PN-ABM-109
ISN 79014

D R A F T for D I S C U S S I O N

ANALYTICAL METHODOLOGY

for

PREPARING NATIONAL URBAN POLICY RECOMMENDATIONS

(RFS-40: DRAFT TASK I REPORT)

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January 1984

P A D C O

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INTRODUCTION

The PADCO NUPS Methodology was intially developed and used in PADCO's National Urban Policy Study for Egypt. It was designed to provide a solid analytical basis for choosing effective urban development strategies in Less Developed Countries (LDCs). Subsequently, the methodology has been fully reviewed and adapted for use on micro-computers. This has permitted use of the methodology for analyzing alternative urban investment strategies for USAID in Senegal, Burundi and Nepal.

This report provides a discussion of the methodology, the inputs necessary to utilize and the outputs which can be expected from its use.

I. THE PRIMARY USES AND MAJOR OUTPUTS OF THE METHODOLOGY

The PADCO NUPS Methodology contains all necessary elements necessary to provide analytical support for the determination of national urban investment strategies. In particular:

- The methodology provides guidance for making consistent spatial and sectoral allocations.
- The approach recognizes the key role of employment in determining population location and provides guidance for the allocation of employment creation investment among areas.
- The approach recognizes the incentive effects and cost implications of sectoral programs in housing and infrastructure and provides guidance on the structuring of shelter and infrastructure standards and service levels among areas.
- The approach provides analysis which demonstrate the trade-offs implicit in different spatial and sectoral alternatives and shows how the total resource requirements are related to future resource availability.

The technical advantages of the methodology is described in more detail in the following sections. However, briefly the methodology:

- Provides a systematic basis for allocating scarce investment funds among urban areas and sectors (industry, housing, inter-urban infrastructure networks).
- Permits the use of different decision rules governing how the allocations are made in the generation of alternative spatial and sectoral strategies.

- Permits advance assessment of the cost and benefit implications of alternative allocations.

- Provides a basis for assessing the financial feasibility (and the relative riskiness) of pursuing different spatial and sectoral alternatives.

- Provides a systematic means of assessing the net effects on costs of actions which change individual elements or multiple elements simultaneously. The method can be used, for example, to test possible effects of changing:

  -- the number of urban areas included in the allocation process;

  -- the level of anticipated growth in GNP, savings, and investment;

  -- land use requirements or density of development;

  -- the location of investment; and

  -- rates of rural to urban migration.

- Can be developed as a RAPID type interactive presentation to allow participants to quickly assess the major implications of adoption of a particular choice.

- Provides a means of utilizing information gathered in the implementation of programs, in order to monitor and revise the strategy as necessary over time.

The final output of the methodology is a recommended "Preferred Strategy" for urban development. The "Preferred Strategy" recommendations include:

- Population targets for individual urban settlements and/or urban settlement groups.

- Investment targets for employment expansion, housing, urban infrastructure, and community services, such as education and health.

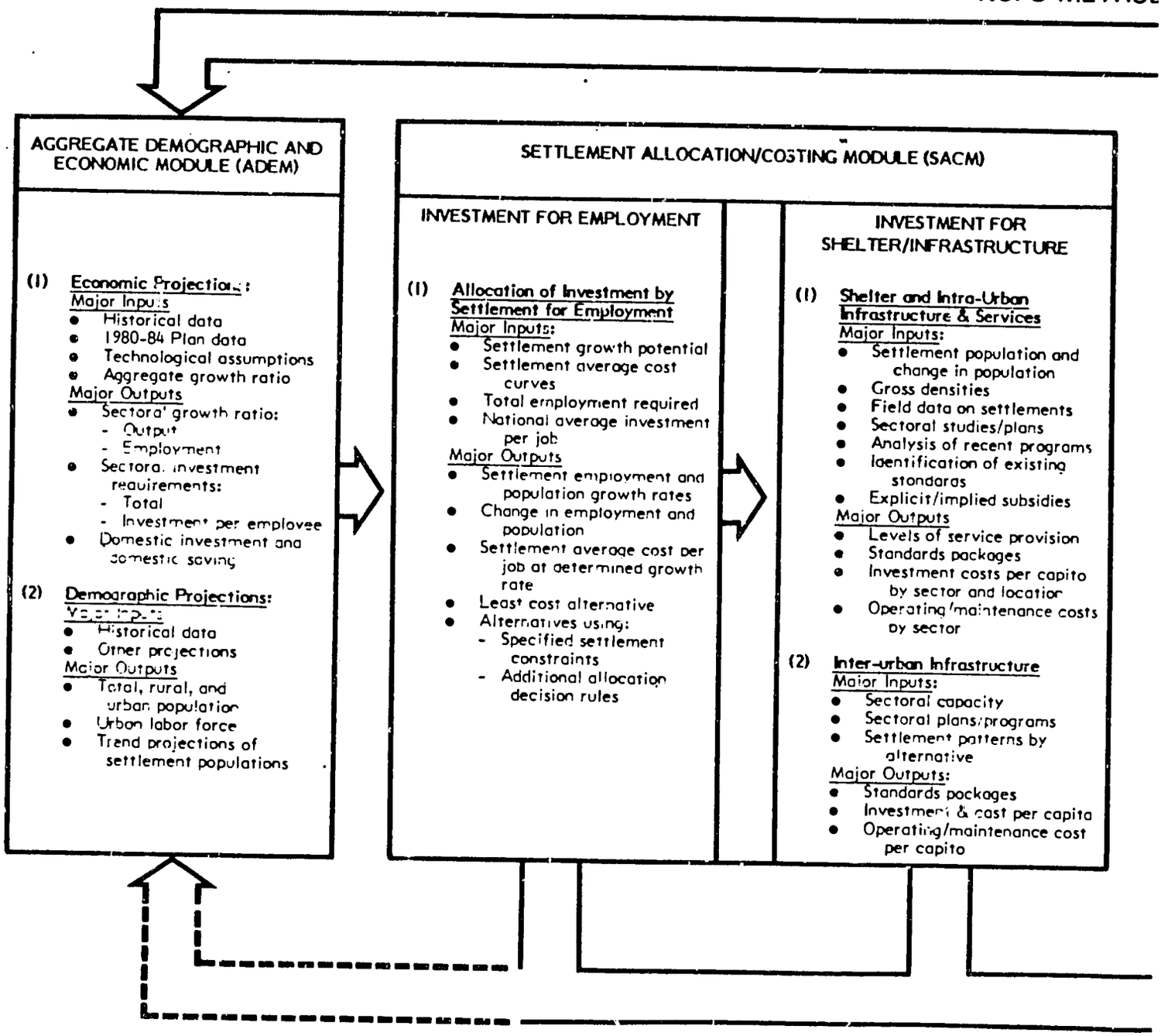
- Packages of standards and estimated levels of housing and service provision for individual settlements and/or urban settlement groups.

- A financial and administrative/legislative feasibility assessment.

- Estimates of net benefits and benefit/cost comparisons plus qualitative assessments of non-quantifiable benefits. Figure I shows the analytic elements used to establish a sound basis for the "Preferred Strategy" recommendations.

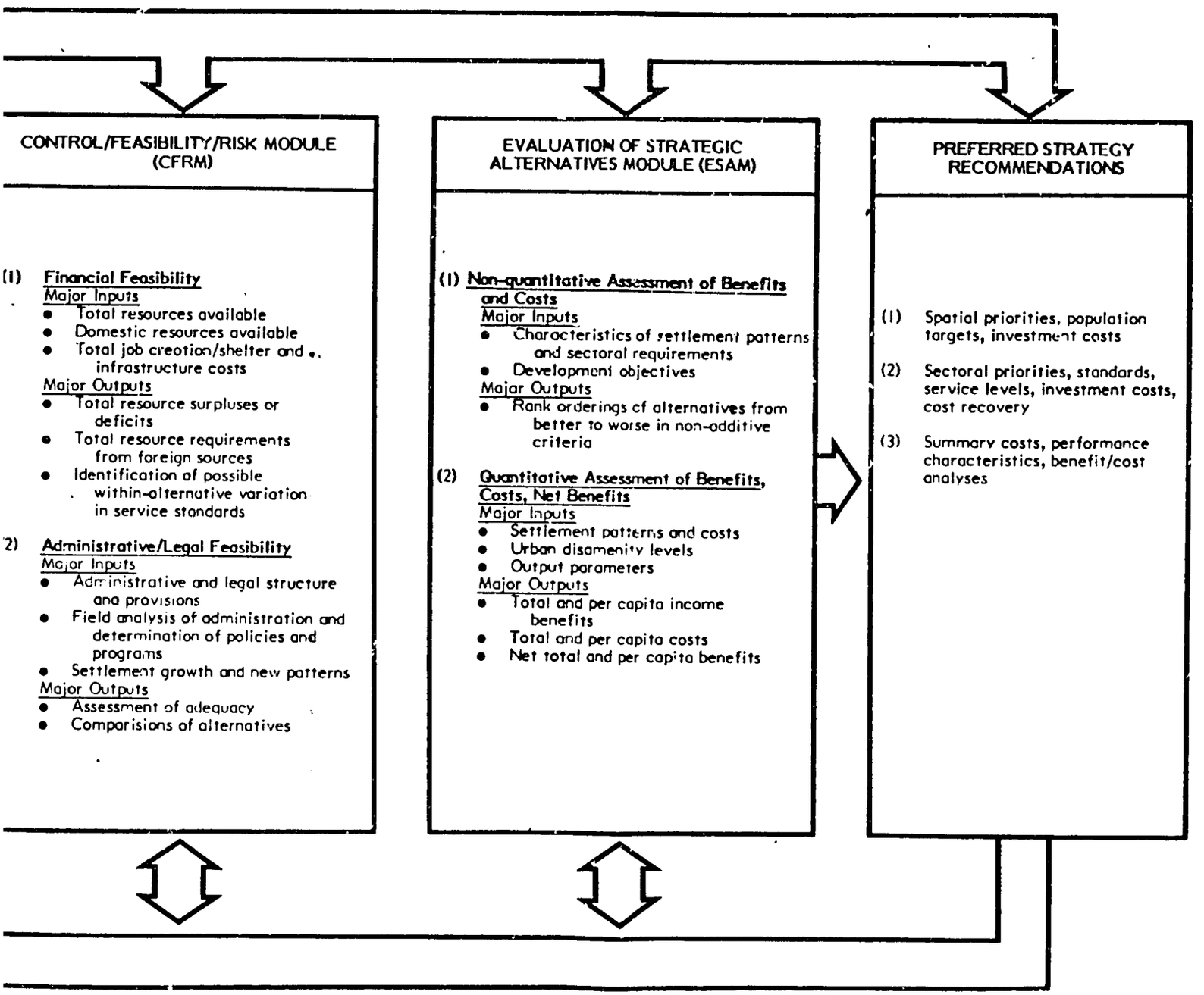
FI

NUPS METHOD



JRE 1

)LOGY OVERVIEW



Prior to determining a "Preferred Strategy" recommendation, the methodology provides a detailed set of similar outputs for other spatial and sectoral alternatives. Each alternative contains a different spatial and sectoral scenario for consideration. These alternatives could include, but are not limited to:

- The spatial and sectoral distribution resulting from a "least cost" allocation of investment in employment. This alternative makes maximum use of the relative advantages of different settlements to contribute to national economic growth.

  -- the number of urban areas included in the allocation process;

  -- the level of anticipated growth in GNP, savings, and investment;

  -- land use requirements or density of development;

  -- the location of investment; and

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- Alternatives based on development of major metropolitan competitors to the primate city as a means of beginning the decentralization process.

- Alternatives developed to further spread decentralization to develop numerous secondary cities as "growth nodes," as a means of decentralizing the population.

- Alternatives aimed at developing essentially non-urban regions such as remote coastal areas or frontier regions.

- Alternatives aimed at deconcentrating the major metropolitan center to surrounding satellites and new towns.

The alternatives which should be developed for a particular country depend, of course, on the characteristics of the country, its development objective, and its own development plans, among other things. The methodology permits testing of a series of settlement alternatives in a consistent manner for consideration by policy makers.

II. An Overview of the Methodology and Its Major Components

The basic structure of the NUPS methodology is presented in Figure I. The framework for analysis shown in Figure I consists of five major components:

(1) An **Aggregate Demographic and Economic Module (ADEM)**;

(2) A **Settlement Allocation/Costing Module (SACM)** with two major sub-components: (a) Investment for Employment; and (b) Investment for Shelter and Infrastructure;

(3) A **Control, Feasibility and Risk Module (CFRM)**;

(4) An **Evaluation of Strategic Alternatives Module (ESAM)**; and

(5) A **"Preferred Strategy Recommendation Module" (PSRM)**.

The following is a brief description of each of the modules.

A. The Aggregate Demographic and Economic Module (ADEM)

The ADEM provides estimates of total urban population and its change over a given time period -- that is, an estimate of the population likely to need urban jobs, shelter and services. It also provides estimates of the total investment resource pool (i.e., the total investment generated by the economy which will be available to finance different sectoral programs) over the planning period to achieve a given rate of economic growth. This module provides sectoral detail on the distribution of total investment among economic sectors.

The ADEM total urban population estimate is used as a control total in the Settlement Allocation/Costing Module (SACM). The estimate of the total resource pool is used as a control total in the Control/Feasibility/Risk Module (CFRM). The sectoral costs per job are used as inputs to the Investment for Employment sub-component of the SACM.

B. The Settlement Allocation and Costing Module (SACM)

The Settlement Allocation and Costing Module builds on the national population and aggregate economic projections developed in the ADEM module. Specifically, it allocates investment in employment and shelter and urban infrastructure at the settlement level. As such, it consists of two subcomponents:

- The Investment for Employment Subcomponent, and
- The Investment for Shelter and Urban Infrastructure Subcomponent.

The two and their inter-relationships are discussed below.

1. Investment for Employment

The Investment for Employment sub-component of the SACM is implemented once total urban population and sectoral costs per job are calculated by the ADEM module. Here, investment is allocated among the urban settlements to generate enough jobs to support the total urban populations. This allocation procedure is one of the most innovative elements of the NUPS methodology.

The SACM provides the basis for establishing population targets by settlement in each of the settlement alternatives to be tested. Specifically, a functional relationship is established between the employment growth rate of each settlement and investment costs per job. Settlement population targets are determined by the rate of growth of employment.

A variety of alternative distributions of population among urban areas can be generated by changing the manner in which investment for job creation is allocated. A given allocation determines simultaneously the expected cost per job created for each settlement and the rate of employment growth in the settlement. Population growth in each settlement is then derived from employment growth.

This sub-component of the SACM produces three analytic outputs that are used later in the methodology:

- Population targets by settlement, which are used to estimate required shelter and infrastructure levels and costs in the Investment for Shelter and Infrastructure sub-component;
- Total employment and population, and
- Total direct investment in employment generation.

The settlement population targets provide the direct link in the methodology between the Investment for Employment and Investment for Shelter and Infrastructure sub-components of the SACM.

2. **The Shelter/Infrastructure Component**

The "Investment for Shelter/Infrastructure" component of the "Settlement Allocation/Costing Module" takes the settlement population distributions derived from the "Investment for Employment" subcomponent. It then calculates the total and per capita costs of the shelter and urban infrastructure needed to support the demand for these services created by the population targets.

This step in the methodology requires a substantial amount of empirical information about the stock, condition, and capacity of shelter and infrastructure in the major settlements. The cost of future investment plans will hinge on the degree to which existing stock can be used or upgraded to handle projected population growth rather than adding new capacity.

The implementation of the "Investment for Shelter/Infrastructure" component provides information on the total and per capita costs of each

alternative and additional information on the sensitivity of these costs to future standards, prices, and demand. The aggregation of the costs from it and the "Investment for Employment" subcomponents provides a means of assessing the financial feasibility of alternatives when compared with the estimated total resource pool (derived in the ADEM Macro-Module).

The sensitivity analysis provides a means of proposing alternative standards, pricing, and cost recovery mechanisms to alter the projected financial exposure resulting from the choice of any particular set of population distribution targets. Finally, the empirical analysis, within a sector, provides decision-makers with information needed to determine which kinds of sectoral choices have the best chance of being cost-effective elements of future development projects.

C. THE CONTROL/FEASIBILITY/RISK MODULE (CFRM)

The sectoral and total costs for the alternatives becomes the major input links between the SACM and the financial feasibility element of the CFRM.

The employment and infrastructure costs resulting from the SAEM module are used to establish whether or not a given settlement strategy is likely to be affordable within the investment resource pool. An alternative is judged to be more or less risky depending upon the degree to which its implementation:

- Requires supplementation of domestic resources with foreign resources (the danger of increased dependence or a foreign resource gap);
- Requires substantial shifts of resources from one sector to another, e.g., from agriculture to urban housing and infrastructure; or
- Requires more total resources than are likely to be generated from both domestic and foreign sources at a feasible rate of economic growth.

