THE AGA KHAN UNIT FOR HOUSING AND URBANIZATION

At the Harvard Graduate School of Design

AFFORD

USER MANUAL

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User Manual

1.0 Purpose of the model

1.1 Importance of affordability as a housing issue

The supply of affordable housing has become a major issue of concern to governments and citizens in developing countries alike. Between 1970 and 1985, housing costs rose faster than median incomes by a factor of 1.5 to 2 in the industrialized nations and as much as 4 to 6 in the developing world.

The problem is less lack of supply per se rather than lack of affordability. The housing produced by the private sector is no longer affordable to a large segment of the population and the cost to the government of subsidy programs is placing too heavy a burden on public finance.

Rich countries as diverse as the U.S., Great Britain, Saudi Arabia or Kuwait are unable to provide affordable housing to all their citizens. Poorer countries from Morocco to the Philippines have to face the undesirable consequences of disfunctional housing markets, namely overcrowding, slums, uncontrolled development and squatter settlements, demography having overwhelmed government's capacity to produce public housing.

1.2 Conceptual approach to affordability

Affordability is an intricate concept requiring the simultaneously manipulation of social, economic and physical variables to arrive at realistic solutions. The interrelations between household size, income and the portion of that income allocated to housing define a demand frame with specific elasticities to respond to changing market conditions. Similarly, the interdependencies between development standards, construction costs, financing terms and required payments define a supply frame with specific flexibility to respond to changing characteristics of demand.

The interaction between such complex formulations of supply and demand require complicated and time consuming computations yet attempts to reduce to manageable proportions results in overly simplified assumptions which undermine the usefulness of the exercise calculations. The lack of a relatively simple way to quickly trace the repercussions of modifying any one variable on the affordability of a project has handicapped policy makers and designers in their search for innovative housing solutions.

1.3 Objective of the Housing Affordability Model

The model allows for an efficient exploration of ways to arrive at a better match between the socio-economic characteristics of a population to be housed and the project's physical and financial parameters. Alternative formulas allow the user to calculate the real costs to the sponsoring agency of housing subsidies in a project area irrespective of the form in which they are given and regardless of whether they are actually included in the project budget or channelled through other funds.

The model is formulated to assist policymakers, planners and designers in appraising the social, financial and technical factors affecting affordability in order to select a preferred course of action. It focuses on development strategy and housing policy and is intended primarily for use in publicly-sponsored projects.

1.4 Structure and Function of the Model

The model is structured into a sequence of five consecutive modules which describe the various aspects of the housing project. The user interfaces independently with each module to allow a partial modification of project characteristics; the implications of changes made in any module are traced automatically through the model.

Proposed projects and programs can be subjected to a rigorous analysis at key decision points when the results can still be integrated in their design to arrive at:

- A better understanding of the impacts of technical factors and development standards;
- A more focused definition of target groups;
- A closer match between supply, user needs and affordability;
- A realistic estimate of the amounts of government subsidies required;
- An internally consistent set of policies optimizing the balance between affordability and other project objectives.

The model offers the flexibility required by designers to develop creative urbanistic and architectural solutions without losing sight of social, economic and financial considerations.

It allows planners to subject design proposals to a sophisticated analytical appraisal to assess their performance at the lower end of the affordability curve.

Finally, the exploration and testing of alternative housing policies can help identify the most promising channels for government assistance. For example, the housing typology may indicate that grants to producers such as housing cooperatives would be an effective mechanism. Alternately, the socio-economic profile of the target group may favor rent supplementation or other forms of direct subsidies to the end user. The ability to trace through the impacts of technical factors will clarify the range within which affordability can be improved by opting for lower cost solutions.

2.0 Installation Guide

The Housing Affordability Analytical Model can be used on any IBM PC or IBM compatible equipment. The following steps initiate the Program.

2.1 Using a Hard Disk

1. Turn on the computer with the Drive "A" door open and wait for the prompt to appear after the machine checks its internal memory. When prompted for the date, press <RETURN>; when prompted for the time, press <RETURN>.

2. Insert the Model diskette into Drive A and close disk drive door.

3. Load the Model onto the hard disk by typing:
   md (your choice of a directory name) and press <RETURN>

   When prompted by the computer, type:
   cd (Your directory name) and press <RETURN>

   When prompted again, type:
   copy a:*.* and press <RETURN>.

Wait until the lights have stopped flashing and the prompt appears. The Model is now on the hard disk. Remove the diskette from Drive A and leave disk drive door open.

4. To initiate the Model from the hard disk, type:

   cd (Your directory name) and press <RETURN>, and
   afford and press <RETURN>.

The opening screen of the Model should appear on the monitor and you are now able to proceed.

Note that it is not necessary to use the Model diskette again once it has been loaded on the hard disk. To start a new session on the computer, simply follow steps 1 and 4.

2.2 Using the A drive

Make a copy of the Model diskette before using it. Load the diskette into drive A. At the A> prompt, type "afford" and press <RETURN>. Leave the diskette in Drive A until you end the session.

