002000030000 3 711586111112 71111120363
13611 60002121013 71012000002000001900001000010000 7 71 210221222 22111120123
16011 81132021023 74075002506012017007530002507500 0 7 512260111112 61111120192
19611020001001013054040001205000002900004000010000007071048011111202111111120188
22611070102022023074030003004002505407505002902500007071160311111207111111160124
24211050121011013094050001507500005300852500300500000707114461111120611111110120
30611070231021113174030002501804509003800003015015013081235211111106111111110175
31011 90221006013174060003001803010009002503007511013 711777111112 61221120158
40811206271022023263040003005001033000001508000001618181170011111 2 71111120241
42411 70131011013004065001703508530007510002002030018 711078111112 31122120324
43111 50110011113000090002505012010010010004503000018181000011111 2 41321110265
43311 60214000113 73060002504004030006004014005010013 711663111112 61111320182
43511 50121001113 74070003002504060004015002520015 0 7 712610111111 52111220230
43611146017041013204060005002507065000015000006000020 712996111110 71111220202
44411 94340201213174060012204500030006015030025000018 711564111111 51111120205
46012 50202101113000070006001500006506015020010000019191151 1 11111 51111120178
46911 20000101013000030002000000007200000000000000601919108 39 11112 31111720205
47311 80313013013 74050004505030075006040030000500019191406 4 11112 71121110193
48111 50012011013 74030002202507525000015000006000023231170 8 11112 61111120340
48812 50021011013 73040002503008027500008000007000023231239 1 11112 81111120302
49611 80121131013 74045002205012020003022503507500022221200 0 11112 71111110310
51611 70142001023 73030001202505025000004002001000026261072 2 11112 32111120380
51711 40101010223133040000803510025000005002502000026261072 2 11112 31111120380
52311 60021012013000030002202010010701006000000000023231091 3 11112 31111120365
52411 50011021013 73030001202507013600007000004500023231113 0 11112 41111120365
52612 90121132013 74055002505007530000018004505002522231354 3 11112 71111120375
52711130252132023000 75005005010076000017505010000030301356 6 11111 61111110378
52911 80021032013 7 045001503505025000017500005000023231136 1 11112 51111120365
53511 50011011113144035001506508020000015000006000023231125 0 11112 81111120370
53911 80023111013 73035001201502216000003500004000030301126 0 11112 51121110420
54012 90132112013 7 045002502005520000006502506002530301262 5 11112 61111110420
54611 80122022013 73040002203007532500008003507000030301153 4 11112 61111110405
54911 60122011013 73035001902004207500003503002500030301123 4 11112 31111110400
57111 70021111111314 050002502009013700005000005000030301105 6 11112 41111110457
57811 90021041123 7 050001805021020000017500005000030301243 3 11112 41111110435
58211 50012011013 7 047501802007520000003000005502530301201 9 11112 51111110430
58812 40111101013 7 045001202503018500005503506000030301168 8 11112 31111110443
59011 80141011113124040002602010002601615002503003030301136 9 11111 41111120472
59111 60021021013 7 036001501004520000007500003000030301202 8 11112 61111110465
06221 50122001013403030001005003507500003001005000 0 7 712046111112 41111110207
13921 50211021013 74050003510000010013530007005000 0 7 711498111111 61111110137
14621 50011030013 73030000003000011600005000075000 7 710877111112 71111120150
16021 90023031031 9303500[illegible] 7 51 [illegible]
18921090331122013043 4500250500100290000250125000000050710797111111[illegible] 2111[illegible]
19421[illegible]
```

TABLE (A1-5) (2)

```
2402106002011111307201500120300000210000050000150000707103262212120321111120100
2902109011103121307406000200250750750000750150750000707107521111120321111120125
37821110033032023133045002520004008000003000000000011111243312211 2 51111120280
38621 81022031013403050001502005016000004002002500013 711720111112 71211110245
39921 70012111123173080002004000006500003001503000013131137311221 2 51111120197
42521 90221003113 140700040000000000000000000000018 712951111112 61121110290
42621 50111100113 730650025025000230000015050050000 18 712135111112 51121110265
428211103310220131840650055010090015000220060050200181810000111112 91112120300
43721 60213011023 740600050035000450045200050100000 7 711837111112 61121220262
44721 70222012013 740500065040060080045200100080000191915479 11111 81111110165
45021 70021102133403030000001005502200006000001000019191036 4 21222 22111120155
46922 80121022023324040002504007505500017504012005019191297 3 11112 71111110230