The administrative/legal feasibility element of the CFRM relies less on quantitative analysis than the other parts of the methodology. It relies heavily on information developed on the current legal framework for urban development, the administrative structure and practices, allocation of decision making authority among national ministries and between the national, governorate and local authorities, as well as some of the empirical analysis described so far.

Places which will require substantial increases in the allocation of industrial, shelter and infrastructure investments in order to reach population targets will pose heavy requirements for planning, project identification and evaluation, as well as management and supervision of project implementation. Thus alternatives with high requirements for growth in areas where administrative support is lacking pose the risk of being costly to implement because the management skills needed to implement those strategies may not be forthcoming.

Finally, alternatives that imply substantial redistribution of the urban population may necessitate restructuring of administrative responsibilities and authority, the possible creation of new institutions, and revised procedures for staffing in places which receive priority attention.

D. THE EVALUATION OF STRATEGIC ALTERNATIVES MODULE (ESAM)

This module is designed to provide an evaluation of the alternatives developed and costed in the preceding analysis. Alternatives that turn out to be financially and administratively **feasible** may differ considerably in the degree to which they contribute to different national development objectives and in the relationship between their expected beneficial results and costs. This portion of the methodology, therefore, assesses in both quantitative and non-quantitative terms the relative value of the alternatives in achieving national development objectives and benefits relative to costs.

NUPS analysis, as well as urban policy analysis in other countries, has made it clear that **no** single settlement strategy is simultaneously the best way of achieving **all** of the multiple objectives of development policy.

The Government of Egypt, for example, had four major national objectives which were likely to be more or less fully achieved depending upon the spatial and sectoral strategy adopted. These were:

- Achievement of a high rate of national economic growth;
- The maintenance of social justice through inter-personal and inter-regional equity;
- Reduction of the adverse consequences of population concentration in Cairo; and
- Protection of arable land to contribute to the production of food and the growth of agriculture-oriented industry.

The approach used in NUPS is to assess the relative value of the settlement alternatives was to:

- To develop performance data (from the preceding analysis) for each alternative and compare them;
- To estimate the quantitative income benefits of each alternative and the net benefits (income benefits minus financial costs).

To peform this analysis, the ESAM module consists of two subcomponent, a non-quantified ranking of alternatives according to the degree to which they meet

development objectives and a quantification of the relative economic benefits and costs of alternatives. The non-quantified ranking of alternatives is based on establishing performance criteria on which an alternative is judged according to how it ranks vis-a-vis other alternatives in meeting development objectives. The quantification of economic benefits and costs shows the degree to which a settlement alternative is likely to lead to national economic growth. An alternative with low net benefits (i.e., the difference between total economic benefits and costs) is less likely to contribute to national economic growth than one with higher net benefits.

1. Aggregate Economic Benefit/Cost Estimate

Any attempt to quantitatively estimate aggregate benefits of all kinds and costs of alternative national urban policies should be treated with caution. This is true for many reasons, including the difficulty of treating benefits on multiple criteria (such as both social, distributional and economic) as if they were commensurable (i.e., subject to a common set of measurements); and that the incidence of benefits and costs (i.e., who receives the benefits and who pays the costs) is often at least as important as their overall magnitudes. That is why the overall benefits described above were not aggregated into a single benefit measure.

Given these caveats, however, an important but limited set of commensurable economic benefits and costs can be calculated to illustrate aggregate economic benefits and costs associated with different urban development alternatives. The primary purpose of these calculations is to demonstrate the direction of effects on net benefits of moving from relatively regionally concentrated strategies to an interregionally dispersed strategy. Thus, the exact magnitude of the calculated benefit streams is not as important as the relationship between the streams associated with different strategies.

E. PREFERRED STRATEGY RECOMMENDATIONS

The final component of the methodology is the "Preferred Strategy" recommendations. Ideally, the preferred strategy recommendations should grow out of the analysis of previous modules whereby desirable elements of different alternatives are combined into a single set of policy recommendations which can be adopted by government. At the very least, the Preferred Strategy recommendations should contain the following:

- Spatial priorities, population targets and investment costs across the settlement system.
- Sectoral priorities standards, service levels investment costs and cost recovery procedures, and

- Summary costs of the Preferred Strategy, performance characteristics, benefit costs analysis showing its desirable characteristics and permitting evaluation of the strategy as it is being implemented.

III. AGGREGATE DEMOGRAPHIC AND ECONOMIC MODULE

The Aggregate Demographic and Economic Module (ADEM) consists of two major subcomponents:

- An aggregate demographic module, and
- An aggregate economic module.

Figure 2 shows the major elements of the ADEM and the processes used to make estimates.

A. DEMOGRAPHIC

1. **Objectives:** To provide baseline projections of national, urban and rural populations and population distribution to provide an estimate of the population likely to need urban jobs, shelter and services. The module also provides baseline trend projections of settlement growth at existing growth rates to serve as a control for comparing other strategies developed by the methodology. See Figure 2.

2. **Rational:** The major assumption is that the primary determinant of urban migration is the search for employment. Therefore, the allocation of investment for job creation among various settlements is one of the most powerful tools governments have in implementing urban policy. To allocate investment for employment, policy makers must have an idea about the aggregate demand for urban employment and the ability of the economy to generate productive employment. They must also have an idea of the existing population distribution trends to determine where in the settlement system intervention is desirable and likely to be effective. Therefore, "trend" projections based on existing growth rates are needed to illustate current urbanization trends.

3. **Projection techniques:** The module as it is presently constituted relies on other national and urban demographic projections to determine future urban and rural populations. These existing projections of urban populations can be evaluated in the Aggregate Economic Module to determine if urban populations are likely to be greater than currently envisioned because of the potential for greater urban job creation.

   Projections of settlement populations at historic population growth rates are usually not available. Further, there is usually a need to project

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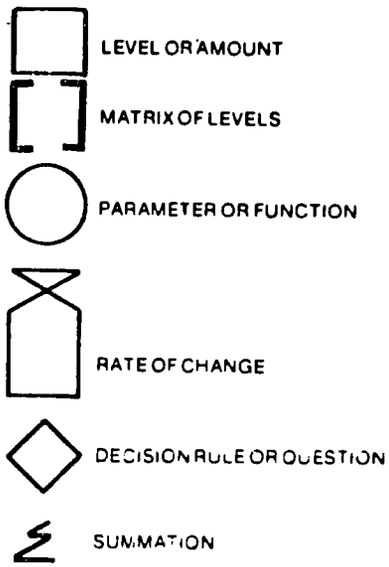


CODE TO ABBREVIATIONS

T = Time To = 0 is initial year, T = 1 is last year of first period

Subscript s = Sectors

Subscript i = Settlements

Subscript e = Total

MMC'S = Mining Manufacturing and Construction plus Services

ICOR = Incremental Capital Output Ratio

ILR = Investment Labor Ration

C = Average Investment Cost per Employee

A = Intercept of Average Cost Function

g = Employment Growth Rate

MC = Marginal Investment Cost per Employee

TC = Total Investment Cost for Job Creation

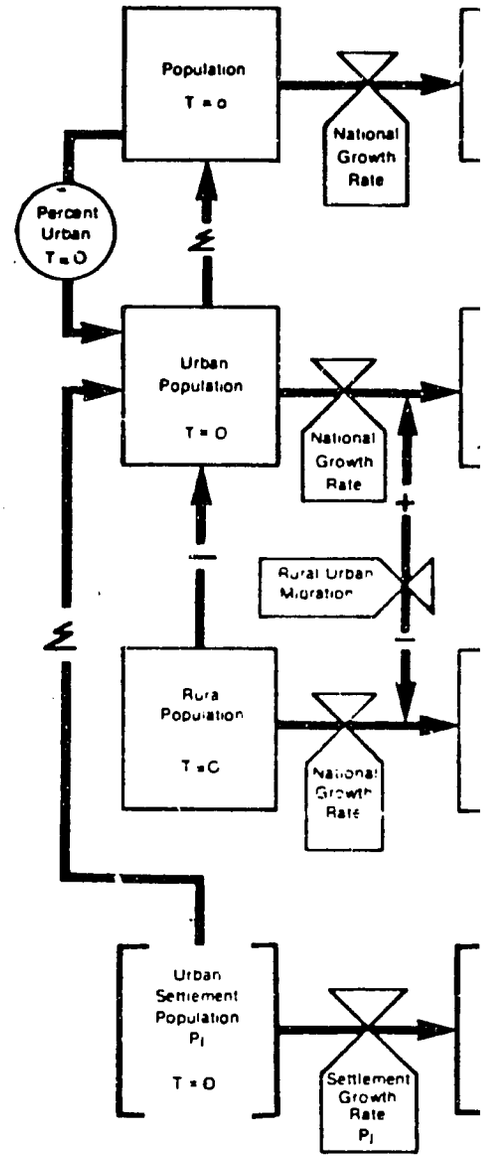
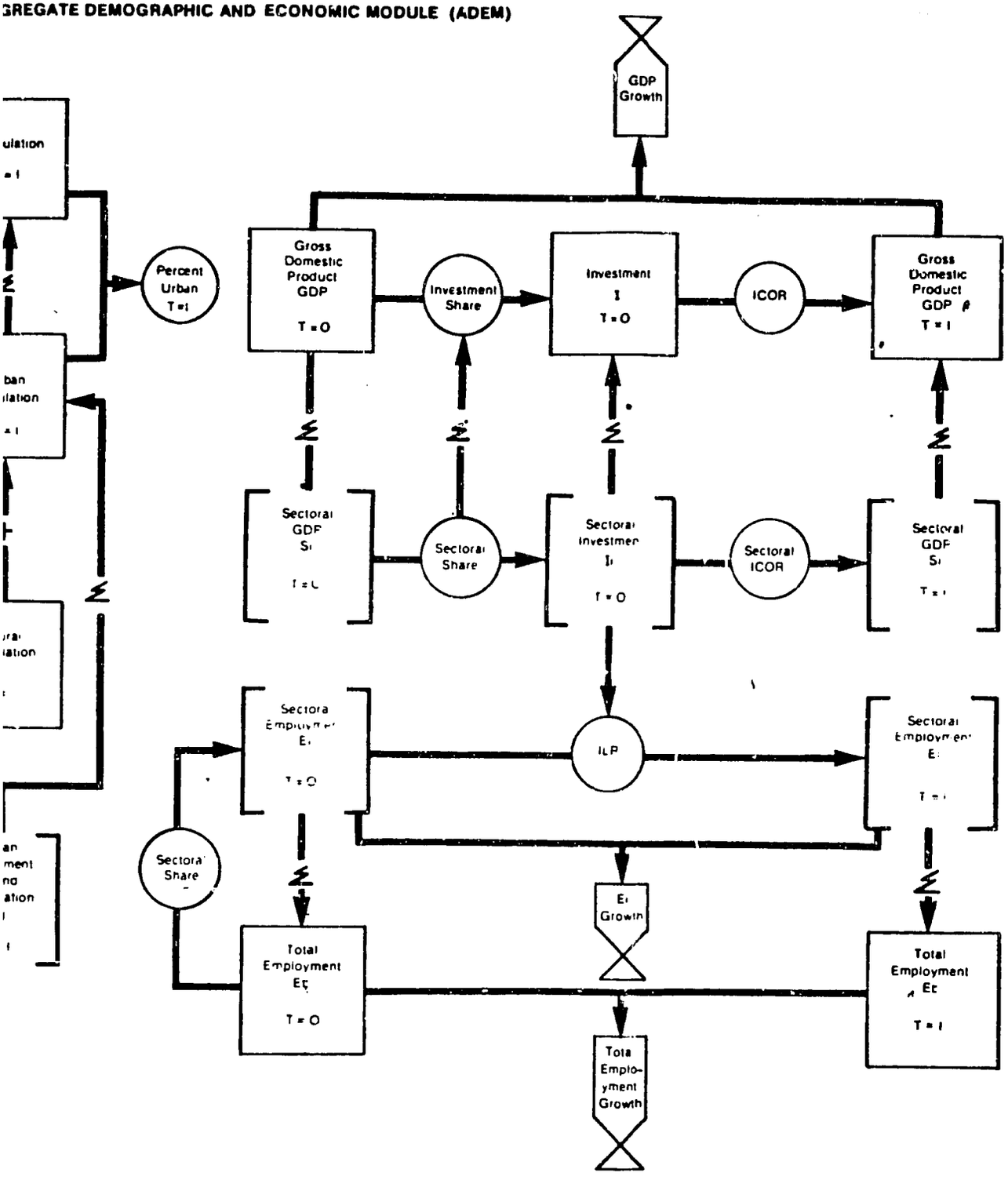


FIGURE 2

GREGATE DEMOGRAPHIC AND ECONOMIC MODULE (ADEM)



settlement populations to a common base year from which alternative settlement strategies can be projected since census data may not be recent. Therefore, the module uses historic growth rates to project future "trend" population growth by settlement and by region. A comparison of these settlement populations with the population of different settlements if they grew at rates of national increase will indicate likely migration trends.

Typically, employment data will also need to be projected to the same common base year as settlement populations. This can be done by assuming that employment has expanded at the same rate as population growth. If data at the settlement level exists about recent trends in employment growth, these trends can be used to project employment to a common base year from which projections are to be made. Unfortunately, this type of data is usually not available, so the procedure previously described must be followed.

4. **Data Inputs and Sources:**

- National population growth: the module uses national population projections as are available from other sources. Usually, national development plans, the World Bank or Ministry of Plan are good sources of national population growth. The following categories of data should be collected:

  -- Census data on national population

  -- Historic growth rates

  -- Urban-rural distribution of population

  -- Migration rates:

     i. rural to urban

     ii. urban to urban

     iii. international migration, historic trends and projections

  -- Demographic indicators

     i. Crude birth rate and projections of changes in birth rates

     ii. Crude death rates and projections of changes in death rates

- **Urban population and urbanization rate:** the module uses urban population forecasts developed by other sources for initial urban

population projections. The Aggregage Economic Component of the ADEM module is capable of producing independant urban population projections based on assumptions about the relationships between urban population growth and employment. See the description of the Aggregate Economic Component which follows. The following should be collected:

-- Census data showing settlement level population distribution

-- Historic growth trends and/or growth rates

-- Disaggregated settlement data (necessary only if intra-urban analysis is desired)

- **National Employment Demand:** National level demand for urban employment as represented by historic and projected labor force participation rates are needed by later components of the methodology to determine the success of different alternatives in generating urban employment to meet that demand.

  In some countries where adequate data is not available, active populations may be used in place of labor force participation rates, but this will result in a high demand for urban employment. If active populations are used as a proxy for labor force participation rates, their use should be noted and assumptions made about their relationship to the actual labor force. This is particularly true if a government has as a major development objective the creation of urban employment.

- **Urban Labor Force:** A distribution of employment by major sector for each settlement is needed to determine the relative agglomeration economies of one settlement over another. At a minimum, recent data on agricultural, industry (mining, manufacturing and construction) and service sector employment is needed. In collecting this data, sectoral definitions should be consistent with those used at the national level. See also Aggregate Economic component and Settlement Allocation and Costing Modules.

  In addition the following information is desirable, particularly if there are significant regional differences in employment.

  -- Active populations

  -- Labor force participation rates

  -- Formal and informal distribution of employment

5. **Major Outputs:**

- Projections by five year intervals of National Population Growth
- Projections by five year intervals of Urban and Rural populations
- Trend projections of settlement growth also by five year intervals
  - -- Natural increase by settlement
  - -- Migration as a component of settlement growth
  - -- Employment demand by settlement and by five year period

6. **Relationship to Other Components:** The Aggregate Demographic Module provides baseline data from which Aggregate Economic Component generates urban job costs and alternative settlement strategies are developed in the Settlement Allocation and Costing Module (SAEM). Baseline settlement populations are also used in the "Investment for Shelter and Infrastructure" component of the SAEM to determine requirements for rehabiliation of infrastructure. Finally, the trend projections of settlement population distribution are compared in the "Evaluation of Strategic Alternatives Module" to determine if national development objectives are being met by different settlement strategies developed by the methodology.

B. AGGREGATE ECONOMIC MODULE

1. **Objective:** To provide estimates of total urban resources likely to be available for investment in urban job creation and provision of urban shelter and services such as water supply, sanitation, etc. The module also provides estimates of supply of urban employment which will be generated by national economic growth.

2. **Rationale:** In most developing countries, development resources are limited in supply and are likely to remain scarce over the forseeable future. Therefore, at the national level, it is important to develop urban policies which efficiently utilize scarce development resources while still achieving other worthwhile national objectives. Equally important is the need to develop national investment policies which allocate resources among productive sectors to generate economic growth while still ensuring that sufficient resources are allocated to shelter and urban infrastructure to support productive investment and to improve overall standards of living.

   The Aggregate Economic module of the NUPS methodology was developed to provide order of magnitude estimates of future urban resources

available for urban development (job creation and provision of shelter and urban services).It is designed to illustrate the impact on those resources of following different investment strategies for allocating those resources sectorally or spatially.