3.0 Basic Approach to Model Use

The Model's design is "user-friendly." To enter data and use the Model, you simply follow the instructions that appear at the bottom of each screen. These "menus" allow you to:

-Enter data in a specific location on the screen.
-Move to another part of the model.
-Change data that have already been entered.
-Print your results.
-Initiate a new run of the model.
-Exit from the model; that is, end the session.

Note that the design of the screen varies somewhat in each segment of the Model in order to create a coherent display of information. It is essential that you carefully read the entire screen before entering data or going on to the next screen. At times, you will be asked a yes/no (Y/N) question that is intended to verify your decision before moving on to the next segment. Be sure of your answer as it may be impossible to change it without initiating a new run of the Model.

The Model is structured in a sequence of five modules to provide a simpler operating framework and facilitate data entry. The sequence follows the rationale used in thinking through the affordability issue.

1. The Demand Module describes the characteristics of population to be housed and calculates its ability to pay for housing in accordance with prevailing patterns of household consumption and the expenditures required for basic needs under a defined standard of decent living conditions.

2. The Cost Module calculates the cost of the different housing options supplied in the project based on planning criteria, engineering factors and design parameters.

3. The Finance Module calculates the sales price of the various housing options offered according to the overhead and profit allowance granted to the developer (public or private) and to the available terms of housing credit finance. Sales prices can be adjusted to permit internal cross-subsidization among project components.

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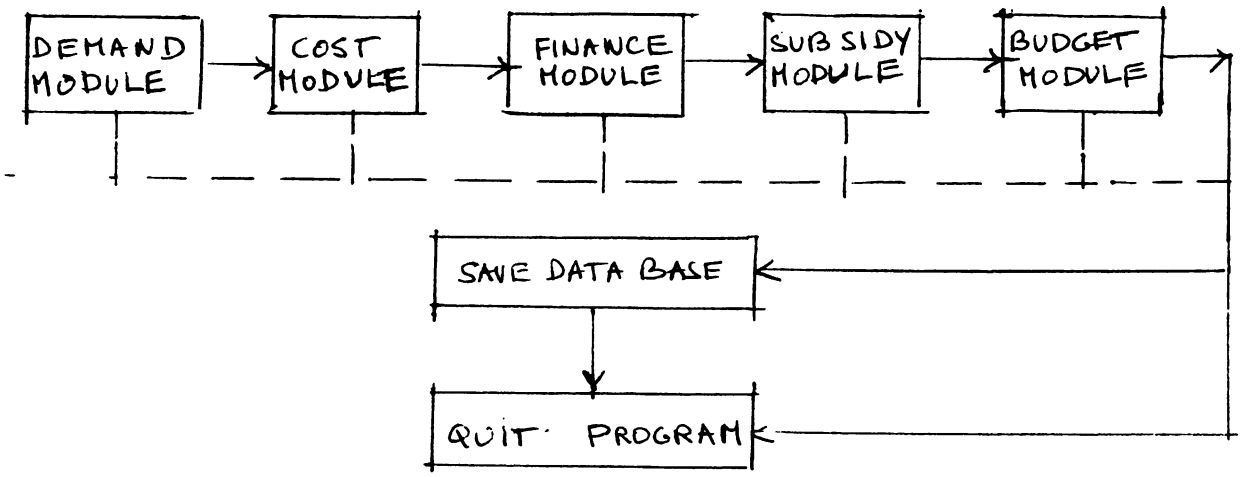
HOUSING AFFORDABILITY MODEL

MAIN MENU



IV. The Subsidy Module calculates the level of subsidies required for the project by matching supply and demand factors under alternative policy options selected by the user.

V. The Budget Module calculates the total budget required for the project in two identifiable components:

* Capital expenditures and receipts
* Finance costs.

In the first two modules the user inputs both the exogenously determined variables and the data base specific to the project. The model calculates the resultant characteristics of supply and demand applicable to the project.

In the finance and subsidy module the user can test alternative policy options to bridge any gaps between supply and demand. Four policy investments are available to minimize the subsidies needed for the project.

i) Cost ceilings.
ii) Occupancy standards.
iii) Targetting of beneficiaries.
iv) Cross-subsidization.

An optimum solution is reached through the manipulation of these four instruments whenever excessive divergences prevent a satisfactory outcome, this signals the necessity to revise the values preassigned to variables exogenous to the project which usually reflect higher level policies such as welfare standards or terms of credit finance.

4.0 Model Operation Guide

4.1 Data Entry

All computer programs expect data input in a specific format and can only use it in that format. Unless instructed otherwise on the screen, data should be entered as a continuous set of numbers (1000 not 1,000); fractions should be entered as 0.00. Some screens will automatically truncate data that you have entered in order to save display space. The real number you have entered is however utilized in all calculations by the Model. It is a good idea for you to keep a written record of the data that you enter in order to remember each component of your decisions. Data should be entered either through the number keys on the upper row of the main keyboard or on the numerical pad.

Pay close attention to any "error message" that may appear following a data entry. A beep tone or change in screen color may accompany the error message and you will be asked to re-enter the data.