47221 50021011023231024001503002520000001000001000023231083 7 11112 51111120277
48021 40101011113 740425035040100450000180040070000232312126 11112 61111110355
48521 70132111023 730350020030050275000050045070000232312074 11112 61111110350
49321 602020211134040425020035050250000225070100000222211406 11112 51111120315
49521 50111012013 740350022030075250025200025085000222213269 11112 81111110310
50521 40011011013 730400015030065275020050000075000262611739 11112 41111120358
51121 60121021013 740450020035125350020125030100000262611778 11112 51111120375
51221 50011021013 730350018030070175000060000050000262611157 11112 41111120360
51621 700330010130000300010025060250025075000040000262610722 11112 32111120380
52421 601011121130000300015020000130000015035000000232311053 11112 41111120365
52521 80021032013 730500020050250136015075000020000232311130 11112 41111120365
53221 701210220132140575016065080225000150035075000303011750 11112 81111120385
53821 60121012013 740400025015045250000120035040000303011271 11112 41111120410
54321 50012011013 730350015020040175000025000030000303011736 11112 41111120414
54421 50021011013 7 02500130150351600000450000250000303011338 11112 41111120430
54821 50011111013 7 02500150100251750000350000200000303010959 11112 41111120410
54921 30001001113 740300012010000175000150000030000303011522 11112 41111110428
551211600441450434 0 04000150200250460000550000300000303011533 11112 61121110425
56021 60141001023 7 03000200200501850001500750500050303011331 11112 51121210437
57121 401210010134040250015015000300000150020015000303011524 11112 41111110444
57321 700210220234030400015050100115000080000010000303011314 11112 41111120443
57621 50011111013 7 04000200250222000000300000150000303011594 11112 61111110442
57721 82021112123 7 04500150200000350000450000500000303012808 11112 71111110463
58521 50011021013 7 02750120200401800000550000200000303011260 11112 51111120480
58621 6002101112340 03000150402000850000500003000060303010968 11112 51111120480
59521 80131112013 730375015030070200000060030045000303012200 11112 61111110480
```

TABLE (A1-6). BLUE COLLAR - ALL TYPES - OWNER OCCUPIED.

(1)

```
01211 50011021011312025001302500203600002000020000 3 711007111112 51111110350
02411 90042021021 7302500070300250130000300000020000 3 71 344221212 22111120276
02511 40021001011 4301750000300000090000200000010000 3 71 915221222 41111120306
02811 70041011011 8303000300250030180000150000020000 3 712037111112 71111110312
02911 80050111011 3102250090250200090000050000015000 3 71 415221212 22111120297
03511 90032031011 7301750000200060040000100000010000 3 71 207221222 22111120352
03611 60012011121 7303000120400400070000250000020000 3 71 423112212 71111120362
04111 50011012011 5302500250400000010000010000025000 3 71 613221212 41111120250
06411 50011111011 4301500000250300060000100000025000 3 71 315221222 22111110152
139111200610410 11 8202000000250010010000080000010000 7 71 437221222 22111120142
14811 40001002111 7101250150250000140000050000010000 7 711150 11112 61111120117
16311 80020050111 9101000000100000030000000000004000 7 71 216121222 22111120188
176110901311210114030500022050006025000050015100000050712396111112061111110220
181110710220110210730380000035004006000036000025000050710347222220321111120229
189110600111120114030120000020000007000020000010000050710413221222041111110195
198111000211330110730300000030000009000050000050000111310201112222022111120204
203111000231211111320180016020000011000010000015000070710272112212022111120196
3241113004410310117303000130180001360000000000000000013131 978111112 61121120170
34811 4000102101113203000150120000140000050000000000111311086111112 51111120200
36311 90032031021183030000000700400400000080000150001 1111 304212122 21111120280
43817 30201001010000015001500500000000300000400000000181818374111112111111110240
45712 70020041011 1304500200150000450000150000100001 91913643 11111 61111110172
48311 830321110214030300015025000065000035000015000232311115 11112 41111110305
50511 7402202101126303000120250000250000200000100000262610886 11112 32111110358
56311 6001103101121302000000100120030000250000200252828108 10 22222 41121210423
01321 90012113111403030001202501000700003500000 25000 3 71 311112212 32111120343
01621 40011011011 8301250000200150090000100000010000 3 71 712112222 71111110256
01821 90031121131 3102500350350000170000150000010000 3 71 966111112 32111120272
01921 90040410011302020000002000001000001000000000 3 71 412222222 22111120280