The module operates using data which is readily available in most developing countries. Its basic utility is in providing rapid assessments of different national economic policies and their impact on the provision of urban employment and services. As such, the Aggregate Economic module is primarily concerned with changes in a country's Gross Domestic Product and not with external factors such as international commodity prices except as these may affect either national savings or foreign savings needed to finance domestic investment.

Throughout the methodology, the industry (mining, manufacturing and construction) and services sectors are referred to as the urban sectors of the economy. This is because these two sectors are the leading urban growth sectors, in that growth in these two sectors spurs demand for growth in other sectors such as transport or housing and infrastructure.

3. **Projection Procedure:** The Aggregate Economic Module is based on a Fixed Component System. That is, it is an investment-driven model in which it is assumed that both increases in output and employment are linked to investment spending made in the previous year. In this formulation, the economic growth rate is a function of the ratio of investment to GDP and the ability of investment (or in other terms, the productivity of that investment) to generate future output and employment. The measure of the ability of investment to generate future output is the incremental capital output ratio (ICOR). The actual formulas used in the Aggregate Economic Module are shown in Figure 3.

Typically, ICORs should be derived using net fixed investment. Using gross investment rather than net investment introduces a bias into the calculations, since gross investment frequently includes large components of investment in inventories which may not directly lead to output growth in the years being reviewed.

Unfortunately, in many national accounts, neither depreciation nor the fixed component of investment is known. Therefore, gross investment may have to be used as a proxy for net fixed investment.

FIGURE 3

EQUATIONS USED IN FIXED STRUCTURE COMPONENT OF AGGREGATE ECONOMIC MODULE

A. PRODUCTION BLOCK:

$$GDP_{a_t} = GDP_{a_{t-1}} + (I * b_{a_{t-1}} / ICOR_a)$$
$$GDP_{mmc_t} = GDP_{mmc_{t-1}} + (I * b_{mmc_{t-1}} / ICOR_{mmc})$$
$$GDP_{i_t} = GDP_{i_{t-1}} + (I * b_{i_{t-1}} / ICOR_i)$$

$$GDPT_t = GDP_{a_t} + GDP_{mmc_t} + \ldots + GDP_{i_t}$$

B. INVESTMENT BLOCK:

$$I_t = a * GDPT_t$$
$$I_{a_t} = b_a * I_t$$
$$I_{mmc_t} = b_{mmc} * I_t$$
$$I_{i_t} = b_i * I_t$$

C. EMPLOYMENT BLOCK:

$$EMP_{a_t} = EMP_{a_{t-1}} + (d_a * I_{a_{t-1}})$$
$$EMP_{mmc_t} = EMP_{mmc_{t-1}} + (d_{mmc} * I_{mmc_{t-1}})$$
$$EMP_{i_t} = EMP_{i_{t-1}} + (d_i * I_{i_{t-=1}})$$

$$EMPTOT_t = EMP_{a_t} + EMP_{mmc_t} + \ldots + EMP_{i_t}$$

Where:

GDP_{a_t} =Gross Domestic Product, Agriculture in year t
GDP_{mmc_t} =Gross Domestic Product, Mining, Manufacturing and construction in year t
GDP_{i_t} =Gross Domestic Product, Sector i in year t
$GDPT_t$ =Total Gross Domestic Product in year t

I_t =Total Gross Investment in year t
a =Total Gross Investment as a Share of Total Gross Domestic Product
I_{a_t} =Investment in Agriculture in year t
b_a =Share of Investment in Agriculture
I_{mmc_t} =Investment in Mining, Manufacturing and Construction in year t
b_{mmc} =Share of Investment in Mining, Manufacturing and Construction
I_{i_t} =Investment in Sector i in year t
bi =Share of Investment in Sector i

EMP_{a_t} =Employment in Agriculture in year t
d_a =Incremental Labor Ratio, Agriculture
EMP_{mmc_t} =Employment in Mining, Manufacturing and Construction in year t
d_{mmc} =Incremental Labor Ratio, Mining, Manufacturing and Construction in year t
EMP_{i_t} =Employment in Sector i in year t
d_i =Incremental Labor Ratio, Sector i
$EMPTOT_t$ =Total Employment in year t

The incremental capital output ratio measures the amount of investment required in year t to generate one unit of output in year t+1 (or in the next year). ICORs can be used to measure the productivity of investment for a country as a whole, or they can be disaggregated at a sectoral level to measure the impact on a country's domestic economy of following different sectoral investment policies.

Finally, since ICORs often display erratic shifts due to short-run cyclic economic effects, or they may reflect a single highly, capital intensive investment such as a railroad or major hydro-electric project, some effort should be made to identify underlying longer-term sectoral trends through use of time series data.[1] The ICORs which result from time series data can be compared with those resulting from a review of national development plan projections to determine changes in national development priorities. Usually, an increase in a sectoral ICOR represents a decrease in the growth of GDP due to a lowering in the productivity in investment. However such changes may also represent short term effects such as technological progress, changes in professional and managerial skills and one-time large scale investments.

The second parameter used in the Aggregate Economic Module is the ratio of investment to gross domestic product. This ratio can either reflect past investment policies or it can reflect future planning. In either case, the policy assumptions under which it was derived should be identified. Assumptions about investment rates should generally be based on review of past trends. Over the short-run it is unlikely that dramatic increases in investment rates are feasible unless of course assumptions are being made about large increases in foreign financing of investment. For example, a country which has had historic rates of investment averaging at about 15 percent of GDP is unlikely to generate investment resources of 30 percent of GDP in a five year period. Thus projections made under such assumptions are likely to be unrealistically optimistic.

The third set of parameters is the sectoral shares of investment. In many developing countries, the bulk of investment takes place through the public sector. Private sector investment is frequently small and often follows the sectoral and locational choices made by public sector policy makers. Thus public sector sectoral and spatial investment choices can have an important impact on national economic growth generally and on urban growth more specifically. However, as the economy grows and diversifies, private sector investment may become a much more significant component of total investment, particularly in industry and services sectors.

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[1]These short-term, high ICORs could conceivably used to demonstrate the impact of continued investment in capital intensive low productivity projects. However, care must be used in making such assumptions that the resulting ICORs actually represent a reduction in capital productivity and not an extension of the period over which returns on an investment are being realized. Some investments such as those in transport for example have a very long gestation period over which benefits are realized. Similarly, the conversion of industrial plant and equipment to processes using higher technologies could result in high ICORs during the period of conversion, but lower more efficient production later once the plant is operational.

Therefore, in making assumptions about the sectoral distribution of investment, it may be necessary to make assumptions about the distribution of public and private investment since its distribution may change as the economy develops.

The final set of parameters are Incremental Labor Ratios (ILR). These coefficients indicate the employment effect of investment spending, and like the ICORs previously described, show the impact on employment growth of previous years' investment decisions. An analytically equivalent and more commonly encountered statistic of employment creation is capital per worker, i.e., the amount of capital introduced into the production process by each worker. ILRs should be derived from historic trends if the effects of a continuation of past policies is desired. They can also be derived from national development plans if an assessment of the impact of those plans on future urban employment is desired. In such a case, the sources of the data should be clearly identified since the data may reflect trends representative of specific policies and not of the country's economy generally.

4. **Data Inputs:**

- Historic national account data showing sectoral distributions of gross domestic product preferably in constant prices. If a constant price series is not available, then GDP deflators must be used to show GDP growth trends in constant prices. In some countries, national account data may be imprecise; however, it is unlikely that other sources of data will be available. Therefore, in such a case, use of the data should be qualified by a commentary on its expected veracity.

  Normally national account data should be disaggregated into the following sectors:

  -- Primary sector or agriculture,
  -- Industry (mining, manufacturing and construction),
  -- Housing and infrastructure (if possible),
  -- Other major sectors (such as petroleum in oil producing countries),
  -- services (this may include informal sector activities, but should include most government services and other such activities).

- Historic data on gross investment, its sources (domestic or foreign savings), and its sectoral distribution. See also the Control and Feasibility Module for a further discussion of savings and consump tion data.

- Historic data on employment growth by sector. In reviewing employment trends, care should be taken to determine the extent to

which small-scale and/or informal employment is included in employment statistics. Frequently, statistics can only be found for large-scale formal sector employment. While these statistics can be used, an attempt should be made to illustrate the contribution of small-scale, informal employment to total employment. In determining employment trends, censuses may be a better source of data than national accounts since they may have measured total employment. However, if census sources are used, care should be taken to ensure that definitions of sectors measured by the census are consistent with those used by national accounts.

- National Development Plan policies, projections and priorities for investment. For many uses of the Aggregate Economic Module, national development plans may be used to test hypotheses and show the impact of following government policies. For example, national development plan data may be used to show the impact on employment policies of following a spatial policies consisting of rapid decentralization to remote areas of the countries at very high construction standards.

- Assumptions about technology, capital intensity of future investments and the capital productivity of future investments. Generally, these assumptions will be country specific and will be used to illustrate the impact of following specific policies.

5. **Major Outputs:**

- Sectoral growth of output and employment. Regarding growth of output, gross domestic product growth rates may be compared with population growth rates to determine whether given investment policies will increase per capita income. In order for per capita income or per capita GDP to increase, its growth rate in real terms must be more rapid than that of the population growth rate. Similarly, if urban employment growth rates are slower than urban population growth rates, increased unemployment or informal sector employment is likely to result. Increased informal sector activity may in itself not be a negative trend, but it may represent a failure in public policies to achieve employment growth.

  The Aggregate Economic Module estimates the impacts on employment of future urbanization in two ways. The first is a comparison of total future supply of urban jobs with the likely demand for employment as represented by growth in the urban labor force. The second measure shows the increased urban population which must be supported by each new urban job. An increase in this statistic indicates either an increase in unemployment and/or the need for increased reliance on informal sector activities for new urban

employment. Determination of these employment impacts is dependant entirely on the way data was entered into the module, as the projection procedures in themselves do not discrimate among sizes of firms or the degree of their formality.

- Sectoral investment resources: The cumulative sectoral investment for industry (mining, manufacturing and construction), and urban shelter, infrastructure and services represent what is called in other parts of the methodology the "urban resource pool". These resources represent the investment which will be available for the provision of new urban employment, shelter, infrastructure and services. If the total sum of requirements for investment in these sectors exceeds the total urban resource pool, the likely result is either reduced national economic growth or the requirement to shift investment from other sectors such as agriculture, or both. If the sum of urban requirements is less than the resource pool, larger urban equity programs can be undertaken, or investment resources can be shifted to other sectors.

- Sectoral investment requirements per worker: These per worker investment requirements give an indication of the relative capital intensity of different sectoral strategies.

- Gross investment and domestic savings: Virtually no third world country has financed all of its investment requirements through domestic savings (i.e., the difference between total GDP and public and private consumption). Furthermore, official donor financing of investment has become an increasingly important component of LDC financing of investment. Therefore, a review of the foreign financing requirements of a strategy may spell its relative success or failure in being implemented.

  Through review of historic rates of private and public consumption (the latter including subsidies), estimates of future foreign savings requirements can be made. Foreign savings requirements in this case being the difference between gross investment requirements and domestic savings. Generally, foreign savings consists of the difference between exports and imports, official capital transfers, remittance income and other sources of foreign capital.

  These estimates of foreign savings represent an assessment of the feasibility of different development policies. Policies requiring large increases of foreign financing may not be successful due to unrealistic requirements for donor assistance or foreign private sector financing. See also the Control/ Feasibility/Risk Module for a further discussion of financing of urban investment programs.

6. **Relationships to other Modules:** Some of the relationships to other modules has already been alluded to: for example, the discussion of urban resource pools or employment. The Aggregate Economic module provides the baseline projections of urban resources and employment which are used by the Settlement Allocation and Costing Module to distributing employment and thus population among the settlement system. It also provides estimates of the likely resources for infrastructure and shelter programs. Finally, comparison of the costs of following different population distribution strategies and their requirements for shelter and urban infrastructure are compared with likely urban resources generated by the Aggregate Economic module to determine if those policies can be supported by the economy and if they are supportive of other national development objectives.

7. **Limitations:** The Aggregate Economic Module provides order-of-magnitude estimates of sectoral growth of output. Its general design is to show these projections over 15 year periods, even though it does so through making annual projections. Thus its utility is in providing medium to long term analysis of development policies rather than evaluation of short-term effects such as changes in weather or cyclic changes in interest rate structure.

   The effect of exogenous factors such as changes in international petroleum prices or commodity prices on the domestic economy of a country can be accounted for in the Aggregate Economic module through modifying assumptions about investment ratios. An increase in petroleum prices could result in reduced investment rates if the productivity of capital does not increase (as measured by a reduction in sectoral ICORs) and/or foreign assistance capital remains either constant or reduces. However, the module was not primarily designed for these purposes.

   The lack of data about the employment effects of investment decisions in many developing countries makes projecting employment with any degree of accuracy difficult. Where statistics exist, they frequently cover only formal sector activities. Further, this formal sector employment growth may have been the result of employment creation policies which have been based on low productivity per worker rather than expanding employment through increasing productivity. (Such policies should be evident through comparison of ICORs over a period of time as sectoral ICORs should increase where such policies are being followed.) These problems may adversely affect employment projections.

IV. SETTLEMENT ALLOCATION AND COSTING MODULE (SACM)

The Settlement Allocation and Costing Module consists of two inter-related subcomponents: 1) The Investment for Employment Component and 2) the Investment for Shelter and Urban Infrastructure Component.

The first subcomponent allocates urban employment as projected by the Aggregate Economic Module among the country's various settlements. The second subcomponent uses the population targets which result from that allocation procedure to estimate requirments for shelter and urban infrastructure investment. See Figure 4

A. INVESTMENT FOR EMPLOYMENT

1. **Objective:** To provide a quantitative methodology for allocating urban investment and thus employment and resulting population growth throughout the settlement system. In addition, the component provides a consistent methodology for establishing population targets for individual settlements from which shelter and infrastructure requirements can be determined.

2. **Rational:** The Settlement Allocation/Costing Module converts settlement possibilities into more sharply defined settlement alternatives by estimating the order-of-magnitude costs assosciated with different distributions of population among urban settlements. Two key principles underlie the estimates of population targets:

   - The distribution of population in the settlement system is not a random occurrence, even though it is the outcome of a large set of separate decisions of individuals, families and organizations in the society.

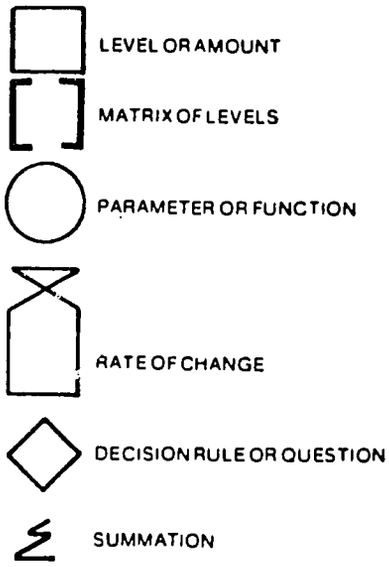
   - Rather, the distribution of population (and hence any major population redistribution) is largely the result of the concentration of economic activity in various urban areas.

   Thus the first step in determining how the total urban population might be distributed across settlements, is to trace the possibilities and costs of generating viable economic activities in different places. This is the major function of the "Investment for Employment" segment of the module.