It is critical that all data be entered accurately. The appearance of an abnormally large or small number (often in scientific notation) is usually an indication that you incorrectly entered a number used by the Model. You will have to determine whether the wrong entry can be corrected within the current run or you need to start the program over.

Should you "crash" the program as a result of an invalid data entry or instruction, you will get an "abort message." You can restart the program by typing "afford" and pressing the <RETURN> key at the prompt. A common cause of crashing is an invalid value in one of the data entries: for example, a value of "0" which is used as a divider or an exponential in a calculation. Another common cause of crashing is an abnormally large number that will cause an overflow in one of the calculations or exceed the amount of space allocated to a screen display. If the program crashes, you will get an "error" message that will look like this:

Run-time Error 01, PC=xxxx
Program Aborted

To load the program:

Wait for the C> prompt then type "Afford." When the program is ready to use, the title screen will appear. Press the "return" key to start the program.

4.2 Data Files

Following the opening screen, you will be asked to choose among three options:

1.) Use a reference data base prepared that is stored in the model.
2.) Use a project data base already loaded in a file.
3.) Create a new database.

Use the cursor to the desired selection and press the enter key. The screen will list its library of files in the selected category. Use the cursor to go down the list to the desired file name, then press the enter key in order to start the operation of the model.

Reference files are labeled with a .ref suffix (for example, "filename.ref"); they are protected data bases which cannot be altered during a run of the model. Other data bases, labeled with a .dat suffix (for example "filename.dat") are working files which can be edited during a run of the model and saved for future reference. This distinction allows the user to run different versions of a project without losing its original description. Reference files can be transformed easily into a working file through the following DOS commands.

Call the model file by typing "cd (Your directory name) and press <RETURN>.

Type "dir" and press <RETURN> - you will see a listing of files in the directory; the files with a REF. or .DAT tag are your data files.

Say your main reference file is called "Housing.ref"; to obtain a working copy where you can edit the data,

Type "copy housing.ref anyname.dat" and press <RETURN>; you will get a message saying : "1 file copied".

Alternatively, you can transform a working file into a reference file by typing

"copy anyname.dat anothername.ref".

When you decide to create a completely new database the system will display blank cells, all numbers having been set at zero, and you will have to enter the project description from scratch.

4.3 Module Operation

Modules are called by typing the highlighted letter in the module's name. It is important that the first time around, the modules are used sequentially since each one draws on data stored in or produced by previous modules. This first round is needed in order to avoid blank entries where actual numbers are expected. However, following this first round, modules can be entered and exited at wish from the main menu. Using the Edit function provided in each screen enables the operator to change parameters and variables and trace through the impact of alternative design criteria and policy options.

Edits must be carried forth through every step which follows even if none of the subsequent variables are altered. This is needed to generate an internally consistent printout. The numbers computed and displayed in each screen will then reflect the values assigned to all the different variables as inputted by their user when called for in the sequence of modules.

4.3.1 The Demand Module

To enter the Demand Module, type "d".

Screen 1 shows a distribution of households by different sizes and income groups. This is the basic matrix needed for the assessment of ability to pay for any commodity and more specifically, housing.

In the absence of information specific to the project site, data obtained from census or household budget studies or social surveys may be used to generate this matrix. These sources usually refer to geographic frames larger than the project area. However the