04721 60021011111 8301200000200000100000100000015000 3 711396222222 32111110228
05321 30000110100 2201200060200020090000050000020000 3 71 981111112 61111110255
11621 600310110111730120010025015008000015000000000 4 71 323221212 22111120150
11821 60021021011 7101200120150040180000000000020000 4 71 738111112 311111 2172
13121 4010201102240304000250500000290000400350300000 7 711680111112 61111110115
141211200211530 21 7102400080300000040000100000020000 7 71 261221212 12111120120
192210400110110110930120000000000010000015000005000111310252221222022111120192
244210800310310110730250000050042027000010000025000070710395221222032111120125
247210700310210210710300015008025000000015000000000070712000211112022112120100
279210800212021000000150015010000016000010000000000141410944111111041111120100
294210600220110114030300000010040000500001200000000070710279111222022211120103
316211000210520112530600015040025004000010000060050 7 71 210111112 22121120145
33521 80012022121 7303500000250020100000150000250001313110811 12222 42121120193
33721 500110210111330300012015000007000020000015000013131 549111112 41121120165
36221 60031011011 7301500100080000060000150000100001111120851 11110 31111120244
367211201613100111110600020015000006000000002500000011111 418112212 32122120270
```

TABLE (A1-6) (2)

```
41923 6001101302118304500170250000120000100000250001 8 71101911111 2 3222222032 5
55721 60021012011 7303000000100060040000120000150002828 10800 13222 3211121042 0
55821 5001102101122301800000150200020000450000100002828 10414 22222 3111121045 5
56121 2000010011100001000000005000003000010000010000282 820442 13222 2111112042 0
10911 30000101111 73010000000100000070000100000005000 4 73 289221222 1111112013 0
38321 40011011011133025000000100000040000100000000000 11133 215222222 2121111024 5
486210 50012011012 7302500500150600700000350000300002 3234632 11111212111111342
```

TABLE (A1-7) WHITE COLLAR. N.P. - OWNER OCCUPIED.

(1) PERM. ONLY.

00311 800210221121730350020020050012000025000050000 3 711077112212 61111110381

00811110261000212 4100008015050006407550012060000 3 714885111112102111120314

01511 300110100221330150008030020033000020000030000 3 711347111112 41111110286

01411 60021021012 730150006020002003000010000010000 3 71 351222212 22111120355

10511 400110110121330150015025095040000025000020000 7 711770111112 71111120150

17111080022103022133045001505000001300003000007500005071126611111204211120210

26911080030221012071030000001200000400000600001000014081008522122201211120083

29211050012011012192025000501000000000000000010000140710298111212031111120105

30812080031003112073030001204003001100001500002505013071085511111203122120170

30911050030101012403036001004000001500001000000000130710325111112051211120165

32011100023032012 730300012018000005000030000015000 7 71 387111212 22221120130

33712 90031013112 7303500000200400100000350000000013131 465111222 42111120185

36811110023024012 73030000001000001200000800000000111111233111122 51111120274

37411 602001021020000400030020000050040350025030000013 711795111112 61111110280

38411 80021122012 730300000020072027000055000050023 11 71 543222222 32111120236

38711 60011022012 73040001501500015000002500002500011 711667111112 51211110250

39011 400010120122030550030025009030030015020075000111312038111112 71221210234

39511 70011022112193030000802501505600002500000000013131 121111112 41111120186

39711 50203011022 740700075050000032020150075200100018 712992111111 61211110227

40111120242212112403050002002505001200003000002007513 71 998111112 51111110200

43411 60121021012 71050006004506525508520000200501001 3 712449111112 61211220242

48011 4001001111200002000150150000700000100000150002323122 67 11112 61111120312

49811 4002100101226 01800100150000070000400000250002626103 69 11112 31111120356

55412 40011101012 830350009010016027000045000030025303011695 11112 51122210441

55511110223113152000050004003005002200005004004000028281169 5 11112 91111110438

56911 600201021120000500025020050030040020000025000293011902 11112 61122110462

59311 500101210120000400010020100022000075000040000303011087 11112 41111120468

59412 30002000112 73030002801500004502503000002000030301405 7 11112 71111110478

59511 3000101101219302500130300500150000450000100003030109 36 11112 41111110500

02021 80023021142 7307000150750000120000650000050000 3 711153112212 52111110273

02421 61021012022 730400015050050033000025000020000 3 711973111112 72111120302