   Target populations by settlement are established through the following sequence:

   - Allocation of investment in plant and equipment;

Legend for Symbols



CODE TO ABBREVIATIONS

T = Time To = O is initial year T = 1 is last year of first period

Subscript i = Sectors

Subscript j = Settlements

Subscript g = Total

MMC S = Mining Manufacturing and Construction plus Services

ICOR = Incremental Capital Output Ratio

ILR = Investment Labor Ration

C = Average Investment Cost per Employee

A = Intercept of Average Cost Function

g = Employment Growth Rate

MC = Marginal Investment Cost per Employee

TC = Total Investment Cost for Job Creation

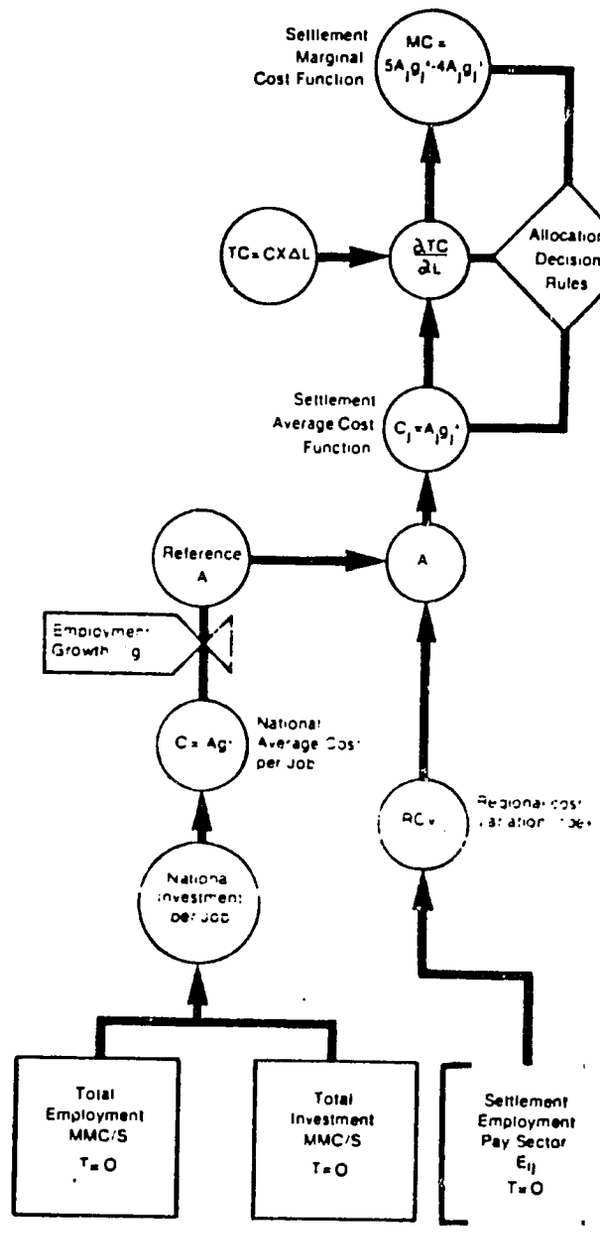
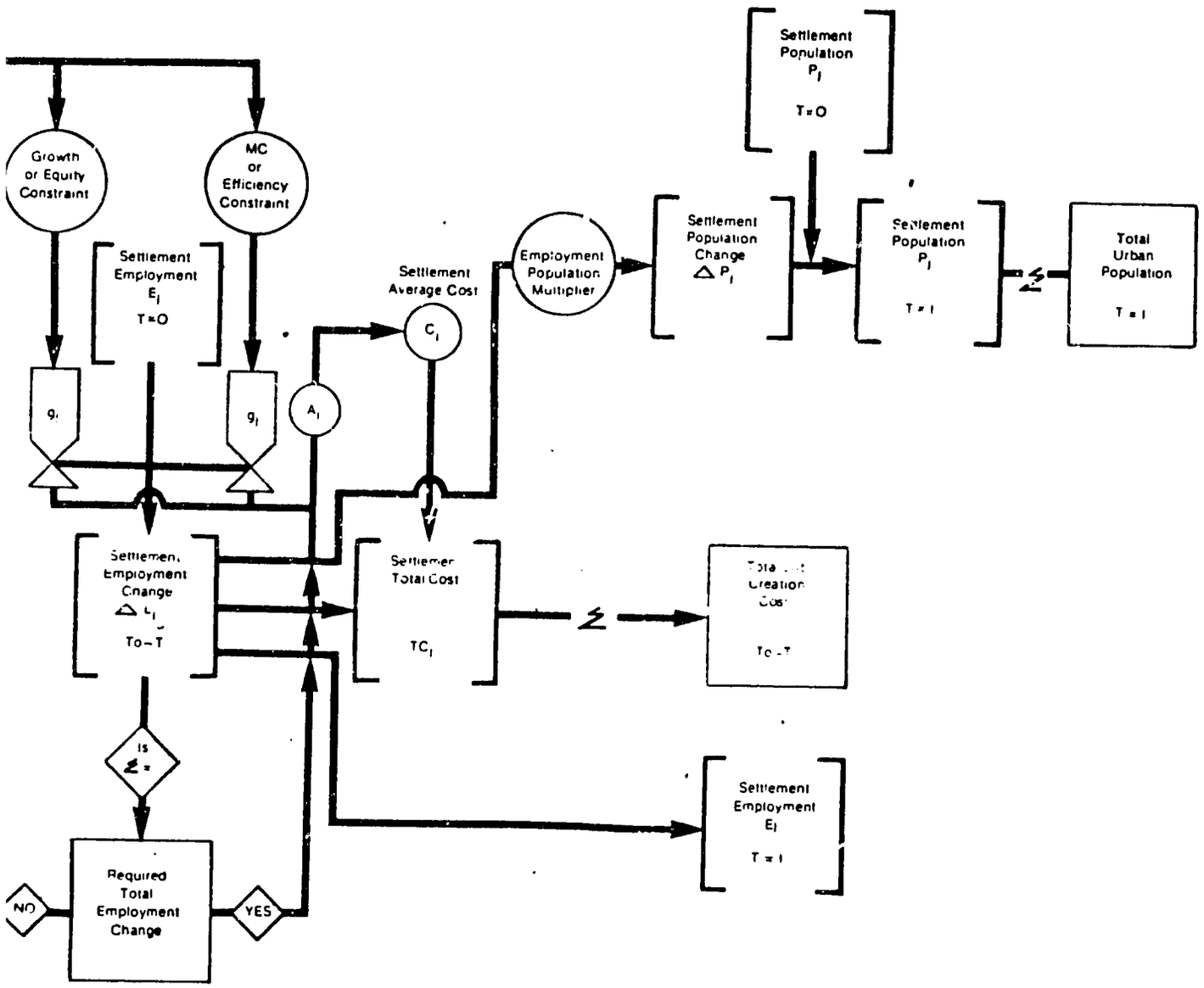


FIGURE 3

PROCEDURE FOR ALLOCATING INVESTMENT FOR JOB CREATION



- Estimation of employment generated by this investment; and
- Estimation of additional population that is associated with the additional employment.

The Investment for Employment component operates on the basic assumption that employment location is a major determinant of population migration. Thus the location of new employment throughout the settlement system becomes an important policy tool for effecting changes in the structure of the settlement system.

The second major assumption used in the component is that industry (defined as mining, manufacturing and construction industries) and services are the leading sectors in urban employment growth. That is, changes in employment in these two sectors results in demand for employment growth in other non-agricultural sectors.

3. **Projection Procedure:** Much has been written about the causes of regional investment cost variations; however, we are unaware of any previous attempt to specify the effects of regional cost differences on investment requirements for urban job creation in a quantitative macroeconomic planning framework. Thus this component of the methodology may be the most original contribution of the methodology to urban analysis.

   Following from the first two assumptions is the assumption that the major measure of agglomeration economies -- or the attraction which a settlement has for future urban investment and thus employment growth --is its relationship of its share of industrial to total employment and the primate city's ratio. That is, the settlement with the highest ratio of industrial employment to total employment is likely to have the greatest attraction for future employment due to agglomeration economies created by past investment. In many, although not all settlement systems, a concentration of investment in the capital city has lead to its primacy, and thus to a situation where employment creation away from the primate city is more costly than in it.

This is expressed by equation below:

Equa.1 $RCVI_i = .5*[1-((EMPMMC_i/TOTEMP_i)/(EMPMMC_p/TOTEMP_p))]$

where:

$RCVI_i$ =Regional Cost Variation Index for City i.

$EMPMMC_i$ =Employment in Mining, Manufacturing and Construction in City i.

$TOTEMP_i$ =Total Employment in City i (i.e., employment in industry and services).

$EMPMMC_p$ =Employment in Mining, Manufacturing and Construction in the Primate City

$TOTEMP_p$ =Total Employment in the Primate City p.

This formulation measures the percentage deviation of a city's average cost per job from the national average cost per job (national average costs per job are shown in Equa. 2). For most developing countries, investment in industry has been concentrated in the primate city. Thus the average costs of new job in the primate city approximate that of the nation as a whole. Thus, its regional cost index by definition is unity according to Equation 1.

The formula used to calculate national average costs per urban job is shown below:

Equa.2 $NA_t = (I_{mmc_t} + I_{s_t}) / ((EMP_{mmc_t} - EMP_{mmc_{t-1}}) + (EMP_{s_t} - EMP_{s_{t-1}}))]$

where:

NA_t =National Urban Average Cost per Job in period t

I_{mmc_t} =Total Investment in Mining, Manufacturing and Construction in period t.

I_{s_t} =Total Investment in Services during period t

EMP_{mmc_t} =Total Employment in Mining, Manufacturing and Construction in Period t.

EMP_{s_t} =Total Employment in Services in Period t.

The next major element in variation in average job costs other than regional cost variations is the growth management cost. These costs represent the additional management costs of growth. For example a settlement whose employment is growing at a very rapid rate is likely to incur higher growth management costs than a slower growing settlement since the settlement with more rapidly growing employment must add management systems and provide for the disamenties (i.e., in part the congestion and pollution) which are associated with growth in larger increments than settlements growing more slowly. The more slowly growing settlement can rely on existing systems to a larger extent than a more rapidly growing settlement.

Again, in developing the NUPS methodology, we have not found a quantitative proceedure for estimating growth management costs (i.e., the additional costs incurred by growth due to the need to add increasing increments supporting investments and to account for the negative effects of growth such as congestion and pollution). Therefore in accounting for the costs of rapid growth, we have assumed that there is a positive expontential relationship between job creation costs and settlement employment growth rates. That is, as a settlement's employment grows at more rapid rates, its costs of adding new jobs increases at an exponential rate.

Graphically, this is illustrated by Figure 5 which shows average cost curves for two cities. As their employment growth rates increase along the cost curves, their costs of adding new jobs (growth manage ment costs) increases as is represented by changes in the slopes of their cost curves. This assumption translates in the following formula for city-specific average costs per job:

Equa.3 $AC_i = A_i g^4$

where:

AC_i =Average Cost per New Job in $City_i$

g =City annual employment growth factor (expressed as 1.03 for a 3 percent growth rate)

A_i $= \left[\frac{(NA_t * (1 + RCVI_s))}{(NA_g)} \right]^4$

NA_g =National Average Annual Employment Growth Factor (expressed as 1.05 for a 5 percent growth rate)

Once city specific average costs of adding new jobs are calculated, total costs or investment requirements for a strategy are shown below:

Equa.4 $TC_{i_t} = AC_i * dL_t$

where:

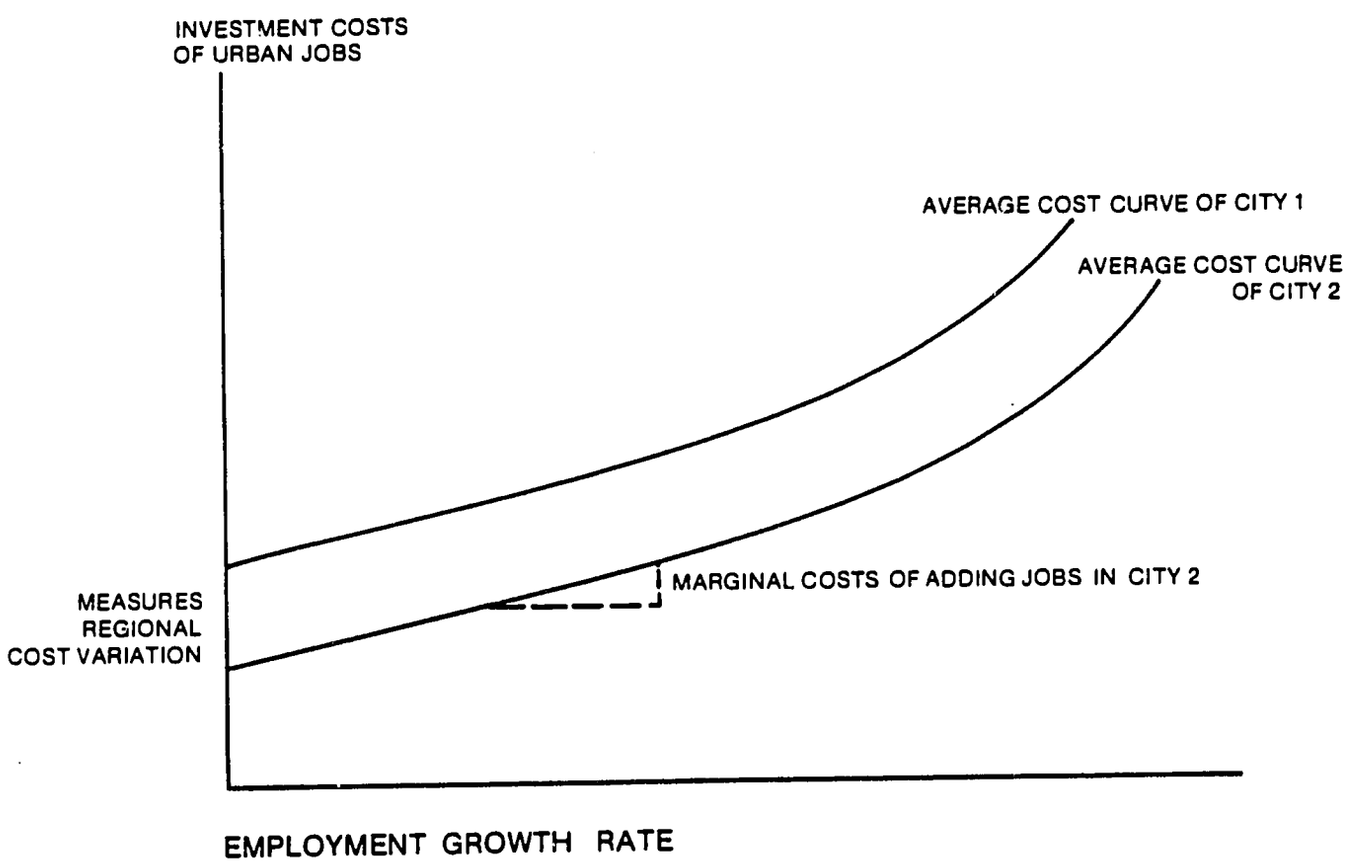
TC_{i_t} =Total Costs for job creation in $City_i$ in period t.

dL_t =Change in employment in $City_i$ during period t.

Using these formulas permits estimations of the total investment costs for new urban employment if current population trends persist or if specific growth targets are already set for each settlement in a settlement system. All one does is insert the appropriate employment growth rates and regional cost indicies and multiply the resulting city specific average costs per new job times the new employment (actually the change in employment over the period). The result, when this is done for each settlement and total costs of each settlement investment requirements is summed, is the total investment requirements for that period of that particular strategy.

FIGURE 5

AVERAGE COST CURVES
(EQUATION 3)



SOURCE: PADCO NUPS METHODOLOGY

If the total costs exceed the total resources (normally the cumulative five year investment available for industry and services, although this may vary according to the way in which data was entered into the Aggregate Economic Module) available for new urban employment (calculated by the Aggregate Economic Module already decribed), one of three actions must be taken:

- More resources must be devoted to urban employment by subtracting resources from other non-urban sectors,
- Greater external resources must be found to increase investment ratios (frequently not possible), or
- A more efficient, lower cost solution to allocation of future urban employment throughout the settlement system must be found.

Implicity, or explicitly the first action noted above is frequently followed, usually at the expense of subtracting resources from primary sector activities. The result has often been reduced primary sector productivity without compensating increases in urban output. For most countries, external resources although they constitute a large share of investment, are fixed. Globally, Official Development Assistance has been declining in real terms. Some countries have been successful in reducing consumption and thus increasing domestic savings, but this too is limited in scope. Ultimately, the need arises to find a more efficient mechanism for allocation of scare employment investment resources.

This has lead us to develop what is called the "least cost" solution for allocation of new employment. In a particular period, the least cost solution is obtained when the marginal costs of creating a new job are equal in all areas receiving an investment allocation.