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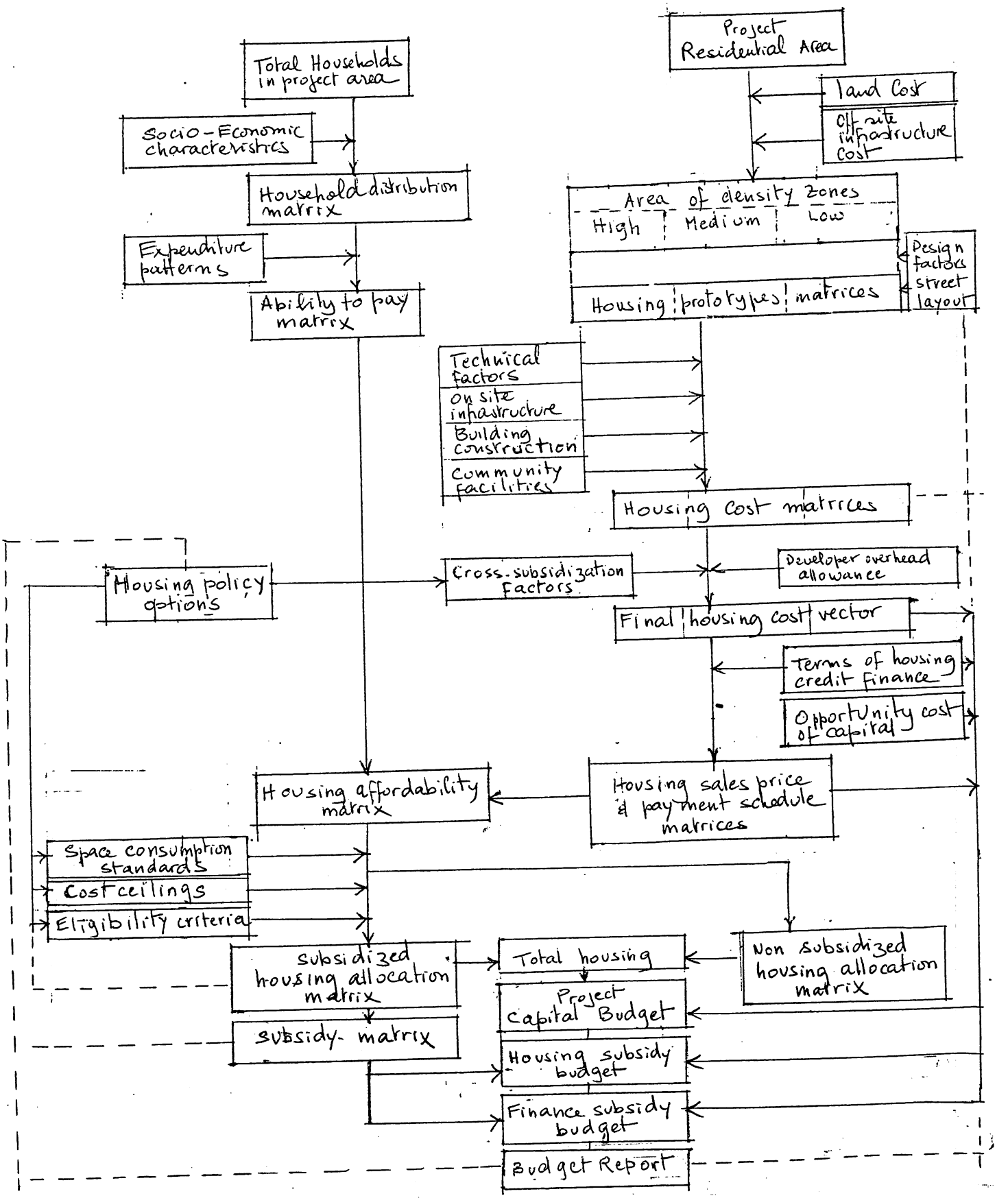
HOUSING AFFORDABILITY MODEL
LOGICAL DIAGRAM



socio-economic profile expressed as a proportional distribution recorded in the matrix can be applied to the project population. The underlying assumption is that there are no marked differences between the characteristics of the general population and the population to be housed in the project.

In special cases where this assumption cannot be made such as in the case of relocation projects, household surveys of the affected groups are usually available and should be obtained to create the matrix.

To continue with the module type "c".

Screen 2 lists two variables which need to be defined:

* The total number of households expected to be housed in the project.

* The income adjustment factor to be applied (if any) in order to adjust survey data to reflect non-salary income not covered by the survey on which Screen 1 information is based. If no adjustment is needed, enter "1.00."

When the appropriate numbers are entered, press "enter" to continue. If no changes are needed, press enter to curse down to the next item.

Screen 3 displays the actual number of households in each income/size category for the target population to be housed in the project. It is generated by multiplying Screen 1 by the factors specified in Screen 2.

To continue type "c".

Screen 4 displays the minimum expenditures required for food, clothing, transport and other expenses for each household size category. Expenditure patterns recorded in this screen are usually obtained from household surveys or derived from income eligibility criteria for government aid programs such as the federal poverty guidelines in the U.S. In general, estimates of median household incomes and poverty levels provide the yardsticks for the derivation of income ranges which represent the lower bound of decent living. This normally lies within 200% of the poverty level and below the median. It refers to the income eligibility limit for government aid programs but who still need assistance to pay their housing costs. Minimum acceptable living standards reflect prevailing conditions and national welfare policies and are exogenous to the project.

To continue type "c".

Screen 5 shows the ability to pay for housing of households in accordance with income and size categories. The model treats "affordability" as a residual that is the disposable income available to each household after the cost of basic needs shown

on Screen 4 are met. Note that this theoretical ability to pay may be and usually is different from actual willingness to pay for housing. Individual tastes, preferences and priorities as well as the possibility to trade off between quality and quantity characterize the highly segmented housing market. These factors are not reflected in the model because of its focus on subsidization policies and new development. The allocation of public funds to supplement income is a welfare policy concerned with households unable to find accommodations on the private market. The rationale is that households who do not require government assistance can select the housing option they prefer on the open market since the project offers options within their means. Households who prefer to trade decent living for other priorities should not place claims on scarce public resources to upgrade their housing conditions.

Screen 5 concludes the demand module by giving a clear picture of the affordability of the target population.

To return to the main menu type "c".

4.3.2 The Cost Module

To enter the Cost Module type "c".

Screen 1 lists three site-specific variables for which values have to be entered.

* land cost which is the price per square meter of raw land prior to site improvement. It depends on project location and is determined by the workings of the real estate market. In tight markets, it can become a very significant component of total project cost and affect its affordability.