04021120122053022 330850048060050046000080035075000 3 713064111112 61111120260

TABLE (AI-7) (2)

```
04321 72071031012 7304500250500070650000200000050000 1 713184111112 91111110250
05121 600010212124030240005025000004000020000030000 3 71 541111112 32111110267
06121 70021021112 73 4500250500100180000250000030000 3 711185111112 52111110182
07321 80022013022 7304500150600180090000500000075000 5 71 609111112 51111120133
17821070021031012073022501103002002000001500002000005071075611111203211112021 0
32021 6000112111213303000100200000006000025000000000 7 71 207211212 32221120134
33421 50021011012403035000002000000400004000002000013131 281221222 22121120175
33621 80131021012404035002002510005000007502002000013131130111111 2 51121120200
34421170224072042 5304500250250000300000600400000000011 712408111112 91111220226
34923 60000014112 73030000001800000400001500001500011111 342121222 31111210211
364211900102105121203060000000250000070000150120000000011111 312221222 2211112S82
38421100121230212 73070007004000000000000200200500001 3 710000111112 72221210230
38521 50102100102 83060002002500001500003001503000013 711045112212 42111120214
38821 602130001221330750030025000026000060050075000 13 712052111112 61211110200
396211402430142121330500020040035065015050075100000 7 713532111112 81121110188
41821100021043012 83030001203500000000000300000250001818 1 900222112 51122110332
429211000310411120030350028020015008000030000020050181810000112112 51111100265
43021 100000010000000150000008000003000005000000000018181000022 1222 21111120324
44121 50002002132173060002030000000280000500000200801818119731111 12 42121110201
45222 81122022012 73040002502005503600004504005000019191244 9 11111 28121120170
45621 80102042012 730300015025060035000010035010070191911027 11112 41121120150
47021 601210210122630375018030085085000080035075000191911747 11112 51111110236
47421 8004012102214303600000150600150000200000000000191910276 21122 32111120270
5072113043312313200007500260400000950251601251000002626126 56 11112 91111110270
55021 401002011120000250025010000021000000001001500030301099 1 11111 41111110403
55621 40021001012 730300015010020015000015000020000282810941 11112 31111210425
55921 501101021120000350018020000017000015015020000282812925 22212 61111210476
56621 201010001 2000010001000500001500000002500000028281174 5 11112 41111210490
56722 70121121012 740500025025000050000150030035000293013639 11112 81111110422
56821 50021011012 730275010010000032000030000002500029301115 0 11112 41111120460
392211001410310 12 140035002001000080400000100200200001 1 711991111112 5211112S30
```

TABLE (A1-8). WHITE COLLAR. PROF. - OWNER OCCUPIED

(1) PERM. ONLY.

```
00911 60021011113 7404000400750500400753500000100000 3 71267811111 2 91111110337
04411 9 121033123 7406000400850600420002000250750000 2 715258111112161111110253
13813 90223011033 7404000400750000600953000700750000 7 71409311111 2 81111110134
17911080121031013051030001504004504000030003002500000507126341111120611111110210
18311050102100113404050002505000005800030004010000011131229711111207111111110238
27911140620431403404100003000000000450001204102000001307128391122120610000000140
35211 60201110132040500030050000035048100030200000013 71340111221 2 61211210203
42611100341002013194080006010040004500035006003000018 81187811111 2 21112110310
44511 50101021113204006040004030008003525005005000018 71404911111 2 51111120240
46111 60202022013 74070004502500010507020000005000019191220 2 11112 71111110275
46211 30010100113000035004005000009004030000005000019191297 1 11111 51111110244
46311140136131033 7 060003502501004002003000010000232313949 11112 71111110295
46511 60021021013354035005502509003500030000000501501919116 52 11112 51111120208
47013 90232121013 740600050065125095050250000125050191919087 111116111111 0222
47112 80222031013194052503506010007003518007015007019191623 0 1111121111110258
47211102233121013 730650028050075065000060080075025191914339 11112 91111110228
47411 24040100113000070012000000015006015000000000019191582 3 11111 61111110226
47511 90222122013 740575035060115080030200070100075191913630 11111 71111120224
47911 60021012013 740350020030100055000130000050000232312387 11112 71111110345
48211100231132013 740600035050120072000250070200000232314413 1111110111111031
48511 40101101113000020004502500008503002005004500026261237 3 11112 61111110355
48611 70221012113 740400020030150045025150070085000232312114 11112 61111110364