Marginal costs are defined as the additional cost incurred by adding a new job. Whereas average costs as previously shown are expotentially derived from a relationship between a settlement's employment growth rate and regional factors, marginal costs become the difference in total investment costs of adding or subtracting a unit of employment and is expressed by a polonomial shown below:

The marginal cost curve for an individual settlement is shown in Equation 5.:

Equa.5 $MC_i = 5Ag^4 - 4Ag^3$

where:

MC_i = The Marginal Cost for adding a new job in $City_i$

A = The Intercept of the city specific cost curve

g = The growth factor of $City_i$

The Marginal Cost curve for an individual settlement in the least cost solution is derived for its average cost curve as follows:

$$AC_i = Ag^4$$

where $g = \left(\frac{1 + dL}{L}\right)$

$$TC = dL * Ag^4$$

$$= \frac{\{TC}{\{L}$$

$$= dL * 4Ag^3 * \frac{1}{L} + Ag^4$$

$$= (g-1) * 4Ag^3 - 4Ag^3 + Ag^4$$

$$= 4Ag^4 - 4Ag^3 + Ag^4$$

$$= 5Ag^4 - 4Ag^3$$

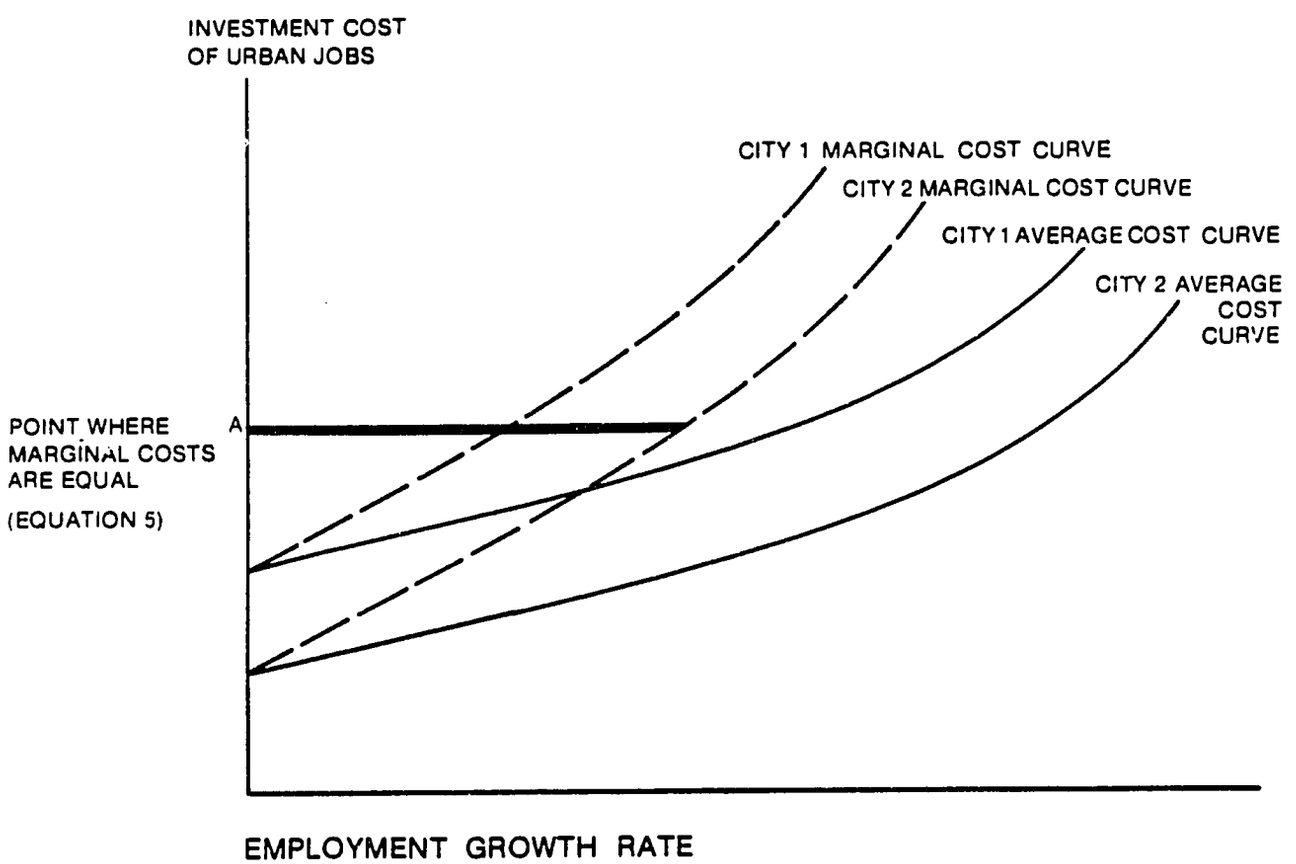
A graphic representation of these relationships is shown in Figure 6.

The procedure for the least cost solution is to find a set of city employment growth rates that simulaneously equalize all the marginal costs of the individual settlement cost curves.

The first step in solving the "least cost" procedure is to determine the target level of employment growth for the entire settlement system during

FIGURE 6

MARGINAL COSTS OF LEAST COST SOLUTION



SOURCE: PADCO NUPS METHODOLOGY

the first period. This was calculated during the macroeconomic projections. If desired, this target employment can be input exogenously.

The second step in the procedure is to calculate the regional cost variation indexes for each settlement using Equation 1. The next step is to guess at a Marginal Cost which will solve the set of equations represented by the individual settlement cost curves and solve each settlement cost curve to determine its employment growth rate. This procedure requires solving a fourth power polinomial approximation procedure.

Once all the settlement employment growth rates are solved the total new employment in each settlement can be calculated by determining the change in employment which would occur at those growth rates. If the sum of the employment created equals the target level employment determined in the macroeconomic projections, since the Marginal Cost for adding new jobs is equal throughout the settlement system, the "least cost" solution is found. If the target is not reached, the procedure described above must reiterated with a new trial Marginal Cost until a solution is reached.

After determining the employment growth rates for each settlement which equalize marginal costs, these growth rates can be used to determine settlement average costs (equation 2). From the average cost curves, the total costs of adding new employment in the settlement system can be found by summing the individual settlement total costs. Graphically, this entire procedure is shown in Figures 7 and 8.

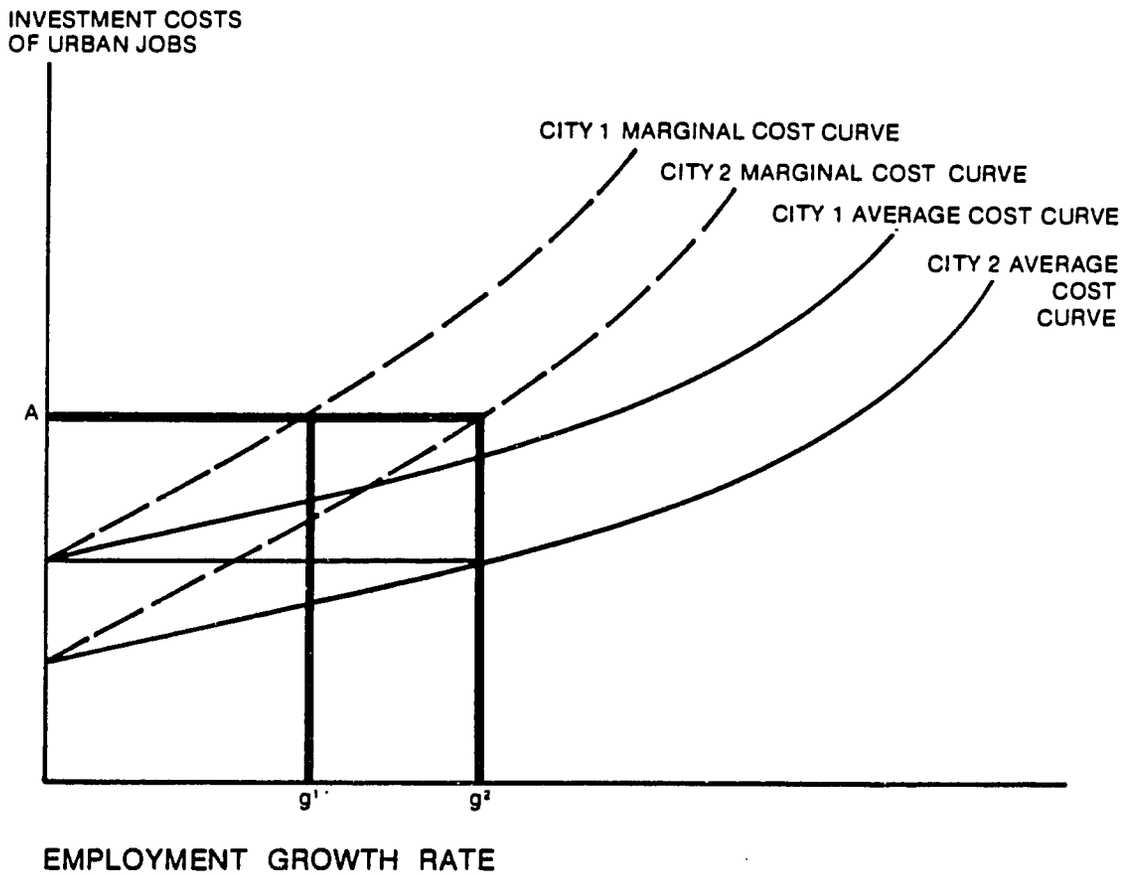
Once a solution for allocation of employment has been derived, settlement populations can be determined by multiplying the change in employment for each settlement times population multipliers. These multipliers were determined during the macroeconomic projections. They represent the number of new urban dwellers supported by each new urban job.

Frequently, the least cost solution will not represent the most desirable solution for a particular settlement system since it may allocate the most growth in primate centers which have the strongest agglomeration economies. Therefore, once the least cost solution has been determined, it is useful to establish policy constraints on settlement growth rates to target more or less growth in particular settlements or regions. This can be done by setting employment growth rates in certain settlements at predetermined levels, and calculating the settlements' resulting average cost curve and new employment.

Then the least cost procedure can be used to allocate the remaining employment. Total costs of the new strategy may then be summed and compared with those of the least cost solution. If the costs of the new

FIGURE 7

DETERMINATION OF CITY EMPLOYMENT GROWTH RATES IN LEAST COST SOLUTION

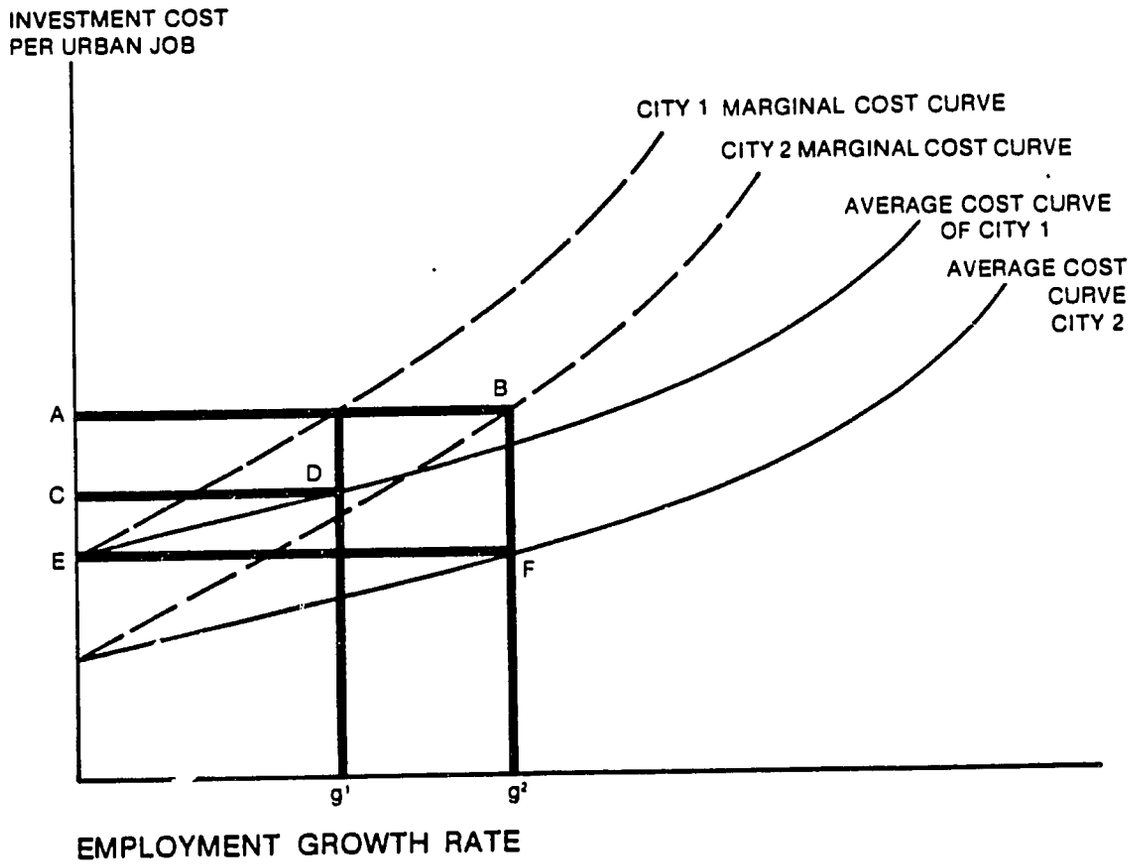


g^1 and g^2 are city B and city A employment growth rates at marginal cost A

SOURCE: PADCO NUPS METHODOLOGY

FIGURE 8

DETERMINATION OF AVERAGE COSTS IN LEAST COST SOLUTION



At employment growth rate g^1 the average cost per job of city 1 is shown by line CD.
At employment growth rate g^2 the average cost per job of city 2 is shown by line EF.

SOURCE: PADCO NUPS METHODOLOGY

solution do not exceed total likely resources the solution can be implemented. If the costs exceed likely resources, policymakers are faced with the choice of either changing the solution, or allocating more resources to urban sectors.

3. **Data Inputs:** The major data inputs for the settlement allocation procedure have already been described in the section on the Aggregate Demographic and Economic Modules. Briefly the major inputs are:

   - Settlement populations projected to the base year of the projections.

   - Total settlement employment in all urban sectors. Frequently, a determination has to be made whether or not to include agricultural employment in settlement employment statistics. Generally, it should be excluded since in most settlement systems, as they develop, agricultural employment becomes increasingly less significant as a source of employment.

   - Settlement employment in industry (mining, manufacturing and construction). As noted, these data are used for calculation of regional cost variation indexes. These employment statistics should be projected to the same base year as settlement population projections.

   - The Urban Investment Resource Pool or investment in industry and services (from Macroeconomic Module).

   - Target urban employment to be allocated during period (from Macroeconomic Module).

   - National Average growth rate of urban employment (from Macroeconomic Module).

   - Policy constraints on individual settlements growth rates as desired.

   Although the Settlement Allocation Module was designed to function with data supplied to it by the Aggregate Economic Module, this data can also be supplied exogenously.

4. **Major Outputs:** Briefly the major outputs of the Settlement Allocation Module are:

   - Settlement employment and population growth rates for a particular settlement strategy,

   - Average costs and total costs of adding new employment by settlement and for the entire settlement system,

- Least cost solution for allocation of new employment throughout the settlement system,

- Evaluation of the costs of following alternative settlement strategies,

  -- Specified settlement growth constraints,
  -- Other allocation decision rules such as providing new employment on an equity basis throughout the settlement system.

- An evaluation of the relative economic strengths of different settlements in the settlement system. During calculation of the "least cost" solution, those settlements with the most economic potential will have the highest growth rates as their growth management costs will be the least.

5. **Relationship to other Modules:** The Settlement Allocation Module utilizes data from both the Aggregate Demographic and Economic Modules. Its results can be compared with sectoral investments projected by the Economic Module to determine if an adequate amount of urban investment is being allocated to implement national policies.

   It may be desirable to follow urban policies which result in higher investment requirements than are available from the urban investment resource pool. Then it may be justifiable to shift resources from other sectors to urban sectors. This, however, is a political decision. The NUPS methodology only indicates the impacts of such decisions. It does not constrain a policy maker from taking such a decision.

   Typically, however since relatively little flexibility exists in sectoral investment allocation, comparison of total costs of employment allocation with investment allocations or the urban investment resource pool should result in modifications in settlement allocations rather than modifications in national investment policies.

   Once settlement populations have been calculated, these form the targets for determining new shelter and infrastructure requirements in the Shelter and Infrastructure Module. Target populations also provide baseline data for determining rehabilitation requirements for existing infrastructure and shelter.

   Finally, the direct investment costs calculated by the module along with the costs for supporting infrastructure provide the basis for determining the relative feasibility of following a particular settlement strategy. For example, if a strategy results in costs which exceed total resource constraints there is a risk that sufficient investment resources cannot be generated to complete implementation of an investment strategy once it is initiated. This risk factor is more fully explored in the Control/Feasibility/Risk Module discussion.

6. **Limitations:** As with the other modules of the methodology, the Settlement Allocation Module is intended to give an overall view of employment allocation costs. At the level of detail specified in the regional cost variation index, some errors in specific subsectoral allocation of employment could occur. For example, it is conceivable that a settlement could have a particular industry which would have strong linkages to very specific industries; this settlement might be the logical location for additional increments of that industry, but would not have the agglomeration of economies which would prove attractive to new investment in other sectors.

   If subsectoral detail on industrial employment exists (generally it does not at a settlement level), it can be built into the regional cost variation indexes by weighting most heavily those subsectors which have the greatest potential for providing productive employment. If the data do not exist, the problem can be resolved through either allocating specific industries to those locations or placing policy constraints on the employment growth of those settlements so that sufficient investment is allocated to them.

   A second frequent problem encountered with allocation of employment is determining the role which informal sector activities are to play in the procedure. Data on the informal sector is usually nonexistent or fragmentary. Part of the solution is to determine the degree to which the informal sector is linked to formal sector activities. For example, studies of the informal sector in Senegal have shown that informal activities are linked to formal manufacturing and warehousing industries both in terms of markets and sources of inputs.[2] Thus, indirectly the informal sector would benefit from investment strategies which emphasize industries associated with its sources of inputs or which could utilize its output. Procedurally, informal sector activities can be included in the Settlement Allocation Costing Module if their employment is measured by censuses on a sectoral level. However, care must be taken in using these data to assure that the definitions used correspond with those used by national account data input into the Aggregate Economic Module.

B. INVESTMENT FOR SHELTER/INFRASTRUCTURE COMPONENT

1. **Objective:** to estimate investment for shelter and intra-urban infrastructure required to support population targets established in the

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[2]Koichi Mera. "City Size Distribution and Income Distribution in Space," Journal of Regional Science. 1981. pp. 105-120. See also: Koichi Mera. "On the Urban Agglomeration and Economic Efficiency," Economic Development and Cultural Change. 1973 Vol.21

"Investment for Employment" component just described. This component also estimates investment needed for rehabilitation of existing shelter and infrasturcture as well as making up pre-existing deficits in shelter and urban infrastructure.