* off site infrastructure per square meter of project area. It represents the cost of bringing utilities to the site and includes any upgrading of the capacity of primary systems to which the project network will connect which is required to allow these systems to carry the additional load generated by the project. Off site infrastructure costs can be small or substantial depending on the location of the project, the selected service options and the condition of regional systems. In the case of mixed use developments, the cost has to be borne by the project as a whole and not just its residential components.

* the Gross Residential Area (GRA). It refers to the total land area on the layout or land use plan allocated to residential zones inclusive at the right of ways for vehicular and pedestrian circulation and small, linear connecting open spaces within these zones. It should not include community facilities, commercial services, parks, playgrounds or other open spaces.

The model allows for up to 15 housing options, 5 each for high-, medium- and low-density zones labelled H, M, and L, 1 through 5. Density levels can be defined with reference to different parameters such as sanitation options or building typologies, therefore actual densities classified under high, medium or low categories will vary from one project to the next. For a given project, the user should select certain criteria for the categorization of densities which facilitate the computation of variations in site development and construction costs. This is particularly important in the case where more than one level of utility service is used in a project area or when wide fluctuations in building costs are encountered. The data entered for each density zone must be internally consistent and reflect the development costs corresponding to its constituent elements.

The model allows the disaggregation of development costs into three main components:

i. On-site infrastructure.
ii. Building construction.
iii. Community facilities.

Infrastructure and building costs are affected by site characteristics, engineering factors, architectural design and prevailing conditions in the construction industry. Preliminary estimates are usually worked out as an integral part of the project design. In the absence of specific estimates, the costs incurred for new development of similar characteristics and at similar locations may be used to derive unit costs applicable to the project area for the purposes of preliminary analysis.

* The building construction cost entered should represent an average of the cost of the different housing types encountered in a single density zone. The less the deviation from the mean, the more accurate the affordability analysis for any housing type.

The computation of on-site infrastructure costs assumes a prototypical grid layout. Individual designs will differ from this theoretical prototype and the model will adjust internally for this difference by taking into account the surface area of the streets in the plan. A proportional adjustment is a good approximation which has the advantage of allowing the testing of alternative schemes for the same site without having to recalculate the unit costs for each scheme exogeneously.

* The cost of community facilities provided to serve the population responds to national policies and design norms. A service standard factor allows for adjustment of the level of services offered in any scheme from full service at international standards expressed by a factor of 1.00 to various levels of overload expressed through fractions. A factor of 0.5 would indicate that facilities are being used at twice their ideal design capacity. Lower service standards are a common occurrence in developing countries where social goals mandate that health,

education and other services be offered without charge to the general population. Lack of resources and high rates of demographic growth combine to preclude the provision of full service standards.

Screen 2 describes the development standards of high density sectors in the project. Six variables are listed for which values have to be entered.

* The percentage of the gross residential area dedicated to high-density units.

* On-site infrastructure costs.
* Construction costs.
* Cost of community facilities.
* Street area.
* Service standard factor.

Type the desired value for each variable, pressing the "enter" key after each entry to register and go down the list and then press "enter" again to continue.

Screen 3 allows programming up to 5 housing options for the high-density zones.

Type "e" to get into the Edit mode then move the cursor to the desired cells using the arrow keys.

For each housing type enter the size of the plot - or equivalent share of the land in the case of apartment buildings - as well as the actual floor area of the dwelling. If only building plots are allocated, enter zero for dwelling size in the corresponding cell. Type the desired number in each cell and press the "enter" key to register it before moving the cursor to the next cell. Unused options should display zero for both plot area and dwelling size.

To quit the Edit mode type "q" then type "c" to continue.

The model allows for up to 15 housing options, 5 each for high-, medium- and low-density zones labelled H, M and L, 1 through 5.

Screens 4 and 5 display development standards and housing typologies for medium-density zones.

Screens 6 and 7 display development standards and housing typologies for low-density zones.

Screens 8, 9 and 10 show the unit cost calculated for each housing option calculated in accordance with the standards and typologies entered above.

At the end of the Cost Module type "c" to return to the main menu.

4.3.3 The Finance Module

To enter the Finance Module type "f".

Screen 1 lists five parameters defining the terms of housing finance. The first three variables relate to mortgage credit. They are usually determined by government housing programs and real estate banks.

* The downpayment requirements and the mortgage period are the most flexible of the terms. They can be specified by law as in the case of government-sponsored programs or left to the various public and private housing institutions to decide upon, in accordance with their own objectives and rules.

* The interest rate reflects national credit policies. Fluctuations fall within a narrow range defined by public policies regarding housing as a sector of the economy, and basic need for which government assistance is provided.

* The opportunity cost of capital represents the real cost of credit money. It is lower for the public sector than for the private sector. Capital in the form of investment or credit made available at a rate lower than its opportunity cost entails significant finance subsidies which must be accounted for in order to assess the real cost to the government of public projects and programs.

* The overhead allowance represents a mark-up that the public or private developer must add to actual construction costs in order to cover fixed costs, and provide for risk and generate a return on the investment.