49511170662063013 741500050100150105035300200350000262617670 111122011111103 3
50311 80131022013 740400020030070055025185030120000262614015 11112 7111111033
50612 90222131013 740550030060105075030175070065000262613433 1111110111111039
50711 80122031023 730300015020028034000045020060000262611930 11112 611111203 5
51112100232122013224075002008012506502520006007500026261277 4 11112 811111103 8
52811 90231122013 740500030045120060035200070080000303012160 11112 71111110 35
53211 70112022013 740350020050110055000200035100030262612350 11112 81111110 35
53312 80222022023203042501506012003500008500075000232311350 11112 51111110 36
53411 60112021013 740400020075070085030180030050000262612373 11112 71111110 37
53611 61021012013 740375012070060058000225000085000262311650 11112 71111110 36
53812 80112031113 740800060025100072000250070100000303015061 11112 71111110 40
54211 80122022013 740475025020050060020175035040000303012833 11112 71111110 41
54411110222141123 750500030015024035030045030045000303011378 11112 51111110 43
54711 60121111013 730400018015040040020050030045000303010938 11112 41111120 41
55911 30011001013 730350022010000025000025000035020181811115 11112 41222220 40
57011 60211022013 730450015025000026000035070035000293011473 11112 51111110 45
57312120131143013 7 0500020025050016000045015035030303011252 11112 61111110 45
57711 40101021013 740500025025080062025150030025000303013288 11112 61111110 44
58011 70321101213 740600020015000045035200170045000292911755 11112 61111110 43
58311 80011132023000035001504502004000003500030000303011830 11112 41111110 43
58611 50011111023 14 0300012025080036000035000010020303010910 11112 41111110 49
58911 80221131013 740500025030065055000175025035070303013356 11112 61111110 43
```

TABLE (A1-8) (2)

```
22211091023031023404060001207540001407520000015000007071100611111204111111120157
35821120103043133 840600025080000025000400020025000011. 711789112112 71121220270
39421 901231111231810600015025000012090100015050000131314028112212 61211110205
40023 60111012013 7406000200250000000001500200050000 7 717391111112 91111110200
43421110623121213181100010003000010004004012502500018 714030111111 61111110253
43821 70212112013 740750035030080000040200060200000 7 712846111111 71211210233
43921 60311021113204050004510002003006010005004004018 713660111112 61111110267
44221 60111021113 110500035040000000025045060200100018 719451111112 61111110230
44421 70221022013 740600040035100000045200045200000 7 712577111112 62111120252
44821 80122022013 740450030040050055000160030075000191911379 11111 51111120195
44921 60002013013 740800060020000690060200120000050191912058 11111 51121110190
46121 803120410134040500050050025110060200200050000191914034 11111 61121110191
46321 60221001213 70050006002020012001605015001000029 714099 11111 51111110291
46421 801411011131340400035030000075040150045150000191911456 11111 41121120235
46521 90232112023 740600030060120082025175100125000191913209 11112 61111110215
466221012420211232240750032050150090020200070125000191913539 11111 91111110200
47621 60121111013 730350018030080065000065045075000191911338 11112 51111110173
47821 60112021013 740450025030075080030200035090000232314806 11111 81111110342
47921 80122112013 7 050002803512006500022504006500023231 3572 11112 71111110335
48121 80321112113 740700030100150105045300105200000232312801 1111101111110310
49121 60111022013 740400015025080040025175030075000262612032 11112 61111120343
50021130242142023144[illegible]005503006004502525007015000262611907 11111 71111110340
52921 60212021013 740500025060075065000185001250002323 14793 11112 91111110365
53122 801220211131440625020075125068035200040100000262612560 11112 61111110337
534211002311320233240700025080110005020180050125035303012274 11111 61111110355
53621 821211220131940625030070100082025175050075020232312827 11111 61111110350
53922 400110110132240400030020000065010150000075040303013418 11112 71111110235
57822 80122112013 7 0400020015055035000035030045000303012845 11112 71111110447
58221 60021012013 740400020025050045030165000350003030 12639 11112 61111110472
58921 502211001134030250018040000050000020030120000303012315 11111 71111110465
59122 60111012013 730300016020075040000065035040000303011350 11112 61111110495
59222 60121012013 740350020035065065000180050500003030 12570 11112 61111110468
358111103301220231330500025025055270000012020025000 7 701045111112 61111120256
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