2. **Rationale:** The provision of investment for new shelter and urban infrastructure can have a pervasive influence in supporting spatial policies. The high levels of public services can serve as the incentive to attract businesses and people to locate or remain in particular locations, that is if such investment policies are coordinated with other spatial and sectoral policies. However, if housing and infrastructure policies are to be instruments for changing the population distribution rather than simply meeting service demands or basic needs where ever they exist, the standards, service levels and cost recovery procedures which make up such policies must be targetted so that they encourage growth in some areas and discourage it in other.

   A key feature of the allocation process of the "Investment for Shelter/Infrastructure Component" is the targetting of shelter and infrastructure investment so that it supports spatial objectives of national urban policies. This is done by establishing "Standards Packages" designed to provide different service levels of shelter and infrastructure for different types of settlements. A "Standards Package" is a grouping of shelter and infrastructure standards and costs expressed in per capita costs which is designed to meet the needs of different types of settlements. For example, a "Standards Package" with relatively high standards of shelter and water supply might be developed for a settlement which is designated to an industrial growth center, whereas, another package with lower standards aimed at meeting unmet needs might be created for a city with low growth potential.

   The cost of future shelter and infrastructure is highly sensitive to the standards of service provision and the degree to which initial development costs are recovered from those who receive the service and reinvested as part of the total urban resource pool. High levels of standards provided throughout the settlement system can result in investment requirements which exceed urban investment resources. Conversely, the provision of uniformly low standards may not provide the development attraction necessary to encourage growth in desirable locations. Finally, the lack of reinvestment of development costs reduces the potential urban resource pool available for supporting future populations.

   The relative ease of horizontal expansion (given physical constraints or the opportunity costs associated with changing prevailing land use on the periphery of urban areas) has an important influence on gross densities and development costs. If vacant urban areas already supplied with infrastructure can be infilled development costs are likely to be lower

than completely new development since past investments can be more intensively used.

3. **Projection Procedure:** The "Investment for Shelter/Infrastructure" component consists of four major subcomponents:

- Analysis of Settlement Absorption Capacity,
- Analysis of requirements for new shelter and urban infrastructure investment, and
- Analysis of requirements for rehabilitation of existing shelter and infrastructure, and
- Assessment of regional construction cost variations.

The following is a more detailed discussion of the major parts of the component.

a. **Settlement Absorption Capacity:** The capacity of settlements to absorb additional population within their boundaries is their ability to infill presently vacant land or to expand vertically by adding floors to existing structures or to replace low density buildings with new, higher stored buildings. In many settlements, the process of infilling and vertical expansion occurs simultaneously.

   Precise measurement of absorption capacity is difficult without recent aerial photos and detailed knowledge about the age and condition of existing structures. Apart from detailed settlement-level studies of absorption capacity, a good indication of absorption capacity throughout the settlement system can be obtained by comparing census populations with settlement boundaries. This gives a cross section of gross densities across the settlement system. Those settlements with lower gross densities have more potential for infill than those with higher densities since it is likely that this infill can occur on vacant land rather than through vertical expansion.

   This relative measurement of settlement gross densities provides a cross sectional review of existing living standards. Settlements with very high gross densities probably represent the highest gross densities which are acceptable to the urban population, while those with very low gross densities could probably infill to a density standard somewhere in between the two to achieve greater land use efficiency.

b. **Shelter and Intra-Urban Infrastructure:** Typically a series of city specific shelter and infrastructure proposals evolves from subsectoral

assessments of service demands. Each of these can include different standards and service levels. Since a large number of standards and resulting costs can evolve, the NUPS Methodology developed the concept that shelter and urban infrastructure investment should be allocated according the spatial priorities being assigned to settlements in a particular strategy. These bundles of shelter and urban infrastructure standards as previously noted, are called "Standards Packages".

Examples of "Standards Packages" developed for the Egyptian urban policy study are shown in Figures 9 and 10.

When developing intra-urban infrastructure costs, care must be taken to distinguish between capital costs and recurrent costs. For these estimates of new infrastructure requirements, only capital costs are desired since these correspond to gross fixed investment previously determined in the Aggregated Economic Module. Recurrent costs, usually comprising routine maintenance, salaries, operations, and depreciation if it is calculated, normally comprise components of public consumption, and thus by definition are not parts of investment.

We have developed two methods of estimating intra-urban infrastructure costs depending on the data available. The more precise method is based on determining the functional relationships among: 1) the size of the population served by infrastructure, 2) standards, 3) gross densities of service areas, and 4) resulting per capita costs. This method requires large amounts of data usually obtainable from infrastructure projects either near to implementation or recently implemented. An indication of functional relationships which resulted from Egyptian data are shown in Figures 11 and 12 for water supply and sanitation. As these figures show, there is a fairly wide variation in per capita costs of infrastructure resulting from changes in consumption standards and gross densities.

The second method is less data intensive and is suitable for more rapid assessments of shelter and urban infrastructure requirements. It relies on average per capita costs of recent infrastructure projects at various standards. These projections can only be used as indicative of the order-of-magnitude investment requirements for new infrastructure.

In either case, only the costs and standards of serving new population groups should be projected. The costs of rehabilitating existing systems should be used in the calculations of investment requirements needed for strengthening service levels for existing populations.

FIGURE 9

INTRA-URBAN INFRASTRUCTURE INDICATIVE SPATIAL TARGET GROUP STANDARDS AND CAPITAL COST PACKAGES: MAJOR METROPOLITAN AREAS -- ALEXANDRIA

I.

GROSS DENSITIES 187	PERSON/HECTARES	POPULATION	EXISTING (1985)	3,042,000
			INCREASE (1986-1990)	678,000

II.

LAND REQUIREMENTS	PHYSICAL STANDARDS		PER CAPITA COSTS OF NEW DEVELOPMENT AND CAPITAL REHABILITATION OF EXISTING INFRASTRUCTURE OF SETTLEMENT 1/
PRIVATE	65%		
--RESIDENTIAL	(45%)		
--NON RESIDENTIAL	(20%)		
PUBLIC	35%		
TOTAL	100%		

III.

HOUSING			
AVERAGE AREA/UNIT 36 M2	AVERAGE UNIT COST: L.E. 2,006	INDICATIVE PER CAPITA COST 2/ L.E. 418	L.E. 93.3

IV.

PHYSICAL INFRASTRUCTURE	PHYSICAL STANDARD	INDICATIVE PER CAPITA COST 2/ L.E.	
WATER	385 l/c/d	73.0	L.E. 33.7
SANITATION	322.4 l/c/d	91.9	L.E. 53.0
ELECTRICITY	DISTRIBUTION ONLY	69.9	L.E. 14.6
CIRCULATION	20% or 10.7 m^2/CAPITA	95.4	L.E. 18.2
TELECOMMUNICATIONS 3/		INCLUDED IN INTER-URBAN INFRASTRUCTURE	--
TRANSPORTATION	BUSES/10,000 4.0	45.6	L.E. 8.0
OTHERS	PROVISIONAL ESTIMATE	10	L.E. 2.6
TOTAL: PHYSICAL INFRASTRUCTURE			L.E. 157.2

V.

SOCIAL INFRASTRUCTURE	PHYSICAL STANDARD	INDICATIVE PER CAPITA COST 2/ L.E.	
EDUCATION	MODIFIED ALEXANDRIA STANDARD "UNIVERSITY"	81	L.E. 37.9
HEALTH 4/	4.5 BEDS/1,000 See Table V-A.13	258	L.E. 68.1
SOCIAL AFFAIRS, AND ADMINISTRATION/OTHERS	30% OF SADAT CITY MASTER PLAN, Table V-A.14	128	L.E. 24.4
TOTAL: SOCIAL INFRASTRUCTURE			L.E. 130.4

VI.

TOTAL HOUSING AND INFRASTRUCTURE CAPITAL COSTS PER CAPITA	BASE COSTS	L.E. 353.6
	ADJUSTED TOTAL COSTS 5/	L.E. 478.7
	PERCENT REHABILITATION	24.5%

VII.

AFFORDABILITY AND COST RECOVERY 6/	NEW AREAS 7/	TOTAL PER CAPITA COSTS	TOTAL COSTS	L.E. 1,982.0
		PORTION NOT AFFORDABLE	PERCENTAGE	44.9%
	EXISTING AREAS 8/	TOTAL PER CAPITA COSTS	TOTAL COSTS	L.E. 143.6
		PORTION NOT AFFORDABLE	PERCENTAGE	0.0%
	ANNUAL LAND PAYMENT/M2 WHICH RECOVERS NON-SUBSIDIZED PORTIONS OF CAPITAL COST NET OF HOUSING COSTS 9/	NEW AREAS	TOTAL COSTS	L.E. 2.29 /M2
		EXISTING AREAS	TOTAL COSTS	L.E. 0.49 /M2
	TOTAL PER CAPITAL COST SUBSIDY: NEW AREAS ONLY			L.E. 888.9

Totals may not add due to rounding.

1/ All prices in 1979 L.E. Assumptions about rehabilitation and its phasing are shown in Tables V.A.23 & 24.
2/ New infrastructure costs only.
3/ Except for comparison with total costs of other alternatives shown in Master Plan Standards Packages Telecommunications have been included in inter-urban infrastructure costs. See Chapter V, Section III.
4/ Standards and capital costs shown include provisions for urban primary health care facilities in addition to secondary health care facilities.
5/ Base costs multiplied times regional construction cost factors. See Table V.A.22 in Appendix V.A.
6/ Based on median per capita household incomes and savings (see affordability analysis in Chapter V, Section III) and an opportunity cost of capital of 12 percent, and a recovery period of 30 years.
7/ Infill areas or new settlement areas.
8/ Costs of upgrading or capital rehabilitation of existing infrastructure.
9/ Annual level payment per square meter for saleable land which recovers the non-subsidized portion capital costs net of housing cost at an opportunity cost of capital of 12 percent over a 30 year recovery period.

FIGURE 10

INTRA-URBAN INFRASTRUCTURE INDICATIVE SPATIAL TARGET GROUP STANDARDS AND CAPITAL COST PACKAGES: HIGH GROWTH AREAS -- SUEZ

I.	GROSS DENSITIES 300 PERSON/HECTARES	POPULATION	EXISTING (1985)	312,000
			INCREASE (1986-1990)	126,000

II.	LAND REQUIREMENTS	PHYSICAL STANDARDS		PER CAPITA COSTS OF NEW DEVELOPMENT AND CAPITAL REHABILITATION OF EXISTING INFRASTRUCTURE OF SETTLEMENT 1/
	PRIVATE	65%		
	--RESIDENTIAL	(45%)		
	--NON RESIDENTIAL	(20%)		
	PUBLIC	35%		
	TOTAL	100%		

III.	HOUSING			
	AVERAGE AREA/UNIT 36 M2	AVERAGE UNIT COST: L.E. 2,008	INDICATIVE PER CAPITA COST 2/ L.E. 418	L.E. 135.1

IV.	PHYSICAL INFRASTRUCTURE	PHYSICAL STANDARD	INDICATIVE PER CAPITA COST 2/ L.E.	
	WATER	353 l/c/d	89	L.E. 53.9
	SANITATION	282 l/c/d	78	L.E. 47.3
	ELECTRICITY	DISTRIBUTION ONLY	131.8	L.E. 45.3
	CIRCULATION	20% or 6.7 m^2/CAPITA	68.4	L.E. 20.1
	TELECOMMUNICATIONS 3/		INCLUDED IN INTER-URBAN INFRASTRUCTURE	--
	TRANSPORTATION	BUSES/10,000 2.0	22.8	L.E. 6.1
	OTHERS	PROVISIONAL ESTIMATE	10	3.6
	TOTAL: PHYSICAL INFRASTRUCTURE			L.E. 176.3

V.	SOCIAL INFRASTRUCTURE	PHYSICAL STANDARD	INDICATIVE PER CAPITA COST 2/ L.E.	
	EDUCATION	DOUBLE ALEXANDRIA STANDARD Table V-A.11	82	L.E. 44.1
	HEALTH 4/	4.5 BEDS/1,000 See Table V-A.13	258	L.E. 92.7
	SOCIAL AFFAIRS, AND ADMINISTRATION/OTHERS	AT SUEZ MASTER PLAN STANDARDS Table V-A.16	112	L.E. 33.0
	TOTAL: SOCIAL INFRASTRUCTURE			L.E. 169.6

VI.			
	TOTAL HOUSING AND INFRASTRUCTURE CAPITAL COSTS PER CAPITA	BASE COSTS	L.E. 481.1
		ADJUSTED TOTAL COSTS 5/	L.E. 659.3
		PERCENT REHABILITATION	24.4%

VII.					
	AFFORDABILITY AND COST RECOVERY 6/	NEW AREAS 7/	TOTAL PER CAPITA COSTS	TOTAL COSTS	L.E. 1,733.5
			PORTION NOT AFFORDABLE	PERCENTAGE	36.7
		EXISTING AREAS 8/	TOTAL PER CAPITA COSTS	TOTAL COSTS	L.E. 225.5
			PORTION NOT AFFORDABLE	PERCENTAGE	0.0%
		ANNUAL LAND PAYMENT/M2 WHICH RECOVERS NON-SUBSIDIZED PORTIONS OF CAPITAL COST NET OF HOUSING COSTS 9/	NEW AREAS	TOTAL COSTS	L.E. 2.61 /M2
			EXISTING AREAS	TOTAL COSTS	L.E. 1.24 /M2
		TOTAL PER CAPITAL COST SUBSIDY: NEW AREAS ONLY			L.E. 636.0

Totals may not add due to rounding.

1/ All prices in 1979 L.E. Assumptions about rehabilitation and its phasing are shown in Tables V.A.23 & 24.
2/ New infrastructure costs only.
3/ Except for comparison with total costs of other alternatives shown in Master Plan Standards Packages Telecommunications have been included in inter-urban infrastructure costs. See Chapter V, Section III.
4/ Standards and capital costs shown include provisions for urban primary health care facilities in addition to secondary health care facilities.
5/ Base costs multiplied times regional construction cost factors. See Table V.A.22 in Appendix V.A.
6/ Based on median per capita household incomes and savings (see affordability analysis in Chapter V, Section II) and on opportunity cost of capital of 12 percent, and a recovery period of 30 years.
7/ Infill areas or new settlement areas.
8/ Costs of upgrading or capital rehabilitation of existing infrastructure.
9/ Annual level payment per square meter for saleable land which recovers the non-subsidized portion capital costs net of housing cost at an opportunity cost of capital of 12 percent over a 30 year recovery period.