Type the desired value for each variable pressing the "enter" key after each entry to register it and go down the list. Press "enter" again to continue.

Screen 2 lists the 15 housing options showing their costs computed in the Cost Module for reference. The model allows the incorporation of intrasectoral cross-subsidy mechanisms. Differential pricing is introduced by specifying cross-subsidy factors to be applied to the different housing options. A factor of 1 implies no change in pricing computations. Assigned factors in excess of 1 imply a proportionate mark-up of prices while factors set at fractions of 1 imply a proportionate reduction in pricing.

In large heterogeneous projects differential pricing is an important component of economic feasibility. It can go a long way towards safeguarding the social objectives of housing projects without adverse impacts on their financial viability.

To record cross-subsidy factors enter the Edit mode by typing "e". Move the cursor to the desired cells using the arrow keys. Type the

desired value of the factor and press the "enter" key to register it and move down the column. To quit the Edit mode type "q", then type "c" to continue.

Screens 3, 4 and 5 display the computed selling price of housing options offered under each density level taking into account the cross-subsidization scheme entered in screen 2 if any is selected. The corresponding monthly payment is computed in accordance with the terms of housing credit finance specified in screen 1.

These computations conclude the Finance Module by giving the purchase price and financial burden associated with the various housing options offered in the project.

To return to the main menu type "c".

4.3.4 The Subsidy Module

To enter the Subsidy Module type "s".

Screen 1 displays a reference matrix drawing on data computed in the previous modules. The rows list the different housing options offered and the columns list household size categories. Entries in each cell give the minimum income needed for a household of the specified size to be able to afford the listed housing option on the open market that is without subsidies other than those provided through credit finance and cross-subsidy schemes which have already been incorporated in the selling price computed in the Finance Module. The purpose of displaying this reference matrix is to help the user in selecting appropriate housing policy options asked for in Screen 2.

Type "c" to move to Screen 2.

Screen 2 lists three key policy options which affect the allocation of housing including subsidized units in any project.

* The maximum allowable cost for subsidized housing enables the decision maker to set a cost ceiling for the shelter options to be subsidized, i.e. allocated to households unable to afford these options. If the State has to bridge the gap between affordability and cost through transfer mechanisms supplementing income, it is natural that the difference be kept within an acceptible range financially and politically.

* Minimum space consumption standards define the upward limit of occupancy in the project. It is a measure of housing quality. Western standards define overcrowding as occupancy rates in excess of one person per room. In most developing countries where housing shortages and overcrowding are prevalent, occupancy rates of 2 to 3 persons per room are the norm. Setting standards for occupancy loads involves a clear trade-off between quality and cost.

* Minimum household size as a criterion for access to subsidized housing allows the decision maker to limit eligibility to high priority groups. In situations of severe housing shortage, shared accommodations and doubling up among close relatives is an accepted fact of life. The stage at which households become eligible for housing assistance is usually defined in accordance with prevailing conditions and national priorities either at marriage or upon the birth of a first child. Thus, single-person households are often excluded from access to subsidized housing. The model does not incorporate household composition, consequently groups of related or unrelated individuals sharing housing accommodations cannot be distinguished from families of the same size.

Define the desired policy options by entering the corresponding figures and pressing the "enter" key to register it and move down the list. Then press "enter" again to continue.

Screen 3 The model will display a matrix allocating housing typologies among eligible households. So as to minimize subsidy levels, this first allocation serves a dual purpose:

i.) To identify the least cost solution.
ii.) To flag deserving families excluded by the choice of public policies from access to subsidized housing. Since these households cannot afford to obtain housing on the open market, their situation could be critical particularly in the case of larger households.

Several iterations may be needed before a satisfactory set of policies is finally reached. Each iteration will require going through the sequence of screens in the module, returning to the main menu and reentering the Subsidy Module again. However, purely economic concerns may not necessarily yield optimal solutions from the social or design viewpoints. The model allows for editing of the final allocation in order to arrive at better social integration, greater variety of housing options, more flexible layouts and other project objectives.

To enter the Edit mode type "e". Move the cursor to the desired cells using the arrow keys. Enter the desired housing type in the corresponding cell by typing the prototype label H-1, M-2, L-3, etc... and pressing "enter" to register it. To quit the Edit mode type "q" then type "c" to continue.

Screen 4 displays the cost of the monthly housing subsidy required by each household size/income category having met eligibility criteria and received a housing allocation in accordance with the policies selected in Screen 2 and the distribution of housing types specified in screen 3. The total subsidy required to meet the needs of the target population is shown at the bottom of the screen.

Type "c" to return to the main menu.

4.3.5 The Budget Module

To enter the Budget Module type "b".

Screen 1 displays two vectors, listing the various housing options offered in the project. The first labelled identifies the number of units of each housing type allocated for subsidized housing in the previous module. The second, labelled total units, allows the user to enter the total number of units, subsidized and non-subsidized, of each type to be constructed in the project. The number of subsidized units of any one type should not exceed the total specified for that particular category.

Total counts are needed in order to compute the project's capital budget. To fill this vector, the user must separately allocate the households who do not require government assistance among the different housing types in the project. The allocation must be made with reference to the distribution of households by income and size shown on Screen 1 of the subsidy module.

The assignments can be guided by design considerations subject to socio-economic constraints or made on economic grounds subject to design constraints. The final choice is the user's.

To enter the totals type "e" to go to the Edit mode. Move the cursor to the desired cell using the arrow keys. Type in the desired number and press "enter" to register it and move down the list. To quit the Edit mode type "q" then type "c" to continue.

Screen 2 The model will display the project budget in two separate components:

i.) The capital budget balancing between revenue from sales of plots and buildings and expenditures on-site improvement and housing construction.

ii.) The subsidy budget comprising both the direct housing subsidy and the finance subsidy entailed by the housing credit formula. The annual subsidy is capitalized over the mortgage amortization period to give a good approximation of the magnitude of the subsidies entailed by the project.

Press "enter" to return to the main menu.

4.4 Saving Databases

To save a database created by entering new data or manipulating an existing data file, select the save function by typing "v". The system will prompt you to enter a file name. Type in a name of not more than 8 characters and press the "enter" key. The system will save the file and return to the main menu.

To quit the system type "q". The system will remind you to save your database before exiting.

Type "y" to exit to DOS.

5.0 Advanced Applications

Afford can analyze a single project phase in each run of the model. In the case of multi-stage developments, successive phases can be tested as a sequence of separate runs. Adjustments can be made to the data base in order to incorporate projected changes in key variables, exogeneous or internal to the project. The most common cases are discussed below.

5.1 Demand Module

5.1.1 Projected increase of the population.

The additional population to be accommodated during successive phases of a project should be treated as incremental to the residents housed in the preceding phase. Successive runs of the model should deal exclusively with the population increment which should be entered in Screen 2 as the total number of households on the site.

If the socio-economic characteristics of the phase 2 population are expected to differ from those of phase 1, Screen 1 can be edited to reflect these differences.

5.1.2 Projected increase in household incomes.

i) If the increase is in the form of a uniform inflation factor applied to all income groups, it should be incorporated through a proportional increase in the income adjustment factor.

ii) If differential adjustments are to be applied to the different income groups, then income brackets displayed on Screen 1 should be changed accordingly, using the Edit function.

iii) Rising incomes are reflected in increased expenditures on goods and services. To maintain internal consistency of the data base, minimum household expenditures listed in Screen 4 must also be adjusted upwards in accordance with projected inflation rates or the rise in the consumer price index.

It is not necessary that the growth of income and expenses match. This is hardly ever the case in reality. In some periods, incomes will rise faster than inflation; in others, inflation will erode income gains or overtake quasi-stagnant incomes. Recently, many developing countries with huge debt burdens and undergoing structural adjustment of their economy have experienced a decline of personal income in real terms.

5.2 Cost Module

5.2.1 The additional land area to be developed

Additional land developed during successive phases of the project should be entered in Screen 1 as the Cross-Residential area of the site to be developed in this phase.

The cost of land should be inflated in accordance with prevailing trends in the real estate market.

5.2.2 The treatment of off-site infrastructure reflects decisions taken in phase 1.

i) If off-site infrastructure works are undertaken when the project is first initiated and the cost is spread over the total site area, not just the area developed in phase 1, then unit costs for off-site infrastructure will remain constant in later phases.

ii) If the works are undertaken in the initial stage and the cost has to be absorbed by phase 1 development, then the unit cost for off-site infrastructure in later phases will be zero.

iii) If each development phase will require some off-site infrastructure works which will be borne by the land developed during this particular phase, then the unit cost of the works required divided by the land area improved.

Projects are often programmed in this manner in order to balance between start-up speed, population buildup and idle infrastructure capacity. Because of indivisibilities in utility systems, costs may be very low in one phase and quite high in the next.

5.2.3 Site development standards and housing typologies

The additional population to be housed in phase 2 onwards can be accommodated by new development by the densification of the previously developed area or by a combination of both.

i) New development

Development standards can be changed and new housing types introduced from one phase to the next. The costs of on-site infrastructure and buildings must be adjusted accordingly and inflated by the inflation factors applicable to light and heavy construction respectively.

ii) Densification of the existing fabric

Densification is a far more complex issue. Newly-added dwelling units are incremented to an already existing structure. In theory,

incremental growth should change the affordability of every unit within the structure since it would change their share of the plot area and the infrastructure costs borne by this land. In reality, it is impossible to implement changes retroactively. Each phase of the project focuses exclusively on the housing produced during that phase.

iii) If the on-site infrastructure provided in phase 1 is designed to carry the ultimate load, and its cost has already been absorbed by the housing developed in phase 1, then both the land and infrastructure should be set at zero for the additional units. The dwelling's share of the plot size should be entered since the newly introduced population will generate demand for additional community facilities.

iv) If project design calls for incremental upgrading of on-site infrastructure in parallel to the buildup of population on the site, then the cost of the upgrading works programmed in each phase must be borne by the units built during that phase.