FIGURE 11

INDICATIVE PER CAPITA COST OF WATER SUPPLY
AT DIFFERENT GROSS DENSITIES AND CONSUMPTION RATES

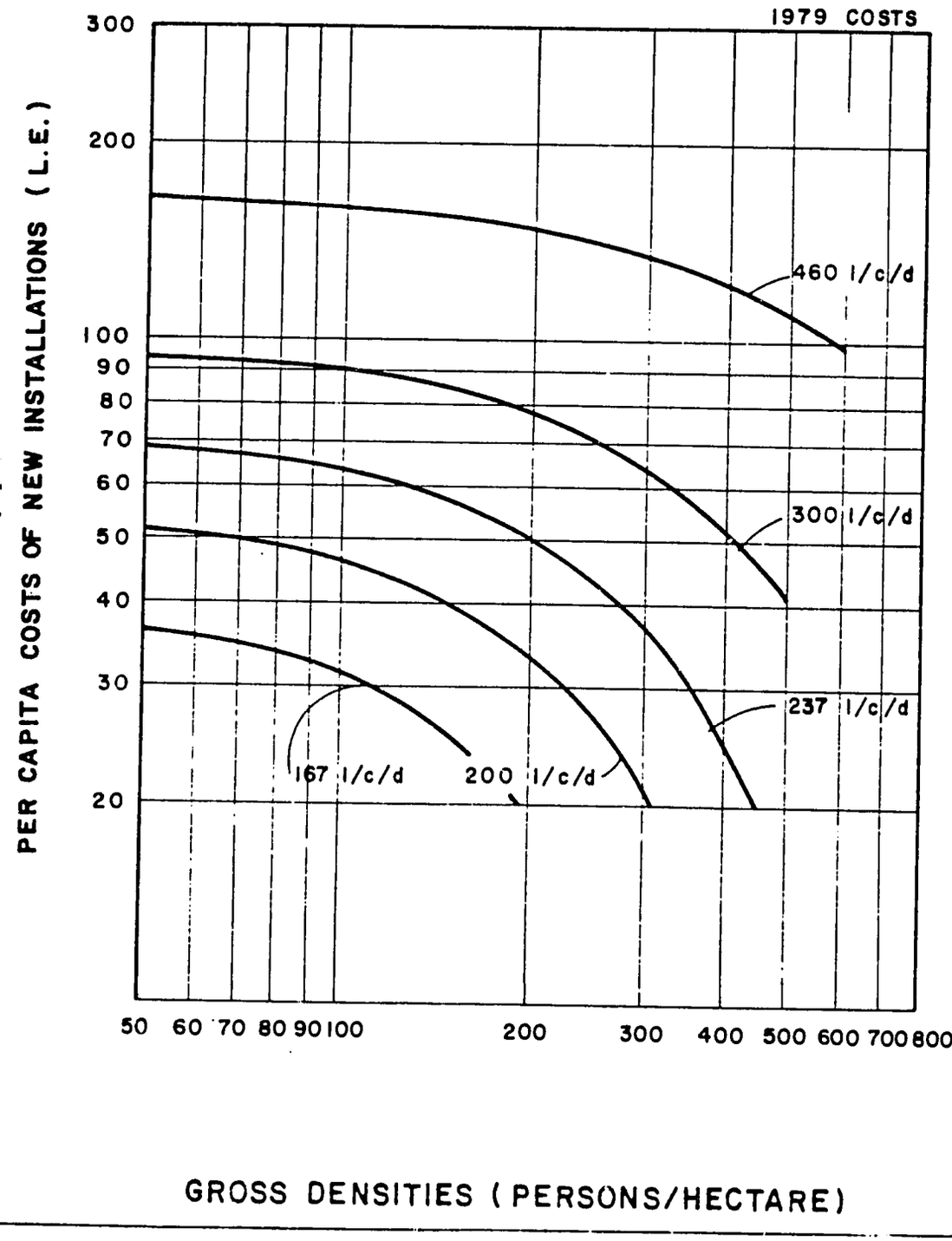
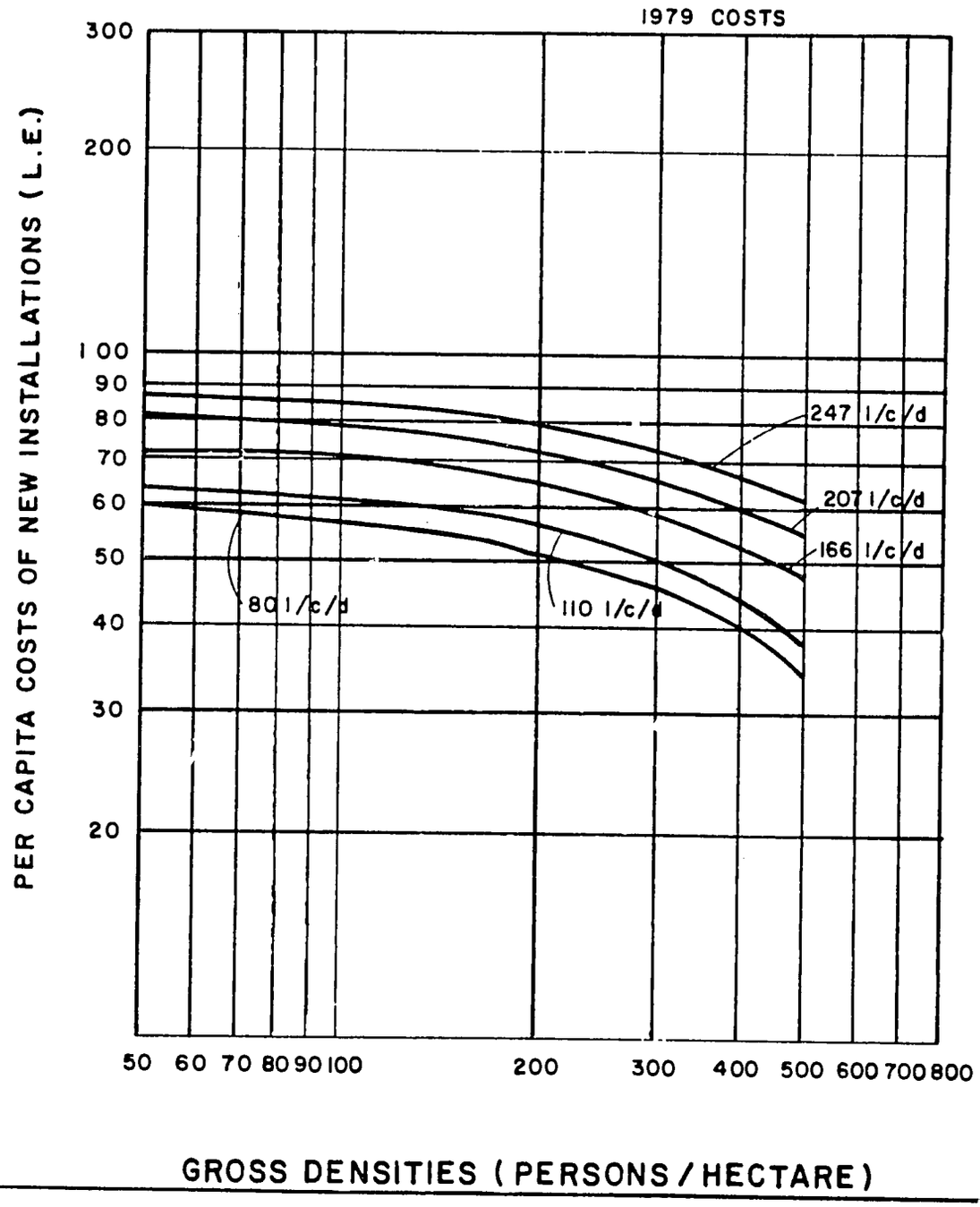


FIGURE 12

INDICATIVE PER CAPITA COSTS SEWERAGE SYSTEMS AT DIFFERENT GROSS DENSITIES AND TOTAL SEWERAGE FLOWS



The estimated functional relationships and their data limits were:

a. Water supply (Figure 12)

$z = 9.99 + (-0.12)\ x + (0.44)y$

Where:
- x = gross density
- y = water consumption standard (1/c/d)
- z = per capita costs

  correlation Coefficient ($R^2 = 0.90$)

Limits: y = where $x = 600$

b. Sanitation (Figure 13)

$z = 48.34 + (-0.06)\ x + (0.17)y$

Where:
- x = gross density
- y = sewerage flow (1/c/d/)
- z = per capita costs

  Correlation Coefficient ($R^2 = 0.87$)

Limits: No limits where reached due to density limitations shown in Equation 1.

c. Circulation (Figure 14)

$z = 52.56 + (-0.06)\ x + (5.05)y$

Where:
- x = gross density
- y = m^2 per capita of circulation (based on an assumed 20 percent of settlement area devoted to circulation)
- z = per capita costs

  Correlation Coefficient ($R^2 = 0.90$)

Limits: No limits where reached due to density limitations in Equation 1.

d. Electricity Distribution (Figure 15)

$y = 152.39\ e\ (-1.15 \times 10\text{-}3)x$

Where:
- x = service population ('000s)
- y = per capita costs

  Correlation Coefficient ($R^2 = 0.77$)

Limits: No limits where reached as population change did not exceed 3 million.

c. **Rehabiliation Standards and Costs:** Typically, most settlements will have fairly large requirements for both infrastructure rehabilition and provision of new services to make-up existing deficits.

Frequently, the per capita costs of rehabilitating existing infrastructure are less than those of building completely new infrastructure. Typically, requirements for rehabilitation of infrastructure can only be determined from master plans. Requirements for extension of infrastructure can be determined from census statistics showing populations actually served by municipal infrastructure systems. Alternatively, infrastructure deficits can be determined from statistics of public utilities. In this case, per of capita consumption standards are good indicators of deficits in infrastructure services. For example, if the production capacity of a municipal water supply system measured in terms liters per capita per day is very low, particularly in comparison to the production of other settlements in the country, it is likely that fairly large portions of the settlement's population lack access to the system.

d. **Operations and Maintenance Costs:** The recurrent costs of shelter and infrastructure systems are frequently as large in magnitude as their capital costs when measured over their useful life. Actual determination of operations and maintenance costs frequently requires a master plan level of analysis to determine if the current provisions are adequate to maintain past investments in capital stock, or determine what increases are necessary to improve routine operations and maintenance.

Cost recovery of investments in shelter and infrastructure is frequently an issue directly related to operations and maintenance. Inadequate cost recovery usually results in infrastructure investment being poorly maintenance and a deterioration in service levels. These issues are further discussed in the **Control/Feasibility/Risk Module.**

e. **Regional Cost Modifiers:** The discussion so far of standards and costs has ignored regional construction cost variations. However, the distance from sources of construction inputs such as labor and materials, and the lack of non-saline water in certain areas can greatly influence costs. Further, other locational factors such as difficult building conditions, differences in soil types and in large countries, regional differences in climate can influence building costs. Determination of the type of regional cost modifiers frequently must be done on a country specific basis. Regional cost modifiers based on distances from imputs can be estimated on the basis of distance from major sources of supply of primary construction materials such as cement.

The best source of regional construction costs variations is measurement of the variations in the value of construction output for a given quantity of construction volume. Frequently, however, while construction output may be known, the actual volume of construction is not. Thus the procedure described below can be used as a proxy.

If it is assumed that for a given volume of construction, the quantity of cement used in construction is constant throughout the country, indexes of regional variation in construction costs can be developed using changes in construction output from one region to the next when information on cement sales, prices and construction output are known. Similarly, once the price of cement is known, its component of construction costs can be identified. Then, changes in the value of output for a constant quantity of cement usage become a function of regional differences in construction costs.

More complex regional construction cost indexes can be constructed if data about other basic building materials prices and consumption are known. To do so, data about the proportion of construction costs represented by each building material must be known in addition to regional consumption and price data. Then each building material used in the index must be weighted for according to its share of construction costs prior to developing the index.

4. **Data Inputs:**

- **Shelter standards and costs:**

  -- Average dwelling unit sizes and costs of different standards of construction

  -- Occupancy rates showing number of persons living in dwelling units

  -- Requirements for rehabilitation and relacement of existing housing stock

  -- National Shelter policies regarding:

    - Provision of shelter to different groups,

    - Standards of shelter provisions to different groups,

    - Unit costs of different shelter provisions,

    - Division of public and private responsibilities for provision of shelter.

- Attitudes towards informal sector provision of shelter

- **Water Supply Standards and Costs:**

  -- Total daily production (usually measured in cubic meters per day)

  -- Service population (population actually served)

  -- Settlement population (from Aggregate Demographic Module)

  -- Costs of adding new population to the system, measured in monetary units per cubic meter (or liter) per capita per day

  -- Requirements for rehabilitation of existing infrastructure

  -- Capacities and service life of different components of the water supply system (necessary only if a detailed evaluation is to be made)

- **Sanitation Standards and Costs:**

  -- Type of system to be provided and ownership. Unlike municipal water supply, large components of urban populations are frequently served by individual private systems such as septic tanks or pit latrines. A determination needs to be made as to whether existing systems are to be maintained or new systems installed.

  -- Service population of existing system (frequently available from census data)

  -- Standards of provision of population served by municipal systems (usually measured in cubic meters per day, but can also be measured in liters per capita per day).

  -- Costs of new provision. If private systems are to be maintained, a decision has to be made whether or not these systems are included in shelter costs.

  -- Requirements for rehabilitation of existing municipal systems.

  -- Capacities and service life of different components of municipal sanitation systems (necessary only if a detailed evaluation is to be made).

- **Circulation Systems:** Consists of road networks only. Data

requirements are the costs of provision of roads at different standards. Typically, the costs of circulation systems are related to gross densities, the percentage of total urban area devoted to circulation and the costs of different types of road standards.

- **Transport Systems:** This data should pertain to intra-urban transport such as buses, taxis, intra-urban rail, etc. Typically, data has to be determined on a case by case basis. However standards based on the costs of providing additional transport units per capita can be determined to test different transport policies. The following is a summary of specific data requirements:

  -- Buses
  -- Number of vehicles,
  -- Number of vehicles in service,
  -- Daily number of users (total and average per unit),
  -- Daily distance travelled,
  -- Costs of provision of new units (including costs of maintenance facilities, but excluding operations costs such as fuels),
  -- Taxis and other public and private vehicles (data is similar to buses),
  -- Urban rail including subways,
  -- Cost of provision of networks,
  -- Cost of provision of vehicles,
  -- Cost of maintenance facilities,
  -- Daily number of users (total and average per unit),
  -- Daily distances travelled,
  -- Number of vehicles or trains,
  -- Number of vehicles or trains in service.

- **Electrical Power Systems:** The first determination regarding electrical power is the extent to which costs are a function of national networks. If settlement power systems are part of a national electrical grid, costs of adding new capacity should probably be treated as inter-regional infrastructure. In the event that settlements are provided with electricity via municipal generating plants the following data should be collected:

  -- Electrical demand by settlement (usually measured in kilowatt hours per capita)
  -- Electrial capacity of generating plants (usually measured in megawatts)
  -- Costs of adding new capacity (usually measured in monetary units per megawatt)
  -- Costs of adding new urban network. Measurements vary, but usually functional relationships between standards of provision, measured in kilowatt hours per capita, and population served can be established.

- **Communication Systems:** As with electrical power systems, the region serving functions of communications checksystems needs to be determined prior to inclusion in intra-urban infrastructure cost packages. The costs of provision of telecommunication systems are frequently more a function of the size of populations, national output and country area than they are of settlement populations.

- **Education Systems:**

  -- Average student population per school for different types of schools

  -- Classroom sizes

  -- Regional service functions of educational facilities (frequently educational facilities will serve rural populations in addition to urban populations).

  -- Costs of providing new student places for different types of schools

  -- Proportion of student population actually attending school and projections for changes in enrollement rates. These data are necessary to relate costs of student places to total population changes.

  -- Service levels in different settlements.

- **Health Systems:**

  -- Types of facilities to be provided and policies towards construction of health facilities, i.e., is the focus on primary health care vs. secondary?

  -- Service populations for different types of facilities. Secondary health care facilities (hospitals, etc.) frequently serve urban and rural populations. Thus the regional functions of health care facilities must be determined.

  -- Costs of providing new health care facilities and populations served by these facilities.

- **Other Types of Physical and Social Infrastructure:** This must be determined on a country-by-country basis, but could include provision of new post officies, new municipal administrative buildings, parks, community centers and other types of urban services.

5. **Major Outputs:**

- **Standards Packages:** As previously described, one of the major outputs of the Investment for Shelter/Infrastructure component is packages of shelter and urban infrastructure standards and costs which can be used to target urban investment to different types of settlements according to the role assigned to them by different spatial alternatives. These spatial "Standards Packages" provide information on standards of infrastructure for new populations and on requirements for rehabilitation of existing infrastructure. They can be used by Ministries of Planning and of Works or Development to develop detailed investment plans for different types of settlements. Examples of two types of Standards Packages have already been shown in Figures 9 and 10.

- **Investment Requirements and Per Capita Costs:** Investment plans can be developed for individual settlements using the spatial target groups. Since the Standards Packages measure costs on a per capita basis, these can be multiplied times expected population growth derived from the Investment for Employment Component to develop sectoral investment plans for each settlement. Some of the infrastructure sectors which should be covered are:

  -- Urban Shelter
  -- Potable Water Supplies
  -- Sanitation (public and private systems)
  -- Transport
  -- Circulation
  -- Power Supplies
  -- Telecommunications
  -- Health
  -- Education
  -- Other Physical and Social Infrastructure

- **Urban Land Needs:** Urban land requirements are produced as a function of density standards established for each settlement. These requirements show the need for new urban land and the capacity of individual settlements to absorb new population through infill or vertical redevelopment.

- **Physical Requirements for Shelter and Intra-Urban Infrastructure:** In addition to estimating investment requirements, the module estimates total requirements for new shelter, new water supply capacity, sanitation, transport, road networks, power supplies, telecommunications (measured in terms of telecommunications lines), health facilities, educational facilities, and other infrastructure.

- **Operations and Maintenance Costs per Capita:** Based on the assessments of operations and maintenance costs developed for individual standards packages, total operations and maintenance costs can be output. These requirements when combined with investment requirements for depreciation of shelter and infrastructure plus debt servicing can be used to ensure that cost recovery mechanisms are adequate to replenish the urban shelter and infrastructure investment pool.

6. **Relationship to Other Modules:** Urban shelter and infrastructure are a major component of most developing country development budgets. The "Investment for Shelter/Infrastructure" component provides a rapid and consistent methodology for developing infrastructure standards and costs suitable for supporting population allocation strategies developed in the Investment for Employment component.

V. CONTROL/FEASIBILITY/RISK MODULE (CFRM)

A. FINANCIAL FEASIBILITY

1. **Objective:** To determine if the total costs of the settlement alternatives developed under the Settlement Allocation Costs Module can be financed by development resources. It also provides an assessment of the foreign financing requirements of those total costs.

2. **Evaluation Procedure:** The sectoral and total costs for a settlement alternative become the major input links between the Settlement Allocation Costs Module and the financial feasibility element of the Control/Feasibility/Risk Module. This is done by determining whether or not the total costs of a settlement strategy are affordable within the sectoral and total investment resource pool. An alternative is judged to be more or less risky depending upon the degree to which its implementation:

   - Requires supplementation of domestic resources with foreign resources. If it does, there is a risk of increasing foreign dependence or of increasing the foreign resource gap to the point where it is not supportable by the economy.