- Land cost should be set at zero.
- The on-site infrastructure cost should reflect the cost of the upgrading works undertaken in the phase divided by the area of the densifying zone.
- The appropriate plot size share and dwelling size should be entered for each housing type undergoing densification. In any phase, from phase 2 onwards, entries should be zero for housing types which do not experience densification during that phase.
- Building costs should be inflated by the inflation factor applicable to light construction.
- The cost of community facilities should be adjusted by a factor proportional to the ratio of the population added in the phase under consideration divided by the population accommodated in phase 1.

5.3 Finance Module

5.3.1 The terms of credit finance can be changed from one phase to the next, tightened or eased.

5.3.2 The opportunity cost of capital must be changed accordingly to reflect underlying assumptions regarding economic trends, inflation and interest rates.

5.3.3 The overhead allowance factor should be maintained irrespective of whether the projected development during any phase is to occur through new construction or densification. Cross-subsidy factors can be altered from one phase to the next to reflect increasing or diminishing need for subsidization as project development proceeds.

5.4 Subsidy Module

Subsidization policy options can, and in most instances, should be revised in successive phases in order to better reflect the conditions prevailing during any one phase. Factors which should be taken into consideration include:

i) The balance between population in need of accommodation and available land under development. At any phase, the prevailing balance results from the project objectives and targets and the development strategies pursued in the previous phases. Unfavorable ratios indicate a need to consider lowering space consumption standards and tightening eligibility criteria. Conversely favorable ratios could allow broadening eligibility and upgrading space standards.

ii) The cost ceiling of subsidized units in relation to total housing production and development costs.

iii) Changes, if any, in the socio-economic structure of the population and, more specifically, in household sizes.

5.5 Budget module

The additional housing units, subsidized and non-subsidized, developed during successive phases of a project should be treated as incremental quanta. the increment for any particular phase should be distributed by housing type and entered in Screen 1 under the heading "total units in the cells" corresponding to the appropriate housing types.

The assignments must be made with reference to the distribution of the incremental population according to household income and size shown on Screen 3 of the demand module and their affordability shown on Screen 1 of the subsidy module. The user retains the flexibility needed to integrate design consideration in the final allocations.

As long as internal consistency is maintained throughout a phase, the workings of successive runs of the model to simulate subsequent phases are not disrupted.

Appendix

List of Variables

Demand Module

1) Percentage distribution of the population by income and household size.
2) Total number of households.
3) Income adjustment factor.
4) Minimum expenditures by household size
    i) food
    ii) clothing
    iii) transport
    iv) other.

Cost Module

1) Land cost per m^2 of project area.
2) Off-site infrastructure cost per m^2 of project area
3) Cross-residential area in m^2.
4) Percentage of GRA allocated to high density.
5) On-site infrastructure per m^2 for high density zone.
6) Construction costs per m^2 for high density building types.
7) Cost of community facilities per m^2 of high density zones.
8) Street area in m^2 within high density zones.
9) Service standard factor for community facilities in high density zone.
10) Housing typology in high density zones
    i) H-1 dwelling size and plot share area
    ii) H-2 dwelling size and plot share area
    iii) H-3 dwelling size and plot share area
    iv) H-4 dwelling size and plot share area
    v) H-5 dwelling size and plot share area.
11) Percentage of GRA allocated to medium density.
12) On-site infrastructure per m^2 for medium density zone.
13) Construction costs per m^2 for medium density building types.
14) Cost of community facilities per m^2 of medium density zones.
15) Street area in m^2 within medium density zones.
16) Service standard factor for community facilities in medium density zone.
17) Housing typology in medium density zones
    i) M-1 dwelling size and plot share area
    ii) M-2 dwelling size and plot share area
    iii) M-3 dwelling size and plot share area
    iv) M-4 dwelling size and plot share area
    v) M-5 dwelling size and plot share area.
18) Percentage of GRA allocated to low density.
19) On-site infrastructure per m^2 for low density zone.
20) Construction costs per m^2 for low density building types.
21) Cost of community facilities per m^2 of low density zones.
22) Street area in m^2 within low density zones.
23) Service standard factor for community facilities in low density zone.

24) Housing typology in low density zones
    i) L-1 dwelling size and plot share area
    ii) L-2 dwelling size and plot share area
    iii) L-3 dwelling size and plot share area
    iv) L-4 dwelling size and plot share area
    v) L-5 dwelling size and plot share area.

Finance Module

1) Down payment as percent of total purchase price.
2) Interest rate.
3) Mortgage period in years.
4) Overhead allowance.
5) Opportunity cost of capital.
6) Cross-subsidy factors for 15 housing types.

Subsidy Module

1) Maximum allowable cost of subsidized housing.
2) Minimum space consumption standards.
3) Minimum size of households eligible for housing subsidies.
4) Revised (final) allocation of subsidized housing units.

Budget Module

1) Number of units to be constructed for each of the 15 housing types.

Total number of variables: 42