   - Requires substantial shifts in resources from one sector to another, e.g., from agriculture to urban housing and infrastructure. If it does, there is an increasing risk of reducing economic growth since, traditionally, investment in urban housing and infrastructure, although necessary to support investments in other sectors, results in less economic growth per unit of investment than does investment in other

sectors such as industry. What is needed is to develop a supportable level of investment in shelter and urban infrastructure.

- Requires more total resources than are likely to be generated from both domestic and foreign sources at a feasible rate of economic growth. An urban investment program which requires a dramatic increase in gross domestic investment say from 15 percent investment of GDP to 30 percent is unlikely to be feasible over the long term. Few countries have been able to sustain such increases in investment through either dramatically curtailing consumption, thus increasing domestic savings or attracting sufficient increases in foreign savings to finance the difference.

  Determination of the capacity of domestic resources (or domestic savings) to finance gross investment requires an evaluation of public and private consumption expenditures to determine domestic savings rates. (By definition, domestic savings is gross domestic product minus public and private consumption.) This review of public consumption expenditures requires an evaluation of cost recovery (i.e., subsidies) and interest rate and pricing policies since these affect 1) whether public consumption expenditures can be controlled and 2) whether private resources are likely to be channelled into increased consumption or will be saved.

  If past policies have led to relatively little of the increase of output being saved (technically, the marginal propensity to save) due to poor cost recovery of investment in public infrastructure, subsidies or poor pricing and interest rate policies, it is unlikely that settlement alternatives requiring large increases in investment can be financed by domestic resources unless there are dramatic changes in those policies. For example, if past shelter policies have resulted in large subsidies in publicly provided housing, it is unlikely that settlement strategies which call for large increases in the quantity of publicly produced housing can be financed by existing savings rates. In this case, the drain on public resources resulting from increases in public consumption of gross domestic product would preclude large increases in savings since public resources are being used to finance subsidies.

  Having once determined feasible levels of domestic savings, the remainder of gross investment requirements must be financed by foreign savings. These savings can take the form of foreign grants and loans from the donor community, surplus export earnings and/or other private resources. If the settlement alternative requires large amounts of foreign savings and this is financed through largely concessionary loans and transfers, the alternative runs the risk of not being implementable due to the vagaries of foreign economic and political events. As has been previously noted, in real terms official

development assistance has remained at relatively stable levels in recent years. Thus dramatic increases in ODA are probably not feasible. Similarly, if the strategy relies on assumptions about increases in remittance income, it is equally risky since these flows fluctuate significantly due to changes in political events.

A settlement strategy which requires large shifts in the sectoral distribution of resources may lead to reduced economic growth. The degree to which resources must be shifted to finance a proposed strategy can be determined by changing the sectoral distribution of investment (parameter "b" shown in Figure 3). Once this is done, new GDP growth rates using this sectoral distribution of investment can be projected. If the shift in sectoral priorties results in a reduction of economic growth at predetermined feasible levels of gross investment, then the settlement strategy being evaluated runs the risk of being only partially implemented since insufficient investment funds will be generated to finance it.

Finally, if the strategy under review requires more total resources than are likely to be available under a feasible rate of economic growth, it runs the risk of being unimplementable. This evaluation can be made by determining the gross investment rates which are necessary to generate sufficient resources to finance the strategy. If these investment rates greatly exceed both historic rates of investment and investment rates experienced by other developing countries w[illegible] similar economic conditions, they are highly unlikely to prove f[illegible]le. Thus if the strategy is pursued, it is likely to either result in reduced economic growth and/or be only partially implemented.

VI. EVALUATION OF STRATEGIC ALTERNATIVES MODULE (ESAM)

This module provides an evaluation of the alternatives developed in previous modules according to the degree to which they achieve national development objectives. Alternatives may prove to be financially and administratively feasible, but may not contribute equally well towards acheivement national development objectives. They may not also perform equally well when measuring the relationship between their expected beneficial results and costs.

The Evaluation of Strategic Alternatives Module assesses settlement alternatives both non-quantiatively and quantitatively.

A. NON-QUANTITATIVE ASSESSMENTS OF BENEFITS AND COSTS

1. **Objective:** To provide a non-quantitative assessment of the degree to which settlement alternatives developed in the previous modules meet national development objectives.

2. **Evaluation Procedures: No single set of settlement strategies is capable of simultaneously achieving all** of the objectives of development policy. Decisions must be made among desirable, but often conflicting objectives as to the degree to which individual objectives will achieved and to the timing of achieving those objectives.

   This component of the methodology relies on professional judgment to assess the relative value of different settlement alternatives in achieving national development objectives.

   The first step in the procedure is to establish a set of performance criteria for spatial alternatives and determine the degree to which various alternatives meet those performance criteria. The objectives on which these criteria are based vary from country to country, but could include:

   - Achievement of high rates of national growth,
   - Maintenance or improvement in social justice through inter-personal and inter-regional equity,
   - Achievement of specific spatial objectives such as decon centration of primate cities or development of target regions,
   - Achievement of other national spatial objectives such as food security, and
   - Other country specific national objectives.

   Each of these objectives requires development of specific performance criteria related to country specific conditions. However, the following are sets of guidelines which can be modified to establish such criteria:

   a. **High Rates of National Growth:** Performance data for measuring national economic growth are usually the growth rate of gross domestic product in real terms and the real growth rate of GDP per capita. Other measures can also be used such as investment rates, foreign and domestic savings, marginal propensity to save, consumption and household consumption per capita.

   b. **Social justice:** The concept of social justice usually includes the idea of sharing national wealth (or income) among the population. The mechanisms for achieving improved distribution of national wealth are usually inter-personal equity (the distribution of national wealth among individuals) or inter-regional equity (the distribution of national wealth among geographic or administrative regions of the country).

The primary measures of improved inter-personal equity include improved distribution of income so that the differences in income from the highest and lowest income groups are reduced, improved access to shelter and infrastructure, and improved access to employment. Improved household income distribution can be measured through changes in the income distribution. Access to infrastructure can be measured through consumption standards and the proportion of population served by infrastructure. Improved employment opportunties can be measured by comparisons of jobs created by the economy with demand for them generated by population growth.

Performance of inter-regional equity considerations is frequently measured in terms of improvements in the distribution of national investment among regions. The distribution can be measured in aggregate terms or in investment per capita. Inter-regional equity performance can also be measured in terms of the geographic distribution of infrastructure services, shelter and employment.

c. **Performance on Special Objectives:** Performance on special objectives usually has to be developed for individual country situations. However, frequently the following need to be considered:

- Disamentities consisting of congestion, pollution, social unrest and other similar problems,
- Growth of primate centers and the location of that growth,
- Growth of secondary centers,
- Urban growth in undesirable locations such as prime agricultural lands,

d. **Food Security:** Performance of urban spatial strategies with regards to food security can have several criteria. The first most commonly encountered criteria is the rate at which agricultural land is being converted to urban uses since a reduction in agricultural land could result in a reduction in the ability to produce food crops. A second, more comprehensive, but less frequently encountered criteria is the degree to which urban areas contribute to domestic food production by converting agricultural products to processed foods and thus generate demand for agricultural products.

Although it is rarely measured as such, the degree to which urban areas rely on transfers of investment resources from rural areas greatly affects agricultural production. A reduction in agricultural investment as the result of the need to finance urban development strategies which either have low cost recovery and/or are costly to

implement frequently results in a reduced capacity to acheive food security.

3. **Major Inputs:**

   a. The characteristics of settlement patterns and sectoral requirements. These are usually determined from the strategies developed by the previous components. They can also be determined by an in-depth knowledge of the country such as the location of agricultural lands and other social and physical characteristics of the country.

   b. Development Objectives. National development plans are usually the best source of development objectives. A determination must be made however as to which objectives are spatial in nature. Defense is usually a non-spatial objective of governments.

4. **Major Outputs:**

   The usual output is a rank-ordering of settlement alternatives according to the degree to which they meet performance criteria set by development objectives. This module can also provide an evaluation of development objectives and the degree to which they can be achieved by spatial strategies. A final output is frequently a schedule of the timing under which development objectives are to be achieved. For example, it may be decided that the desirable performance of a particular alternative on several development objectives merits its implementation even though other development objectives can be only partially achieved or must be postponed.

5. **Relationship to Other Modules:** This component of the methodology is aimed at testing the success of the strategies which were developed in other modules. Thus it can be used to eliminate alternatives which have undesirable performance characteristics or to improve the performance of specific components of an alternative.

6. **Limitations:** This subcomponent does not aim at optimizing any single set of development objectives or urban spatial alternatives. It is designed to show the degree to which alternatives meet specific criteria relating to different objectives. Once this is done, policymakers have the choice as to importance of achieving one set of development objectives at the expense of others.

B. QUANTIFIED ASSESSMENTS OF BENEFITS AND COSTS

1. **Objective:** To provide a quantitative assessment of the economic benefits and costs of following different settlement strategies.

2. **Assessment Methodology:** Any attempt to quantitatively estimate aggre gate benefits of all types and costs of alternative national policies should be treated with caution. This is true because benefits can be measured according to multiple criteria such as social, distributional and economic criteria. The measurement of benefits according to these criteria is further complicated as they are not commensurable or subject to a common set of measurements. Furthermore, the incidence of benefits and costs (i.e., who receives the benefits and who pays the costs) is frequently as important as the their overall magnitudes. This is why, the assessment shown in the first part of this module was not aggregated into a single benefit measure.

Given these difficulties with benefit estimation, an important, but limited set of commensurable economic benefits and costs can be calculated to illustrate aggregate economic benefits and costs associated with different alternatives. The primary purpose of these calculations is to demonstrate the direction of the effects on net benefits of developing different population location strategies and providing shelter and infrastructure for those different strategies at differing standards.

The analytical procedure makes use of a well known positive relationship between city size and output or income. In 1973, Koichi Mera showed that for 46 developing countries, increased primacy (that is, increased concentration of urban population in major metropolitan centers) had a high positive correlation with with increased economic growth in output. More recently, he reviewed empirical studies of the relationship between city size and output which were also found to be positively correlated. He fitted the data from these latter studies to an equation of the following form:

$$GDP/C_t = A * (P_t)_B$$

where:

GDP/C_t =GDP per capita or income benefit per capita in city t

A =Country specific parameter which equalizes city specific per capita income benefits throughout the settlement system

P_t =Population Size of city $_t$.

B =Income parameter which varies from 0.04 to 0.20. depending on the definition of income or output used. The value corresponding to the definition used by the NUPS methodology is 0.10.1/

The procedure assumes that maximum income or output benefits per capita are obtained from the "least cost solution" since the solution minimizes costs and thus potentially maximizes net benefits. All other settlement

alternatives are measured against the net benefits derived from the least cost solution to determine their per capita GDP benefits relative to those of the least cost solution.

It is of course possible to maximize benefits in other alternatives through reducing infrastructure standards or through allocating more investment in settlements which have lower average costs per job than is allocated by the least cost solution. Usually however, these decisions must be made after a series of alternatives have been evaluated to determine where standards can be reduced or where it is desirable to allocate more employment.

The first step in the procedure is to solve for the country specific "A" parameter. This is done by using the mid-point settlement popula tion distribution generated by the least cost solution and solving a set of simultaneous equations for the parameter A in which the sum of city specific GDP or income per capita equals the national annual average urban GDP per capita. Urban GDP per capita in this case is defined as the average non-agricultural GDP for the period in question divided by the period's mid-point urban population.

Once parameter A is determined and average annual GDP benefits per capita are calculated for each settlement, total benefits for the period are estimated. This is done by multiplying city specific annual average benefits times the change in population for the strategy in question. Next, this product is multiplied times 5 to estimate total city specific benefits for the period. These are then summed to obtain total benefits for the period.

The next step in the procedure is to calculate economic costs of the strategy. This is done first for Growth Management Costs. These costs take account of the increased average costs per job which result from increasing rates of employment growth. Such increased costs include diseconomies such as pollution, congestion, the need to incur greater managment costs, etc.

Growth Management Costs for each settlement are calculated by finding the difference between the average costs per job calculated at the employment growth rates specified in the strategy times the change in employment minus the average costs per job calculated at growth rates set at zero times the change in employment.

This the equation for this formulation is shown below:

$$GMC_i = (A_i * g_{i_s}{}^4 - A_i * g_{i_o}) * dL_{i_s}$$

where:

GMC_i =Growth Management Costs in City i.
A_i =City i specific Cost Curve Intercept, see Equation 1.
g_{i_s} =City i specific employment growth rate in Strategy s.
g_{i_o} =Employment growth rate set at zero. In this case, the growth rate is equal to 1.00.
dL_{i_s} =Change in employment in City i in Stategy s.

Total costs for the stategy are found by adding city specific growth management costs, investment in plant and equipment and investment in shelter and urban infrastructure. These are then summed to find total costs for the period.

Net benefits for the strategy are simply the difference between total benefits and total costs. Per capita net benefits are the city specific net benefits divided by the period's mid-point population.

After having calculated total and net benefits for all three periods of the least cost solution, the parameter A can be used to find total benefits and net benefits of other strategies. To do so, the same procedure is used for the first periods of these strategies.

Once this is done, a comparison of the total net per capita benefits of the least cost and other strategies should be made. If the net benefits of the other strategies are significantly lower than the least cost solution's, adjustments in economic growth rates should be made in later periods of these strategies. If a significant drop in national income (in this case represented by net GDP benefits per capita) occurs, it signifies a drop in the capacity to generate domestic economic resources needed for economic growth.

This reduction in the ability to generate domestic resources should be reflected by either reducing investment rates or by increasing the foreign savings component of gross investment. Since increasing foreign savings is generally not possible to any significant extent, the usual impact of following strategies resulting in reduced net benefits is to reduce the ability to stimulate investment.

The investment rates in the second period should be adjusted by the percent difference between total net per capita benefits of the least cost solution and the benefits of the strategy being reviewed. This percentage represents the foregone ability to generage investment

resulting from following strategies with significantly higher costs than can be supported by the economy.

Having done so, new macro economic projections should be made and new settlement allocations made. Note, this will not change the settlement population distribution or shelter and infrastructure requirements of the strategy. It will however change the magnitude of employment investments of the strategy.

Once these adjustments have been made, second period benefit calculations should be made using the procedures described above. Final period macro economic projections and settlement allocations should be adjusted using the second period relationship between total net per capita benefits of the least cost solution and other strategies.

3. **Major Inputs:** The major imputs of this component are the supplied by the other components of the methodology. Briefly these are:

   - National Populations,
   - Settlement populations,
   - Cummulative GDP projections,
   - Least Cost Solution allocation of population and employment,
   - Least Cost Solution allocation of shelter and urban infrastructure,
   - Other Strategies.

4. **Major Outputs:** The major outputs of this component of the methodology are evaluations of the likely economic performance different settlement alternatives. This performance is measured in terms of:

   - Total and per capita income benefits,
   - Total and per capita net benefits,
   - Total and per capita capital costs,
   - Evaluation of Growth Management Costs of different alternatives,
   - Measurement of impact of alternative on likely economic growth.

5. **Relationship to Other Modules:** The net benefit estimations made in this component are a quantitative means of assessing the economic impact of policies delineated in other components of the methodology. This module can be used to test specific settlement population allocations, modify the impact of those allocations on national resources through changes in standards and refine settlement alternatives to the point where they represent strategies capable of being adopted as components of national development plans.

6. **Limitations of the Component:** The absolute magnitude of economic benefit and cost calculations is always subject to question. Thus in making these projections, they should be used to represent likely trends resulting from following different policies.

VII. PREFERRED STRATEGY RECOMMENDATION

The NUPS Methodology has multiple uses in evaluating settlement strategies and shelter and urban infrastructure policies. However, its main utility is developing national urban investment policies. This final product of the methodology, a Preferred Strategy, should be the result of re-iterative testing of settlement alternatives so they are refined to point where they have the greatest potential of meeting national development objectives. This process of refinement of settlement alternatives should include:

- determination of feasible population and employment targets for primary and secondary cities,
- establishment of shelter and urban infrastructure standards and targets which meet national resource limitations and support settlement population targets, and
- establishment of sectoral investment priorities that are mutually supportive.

A fully developed set of **Preferred Strategy Recommendations** should delineate the following:

- Spatial priorities showing the roles of major metropolitan areas, secondary and tertairy settlements in national development plans,
- Urban Components of regional development strategies
- Population and employment targets supporting spatial priorities
- Investment targets needed to support spatial priorities for:
  - -- Employment creation
  - -- Shelter
  - -- Urban Infrastructure
- Sectoral priorities
- Shelter and urban infrastructure standards, service levels and cost recovery
- Summary of total costs
- Performance Criteria with which implementation of the Preferred Strategy can be judged and modified if necessary
- Benefit/Cost analysis of the impact of the Preferred Strategy